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Title: An Experimental Translocation of the Eastern Timber Wolf

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Release Date: January 19, 2011 [EBook #35006]

Language: English

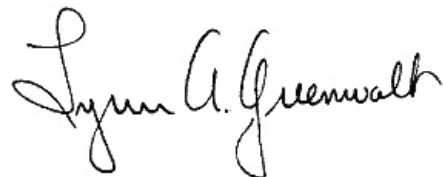
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*** START OF THE PROJECT GUTENBERG EBOOK AN EXPERIMENTAL TRANSLOCATION OF THE EASTERN TIMBER WOLF ***

FOREWORD

The Fish and Wildlife Service is proud to present this bulletin describing an experimental attempt to re-establish an endangered species in part of its native range. Two States, a Federal agency, a university, and two private conservation groups pooled their resources to make the project possible. This effort exemplifies the type of cooperation the Department of the Interior believes is imperative in beginning the gigantic task of trying to save and restore the threatened and endangered animals in this country today.

Our pride is bittersweet, however. The experiment was a complete success in providing the information sought: What might happen when a pack of wolves is transplanted to a new area where the native population has been all but exterminated by Man? It was the answer to this question that was disappointing. Nevertheless, experiments are for learning, no matter what the answers may be. We are convinced that the answers provided by this project will ultimately be most helpful in future attempts to restore endangered animals to parts of their native ranges where they can begin again on the road to recovery.



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AN EXPERIMENTAL TRANSLOCATION OF THE EASTERN TIMBER WOLF

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ABSTRACT

Two male and two female eastern timber wolves (*Canis lupus lycaon*), live-trapped in Minnesota were released in March 1974 near Huron Mountain in the Upper Peninsula of Michigan. Their movements were monitored by aerial radio-telemetry.

The wolves separated into a group of three and a single animal after release. The single, a young female, remained in the release region in an area of 346 square miles (896 km²). The pack of three moved generally westward for 13 days and then explored a 1,631 square-mile (4,224 km²) region but settled after 2 months in a 246 square-mile (637 km²) area about 55 miles (88 km) southwest of the release site. The adult female, which mated while captive prior to release, failed to whelp.

In early July, one male was killed by an automobile, and the other was shot. The remaining female from the pack then began to move over a much larger area again. On September 20th she was trapped by a coyote (*Canis latrans*) trapper and shot. Two months later the single female was killed by a deer (*Odocoileus virginianus*) hunter.

These results indicated that wolves can be transplanted to a new region, although they may not settle in the release area itself. The displacement of the translocated wolves in this experiment apparently caused an initial increase in their daily movements, and probably increased their vulnerability, at least during the first 2 months after release. The two females examined post-mortem were in good physical condition indicating that food supplies were adequate in Michigan.

Human-caused mortality was responsible for the failure of the wolves to establish themselves. Therefore recommendations for a more successful re-establishment effort include a stronger public-education campaign, removal of the coyote bounty, and release of a greater number of wolves.

INTRODUCTION

The eastern timber wolf (*Canis lupus lycaon*) originally occurred throughout the eastern United States and Canada but is now extinct in most of the United States. The only substantial population left inhabits northern Minnesota (Fig. 1). The estimated wolf population in the Superior National Forest of northeastern Minnesota in winter 1972-73 was about 390 (Mech 1973), and a tentative population estimate for the entire state is 500 to 1,000 (Mech and Rausch 1975). A well known population of about 15 to 30 wolves is also found in Isle Royale National Park, Lake Superior, Michigan (Mech 1966; Wolfe and Allen 1973; Peterson 1974).

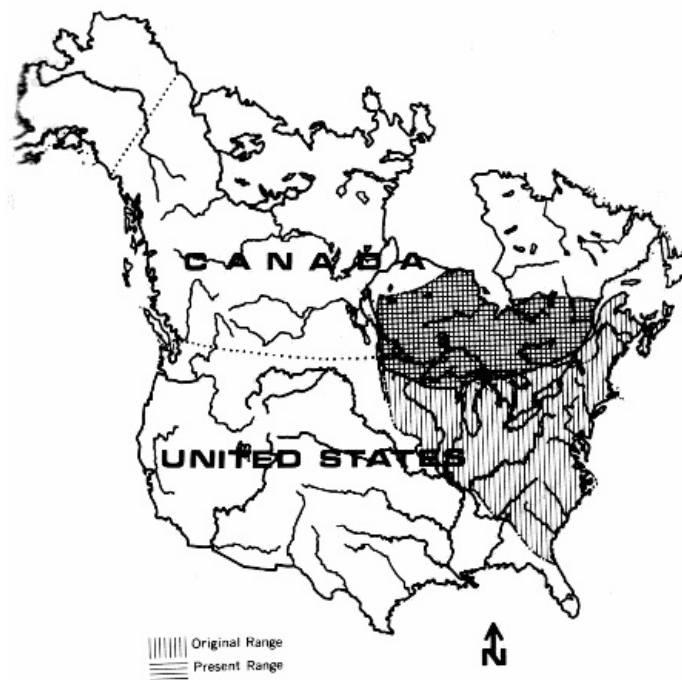


Fig. 1—Original and present range of the Eastern Timber Wolf

In the Upper Peninsula of Michigan, Hendrickson et al. (1975) estimated the wolf population in 1973 at 6 to 10 animals, existing in three scattered areas: Iron County, Northern Marquette County, and Chippewa and Mackinac Counties (Fig. 2). Lone wolves made up 90 per cent of verified wolf observations there in recent years, and no more than two animals have been found together in at least the past 13 years.

Hendrickson et al. (1975) postulated that the current low wolf population is maintained through possible sporadic breeding and immigration from Ontario and Minnesota (via Wisconsin), but is suppressed by illegal shooting and losses incidental to coyote (*Canis latrans*) bounty trapping.

The eastern timber wolf was classed as an endangered species in the conterminous United States in 1967 under the Endangered Species Act of 1966. There then followed widespread

national and international concern and support for preserving natural wolf populations. Substantial scientific and ethical arguments exist for preventing the extinction of a species or subspecies of any plant or animal. In addition, the presence of the wolf adds immeasurably to a wilderness experience; its esthetic value is incalculable.

Thus in 1970, D. W. Douglass, Chief of the Wildlife Division, Michigan Department of Natural Resources, suggested that restoration of a viable population of wolves in Michigan would be desirable, especially if such efforts could be supported by private organizations. In 1973 the Huron Mountain Wildlife Foundation and the National Audubon Society offered financial support, and we undertook this pilot project to obtain information necessary for a full-scale restoration effort.

The objectives of the research project were to determine whether (1) wild wolves could be moved to a new location, (2) such translocated wolves could remain in the new area, (3) they could learn to find and procure enough food in the new area, (4) they could tolerate and survive human activities, and (5) they would breed and help to re-establish a new population in Upper Michigan.

As background we had the results of three previous attempts to transplant wolves to new areas. In 1952, one male and three female zoo wolves were released on Isle Royale (Mech 1966). They were attracted to humans, became nuisances, and had to be disposed of. Two were shot, one was captured and returned to the mainland, and the male escaped; his fate is unknown.

The second transplant effort took place on uninhabited, 36-square-mile (92 km²) Coronation Island in southeastern Alaska (Merriam 1964; Mech 1970). In 1960, two male and two female, 19-month-old captive wolves, were released there. They learned to prey on black-tailed deer (*Odocoileus hemionus columbianus*), and multiplied to about 11 members by 1964.

In the third case, two male and three female laboratory wolves from Barrow, Alaska were released near Umiat in August 1972, 175 miles (282 km) southeast of Barrow (Henshaw and Stephenson 1974). Eventually, all moved toward centers of human habitation and three were shot within 7 months. A fourth returned to the pens where she was reared, and was recaptured, while the fate of the fifth wolf remains unknown. Three of the five had taken the correct homing direction.

Because results of the earlier attempts at translocating wolves suggested that pen-reared wolves did not fare well in the wild, we decided to use wild wolves that were accustomed to fending for themselves and avoiding people. They would have to be released in the most inaccessible area we could find and encouraged to stay there. To maximize their chances of breeding, we would have to try to obtain animals with already established social ties, that is, members of the same pack. Approval was obtained from the Minnesota Department of Natural Resources to live-trap up to five wolves in Minnesota, and a permit was granted by the Michigan Department of Natural Resources to release up to five in Upper Michigan.

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This bulletin describes the results of the experimental translocation.

THE STUDY AREA

The area selected for the release of the translocated wolves was the Huron Mountain area (Fig. 2) in northern Marquette County in the Upper Peninsula of Michigan (47° N Latitude; 88° W Longitude). This is one of the largest roadless tracts in Michigan, and has one of the lowest year-around densities of resident humans. Much of the area is owned by the Huron Mountain Club, on which accessibility is restricted.

The Upper Peninsula is 16,491 square miles (42,693 km²) in area, bounded by Lake Superior to the north, and by Lakes Huron and Michigan to the east and south. The Wisconsin border along the western portion of the Upper Peninsula forms no distinctive ecological boundary. The Upper Peninsula is in the Canadian biotic province (Dice 1952), characterized by a northern hardwoods climax, interspersed with spruce-fir and pine subclimaxes. The northwestern portion of the Upper Peninsula, including Marquette, Baraga, Houghton, Ontonagon, and Iron Counties, contains rugged highlands and rock outcroppings which rise to elevations approaching 2,000 feet (610 m) in several locations.

