MOOSE TRANSPLANT TO SOUTHWESTERN COLORADO

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ABSTRACT: During December 1991, January 1992 and January 1993 106 moose (*Alces alces shirasi*) were captured in north central Colorado, northeast Utah and southwest Wyoming and transplanted to the upper Rio Grande river basin in southwestern Colorado. Moose were captured by stalking them on the ground and administering a 2.7mg carfentanil-40mg xylazine mixture from dart guns (n=9), by darting from a helicopter with 5mg carfentanil per animal (n=26) and by nets fired from helicopters (n=71). Both helicopter techniques involved transporting moose by suspending them from lines under the aircraft and flying them to nearby stock trailers. Overall capture related mortality of moose was about 12%. Necropsies were performed on 9 animals. Aspiration of rumen fluid was a factor in the death of 4 animals drugged from and transported by helicopter. Mortalities associated with the helicopter/net gun technique appeared related to capture myopathy and, in one case, aspiration pneumonia. Moose from north central Colorado were larger and in better physical condition than the Utah and Wyoming animals. Mortality rates for Utah and Wyoming moose (18.2%) and Colorado moose (4%) appeared closely related to the physical condition of moose at the time of capture. Forty-four moose were fitted with radio collars and periodically located after release. After two years the animals occupied an area of approximately 10,000 km^2. We recommend the helicopter/net gun technique as the most cost effective and least stressful method of capture. We further recommend that transplants be made at times when stress levels are at a minimum for the animals to be captured. We believe early winter is the optimum time.

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Although individual moose were documented to occur in Colorado prior to 1978 (Bailey 1944, Hall and Kelson 1959, Duvall and Schoonveld 1988), no reproducing population existed. Transplants of moose from Utah in 1978 and Wyoming in 1979 and 1987 to north central Colorado were successful and their progeny expanded into surrounding habitat (Nowlin 1985, Duvall and Schoonveld 1988). Based on the initial success, it became clear that Colorado has habitat capable of supporting significant moose populations.

Introduction of moose to southwestern Colorado was first considered in 1976 when biologists recommended the Gunnison area. That proposal was not implemented because of opposition from local livestock operators. Other potential release areas were considered, and in 1991 an environmental assessment was prepared to facilitate the release of moose on the Rio Grande National Forest near Creede, Colorado.

STUDY AREA

The Upper Rio Grande river drainage was chosen as a release area for moose because it offers excellent habitat and is over 90% public land. The Creede Ranger District(USFS) administers about 213,000 ha of land that varies from approximately 2,590 m to 4,270 m in elevation. Higher elevations receive an average of 135 cm of precipitation, with 102 cm in the form of snow; lower elevations average 30 cm of precipitation with only 10 cm as snow.

Over 59,000 ha of coniferous forest consisting primarily of spruce (*Picea spp.*) and fir (*Abies spp.*) and 20,000 ha of aspen (*Populus tremuloides*) occur on the District. Eight species of willow, *Salix wolfii, S. monticola, S.*

geyeriana, *S. planifolia*, *S. lasiandra*, *S. brachycarpa*, *S. subcoerulea* and *S. lutea* have been identified on the District and cover about 6,000 ha.

METHODS

The environmental assessment process was completed in July 1991 and a finding of no significant impact was signed by the USFS in August 1991. The document approved the release of up to 100 moose and set a long term objective of 350 animals in the study area. That population objective will be reviewed and possibly modified once it's attained.

Agreements were made with the Utah Department of Natural Resources and the Wyoming Game and Fish Department to obtain moose. We also obtained animals from north central Colorado as they became available.

Moose Capture

Three methods were used to capture moose. A ground stalking technique that involved hunting the animals on foot or from a vehicle and immobilizing them with a carfentanil (Wildnil, Wildlife Laboratories, Inc., Fort Collins, Co.)-xylazine (Ropun, Bayvet, Shawnee, Ks.) mixture administered at the rate of 2.7mg of carfentanil and 40mg of xylazine per adult moose. Half doses were used for calves. The drugs were delivered using Pneu-dart rifles and darts (Pneu-Dart,Williamsport, Pa.). Naloxone (Dupont Pharmaceuticals, Garden City, NJ) was used to reverse the carfentanil. Moose were captured in forested areas and riparian willow bottoms with this technique.

