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# CAN RELOCATED WOLVES SURVIVE?

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Considerable interest has been expressed recently in establishing gray wolves (*Canis lupus*) into parts of their former range (Bailey 1978, Weaver 1978, Klinghammer 1979, Mech 1979, Henshaw 1982). However, the proper procedure for reintroductions is debatable (Klinghammer 1979). To date, wolf relocations have been conducted in Alaska, where 5 2-year-old captive-reared wolves were released into an area occupied by wolves, (Henshaw and Stephenson 1974, Henshaw et al. 1979) and in Michigan, where a pack 4 wolves was released in a relatively wolf-free area (Weise et al. 1975).

Wolf reintroductions are expensive, controversial, and attract considerable public attention. The potential for success of an effort will greatly influence the willingness of agencies to attempt reintroductions.

The 9 wolves released in Alaska and Michigan had a high rate of mortality, with humans being the major cause. The present study assessed the survival and behavior of relocated wolves. We hypothesized that relocated wolves, especially pups, would have poorer survival when moved outside a familiar territory.

## METHODS

Wolves were captured from February 1975 to May 1978 in northern Minnesota where depredations or harassment of domestic animals were reported (Fritts 1982). Sixty-two adults (32M:30F) and 45 4–7-month-old pups (21M:24F) were relocated. All were ear-tagged and weighed; 15 adults and 4 pups were fitted with radio collars and monitored from aircraft (except 2 adults whose signals were soon lost and 1 pup killed by wolves released with it). Most wolves were released within 1–2 days of capture: 104 into the Superior National Forest (SNF) of northeastern Minnesota and 3 into the Beltrami Island State Forest in the state's northwest. Releases were made from May to November, but primarily during July to September. Details of handling and release procedures and distances transported were described by Fritts et al. (1984). Capture-caused injuries were slight in most cases and were not believed to have been a significant factor affecting survival. Ten male and 6 female wolves were tracked beyond their release sites.

Resident wolves were present in both release areas at a winter density of about 1/38–44 km$^2$. White-tailed deer (*Odocoileus virginianus*), the major prey of wolves in Minnesota, were believed to be abundant in both areas. In 1979 the pre-fawning deer population estimate in the SNF release area was about 8/km$^2$ (J. J. Mooty, pers. commun.).

Nine wolves were relocated twice, and 1 was relocated 3 times following their recaptures near original depredation sites. Information on fates of wolves came from radio-tracking, recapture during U.S. Fish and Wildlife Service (FWS) wolf control and research activities, and the Minnesota Department of Natural Resources, the Ontario Ministry of Natural Resources, and private citizens.

An annual survival rate for the radio-tagged wolves was extrapolated from daily survival rates (Trent and Rongstad 1974). In that calculation we assumed daily survival rates to be constant within monthly intervals. One radio-tagged pup was excluded from this computation because its early death resulted from being released with adults from a different pack. Information on feeding behavior, activity, and social behavior was obtained by aerial observations. Some wolves are identified by number herein to allow reference to their movements (Fritts et al. 1984).

## RESULTS AND DISCUSSION

### *Survival Rates and Causes of Mortality*

Ten radio-tagged wolves were recovered either before or after radio expiration; radio

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signals from 7 others eventually were lost, and their fates were unknown. Minimum survival time averaged 403 days (1–1,369 days) for the 17 radio-tagged wolves (time until death, last recapture, or loss of radio contact).

Ear-tag returns were obtained from 7 males and 9 females (18%) of the 88 ear-tagged wolves. Minimum survival time averaged 278 days (17–1,011 days) for that group. The difference in minimum survival time between radio-tagged and ear-tagged wolves can be explained, at least partly, by intensive FWS trapping around a farm that was 51 km west of a release site, resulting in recapture of several ear-tagged wolves that originally were captured there. Proportionately, few wolves had been radio-collared there, and most of these wolves were released if recaptured. Minimum survival time combined for the radio-tagged and recovered ear-tagged wolves averaged 342 days. This figure is similar to an average minimum survival time of 397 days for an increasing population in northwestern Minnesota based on a combination of telemetry and recovery data (Fritts and Mech 1981, and unpubl. data).

Among the 17 radio-tracked and 16 recovered ear-tagged wolves, 3 radio-tagged and 11 ear-tagged animals were recaptured by the FWS at or near farms following reports of depredations or harassment of livestock. Ten of these wolves were relocated again and released alive (including 1 moved 3 times), whereas 4 died or were killed. Thus, FWS regulations influenced the minimum and actual survival time of some wolves. However, if all wolves recaptured by the FWS had been killed, the average minimum survival time derived from all available data would not have been significantly different (331 $\pm$ 55 days rather than 342 $\pm$ 54 days, $t = .1447$, 64 df, $P > 0.05$).