Fig. 2.—Range of the wolf in Upper Michigan in 1973, and the release point (from Hendrickson et al. 1975)

The human population of the Upper Peninsula is 303,342, with a rural density of about 9.0 persons per square mile or 3.5 persons per square kilometer (Table 1). The population of the Upper Peninsula has remained at about 300,000 for the past 50 years, and the rural human populations of local areas have generally declined or remained stable. During those 50 years, the wolf population has declined from several hundred animals to near extinction, with the population estimated by Hendrickson et al. (1975) at 6 to 10 remaining wolves. These authors concluded that the bounty on wolves between 1935 and 1960 was largely responsible for the demise of the species in the Upper Peninsula. The bounty was removed in 1960, after only one wolf was taken in 1959. Legal protection was granted by Michigan in 1965. The Endangered Species Act of 1973 added federal protection in 1974.

Location	Area in Square Miles (Square Kilometers)	Percent Urban[3]	Rural Population	Rural[4] Population Density Per Square Mile (Square Kilometer)
Ontario[5]	412,582 (1,068,125)	80.4	1,364,33	3.3 (1.27)
Northern[6] Minnesota	12,627 (32,690)	68.0	81,246	6.4 (2.5)
Upper Michigan[7]	16,491 (42,693)	51.4	147,841	9.0 (3.5)
Iron and Oneida Co. [8] Wisconsin	1,859 (4,812)	26.0	22,899	12.3 (4.7)

[3] Towns or cities of more than 2,500 people

[4] Including towns with a population less than 2,500

[5] 1966 Census, 1970-71 Canada Yearbook

[6] Cook, Koochiching, Lake and St. Louis Counties

[7] All 15 Upper Peninsula counties

[8] Last described wolf range in Wisconsin (Thompson 1952)

The white-tailed deer (*Odocoileus virginianus*) would be the major prey for wolves in Michigan, and there appear to be sufficient numbers to support wolves. The Michigan Department of Natural Resources pellet count estimates for the spring deer population in the Upper Peninsula in 1973 was $10 \pm 21.9\%$ deer per square mile ($3.9 \pm 21.9\%$ per km²). Deer densities of 10 to 15 per square mile (3.9 to 5.8 per km²) supported wolf densities of one wolf per 10 square miles (26 km²) in Algonquin Provincial Park, Ontario (Pimlott 1967).

The population of deer wintering on the 14 square-mile (36 km²) Huron Mountain deer yard in winter 1973-74 was estimated at $73.3 \pm 49.5\%$ deer per square mile ($28.3 \pm 49.5\%$ deer per km²) by the pellet count method (Laundre 1975). Thus total wintering population on the Huron Mountain Club, the wolf release area, would be about 1,000 deer.

The utilization of available browse by deer in the Huron Mountain deer yard reached 95% by March 8, 1969 and 92% by March 5, 1970 (Westover 1971). The minimum winter deer loss (actual number found) in 1969 was 40 animals, of which at least 12 had starved, and it was estimated that perhaps up to 33% of the deer starved in the Huron Mountain Yard in 1968-69 (Westover 1971). The Huron Mountain yard continues to be overbrowsed, with high deer mortality expected in severe winters. Many other northern deer yards of the Upper Peninsula are also overbrowsed and are dwindling in area. Thus we expected that numbers of vulnerable deer (Pimlott et al. 1969; Mech and Frenzel 1971) would be available to wolves.

Beavers (*Castor canadensis*) are an important food source for wolves in many areas during summer (Mech 1970), and they are common throughout the Upper Peninsula. The beaver population on the 26 square-mile (67 km²) Huron Mountain Club was estimated at 46.9, or about 1.9 beavers per square mile (0.7 per km²) (Laundre 1975). Moose (*Alces alces*) are rare on mainland Michigan.

METHODS

The general procedure for this study was to attempt to capture an intact pack of wolves in Minnesota, fit each animal with a radio-collar (Cochran & Lord 1963), release them in northern Michigan, and follow their fate through aerial and ground radio-tracking (Kolenosky and Johnston 1967).

A pack was selected from an area near Ray, Minnesota (Fig. 3), south of International Falls (48° N Latitude, 93° W Longitude), where wolf hunting and trapping were legal. Two male and two female wolves were captured by professional trapper Robert Himes, under contract for the project, between December 24, 1973 and January 21, 1974 (Table 2). Three of the wolves were trapped (Fig. 4) in No. 4 or 14 steel traps (Mech 1974), and one (No. 13) was live-snared (Nellis 1968). If these animals had not been solicited for this study, they would have been killed and their pelts sold, as part of the trapper's livelihood, before the Endangered Species Act of 1973 took effect.

At capture each wolf was immobilized with a combination of phencyclidine hydrochloride (Sernylan) and promazine hydrochloride (Sparine) intramuscularly (Mech 1974), with dosage recommendations from Seal et al. (1970). They were then carried out of the woods (Fig. 5), held in pens in Minnesota, and fed road-killed white-tailed deer, supplemented with beef

[Fig. 3.—Capture and release points of the translocated wolves](#)

scraps.



Fig. 4.—Wolf caught in trap (Photo by Don Breneman)



Fig. 5.—The captured wolves were drugged and carried to an enclosure in Minnesota (USFWS Photo by L. David Mech)

There is no certain way of ascertaining that wolves are related or that they belong to the same pack. Thus to maximize chances that members of the same pack would be captured, the trapper set traps where he suspected only one pack ranged. To try to determine whether the individual wolves he caught were socially related, we instructed the trapper to hold the wolves in individual pens until we could observe their introductions to each other. Wolves No. 10 and 11 were placed together on January 23, 1974, and No. 13 and 14 were released into the pen with No. 10 and 11 on February 4.



Fig. 6.—Before being transported to Michigan, each wolf was weighed (USFWS Photo by Don Reilly)

Table 2. Background information on the translocated wolves

Wolf Number	10	11	12	13
Sex	F	F	M	M
Estimated age ^[9]	1-2 years	6-7 years	2-3 years	2-3 years
Capture date	12-24-73	1-5-74	1-19-74	1-21-74
Capture Method	Trapped	Trapped	Trapped	Live-snared
Capture foot	Left front	Right front	Right front	
Capture-related damage	Two nails lost	Three nails lost	None	None
Weight at capture	55 lb. (24.9 kg)	65 lb. (29.4 kg)	74 lb. (33.5 kg)	75 lb. (33.9 kg)
Weight, March 5	46 lb. (20.8 kg)	58 lb. (26.3 kg)	66 lb. (29.9 kg)	60 lb. (27.2 kg)
% weight loss	16%	11%	11%	20%
Canine length, upper	0.83" (21 mm)	0.25-0.50" (6-13 mm)	0.93" (24 mm)	0.87" (22 mm)
Canine length, lower	0.75" (19 mm)	very worn	0.82" (21 mm)	0.85" (21 mm)
Testes ^[10]	—	—	0.5 × 1.0" (13×25 mm)	0.5 × 0.75" (13×19 mm)
Teats	Tiny, not apparent	Dark, evident	—	—

[9] Gross subjective estimates based on tooth wear

[10] Estimated

On March 5, 1974, the wolves were again immobilized for pre-release processing in Minnesota. An initial dose, and several supplemental doses of phencyclidine and promazine were administered intramuscularly and intraperitoneally between 9:00 a.m. and 4:30 p.m. CDT. The wolves were restrained with muzzles and their legs were bound together during processing and transport. Two of the wolves were blindfolded because they were too active otherwise.

The wolves were ear-tagged with both Minnesota and Michigan Department of Natural Resources tags, and weights and body measurements were taken (Fig. 6, 7). Their teeth were inspected and canines were measured to try to obtain an indication of age. Each animal was fitted with a radio transmitter (AVM Instrument Co., Champaign, Illinois^[11]) molded into an acrylic collar (Mech, 1974).



Fig. 7.—Standard body measurements were also taken (USFWS Photo by Don Reilly)

Each wolf was injected with 1,200,000 units of Bicillin (Wyeth), 2 cc of distemper-hepatitus-leptospirosis vaccine (BioCeutic Laboratories D-Vac HL), 0.5 cc of vitamins A, D, E, (Hoffman-LaRoche^[11] Injacom 100), 1 cc of vitamin C-fortified vitamin B complex (Eli-Lilly, Betalin Complex FC), and 2 cc anti rabies vaccine (Fromms Raboid). These injections (Fig. 8) were given to insure that the wolves would be as healthy as possible upon release, and would not contract or introduce diseases in the release area.

[11] *Mention of trade names does not constitute endorsement by the U. S. Government.*

Some 30 to 60 cc of blood were drawn from each wolf for analysis of its physical condition (Seal et al. 1975).

The processing of the wolves took from 8:45 a.m. to 2:00 p.m. CDT on March 5, 1974. The animals were then transported by truck to International Falls, loaded on an airplane (Fig. 9), and flown for 2 hours (Fig. 10) to the Marquette County Airport, Michigan. They were turned on different sides each half hour while drugged during their processing and transport to prevent lung congestion. At the Marquette Airport they were transferred by van to a 25 foot by 25 foot by 12 foot (7.6 m × 7.6 m × 3.7 m) holding pen on the Huron Mountain Club property 35 miles (56.3 km) northwest of Marquette.



Fig. 8.—Various vitamins and vaccines were administered to each wolf to insure their health and freedom from common canine diseases (USFWS Photo by Don Reilly)

The wolves were released individually into the holding pen while each was still partly under sedation (Fig. 11). The transmitting frequency of each wolf's collar was rechecked on the receiver as each wolf was released into the pen (Fig. 12). All wolves were in the pen by 10:00 p.m. EDT, and were held there until March 12.

Four road-killed deer carcasses, provided by the Michigan Department of Natural Resources, had been placed inside the pen for food (Fig. 13), and a tub of drinking water was provided. Carcasses of five road-killed deer and a black bear (*Ursus americanus*) were placed within a half-mile (0.8 km) of the release pen as food for the wolves after their release.