The second technique was immobilization with 5mg of carfentanil from a helicopter using Pax-Arms equipment (New Zealand). The animals were placed sternally in a sling and transported with a long line under a helicopter to waiting trailers where they were reversed with the antagonist nalmefene (Sigma Chemical, St. Louis, Mo.).

The third technique was a helicopter/net gun system developed by Helicopter Wildlife Management, Salt Lake City, Ut.. A net was fired over the moose from a helicopter and one or two individuals left the aircraft and tied the animal's legs with straps. The moose were suspended, upside down, from a short line and transported to the trailers. The average flight time with the animal was about 3 minutes. Selected animals were fitted with radio collars (ADVANCED TELEMETRY SYSTEMS, Isanti, Mn.). Both of the helicopter techniques required that the animals be in open terrain. In most cases the moose were herded, with the helicopter, from willow bottoms to adjacent openings where they were darted or netted.

All moose were transported to release sites near Creede, Colorado using livestock trailers. In most cases only two moose were transported in each trailer. The animals were separated by a divider to prevent injury. In a few cases cows and their calves or two adults were transported together without apparent problems. The Colorado moose were in the trailers about 7 hours and the Utah and Wyoming moose traveled for about 12 hours. All captures were made in December and January.

Home ranges were calculated based on the harmonic mean of 90% of the observed locations using McPAAL software (Conservation and Research Center, National Zoological Park, Smithsonian Institution). Seasonal ranges were grouped as follows: summer- locations from May 1 through August 31; fall- locations from September 1 through November 30; winter/spring- locations from December 1 through April 30. Tracking of radioed animals was accomplished using a Cessna 185 aircraft and locations were recorded on maps and by Loran- C. Females were also tracked on the ground in July of each year to determine if calves were present. All radio collars were equipped with mortality sensors and all mortalities were investi-

gated to determine cause of death. Each moose was tracked at least once each month for a total of 742 locations.

RESULTS

Capture

During the first year of the project (1991-92 winter) 5 moose (4 adult cows and 1 female calf) were captured in north central Colorado using ground stalking and immobilization techniques. Also, during the first year 26 moose (10 yearling or adult males, 12 adult females and 4 female calves) were captured on the north slope of the Unita Mountains in Utah using the helicopter/drug technique. Fifteen animals were captured in the Bear River drainage and 11 were captured in the Henry's Fork drainage. Three adult cows from north central Colorado and 5 bulls and 10 cows from Utah were fitted with radio collars.

During the second year of the project (1992-93 winter) 4 moose (1 adult male, 1 male calf, 1 adult female and 1 yearling female) were transplanted from north central Colorado using the ground stalking method. An additional 42 moose (10 adult or yearling males, 8 male calves, 16 adult females,8 female calves) were captured in north central Colorado using the helicopter/net gun technique. Also, during the second year 29 moose (9 adult and yearling males, 3 male calves, 14 adult and yearling females, and 3 female calves) were captured and transplanted from the Smith Fork drainage in southwestern Wyoming near Robertson using the helicopter/net gun method. Twenty Colorado moose and 6 Wyoming moose were fitted with radio collars during the second year.

Capture Mortality

Of 9 moose handled by the ground stalking method, 1 adult male was found dead within 5 days of release. No cause of death was determined because of the activities of scavengers.

Six (4 yearling males, 1 adult female and 1 female calf) of 26 moose captured in Utah with the helicopter/drug technique died within 1 week of release. Four were necropsied. The cause of death was found to be aspiration pneumonia associated with rumen fluid and ingesta in the lungs.

One adult female of the 42 moose transplanted from north central Colorado with the helicopter/net gun technique could not rise to leave the trailer at the release site. She was placed in the care of a rehabilitation center and had to be euthanized after 10 days. Necropsy indicated that capture myopathy was the most likely cause of inability of the animal to rise. One additional animal (adult male) died at the capture site as a result of a fractured vertebrae sustained in a fall while under the net.

Four (1 adult female,1 adult male, 1 female calf and 1 male calf) of 29 moose captured with the helicopter/net gun technique in southwestern Wyoming died within two days of release. Necropsy indicated that the cow was very old and in poor physical condition. The calves were also in poor physical condition and were very small; one had aspirated rumen contents. The bull suffered from pulmonary edema. Death was likely due to capture myopathy and/or hypotensive shock associated with stress.