Seventeen radio-tagged wolves were monitored intermittently for $\leq$19.5 months. Annual survival rate calculated for the radio-tagged sample was 0.60, including 0.70 for 3 wolves released as pups and 0.57 for 13 released as yearlings and adults. The annual rate for the entire sample was similar to those we calculated by the same method for radio-tagged wolves, mostly pack members, from other areas of Minnesota: 0.66 for an increasing population in the Beltrami Island State Forest (Fritts and Mech 1981), 0.21–1.00 in the Chippewa National Forest, and 0.65 in the Hill City area (Berg and Kuehn 1982, and pers. commun.). Other survival rates from Minnesota, calculated by other methods, were: 0.60–0.80 (Van Ballenberghe et al. 1975), 0.35–0.93 (Mech 1977, corrected in Fritts and Mech 1981), and 0.59 (Stenlund 1955). Stenlund's rate included human-caused mortality only.

We suspected that males survived better than females. Excluding instances in which telemetry data facilitated recovery and assuming death at first recapture, the average survival time was 473 $\pm$ 90 days for males and 296 $\pm$ 103 days for females ($t = 1.277$, 21 df, $P > 0.05$). If not for the exceptionally long survival of 1 female (1,369 days), the means would have differed significantly by 349 days ($P < 0.02$). This comparison suggested that females may have been more vulnerable to retrapping, especially by the FWS. Among all recovered wolves, 10 of 11 females vs. 6 of 12 males were recaptured by the FWS. This finding did not seem to result from more females being caught or released near areas where trapping was most intensive. Moreover, it did not result from females traveling farther from release sites ($P > 0.05$). Adult females were thought to be less difficult to capture than adult males during 16 years of research trapping in the Superior National Forest (L. D. Mech, unpubl. data).

Other than the FWS control program, causes of wolf mortality included: illegal shooting and trapping in Minnesota (2), legal shooting and trapping in Canada (3), intraspecific strife (2), highway mortality (3), and starvation (1). These mortality causes are typical of those of nonrelocated wolves in Minnesota (Van Bal-

lenberghe et al. 1975, Mech 1977, Fritts and Mech 1981, Berg and Kuehn 1982). No age differences were obvious among wolves dying of various causes.

We suspect that illegal shooting and trapping were more common than our limited data indicated because of the obvious negative reporting bias. (Wolves were legally protected in Minnesota during this study.) A large part of known wolf mortality in Minnesota in recent years was human-caused: 42% in the Superior National Forest (Mech 1977), 33–50% in northwestern Minnesota (Fritts and Mech 1981), and 76% in north central Minnesota (Berg and Kuehn 1982).

Among 12 radio-tagged and ear-tagged wolves dying from causes other than control activities in Minnesota, at least 8 succumbed from October through March. About 83% of the mortality of nonrelocated, radio-tagged wolves in Minnesota has occurred during autumn and winter (calculated from Van Ballenberghe et al. 1975, Mech 1977, and Fritts and Mech 1981).

All 3 radio-tagged pups and at least 4 of 45 ear-tagged pups survived the winter following release, even though apparently alone. Annual survival rate of the 3 radio-tagged pups was high (0.70). Eleven (22%) of the 49 ear-tagged adults and 6 (15%) of 41 ear-tagged pups were recovered. The lack of a significant difference between recovery rates ($\chi^2 = 2.16$, $P > 0.10$) suggested comparable survival of ear-tagged adults and pups during the first months after relocation. However, because nothing was known about the individuals not recovered, no further deductions could be made. Each of the 3 radio-tagged pups (as well as 1 radio-tagged adult) temporarily settled for 40–146 days in winter before dispersing to other areas (Fritts et al. 1984), which probably enhanced their survival.

Van Ballenberghe and Mech (1975) found a strong relationship between summer or fall weight and survival of wolf pups in Minnesota, with those ≥80% of a standard weight showing high survival. Weights of our relocated, radio-collared pups ranged from 7.7 to 21.3 kg, or 91, 98, and 121% of this standard weight. Nonetheless, because the relocated pups had no assistance in obtaining food and traveled through unfamiliar areas occupied by resident wolves, we expected survival to be low. Similarly, 37 ear-tagged pups averaged 96% of the standard weight, with only 4 <80% of standard. Five of the recovered ear-tagged pups for which data were available averaged 113% standard weight when first captured, and none weighed under 80%, whereas weights of 32 that were released and not recovered averaged 93% of standard. The radio-tagged pups and recovered, ear-tagged pups weighed ≥ 13.1 kg ($\bar{x} = 16.1$ kg) and were released after 7 August. Conceivably, lighter pups may have died of natural causes and would not have been recovered.