We had scheduled the release for mid-March for several reasons which we felt would maximize chances for success. Deer are concentrated then in the Huron Mountain area and vulnerable to predation. Pregnancy and subsequent whelping of the alpha female might increase her attachment to the new area. Furthermore, the snow is usually deepest then and hinders travel. However, a few days before the release, a freak rainstorm had settled the snow, and cold temperatures had frozen it so hard that animals could walk readily on top, making travel conditions excellent.



Fig. 9.—The anesthetized wolves were placed aboard an aircraft in International Falls, Minnesota (USFWS Photo by Don Reilly)



Fig. 10.—The wolves were kept lightly drugged during the flight to Michigan (USFWS Photo by L. David Mech)



Fig. 11.—In the Huron Mountain area of Upper Michigan the wolves were taken to another holding pen (Photo by Don Pavloski)



Fig. 12.—Biologists checked the signal from each radio-collared before the wolves were released into the holding pen (Photo by Don Pavloski)

An observation shack 120 feet (36.6 m) from the pen was used to determine the activities and interactions of the four wolves. Weise spent three nights in the shack and also observed the wolves each day of the one-week penned period, for a total of 20 hours of observation (Fig. 14).

During preliminary air and ground checks of radio equipment, we discovered that Wolf No. 10 had a defective collar. Thus on March 12, we subdued her with a choker, restrained her with ropes, replaced her collar and released her just after sunset. We then opened the pen, and let the other wolves loose.

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Fig. 13.—While in captivity, the wolves were fed primarily on road-killed deer (Photo by Don Pavloski)

The subsequent locations of the wolves were then checked intermittently through aerial radio-tracking (Mech 1974), with a receiver and antenna from the AVM Instrument Co., Champaign, Illinois, used in a Cessna 172 and a Piper Colt. We made two flights each day for the first 2 days after release, one each day when weather permitted, until April 20, three per week in May, approximately two per week from June through September, and three per week in October and

November. A total of 194 hours were flown, 80 per cent by Weise, and the remainder by Hook. Aerial locations were usually recorded to the nearest 40 acres (16 ha.).

We also tracked the wolves from the ground whenever interesting or significant activities were observed during flights or were reported by ground observers. Carcasses of prey animals were investigated from the ground after consumption was complete and the wolves had left. Deer eaten by the wolves were considered killed by them if the ground check revealed fresh blood or flesh, or signs of a struggle. Scats were collected along the tracks of the wolves in the snow whenever possible.

When radio signals were received from the same location for unusually long periods, ground checks were made to determine the cause.

Attempts were made to verify all sightings and track records reported by local citizens, by comparing them with the aerially-determined locations.

RESULTS

Social Structure of the Translocated Wolves

Wolves No. 11, 12, and 13 were captured in Minnesota within a mile (1.6 km) of each other, and No. 11 and 12 were taken in the same trap set 12 days apart; Wolf No. 10 was caught approximately 7.5 miles (12.1 km) southeast of the others (Table 2). All were judged to be thin but in good condition.

Females No. 10 and 11 were introduced into the same pen on January 23. No. 11 was reluctant to enter the pen containing No. 10 while several observers were around, but entered within 15 minutes after all but one had left. No. 11 went directly to No. 10 which was lying in a corner as she usually did, and pawed the fence at No. 10's back. When the pawing became more vigorous, No. 10 snapped at No. 11, moving only her head and neck. No. 11 then turned directly to No. 10, sniffed the top of her head and mane, and lay down beside No. 10 with her nose still in No. 10's mane. No. 10 remained still throughout the whole process. The trapper reported that later No. 11 licked the face of No. 10. Sniffing and licking anteriorly are usually signs of intimacy between wolves (Schenkel 1947).

The two male wolves (No. 12 and No. 13) were allowed into the pen with the two females on February 4. No. 13 remained in the original adjoining pen and did not move in with the females immediately, but No. 12 did. There were no signs of aggression among any of the four wolves. No. 11, 12, and 13 moved freely around the pen while in Minnesota, but No. 10 most often lay in one corner by herself.

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Trapper Himes first observed vaginal bleeding in female 11 on February 7. He observed Wolves 11 and 12 mating (with normal coupling) on February 12 and 16.

No unusual aggressive or agonistic social interactions of consequence were observed among the wolves while penned in Michigan, from March 5 to 12. Animals 11, 12 and 13 would lie down and feed together in various combinations. No. 10 was less active than the others and often stayed inside a shelter box within the enclosure, but would come out and mix with the other wolves for brief periods when humans were not in evidence. Her actions were indicative of a low ranking, immature, distressed, or alien animal.

Male No. 12 was the only wolf that would stare directly at a person approaching the pen. He was bolder and more direct in his actions than any of the other animals. This is the wolf that mated with adult female No. 11 while penned in Minnesota, and thus can be considered the "alpha male," or pack leader.

When approached by humans, all the wolves would urinate and defecate; No. 11 and 12 would pace, No. 10 (when out of the shelter box) and No. 13 would lie in the far corner of the pen and remain motionless (Fig. 14). No. 11 limped on her right front foot throughout the penned period, but this limp did not appear to have a significant effect on her activities or movements.

Blood samples taken on March 5, 1974 were analyzed and interpreted by Dr. U. S. Seal of the Veterans Administration Hospital in Minneapolis. The assays performed included hematology, 16 blood chemistries, thyroxine, and cortisol (Seal et al., 1975), plus estrogen and progesterone. According to Seal (personal communication), all blood values for wolves No. 10, 12, and 13 were similar and indicative of good health and minimal stress, as indicated by very low levels of the enzymes LDH, CPK, and SGOT. Such levels are typical of animals in a state of good nutrition that have been in captivity for several weeks and have accepted their captive circumstances. The MCV's were normal, indicating no vitamin deficiency, and the MCHC showed full hemoglobin content in the red cells, indicating no lack of iron. The white blood cell counts were much lower than usually seen in newly trapped wolves. All the remaining chemistry values from these three wolves were in the normal range for the season.



Fig. 14.—The Minnesota wolves in their Michigan pen (Photo by Tom Weise)

Wolf No. 11, however, differed in that she had a much higher hemoglobin level, higher blood glucose and white cell count, and higher levels of LDH, CPK, and SGOT, indicating that she was significantly stressed. This is corroborated by a low thyroxine level of 0.6 micrograms percent, which is hypothyroid for wolves.

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The fibrinogen levels of all four animals were normal, indicating that there was no acute or chronic inflammation in progress.

The wolves ate well in captivity but still lost from 11% to 20% of their capture weight (Table 2). Himes estimated that they consumed an average of 8 lb. (3.6 kg) of food per wolf per day, while penned in Minnesota. In Michigan the wolves consumed about a deer and a half, or an estimated 5.5 lb. (2.5 kg) per wolf per day. These estimates fall within the range of food consumption figures estimated for wolves in the wild (Mech and Frenzel 1971). After the wolves began feeding on the first carcass, they completely consumed it before starting a second one, even though four carcasses were available; they ate nothing from the other two carcasses.

We released the wolves at dusk on March 12, 1974. Having just restrained Wolf No. 10 without drugs, to replace her collar, we untied her and let her free; she bounded off northwestward. We then opened the pen, and No. 12, whom we had judged to be the alpha male, left in less than 5 minutes and trotted off steadily toward the west-southwest. The remaining two animals paced around the pen for about 5 minutes and then lay down. Because we felt that they might become too widely separated from the others, three of us approached the pen opposite the door to encourage the wolves to find the open gate. Five minutes later No. 13 left the pen running southwestward, and No. 11 left less than 5 minutes later. Upon exiting, No. 11 appeared to smell the track of No. 12 and slowly trotted in his direction.

Aerial Tracking

Our success in locating the translocated wolves by aerial radio-tracking was 95% (Table 3), similar to that of Mech and Frenzel (1971) working with wolves in their native range in Minnesota.

During the part of the study in which extensive snow cover was present (March 13 to April 20) wolves No. 11, 12, and 13 were observed 14 times from the aircraft. The first time they were seen, near Laws Lake, they appeared alarmed and moved into heavy cover. The next day, however, and on all subsequent observations, the aircraft appeared to have little effect on their behavior, although they sometimes looked up at it. No. 10 was seen only once by a passenger in the tracking aircraft, and she immediately hid from view. It seems likely that she avoided the aircraft. After the snow melted and leaves appeared, we no longer saw the wolves.

The activities of the three wolves during the 14 aerial observations were as follows: traveling 4 (Fig. 15), feeding and scavenging 5 (Fig. 16), resting 4, and sleeping 1.

Table 3. Success in locating wolves by aerial tracking

Wolf Number	10	11	12	13
Number of tracking attempts	113	65	59	67
Number of times located	105	62	59	61
Percent located	93%	95%	100%	91%
Number of times observed	1	14(Pack)		
Last date tracked	Nov. 17	Sept. 19	July 10	July 27



Fig. 15.—The wolves often used woods roads for traveling (Photo by James Havemen)



Fig. 16.—The released wolves were sometimes observed from the aircraft feeding on deer they had killed (Photo by Richard P. Smith)

Movements of the Translocated Wolves

Wolf No. 10 never joined any of the other radioed wolves after their release, whereas the others generally remained as a pack. Thus the movements of the pack will be described separately from those of lone wolf No. 10.

Four phases were seen in the movements of the pack: (1) Post-Release Phase, March 12 to 14; (2) Directional Movement Phase, March 15 to 24; (3) Exploratory Phase, March 25 to May 7, and (4) Settled Phase, May 7 to July 6.