Mortality of moose transplanted from Utah and southwestern Wyoming was significantly higher ($P = .002$) than for moose transplanted from north central Colorado. Of 55 moose captured and transplanted from the same population in Utah and Wyoming, 10 died (18.2%) within 5 days; 2 of 50 (4%) moose transplanted from north central Colorado died. This increased mortality of Utah-Wyoming moose occurred despite some differences in capture techniques per area. Mortality of moose captured with the helicopter/net gun technique was significantly higher ($P = 0.34$) for Utah-Wyoming moose (14%) than Colorado moose (5%).

Other Mortality

During the first year of the project 19 radio collared moose were tracked. Only one mortality was recorded. A 2 year old male was found dead immediately following the big game hunting season apparently from a gunshot wound. One radio signal was lost from unknown causes. During the second year of the project 39 radio collared animals were tracked. Three adult females died in June. At least one mortality appeared to be related to complications with giving birth. The cause of death of the other two was undetermined. Of the remaining 36 collared animals 4 (1 male and 3 females) were illegally killed during the 1993 combined deer and elk hunting seasons.

Post-Release Dispersal

Moose were released at 12 sites along the Rio Grande river and it's tributaries (Fig.1). The maximum straight line distance between sites is 32km. All radio collared animals remained in the vicinity of the release sites during the winter months following release. Snow depths likely precluded long distance travel. Three radio collared moose traveled more than 50km from the release area during the summer following release. One male traveled 156km to the north and returned to the release area in September. One adult female accompanied by her yearling calf traveled 75km to the southwest and remained in that area until she was illegally killed after about 17 months. A second adult female moved 145km to the north and remained in the area. One yearling male without a radio transmitter moved at least 165km to the west and was recaptured and returned to the release site when he moved into an urban area of Cortez, Colorado. One radio collared male moved 61km northeast during the second summer following release and returned to the release area in September. Many animals, both male and female, moved between 25 and 50km,

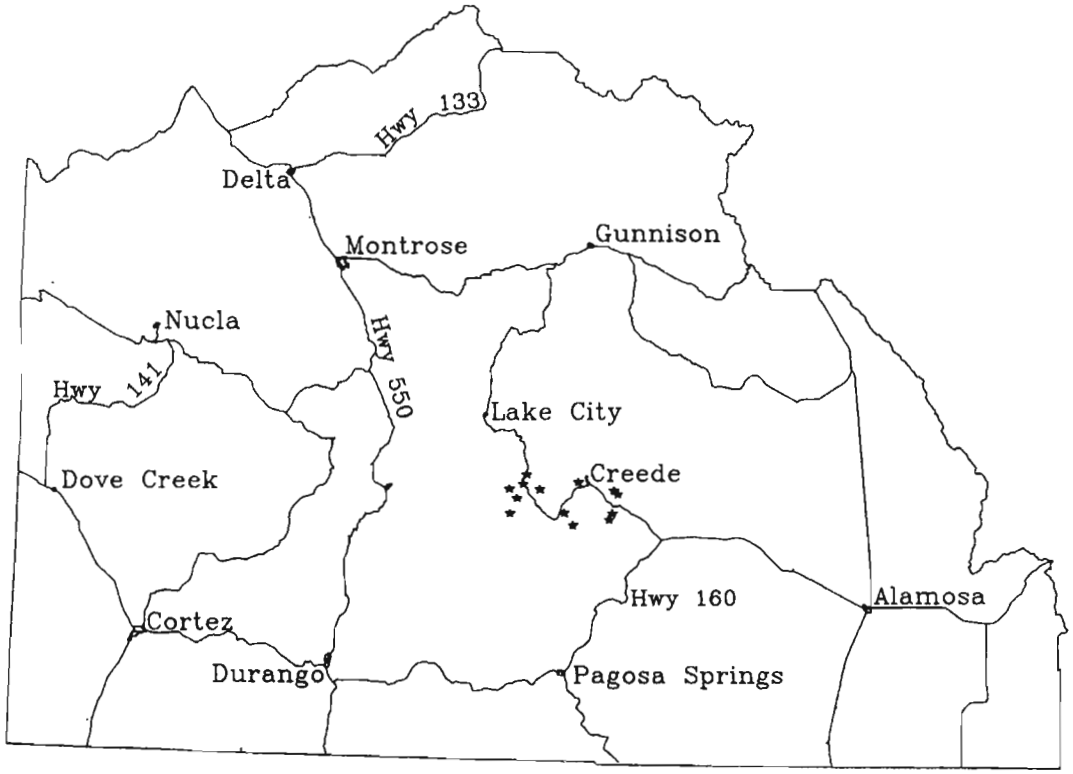

Fig. 1. Moose release sites in southwestern Colorado.

often returning to the vicinity of the release site. The movements appeared to be random in direction and occurred more frequently during September. We believe both sexes were searching for mates and that the low density of moose contributed to the movements.