Seven wolves released as pups and recovered as yearlings or adults had attained or maintained normal adult weights. Ten adults lost weight ($\bar{x} = 5.0$ kg) between initial capture and recovery, whereas 5 gained ($\bar{x} = 5.0$ kg). Five of 8 males gained weight, and 5 of 7 females lost. Adults lost an average of 1.7 kg each.

### *Social Behavior and Breeding Season*

Behavior of our translocated wolves was similar in many respects to that of dispersing lone wolves in Minnesota (Mech and Frenzel 1971, Rothman and Mech 1979, Fritts and Mech 1981). At least 5 of the 16 radio-tracked wolves ultimately associated with other wolves. One adult female (F361) joined a pack of at least 4 other wolves 3 months after release. She was 158 km from her capture point and 66 km from her release point. She remained with that pack for about 10 months until located again, at which time she appeared to be its breeding female. Known incidents of single wolves joining a pack are rare. Two, and pos-

sibly 4, instances were reported from over 50 pack years of data from Minnesota (Rothman and Mech 1979, Fritts and Mech 1981).

Adult F351 paired about 8 months after relocation. She was observed with a companion throughout winter 1975–1976 in the area where she settled and was seen at a den the following spring, implying birth of pups. Adult M319 settled and traveled with a female wolf. Both were killed about a year after his release. These wolves probably were attempting to colonize the local area and thus might have established a new pack if they had not been killed (Rothman and Mech 1979, Fritts and Mech 1981).

Brief associations with resident wolves were noted: an adult male and a pup were each found with non-radioed wolves on 1 occasion. Adult M319, mentioned above, once was located within 90 m of a pack of $\geq$12 wolves.

Thus, at least 3 of 16 adult wolves from the radio-tagged sample succeeded in finding a mate and a territory, and 2 probably reproduced, a rate not greatly different from that of natural dispersers in Minnesota (Fritts and Mech 1981, Mech, unpubl. data).

## CONCLUSIONS AND IMPLICATIONS FOR WOLF REINTRODUCTIONS

This study showed that relocated wolves, including pups, survived comparably to resident wolves. We suggest that the ability of wolves to survive and reproduce in unfamiliar, currently occupied surroundings need not in itself be a primary concern in wolf reintroductions when suitable prey are available.

As was true in Michigan (Weise et al. 1975) and Alaska (Henshaw et al. 1979), humans were the major cause of mortality for our relocated wolves. Trapping, shooting, and auto mortality are the greatest threats to wolves. Consequently, releases should be made in protected areas of least human access, such as national parks. Because wolves tend to move extensively after release (Henshaw and Stephenson 1974, Weise et al. 1975, Fritts et al. 1984), only releases into relatively large nonagricultural areas are likely to succeed.

We concur that wild wolves rather than wolves reared in captivity should be used as transplant stock (Weise et al. 1975, Henshaw et al. 1979, Mech 1979). Our results and the Michigan effort (Weise et al. 1975) indicate that most wild wolves can survive after being relocated. Wild wolves have not developed an affinity for man as provider that characterized the captive-reared wolves released in Alaska (Henshaw et al. 1979). The probability of success in a wolf reintroduction appears proportional to the wolves' fear and avoidance of man. Some form of negative conditioning to man might be useful in encouraging fear and avoidance behavior (McCullough 1982).

We strongly recommend that all reintroduced wolves be radio-tagged and monitored routinely so their movements, behavior, and fates can be determined (Mech 1979). Consideration should also be given to outfitting reintroduced wolves with radio-triggered anesthetic-dart collars (Mech et al. 1984). Any individual wolf that wandered too far from the target area and created problems could then be anesthetized and returned to the desired area or removed from the experiment. This capability should make reintroductions more acceptable to any livestock producers living near the release area, at least during the crucial early stages of the attempt. Also, use of such collars would allow a fresh radio to be applied at any time without resorting to conventional recapture methods.

## SUMMARY

From 1975 to 1978, 107 wolves were captured at Minnesota farms where depredation or harassment of livestock had been reported and were relocated into nonagricultural forest lands inhabited by wolves. Radio-tracking of 16 of the relocated wolves indicated an annual survival rate (0.60) approximating that of wild wolves in Minnesota. The average minimum survival time of the radioed wolves and of 16

recovered, ear-tagged wolves combined was 342 ± 54 days. The limited data on pups (3) suggested comparable survival. Fourteen (13%) of the wolves were recaptured at least once by the FWS at farms. Otherwise, causes and seasonal patterns of mortality were typical of those of other Minnesota wolves.

At least 3 of the 16 radio-tracked wolves succeeded at finding a mate and a territory. Overall, survival and behavior of the relocated wolves appeared comparable to that of other wolves in Minnesota and much like that of naturally dispersing wolves. Wolves evidently can be released into new surroundings that already have a wolf population without substantially reducing their survival rate. However, extensive movements must be anticipated (Fritts et al. 1984).

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