Post-Release Phase

This first phase of the wolves' movements, including the first 2 days after release, seemed to be characterized by confusion and indecision. On March 13, the morning after the release, the three wolves were separated, but all remained within 2.0 miles (3.2 km) south to west of the release site, the general direction in which they had headed upon release (Fig. 17). No. 11 and 13 were about a half-mile (0.8 km) apart in the morning, and by late afternoon, No. 13 apparently had joined No. 11. No. 12 remained about 2 miles away from the others all day, although he did move about a half-mile during the day. By the 14th, No. 11 and 13 had moved 2 miles southwestward, but were separated by a half-mile; No. 12 had moved only a half-mile west.

Directional Movement Phase

During this phase, all three wolves left the immediate vicinity of the release point and headed southwestward. Early in this phase, wolves No. 11 and 13 rejoined (by March 15) and traveled 9 miles (14.5 km) west-southwest of their previous day's location, while No. 12 took a more northerly route. Nevertheless, by March 19, No. 12 had joined the other two wolves near Skanee, some 14 miles (22.5 km) west-southwest of the release point (Fig. 17). For the next several weeks these wolves all remained together and travelled a straight-line distance of about 40 miles (64.1 km) to a point just north of Prickett Dam about 11 miles (17.6 km) west-southwest of L'Anse, arriving there on March 24 (Fig. 17).

Exploratory Phase

In the Exploratory Phase of their movements, from March 25 to May 7, wolves No. 11, 12, and 13 covered a 1,631-square-mile (4,224 km²) area from the town of Atlantic Mine on the Keweenaw Peninsula to the north to a point about 64 miles (103.0 km) south, near Gibbs City (Fig. 18). In the opposite dimension, they ranged from Keweenaw Bay on the east to 9 miles (14.5 km) south of Ontonagon, 42 miles (67.6 km) west of there. This phase was characterized by long movements, considerable zigzagging, and revisiting of certain general regions such as the base of the Keweenaw Peninsula and areas east and north of Kenton (Fig. 18).

An interesting social change also occurred during this phase: No. 13 split from the pack sometime after April 26 when the pack had reached its westernmost location, south of Ontonagon. Whereas No. 11 and 12 returned east-northeastward toward Otter Lake, where they had been in late March, No. 13 headed west-northwestward to the Porcupine Mountains, 18 miles (30.0 km) west of where the pack had last been located together (Fig. 18). Thus on May 2, Wolf No. 13 was 51 miles (82.0 km) west of No. 11 and No. 12. Nevertheless, 5 days later all the wolves were found near Gibbs City, 62 miles (99.8 km) southwest of the Porcupine Mountains, and 45 miles (72.4 km) south of Otter Lake; No. 13 was only 6 miles (9.7 km) from his packmates. The next time an attempt could be made to locate the wolves, on May 16, they had reunited.

Settled Phase

This last phase of the wolves' movements includes the period when the animals had settled into an area similar to the size of home ranges reported for other wolves in the Great Lakes Region (Mech 1970). From May 7 to July 6, this pack lived in a 246-square mile (637 km²) area with its center north of Gibbs City (Fig. 18). On July 10, wolf No. 12 was found dead. Presumably he had died by July 6, for he had not moved since then.

Wolf No. 13 had again split from his associates between June 14 and 19 and begun to travel alone. On July 20, his remains were discovered 24 miles (38.6 km) southeast of where the pack had settled. These deaths will be discussed in detail later.

Movements of the Remaining Pack Member

After the death of her mate (No. 12), Wolf No. 11 left the 246-square-mile area in which the pack had settled (Fig. 19). By July 15, she had traveled 28 miles (45.0 km) northwest of this area and by the 20th, was back by Otter Lake, 40 miles (64.4 km) north. She returned south of Gibbs City on July 27, and was found about 3 miles (4.8 km) north of the Wisconsin border on August 2, near Lac Vieux Desert about a half mile (0.8 km) north of the Wisconsin border on August 6, and near Bruce Crossing on August 9.

On August 13, Wolf No. 11 was located 1½ miles (2.4 km) southeast of Ewen on the western edge of her previous locations. She was not located again until August 28. By then she had moved a straight-line distance of almost 60 miles (96.5 km) to an area in Marquette County just south of Squaw Lake, in the Witch Lake area. In doing so, she probably had passed through the area previously explored just north of the Iron County region where the pack had spent so much of its time. These widespread movements are characteristic of lone wolves even in their native range (Mech and Frenzel 1971).

No. 11 was still in the Witch Lake area on September 2. Due to poor flying conditions we did not locate her again until September 19. At that time she was on the Floodwood Plains a quarter mile (0.4 km) north of the Floodwood Lakes. She was caught in a coyote trap during the night of September 19 and shot about 10 a.m. on September 20.

Fig. 17.—Movements during the Post-release and Directional Movement Phases of Wolves No. 11, 12, and 13

[Pg 12]

Movements of Wolf No. 10

The movements of female wolf No. 10 during the post-release phase were markedly different from those of the pack. In fact, this wolf apparently skipped the relatively sedentary post-release phase of movements that the pack displayed, and immediately dispersed (Fig. 20).

By the morning after release, No. 10 was 10 miles (16.0 km) southeast of the release point and by late afternoon was an additional 5.5 miles (8.8 km) southeast (March 13). On the night of March 15 this wolf crossed four-lane Highway 41, and on the 16th was found 1¼ miles (2.0 km) south of the Marquette County Airport, approximately 32 miles (51.5 km) from the release site; she had traveled a minimum of 36 miles (57.9 km) to get there. However by March 20 she had returned to within 4 miles (6.4 km) of the release point, and by the 24th was within a quarter mile of the site.

The other three wolves had already dispersed westward and were near Prickett Dam, some 40 miles (64.0 km) away. It is not known whether No. 10 tried to locate them. Her locations indicate that she did not, although she may not have been able to find or follow their route. From April 2

to 15, No. 10 made a second exploration southward, again returning to the Huron Mountain area. She also made a third such trip on June 14 to 22, even crossing Highway 41 again.

[Pg 13]

From the time of release until the first week in September, there seemed to be a pattern to the movements of Wolf No. 10. She made nine trips of about 40 miles (64.0 km) each, starting near Huron Mountain, extending southeasterly about 20 miles (32.0 km), and then returning northwesterly to the Huron Mountain area (Fig. 20).

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Fig. 18.—Exploratory and Settled Phases in the movements of Wolves No. 11, 12, and 13

Fig. 19.—Movements of No. 11 after the death of No. 12 and 13

Fig. 20.—Movements of Wolf No. 10

During March, April, and the first week of May Wolf No. 10 made three of these trips roughly paralleling the Lake Superior shore, and she remained in the Huron Mountain area for several days between trips. From late May until mid-July she made four such trips but did not remain long anywhere. During that time she gradually moved westerly to near the Dead River Basin. In late July she made another trip to the Dead River Basin area after a stay near the Big Bay dump. These trips enlarged No. 10's range considerably.

[Pg 15]

Early in July, Wolf No. 10 moved almost directly south from the Huron Mountain area to the Silver Lake area, again expanding her range to the west. From September 5 until October 10 she remained in the Silver Lake area, and there was no apparent pattern to her movements then. After the wolf was located on September 15 near a bait that bear hunters had put out on the west edge of the Mulligan Plains, a ground check was made. No evidence of the wolf was found at the bear bait, consisting mostly of fish, and no signal was heard there. A signal was picked up in the southwest corner of the Mulligan Plains, and the wolf was flushed from her bed about 80 yards (75 m) away.

On October 10, this wolf began a westward move, and on October 22 she was found south of Herman, 25 miles (40.2 km) west of Silver Lake. On October 24 she was located 6.5 miles (10.4 km) to the northeast, near Dirkman Lake. By October 26 she had moved 12 miles (19.3 km) southeast to within a mile of the town of Michigamme. From there she gradually moved northeastward. She was shot near Van Riper Lake during deer hunting season, probably on the morning of November 16.

During the westward move, this wolf had increased the size of her range by 87 square miles (222.7 km²), about a 30% increase. She seemed to be heading back to the Silver Lake area when she was killed.

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Feeding Habits

What little information we could obtain on the wolves' feeding habits indicated considerable variation (Table 4).

In the Skanee area, which the pack of three first visited after leaving the release area, deer were abundant, and 7 to 10 were seen within a quarter mile (0.4 km) of the pack on March 20. It is possible that the wolves killed a deer there, for they remained in the area for a few days. They did scavenge deer feet and head remains on the 22nd at Laws Lake, 12 miles (19.3 km) southwest of Skanee. Deer were also sighted within a quarter mile of the wolves on March 25, April 15, April 16, May 7, June 8, and June 14.

The first confirmed deer kill was made east of Otter Lake about April 1. The deer was a 4½-year-old doe with a partly healed broken left front leg (radius) and fat-depleted bone marrow (1%); a bullet was found in the skin of the right front leg.

The pack also fed on a discarded deer carcass near Nisula, and then killed a 5½-year-old doe near Kenton on April 15 (Fig. 21); this animal also had bone marrow with a low fat content (6%).

The next day, lone Wolf No. 10, back in the Huron Mountain area, killed a 4-5-year-old doe with fat-depleted marrow (5.6%).

No doubt not all of the deer killed or fed upon by the translocated wolves were found, even when snow was present. However, it is clear from the observations we did make, and from the fact that all 26 scats we analyzed from this pack contained deer hair, that the wolves did adapt to killing deer in their new environment and that it was their primary food.

Near Atlantic Mine the wolves scavenged on garbage from loggers, and then near Otter Lake they spent several days also feeding on garbage. A discarded cow (*Bos taurus*) head was scavenged, and at least one red-backed vole (*Clethrionomys gapperi*) was consumed. Lone Wolf No. 10 was found near the Big Bay dump nine times, or 29% of the times she was located during tourist season (May through August).