Reproduction

In July 1992 14 adult females were located and observed to determine if calves were present. Seven calves were observed, 4 with the 4 cows transplanted from north central Colorado and 3 with 10 cows transplanted from Utah. The same animals were observed in 1993 and 5 calves were present, 3 with the Colorado cows and only 2 with the Utah cows.

The 17 adult cows transplanted in 1993 had 12 calves with them in July of 1993, 11 with 12 cows from north central Colorado and only 1 with 5 cows from southwestern Wyoming.

DISCUSSION

Moose Capture

Although we did not weigh the moose that were captured, it was apparent during capture and handling that animals from north central Colorado were in better physical condition than animals from Utah and Wyoming. The Colorado animals were larger and appeared to have more fat reserves and better hair coats. The Utah and Wyoming animals were under stress from severe winter conditions during both years. The reproductive performance of Colorado moose was much better than the Utah and Wyoming moose, a further indication of superior physical condition. We believe capture related mortality is directly related to the physical condition of the animals. The duration of transport time could also be a factor although we doubt the additional 5 hours of transport for the Utah and Wyoming animals was significant. Schmitt and Dalton (1987) documented mortalities of 4 moose captured in Ontario and suggested that 2 were predisposed to death because of age and physical condition.

The helicopter/drug technique resulted in problems with aspiration of rumen fluid and secondary pneumonia. Drugs may have exacerbated regurgitation during handling, especially when the weight of the animal was on the ventral abdomen while suspended under the helicopter. Similar problems were observed when moose were drugged with carfentanil and carfentanil-xylazine on Isle Royale (Seal *et al.* 1985).

Of the three capture methods used, the ground stalking method was least efficient and required the most manpower. We were only able to obtain 3 or 4 animals per day by this method. Moving the immobilized moose onto a sled and pulling it to a location where it could be loaded into a trailer required efforts of 6 to 8 people and subjected the animal to the effects of the drug for an extended period of time (45 min.to 1.5 hrs). Since the body temperature of the animals under the influence of the drug can become elevated it is imperative to handle them quickly.

The helicopter/drug immobilization method was about twice as expensive as the helicopter/net gun method. We were able to deliver moose to the trailers at the average rate of about 4 per hour using the net gun and at about 2 per hour using drugs. In addition, 2 helicopters were used for the drug operation, 1 to shoot and a larger one to transport. Drugs are also costly and can be dangerous to humans. The average cost per moose delivered to the trailer with the net gun technique was $250.00. The helicopter drug method cost over $500.00 per animal.

Post-Release Dispersal

Although most of the moose remained in the general area of the release sites for the duration of the first winter many seemed to wander in summer and fall. They frequently returned to the vicinity of the release site. The

fall movements were more pronounced and may have been in response to breeding season. We considered all moose that remained within 50 km of the release area to be a part of the breeding population. The radio collared moose, excluding two females that moved more than 50 km and never returned, occupied an area of approximately 10,000 km^2. The occupied area was largest in the fall at 10,014 km^2 (Fig 2). The winter range was the smallest at 2,358 km^2 (Fig.3). During summer 4,963 km^2 were occupied (Fig.4). The animals were most often associated with riparian willow habitat.

MANAGEMENT IMPLICATIONS

We found the helicopter/net gun method of capturing moose for transplant to have the lowest mortality rate and to be the most cost-effective of the 3 methods we used. The animals are not subjected to the effects of drugs and can be handled quickly.

We recommend that moose be moved in early winter before they are stressed by severe winter conditions. We also recommend avoiding moving small calves or very old animals that are in poor physical condition.