Table 4. Analysis of scats collected from released wolves

Date	No. Scats	Wolf No.	Location and items found
March 22	5	Pack	Laws Lake, deer hair

March 29	1	Pack	Otter Lake area, deer hair, red-backed vole hair, grass, refuse (including coffee grounds)
April 3	2	Pack	Otter Lake deer kill, scats soft and dark, some deer hair
April 8	3	Pack	Nisula, deer hair
April 17	5	Pack	Kenton deer kill, scats soft and dark, deer hair
June 28	3	Pack	Gibbs city area, summer and winter deer hair
Total (Pack)	19		
March 27	2	No. 10	Conway Lake, deer hair
April 18	2	No. 10	Pine Lake, deer hair
June 1	1	No. 10	Huron Mountain Club, fawn deer hair and hoof
Total No. 10	5		
Sept. 20	1	No. 11	Floodwood Plains 3.1 miles (5.0 km) south of Witch Lake, deer hair, and ruffed grouse (<i>Bonasa umbellus</i>) bones and nails
July 1	1	No. 12	Collected from under dead No. 12, 1.9 miles (3.0 km) north of Amasa, deer hair
Total	26	All	

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Fig. 21.—Each deer killed by the translocated wolves was examined from the ground (Photo by Richard P. Smith)

The three wolves were located near beaver lodges or dams on April 10, April 15, May 7, June 8, and June 12. No beavers were known to have been killed by them, however, and no beaver remains were found in their scats (Table 4).

Citizen Sightings

The wolves were seen by many citizens early after their release (Table 5 and 6), no doubt because of the wolves' confusion, their extensive movements, and their lack of familiarity with the region. They often traveled near populated areas and probably moved more during the day than they would have in their native territory. They were known to have made 14 daytime moves (from citizen reports) in addition to those observed from the aircraft. In at least five of the citizen reports, the wolves were observed sitting alongside the road, or otherwise making little attempt to move away immediately. However, after April 13 the group of three wolves was reported by citizens only twice, and Wolf No. 10, three times.

Table 5. Significant events in history of Wolf No. 10

Date	Event
March 12	Wolves released in Huron Mountain area (T52N-R28W-Sec 20)
March 13	No. 10 separated from the other three wolves and never reunited
March 15	Sighted from tracking car crossing County Road 492 south of Marquette County Airport, 6:35 p.m. (EDT) (T47N-R26W-Sec 33)
March 15	Crossed a four-lane highway between Marquette and Negaunee about 4:00 p.m. (EDT) (T49N-R26W-Sec 29)
March 24	Located from the air less than 0.5 miles (0.8 km) from release pen (T52N-R28W-Sec 20)
March 27	Reported seen by Huron Mountain Club guard on edge of First Pine Lake, 6:30 p.m. (EDT) (T52N-R28W-Sec 29)

April 18	Visited bear carcass 100 feet (30.5 m) from release pen, had also visited 3 nearby deer carcasses (T52N-R28N-Sec 20)
April 18	Confirmed deer kill by No. 10 near Pine Lake, Huron Mountain Club (T52N-R28W-Sec 20)
June 6	Reported seen by gate guard, Huron Mountain Club (T51N-R27W-Sec 6)
June 3	Reported seen north of Saux Head Lake on Lake Superior beach (T50N-R26W-Sec 17)
June 20	Reported seen crossing four-lane highway headed north about 5 miles (8.0 km) west of Marquette (T50N-R26W-Sec 24)
May 22	
May 23	
June 5	
July 15	Located near Big Bay dump, probably scavenging. Bears are baited at the dump by local citizens and tourists (T51N-R27W-Sec 16)
July 20	
July 31	
Aug. 6	
Aug. 13	
Aug. 16	Back in Huron Mountain area between Conway and Ives Lakes. 5:35 p.m. (EDT) (T52N-R28W-Sec 35)
Aug. 27	Returned to Big Bay dump, 11:10 a.m. (EDT) (T51N-R27W-Sec 16)
Aug. 30	Huron Mountain area, 8:45 a.m. (EDT) (T49N-R28W-Sec 9)
Sept. 2	Left Huron Mountain area for last time. Located on Yellow Dog Plains, 8:45 a.m. (EDT) (T50N-R28W-Sec 13)
Sept. 5	Near Silver Lake, 8:45 a.m. (EDT). Begins rambling move westward out of established range (T49N-R28W-Sec 17)
Sept. 15	Tracked on ground on Mulligan Plains, 4:45 p.m. (EDT) (T49N-R28W-Sec 9)
Oct. 22	Farthest west, 22 miles (35.4 km) west of Silver Lake. Begins rambling return east.
Nov. 16	Killed ½ mile (0.8 km) south of Van Riper Lake, 5.4 miles (8.4 km) north of Champion (T49N-R30W-Sec 36)

Table 6. Significant events in history of Wolves No. 11, 12 and 13

Date	Event
March 12	Wolves released in Huron Mountain area (T52N-R28W-Sec 20)
March 18	Two wolves reported seen near Ravine River, Skanee area, the smaller one limping (T51N-R31W-Sec 2)
March 19	First aerial fix of the three wolves in the same location (T52N-R31W-Sec 36)
March 20	Wolves reported howling about 2 miles (3.2 km) east of Arvon Tower, 10 miles (16 km) south of Skanee (T50N-R31W-Sec 4)
March 22	Wolves dug up five discarded doe and fawn heads and 27 deer legs near Laws Lake (T50N-R32W-Sec 18)
March 22	Wolves reported crossing highway north of Herman, 4 miles (6.4 km) southeast of L'Anse, 8:30 a.m. (EDT) (T50N-R33W)
March 25	Wolves reported in Pelkie area 6 miles (9.6 km) east of Baraga by DNR officer, 8:30 a.m. (EDT) (T51N-R34W-Sec 27SW)
March 25	Wolves crossed road 2.5 miles (4 km) north of Pelkie near Otter River 11:00 a.m. (EDT) 5 miles (8 km) southwest of Otter Lake (T51N-R34W-Sec 5)
March 25	Wolves reported seen crossing Highway M26, 2 miles (3.2 km) north of Twin Lakes 7:30 a.m. (EDT) (T52N-R38W-Sec 12)
March 26	Wolves reported seen by logger during most of morning 9:00-11:00 a.m. (EDT), 4 miles (6.4 km) south of Houghton, (T54N-R35W-Sec 14)
March 26	Wolves crossed Highway M26 south of Atlantic, 4:30 p.m. (EDT), (T54N-R34W-Sec 16)
March 26	Wolves sighted from aircraft, eating garbage from cutting crew, 4:20 p.m. (EDT) (T54N-R34W-Sec 9NE)
March 29	Wolves reported being chased away from house by dog, had been feeding on discarded cow head 150 feet (45.7 m) from house near Otter Lake (T52N-R33W-Sec 5)
March 31	Wolves sighted in Otter Lake area (T52N-R33W-Sec 5)
April 2	First confirmed wolf-killed deer, Arnheim area about 10 miles (16 km) north of Baraga (T52N-R33W-Sec 11)
April 5	Wolves reported seen at 9:00 a.m. (EDT) on county road 5 miles (8 km) southwest of Otter Lake, small wolf reported as appearing fat (T53N-R35W-Sec 36)
April 8	Wolves dug up old deer carcass about 150 feet (45.7 m) from house near Nisula (T50N-R36W-Sec 4)
April 10	Wolves reported seen by logger in Nisula area (T50N-R36W-Sec 5)
April 13	One wolf sighted crossing Highway M28 in morning between Kenton and Sidnaw
April 15	Wolves killed deer near Kenton (T47N-R36W-Sec 8)
April 18	Observed the three wolves from the tracking aircraft swim the East Branch of Ontonagon River, southeast of Kenton (T47N-R37W-Sec 7)
May 2	No. 13 split from other two wolves; found in northwest Ontonagon County (T51N-R32W-Sec 21)
May 7	All wolves back in Iron County for the second time, not known to leave until July 15
May 7	Forest service crew reported seeing the wolves and tracking aircraft north of Gibbs City near old deer carcass (T45N-R35W-Sec 26)

May 15	Loggers reported six wolves (one with collar) (T54N-R37W-Sec 33)—Probably saw the collared wolves twice
May 16	Confirmation from aerial location that the three wolves had reunited south of Mallard Lake after May 2 split
June 19	No. 13 again separated from No. 11 and 12
July 11	Wolf No. 12 found dead, killed by automobile just before July 6, north of Amasa (T45N-R33W-Sec 17)
July 15	Wolf No. 11 moved out of Iron County for the first time since May 7, found north of Kenton (T49N-R38W-Sec 31)
July 20	Wolf No. 13 found dead from gunshot, south of Sagola, last previous location (June 27) at same location where No. 12 killed by automobile (T52N-R30W-Sec 5)
Aug. 6	Wolf No. 11 located near Wisconsin border, ¾ miles (1.2 km) east of Lac Vieux Desert, 10:15 a.m. (EDT) (T43N-R38W-Sec 9)
Aug. 13	Wolf No. 11 located 1.5 miles (2.4 km) southeast of Ewen 25 miles (40.5 km) north of Lac Vieux Desert, 10:10 a.m. (EDT) (T46N-R40W-Sec 36)
Aug. 28	No locations since Aug. 13. Wolf No. 11 back in Marquette County .25 miles (0.4 km) south of Squaw Lake, a 60-mile (96.5 km) move eastward (T45N-R30W-Sec 21)
Sept. 20	No. 11 trapped and shot on Floodwood Plaine 3.1 miles (5.0 km) south of Witch Lake (T44N-R24W-Sec 11)

Habitat Use

The relative percentages of various habitats in which the translocated wolves were found during aerial locations (Table 7) did not indicate a preference for any particular habitat type. Evidently the animals chose their travel routes and ranges on some basis other than forest habitat, or at least habitat was not of any overriding importance in their movements.

Table 7. Habitat types in which the released wolves were located

Habitat	No. of Locations	Percent of Total	Percent Available ^[12]
Northern Hardwoods	43	48.3	40.9
Northern Hardwoods-Coniferous ^[13]	(57)	... ^[13]	... ^[13]
Spruce-fir	19	21.3	17.0
Aspen-hardwoods	11	12.4	20.5
Elm-ash-maple	1	1.1	4.5
Pine	2	2.2	5.5
Oak	0	0.0	1.4
Non-commercial forests	0	0.0	2.6
Other (near towns, farms, dumps)	13	14.6(8.9) ^[13]	7.6
Totals	89(146)	100.00	100.0

[12] Spencer and Pfeifer 1966.

[13] This forest type was not distinguished separately by Spencer and Pfeifer (1966), so they did not provide availability figures for it. Thus in this comparison, we did not include the 57 wolf locations that fell in the type. However in calculating percentage figures for non-forest areas (towns, farms, dumps), these 57 fixes could validly be used as representing forest locations.

Failure of Female No. 11 to Whelp

There was no sign that adult female No. 11 whelped or attempted to locate or construct a den. The usual gestation period for wolves is about 63 days (Brown 1936). Because No. 11 was seen coupled in copulation on February 12 and 16, she should have whelped between April 13 and April 21, if she had conceived. Probably she would have moved little during the preceding 2 or 3 weeks (Mech 1970). However no such changes in this animal's movements were noticed. The three wolves stayed near Kenton between April 15 and April 18 but also killed a deer during that time. They moved extensively from April 19 to May 7. The only indirect evidence that the female may have been pregnant was an observation made by a local citizen on April 5 (Table 6) who saw the three wolves and stated that the small wolf looked "fat." This would probably have been No. 11, but a full stomach could easily have been mistaken for pregnancy.

Unfortunately, neither the reproductive tract collected from No. 11 in September nor the blood sample taken in early March shed any light on the cause for the wolf's failure to produce pups. The ovaries did contain *corpora albicantia*, indicating that at some time the wolf had ovulated, but it could not be stated with certainty just when (R. D. Barnes, personal communication). The blood progesterone levels were more helpful. No. 11 had 3,560 picograms of progesterone per

milliliter, compared to 56 picograms per milliliter for Wolf No. 10, whose reproductive tract appeared immature. This high progesterone level of No. 11 indicated that the animal had recently ovulated, but it was impossible to tell whether she was carrying any fetuses at the time the sample was taken (U. S. Seal, personal communication).

Demise of the Translocated Wolves

All four translocated wolves were killed by humans (Table 8). The alpha male (No. 12) was the first victim. He was found from the air in the same location on July 6 and 10. A ground check on July 11 showed him already decomposed. He lay about 60 feet (18.3 m) from paved highway US 141 north of Amasa (Fig. 22). The articular processes on the right side of his fifth and sixth cervical vertebrae were broken and inverted. Part of the process of the sixth cervical vertebra was lodged in the neural canal between the fifth and sixth cervical vertebrae and would have exerted pressure on his spinal cord. His acrylic radio collar was also cracked on the right side in three places. We concluded that he had been struck and killed by an automobile. A scat found beneath the remains contained deer hair, so apparently the animal had been feeding not long before his death.

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Fig. 22.—The remains of Wolf No. 12 were found near a highway, and broken bones indicated he had been hit by a vehicle (Photo by Richard P. Smith)

Wolf No. 13 was killed next. He had been located south of Sagola in Dickinson County on July 20, the first time he was found since June 27. He was still there on July 27, so a ground check was made. It revealed that the wolf had been dead for perhaps 2 or 3 weeks. His flesh had decomposed, and only hair, bones and the transmitting collar remained (Fig. 23). His leg bones and ribs were mostly disarticulated, his skull was separated from the vertebral column, and his mandible had separated. A small caliber bullet had passed through the ramus of the left mandible and had entered the base of the cranium. The hole through the mandible was 0.26 inch \times 0.34 inch (6.6 mm. \times 8.6 mm.) and that through the cranium was 0.34 inch \times 1.30 inch (8.6 mm. \times 33.0 mm.). Three small lead fragments were removed from the cranium.



Fig. 23.—Wolf No. 13 had been shot, as the hole in the jawbone indicates (Photo by Tom Weise)

The remains of Wolf No. 13 were sent to the Michigan Department of Natural Resources Wildlife Research Center at Rose Lake and examined by staff pathologists Dr. L. D. Fay and Mr. John Stuht. No fractures or other signs were found that might indicate that he had been trapped. However, some of the smaller foot bones were missing and a complete examination was not possible. Notches were found in both shoulder blades, and one rib was broken, suggesting that the animal had been shot twice by a small caliber firearm in addition to the head shot. The hole in the left scapula indicated a deep penetrating wound. The notch in the right scapula indicated a bullet traveling more parallel to the body.

Table 8. Details of Deaths of Translocated Wolves

Wolf No.	10	11	12	13
Sex	Female	Female	Male	Male
Last date tracked	Nov. 17	Sept. 19	July 10	July 27
Date killed	Nov. 16 ^[14]	Sept. 20	June 28 to July 4	Early July ^[14]
Date found	Nov. 18	Sept. 20	July 11	July 28
Manner of death	Gunshot in head and right foreleg	Gunshot in, head, after being trapped	Struck by automobile	Gunshot in head and chest
Location of death	Van Riper Lake 5.4 miles (8.7 km) north of Champion (T49N-R30W-Sec 36)	Floodwood Plain 3.1 miles (5.0 km) south of Witch Lake (T44N-R24W-Sec 11)	1.9 miles (3.0 km) north of Amasa (T45N-R33W-Sec 17)	2 miles (3.2 km) south of Sagola (T42N-R30W-Sec 5)
Weight	52 lb. (23.6 kg)	56.5 lb. (25.6 kg)	Unknown ^[15]	Unknown ^[15]
Condition	Excellent	Good	Unknown ^[15]	Unknown ^[15]

^[14] Estimate

^[15] Decomposed

Wolf No. 11 was caught the night of September 19, 1974 in a coyote trap set by a trapper from Channing. The next morning the trapper came upon the trapped wolf by surprise at a range of 12 feet (3.6 m). She growled and lunged toward him, and thinking he was in danger, the trapper shot the wolf in the head. The .22 caliber bullet entered below the right eye and lodged in the skull. The trapper immediately took the animal to the Michigan Department of Natural Resources office in Crystal Falls and reported the incident.

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The wolf weighed 56.5 lb. (25.6 kg), 1.5 lb. (0.68 kg) less than when she was brought to Michigan. Her general condition was good, with some omental fat, but no subcutaneous fat. She did harbor ten tapeworms (*Taenia pisiformis*) about 40–50 cm long and a few hookworms (*Uncinaria stenocephala*), as determined by Mr. John Wenstrom (personal communication), Biology Department, Northern Michigan University. Both are common tapeworms of wolves (Mech 1970).

Wolf No. 10 was shot by a deer hunter, probably on the morning of November 16, the second day of firearms deer season. On November 17 her signal was heard from near a cabin on the south shore of Van Riper Lake. The hunters occupying the cabin later said they had removed the collar from the wolf, which they had found dead on the afternoon of November 16. Before we had learned this, the carcass of Wolf No. 10 was discovered without the collar by another hunter, about a half mile (0.8 km) south of Van Riper Lake. It had been shot through the right leg, shattering the radius and ulna, and through the head, the bullet entering the left frontal bone and exiting below the right eye. In addition the radio collar had been shattered by a bullet and was missing, and one ear had been cut off. We identified the wolf from the tag in the other ear.

The wolf had gained 6 lb. (2.7 kg) since she had been brought to Michigan, and had heavy internal and subcutaneous fat. She had light infections of two species of tapeworms (*Echinococcus granulosus* and *Taenia pisiformis*), and of one species of hookworm (*Uncinaria stenocephala*), as determined by John Wenstrom. *Echinococcus granulosus* is not uncommon in wolves (Mech 1970). The other two species were discussed above.

DISCUSSION

Wolves No. 11, 12, and 13 undoubtedly were members of the same pack. This conclusion is based on the fact that they did not fight when placed together in captivity, that they freely intermixed while penned, that No. 11 and No. 12 copulated, and that all three wolves generally traveled as a unit after their release. No. 11 and No. 12 were always located together from a few days after their release until the death of No. 12. Temporary splitting, as with No. 13 is a normal occurrence in wild wolf packs (Mech 1966).

The identity of Wolf No. 10 remains unknown. She was captured 7.5 miles (12.1 km) away from the other three, and in captivity she behaved differently from them, remaining more to herself but intermingling with the others occasionally, with no signs of aggression. The face licking of No. 10 by No. 11 could be interpreted as a sign of patronizing intimacy as an adult might treat a subordinate offspring. The teeth of Wolf No. 10 had very little wear, indicating that she probably was less than 3-years old, whereas the teeth of No. 11 were blunt from wear. The tendency for No. 10 to withdraw from the others and from human beings indicated that she probably was a low-ranking or subordinate animal, a peripheral member of the pack (Woolpy 1968), or even a lone wolf currently dispersing from the pack (Mech 1973).

The separation of No. 10 from the others upon release does not necessarily mean that she was not a member of the pack. No. 10's radio collar was replaced just before she was released. The handling without sedation could have frightened her enough that she ran some distance before the others were even released. The fact that No. 10 returned to within a half mile (0.8 km) of the release pen on March 20 and to within less than 100 feet (30.5 m) on April 18 may indicate she was seeking the other wolves. However, she may also just have used the release pen as a reference point in a generally unfamiliar area, or may have been attracted by the remains of carcasses left there.