The most significant cause of non-capture related mortality to moose in our study was illegal killing by hunters who were in the field pursuing other species. This occurred in spite of a large effort to educate hunters and the general public about the presence of moose in the area. Signs were placed along access roads and each elk hunter who was successful in drawing a license for the area was sent an informational letter about moose, including drawings showing differences between moose and elk. During the second year of our project, 4 of 36 radio collared animals were illegally killed. We recommend that biologists plan for similar losses when proposing a transplant.

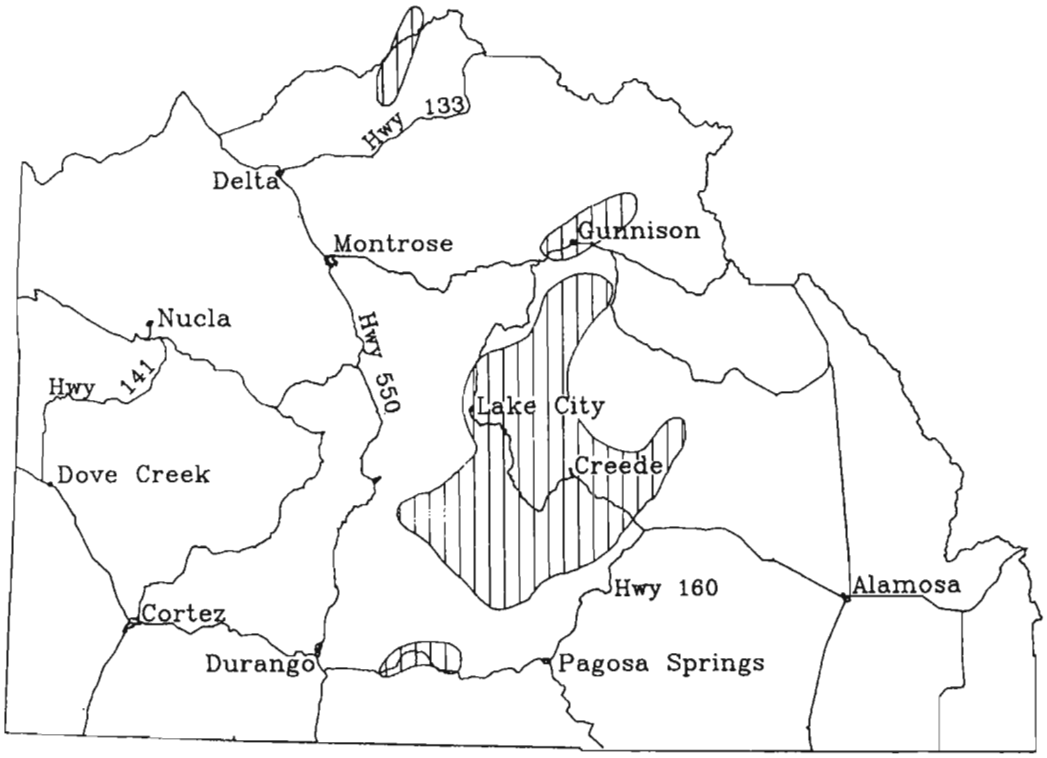

Fig. 2. Area occupied by 44 radio collared moose in SW Colorado in the fall of 1992 and 1993 (September 1 to November 30).