Effect of Captivity and Human Contact

The necessary capture, captivity, translocation and contact of the experimental wolves with humans had an unknown effect on the wolves. They had been exposed to humans for over 2 months while in captivity. No attempts were made to tame them, and they never passed the escape stage of socialization as described by Woolpy and Ginsburg (1967). The dominant wolves (No. 11 and No. 12) were more relaxed when approached than were No. 10 and No. 13, however.

The failure of female No. 11 to bear young probably can be attributed to her captivity and handling. The fact that two couplings were observed over a 5-day period indicates normal estrus in the female, and a normal response in the male. Conception would have been expected from such a mating. In wild wolves, it is known that there is only a small loss between number of ova shed, number of embryos implanting, and number of fetuses being carried (Rausch 1967). Thus it seems unlikely that, if No. 11 conceived, she lost her fetuses *in utero*. Rather, she probably did not conceive, or perhaps the embryos never implanted. This wolf lost about 11% of her capture weight during captivity, despite an adequate food supply. This fact, plus the results of her blood tests indicate a high degree of stress, which probably explains why she never produced pups.

The possible interference of the drugs used can be ruled out, for they were chosen because of their known lack of effect on pregnancy (Seal et al. 1970).

The radio collars placed on the wolves had no noticeable effect on the animals. Radioed wolves are regularly accepted back into their packs in Minnesota, where they also reproduce and function normally (Mech and Frenzel 1971; Mech 1973, 1974).

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Movements

Environmental Influences

Lake Superior was a barrier to the northward and eastward movements of the wolves. Apparently it also directed wolves No. 11, 12, and 13 southward around Keweenaw Bay, and possibly it prevented their eastward movement on April 2 when they approached Keweenaw Bay from the western side. The Bay is approximately 6-miles (9.6 km) wide there, and was frozen until late April.

One to two miles (3.2 km) south of the release site, the Huron Mountains, with an elevation of 1,500 feet (457.5 m) might have prevented the southward movement of the wolves. Along the lakeshore, the land is relatively flat, which may have facilitated east-west movement. Wolves No. 11 and 13 were found at an elevation of 1,300 feet (490 m) the day after release but had returned to the flat shore areas (600 to 700 feet, or 200 to 230 meters above sea level) by the next day. Topography likely had effects in other areas but the actual travel routes, in most instances, are unknown. The pack did travel along an abandoned railroad grade near Gibbs City and for 2 miles (3.2 km) on a muddy road north of Kenton. Wolf No. 10 used a railroad bridge to cross a river in mid-March. It is well known that wolves generally choose the easiest routes of travel (DeVos 1950, Stenlund 1955, Mech 1966).

Possible Homing Tendencies

Some of the movements of the wolves during the Directional Movements Phase could in part have resulted from a tendency for the animals to home, that is to return to their home territory. Packs have been observed to travel 45 miles (72 km) in 24 hours in Minnesota (Stenlund 1955), Alaska (Burkholder 1959) and on Isle Royale (Mech 1966). In Minnesota, a radioed wolf was tracked a straight-line distance of 129 miles (208 km) over a 2-month period before being lost by researchers (Mech and Frenzel 1971), and annual migratory movements of over 200 miles (320 km) have been reported for Canadian wolves (Kuyt 1972). Therefore it seems within the capabilities of the released wolves to return the 270-mile (434 km) straight-line distance, or the 340-mile (547 km) travel distance around Lake Superior to Ray, Minnesota, if the orientation ability and inclination were present.

Homing tendencies have been reported in wolves and other carnivores. One of five laboratory-reared wolves returned to her Barrow, Alaska homesite within about 4 months after a 175-mile

(282 km) displacement (Henshaw and Stephenson 1974). An adult female red fox (*Vulpes vulpes*) returned to her homesite within 12 days after being displaced 35 miles (56.3 km) (Phillips and Mech 1970). For black bears there are many records of apparent homing. Harger (1970) displaced 107 adult black bears from 10.0 to 168.5 miles (16.1 to 270.3 km) with an average displacement of 62.5 miles (100.6 km). Thirty-seven of them homed and 11 others moved long distances toward home. The longest distance homed was 142.5 miles (229.4 km). The return travel routes seemed direct, with little evidence of wandering or circling. Harger (1970) concluded that bears could navigate by some means, as yet undetermined.

There is some indication that the pack of three wolves may have attempted to return home to Minnesota, although it is possible that exploration itself also may have produced the movement pattern observed.

If the translocated wolves were to try homing directly toward their previous territory, they would have had to travel west-northwestward. However, within a few miles they would have encountered Lake Superior. The next closest choice would have been to head westward, and this is what the pack did (Fig. 17). The next possible barrier to their homeward movements would have been Huron Bay, which would have forced them southwestward, at least temporarily. Again this is what actually happened. The pack maintained its southwestward movement beyond Huron Bay until reaching a point southeast of the next possible barrier, Keweenaw Bay. They then continued westward south of Keweenaw Bay to the Prickett Dam area, and veered northwestward to Twin Lakes on March 25.

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By this time, the wolves had traveled for 13 days and covered a minimum distance of 59 miles (94.9 km), and they were 42 miles (67.6 km), closer to home (16% of the straight-line distance between home and release site). The directions of the movements of the wolves were consistent with what they would have to be if the wolves were to return home.

However, after March 25, the directionality in the movements of the pack ended (Fig. 17), and the animals began what we consider the Exploratory Phase of their movements. If the wolves actually were homing, perhaps the tendency diminished as they failed to encounter familiar terrain, or perhaps they met too many obstacles, or became confused after encountering too much human activity. Or possibly these factors or the need to find food and security overcame the homing tendency. As discussed earlier in relation to the unusual number of times the wolves were observed, it is clear that they were not moving normally during this period.

The lone wolf, No. 10, dispersed from the release site in as much of an opposite direction as it could from the pack (Fig. 20). Thus there is no evidence that this animal was trying to home. However, it is of interest to note that the first 32 miles (51.5 km) of her travel was directional rather than random. Furthermore, when the animal encountered what probably was a psychological barrier, a high concentration of human activity along Highway 41, she reversed her movements but still maintained a directionality by returning to the release area. In fact a striking pattern of southeast-northwest movements characterized this wolf's travels for several months after her release, with a gradual westward drift developing in the southeast-northwest movements (Fig. 20).

Mech and Frenzel (1971) found that a wolf dispersing from his former home range in Minnesota maintained a general southwestward movement for a straight-line distance of 129 miles (207.6 km) over a 2-month period, and Mech (unpublished) has three additional records of dispersing wolves that maintained directionality for distances of 48 to 130 miles (77.2 to 209.2 km). Storm (1972) followed 12 dispersing red foxes in Iowa, Illinois, and Minnesota that moved directionally for distances of 12 to 110 miles (19.2 to 176.0 km).

The ability of wolves to orient and navigate even in unfamiliar surroundings was demonstrated dramatically by the separation of Wolf No. 13 from his two packmates and his later rejoining of them. On May 2 he was 51 miles (82.1 km) away from them. Five days later he and his packmates were only 6 miles (9.6 km) apart, in an area 62 miles (99.8 km) from where No. 13 had been on May 2, and 45 miles (72.4 km) from where his packmates were on that date (Fig. 18 and p. 11).

Because No. 13 had taken such a divergent route from that of No. 11 and 12 upon splitting, and then had met them again at a point so far from (1) where they had split and (2) where either had gone after the split, mere backtracking would seem to be ruled out as explanation of how they were able to rendezvous. Possibly No. 13 backtracked to the separation point and then followed the others by scent, although this seems unlikely because of the amount of time that had elapsed. Perhaps a combination of memory of the general lay of the land, and some backtracking and eventually howling and the crossing of each group's fresh tracks could explain this remarkable feat.

Distances Traveled

The average daily straight-line distances (average of all known 24-hour moves) traveled by Wolf No. 10 was 3.6 miles (5.8 km). For Wolf No. 11 and her associates it was 5.8 miles (9.3 km) for the period before the settled Phase of their movements. The daily summer straight-line movements of an immature radioed female in Ontario ranged from 0.0 to 3.5 miles (5.6 km) per day and averaged 1.0 (1.6 km) per day (Kolenosky and Johnston 1967). Mech and Frenzel (1971) found that the average daily straight-line distance traveled in Minnesota by three lone wolves

was 2.0, 1.0 and 2.9 miles (3.2, 1.6, and 4.6 km), and a pack of five averaged 2.5 miles (4.0 km) straight-line distance per day. A pack of eight wolves in Ontario traveled actual distances of 0.0 to 13.2 miles (21.1 km) per day during winter with an average movement of 4.4 miles (7.1 km) per day (Kolenosky 1972).

Thus distances moved by both lone Wolf No. 10 and the pack were greater than the distances reported for lone wolves and packs in their native range. In Harger's (1970) study of homing in black bears, he also found increased movement by displaced animals.

There was a general reduction in distances moved by the pack in May and June after the wolves had settled in Iron County (Fig. 19), compared with their earlier exploratory movements (Fig. 24). The movements during the Settled Phase were similar to those reported from the studies in Ontario and Minnesota.

Fig. 24.—Straight-line distances between consecutive locations for (A) Wolves No. 11, 12, and 13. (B) Wolf No. 10. (Gaps between data points represent periods when no data were obtained. Because these periods varied, and because distance traveled is partly a function of duration between locations, it is only valid to grossly compare distances from one period to the next.)

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Home Range Size

At least in some areas, wolves are territorial (Mech 1972, 1973), and the sizes of their home ranges are restricted somewhat by boundaries established by the scent marks of surrounding packs (Peters and Mech 1975). The introduced wolves probably encountered no native packs with established territories (Hendrickson et al. 1975), so they would not be similarly restricted. The total area that wolves No. 11, 12, and 13 explored, 2,918 square miles (7,586 km²), is larger than any reported from the Great Lakes area and is comparable to home ranges of "tundra wolves" (Mech 1970). Even the area in which they settled (May 7 to July 6) until the deaths of the males was 246 square miles (637 km²), which is larger than most reported ranges in the Great Lakes Region.

The deaths of the two males seemed to cause an increase in both daily distance traveled and home range in Wolf No. 11. Essentially she began traveling as extensively as do lone wolves in Minnesota (Mech and Frenzel 1971).

The home range of Wolf No. 10 from March through mid-November, 346 square miles (895.7 km²), was smaller than those of lone wolves in Minnesota (Mech and Frenzel 1971). Apparently she was still expanding her range when killed, however.

Selection of a Territory

The eventual settling of the pack of translocated wolves into a territory would be expected because such behavior is characteristic of wolves in other areas. The translocated pack did settle into a territory of 246 square miles (637 km²) after about 2 months (Fig. 18). Although the region where they settled was not as remote as the release area, it was more inaccessible than most of the rest of the 1,631 square mile (4,224 km²) area they explored after dispersing. As with the rest of Upper Michigan, the pack's adopted territory was inhabited by a moderate population of deer and beavers. It seems significant that this area is one of three where a few native Michigan wolves are known to still exist (Hendrickson et al. 1975).

Vulnerability and Mortality

It could be expected that the translocated wolves would be more vulnerable than wolves in their native environment. Although no data are available from any previous study of translocated wild wolves, Harger's (1970) investigation of displaced wild black bears showed that they were more vulnerable. In our study, it was clear that during the Directional Movement and Exploratory Phases Wolves No. 11, 12, and 13 were observed by local residents an unusual number of times (Table 6). No. 10, which did not explore such an extensive area and which spent considerable time in a more remote area, was seen less (Table 5).

It is not clear why the wolves were not killed by humans during these periods when they appeared so vulnerable. Perhaps the novelty of the transplant coupled with the awareness that frequent aerial checks were being made of the wolves had some effect. Furthermore, spring is not generally a season of intensive hunting and trapping.

Whatever the explanation, the wolves did survive what seemed to be their most vulnerable period. We do not believe that the deaths of the wolves can be attributed to the conditions of their translocations. Instead, we think that the most important factor in their demise was the accessibility of the area to human beings and the attitudes of humans towards wolves.

As indicated earlier, there appears to be an inverse relationship between human density and wolf density in the Great Lakes Region (Table 1). Wolves are vulnerable to both accidental and deliberate mortality from humans. For example, in winter 1947-48 at least 14 wolves were struck

by automobiles in northern Ontario (DeVos 1949). In Michigan, a \$15-\$20 bounty still exists on coyotes, so these animals are commonly shot and trapped. Because many people cannot distinguish wolves from coyotes, and because wolves are often caught in the same kind of trap sets made for coyotes, wolves might be killed accidentally.

Whether the killing of the translocated wolves was deliberate or accidental is unknown except in the case of No. 11. No. 11 was caught accidentally in a coyote trap, but was killed deliberately when the trapper thought the animal might attack him. The best guess about No. 12, which was killed by a car, is that it was accidental. No. 10 and No. 13 were shot, but it is possible that the hunters in each case may have mistaken them for coyotes. On the same day that No. 10 was killed, a deer hunter shot a 76-lb. (34.5 kg) native Michigan wolf and turned himself in to authorities, stating that he had thought it was a coyote, and in March 1975 there was a similar occurrence.

Some Upper Michigan residents strongly opposed the transplant experiment, largely out of concern for deer populations. The Northern Michigan Sportsmen's Association passed a resolution against it, and the Baraga County Wolf Hunters Association was formed with the express purpose of interfering with the transplant effort. This association offered a reward of \$100 to a person killing a wolf (Fig. 25). Supposedly 132 memberships at \$1.50 each were sold.

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It is unlikely that members of the Baraga County group killed the experimental wolves, for it would be extremely difficult for anyone to deliberately hunt down and kill a wolf. Most wolves that are shot anywhere just happen to be seen by a few of the hundreds of thousands of hunters that are afield or by local residents who keep a gun handy. Thus the more accessible the area, and the higher the density of human beings, the greater the chances that wolves will encounter such people.

Of course there was also excellent public support for the experiment. With weekly newspaper accounts of the travels of the wolves, many people began to develop an interest in, and sympathy for, the wolves. Some letters in the newspapers expressed regret that the animals had been killed.

Food Habits and Predation

The translocated wolves apparently scavenged more in Michigan than in Minnesota, at least shortly after their release. There were no known garbage dumps within their native territory. The dumps in Michigan presumably offered more readily available food during a time when the wolves appeared preoccupied with extensive travel.

Nevertheless, the wolves did kill at least the three deer that we found, and no doubt took several others. Although the sample size is small, the results of our analysis of the condition of the deer are consistent with those from other studies, indicating that wolves prey primarily on debilitated deer (Pimlott et al. 1969, Mech and Frenzel 1971).

All three deer killed by the wolves were seriously malnourished, with 6% or less fat content in the marrow of their femurs, or thigh bones. At less than 25% fat in the marrow, serious malnutrition has developed (Cheatum 1949). (In comparison, the femur fat of 59 doe deer killed by automobiles in the Upper Peninsula in March and April 1974 averaged 46%, according to Dr. L. D. Fay, Michigan Department of Natural Resources.) In addition, one of the animals killed by the wolves had been wounded by a bullet and had a broken leg; all three were does, and were over 4 years of age, a factor that Pimlott et al. (1969) and Mech and Frenzel (1971) have also found important in wolf kills.

An Alternate Approach

Although the time of release for the four wolves in this study was selected in order to maximize chances that they would remain in their new range, possibly a release earlier in winter would be more successful. The failure of the adult female to conceive was probably a result of captivity and handling, although this needs confirmation through additional studies. Nevertheless, an early winter release might be favored by deep snows hindering travel. Furthermore, by breeding season in late February the wolves might already have settled into an area. Then the entire breeding cycle might take place outside captivity and stand a better chance of succeeding.

CONCLUSIONS

Three principal conclusions can be drawn from the results of this experiment: (1) It is possible to transplant a pack of wild wolves into a new range. That new range, however, must be large enough to permit some initial wandering. The animals cannot be expected to establish a home range centered on or even including the point of release. (2) The habitat in Upper Michigan apparently is adequate to support wolves, in terms of food and cover, for the carcasses of the two

experimental wolves that could be examined intact had maintained or improved their condition during their 6-to-8-month residence in Michigan. (3) The reason for the failure of the experimental wolves to re-establish themselves was direct mortality by human beings, just as Hendrickson et al. (1975) concluded was the case for the failure of native and immigrant Michigan wolves to re-establish a population. This mortality probably is related to two factors, negative human attitudes toward wolves and accessibility of humans to wolf range.

We are convinced that, ecologically, wolves can be re-established in Upper Michigan. However, a successful program of re-establishment will require the following:

1. A survey of public attitudes in Upper Michigan toward re-establishing wolves,
2. An intensive public relations campaign to promote an understanding of wolf ecology and the benefits of a wolf population,
3. Suspension or removal of the bounty on coyotes,
4. Releases of additional wolves in larger numbers perhaps over a period of a few years, if public attitudes appear favorable,
5. A concentrated effort to inform the public of the penalties for killing wolves,
6. A concerted law enforcement program, and
7. Monitoring of translocated animals through radio-tracking to determine the results.

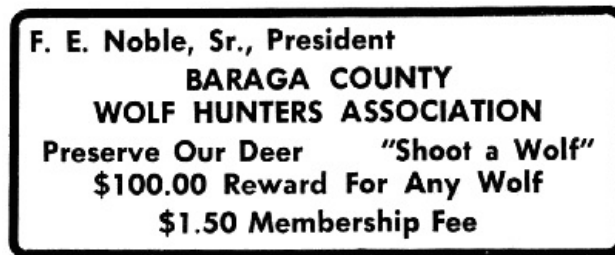


Fig. 25.—Although the transplant experiment enjoyed wide public support, some people opposed it and organized the Baraga County Wolf Hunters Association to try to prevent the re-establishment effort

ACKNOWLEDGMENTS

This project was a cooperative effort among the Michigan Department of Natural Resources, The Minnesota Department of Natural Resources, the U. S. Fish and Wildlife Service, Northern Michigan University, the Huron Mountain Wildlife Foundation, and the National Audubon Society.

The Michigan and Minnesota Departments of Natural Resources provided the legal permits and logistical support necessary for the transplant. The Fish and Wildlife Service assisted in the planning and fund-raising for the overall project, and provided the technical expertise in the live-trapping, radio-tagging and radio-tracking of the wolves. Northern Michigan University initiated and administered the project and conducted the Michigan aspects of the work. Financial support was provided by the Huron Mountain Wildlife Foundation and the National Audubon Society.

Dr. U. S. Seal of the Veterans Administration Hospital in Minneapolis analyzed and interpreted the blood samples, and Dr. Ray D. Barnes, University of Minnesota, the female reproductive tracts.

The authors wish to thank all of the people mentioned above and the following individuals: Ralph Bailey and Robert Rafferty, Michigan Department of Natural Resources; Jeff Renneberg, U. S. Fish and Wildlife Service; Fred Harrington, State University of N. Y. at Stony Brook; Roger Peters, University of Michigan; Tom Jernstad, Leo Maki, and Leo Wouri, Huron Mountain Club; the late William P. Harris Jr. and Theodore A. McGraw of the Huron Mountain Wildlife Foundation; Edward H. Brigham III, National Audubon Society; Dennis Diaz and William Rowloff, pilots of Northern Airmotive; Robert Neil, owner of the research airplane; Denis Kallery, Cynthia Watt, and George Wilson of Marquette; and last but certainly not least, wolf-trapper Robert Himes of Ray, Minnesota.

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