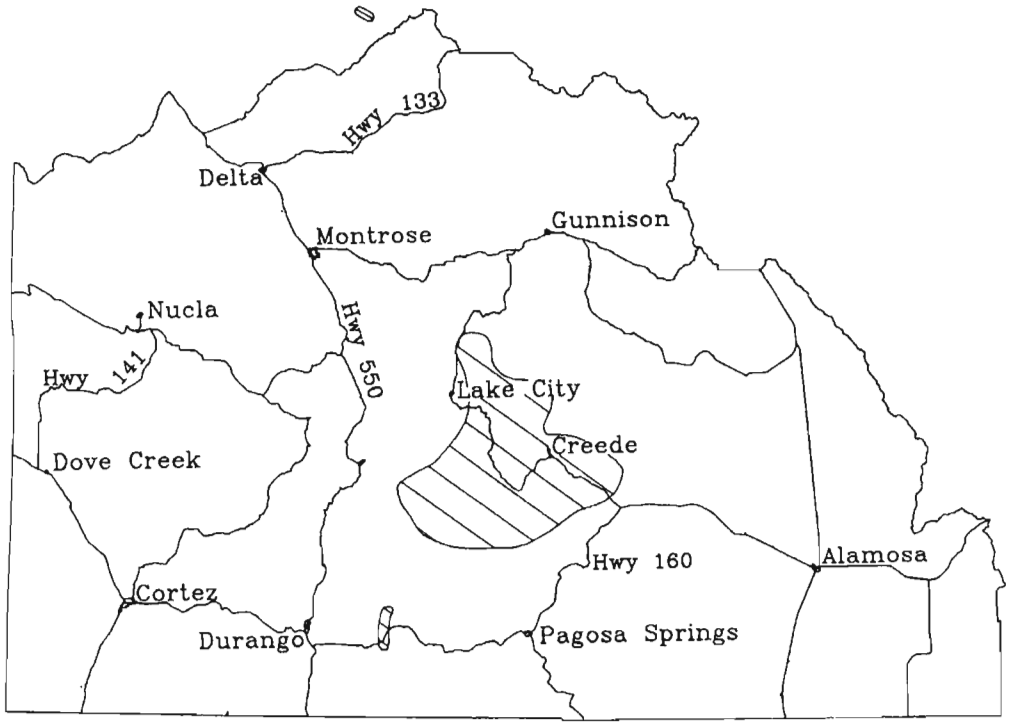

Fig. 3. Areas occupied by 44 radio collared moose in SW Colorado in the winters and springs of 1992-93 and 1993-94 (December 1 to April 30).

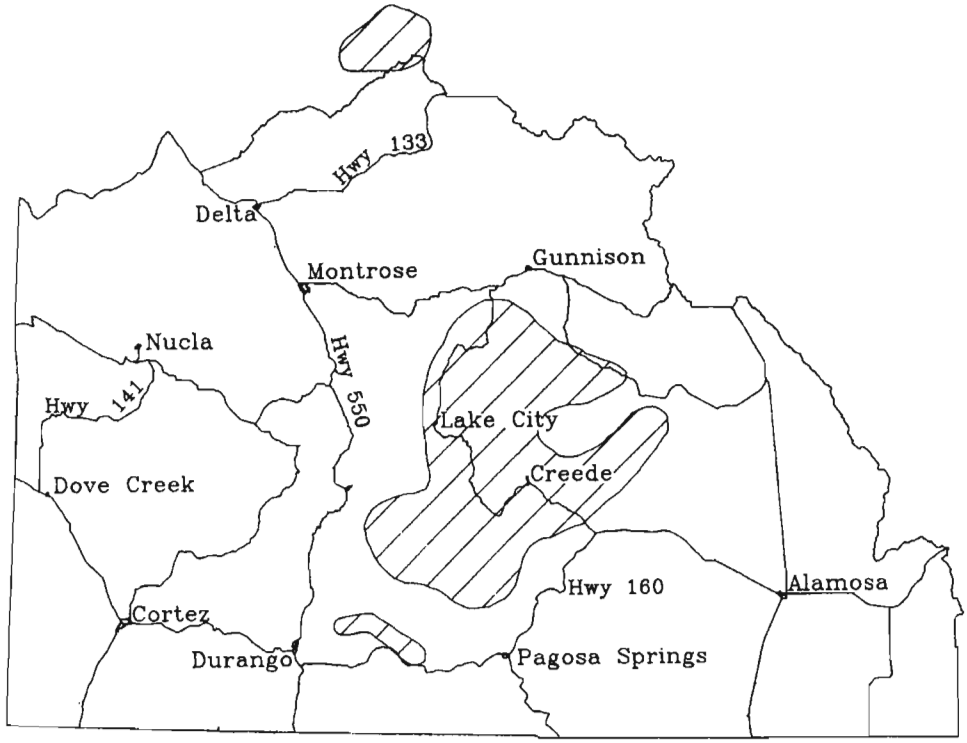

Fig. 4. Areas occupied by 44 radio collared moose in SW Colorado during the summers of 1992 and 1993 (May 1 to August 31).

Some transplanted animals will leave the release area and become lost to the breeding population. In our study, 2 of 30 radio collared females left the area and established home ranges where there were no other moose. In addition, at least 6 marked moose without radio transmitters have been observed more than 50 km from the release area. We believe that it is important to transplant relatively large numbers of moose to insure that a viable breeding population is established. The minimum number of animals required will depend on the amount of habitat available, the proximity to other moose and the subspecies of moose to be transplanted.

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