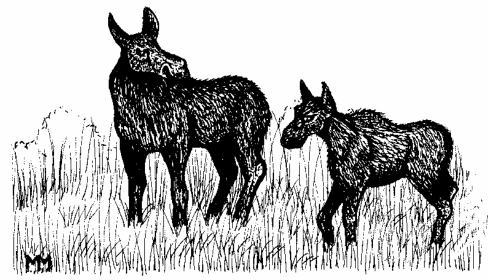
# Northwest Minnesota
# Moose Mystery Research



## Summary Report

**Acknowledgements:** Results are finally in on the moose research project initiated in 1995. The death of the graduate student Eric Cox and pilot Grant Coyour, June 11, 1999, on the last calf production flight of the study was a great set back to getting the data analyzed and put into publication. Dr. Warren Ballard of Texas Tech University, who has vast experience working with moose and predators in Alaska, was hired to complete the job. Eric was an ambitious researcher and left no stone unturned. The volume of data that was collected made Dr. Ballard's undertaking monumental.

**Our sincere thanks and appreciation goes out to all of the citizens and land owners** who assisted with the study by allowing access to your property, reporting sick or dead moose and monetary donations. Many of you became involved with captures, transportation and pulling our vehicles out of mud or snow. Without your interest and assistance the project would not have been as complete. Thank you to the many private citizens, local businesses, sportsmen and conservations groups who provided funding for the study and the very successful **Adopt-A-Moose** program. We are also indebted to the numerous student volunteers that endured the cold and the mosquitoes just for the experience. We hope it has benefited your careers.

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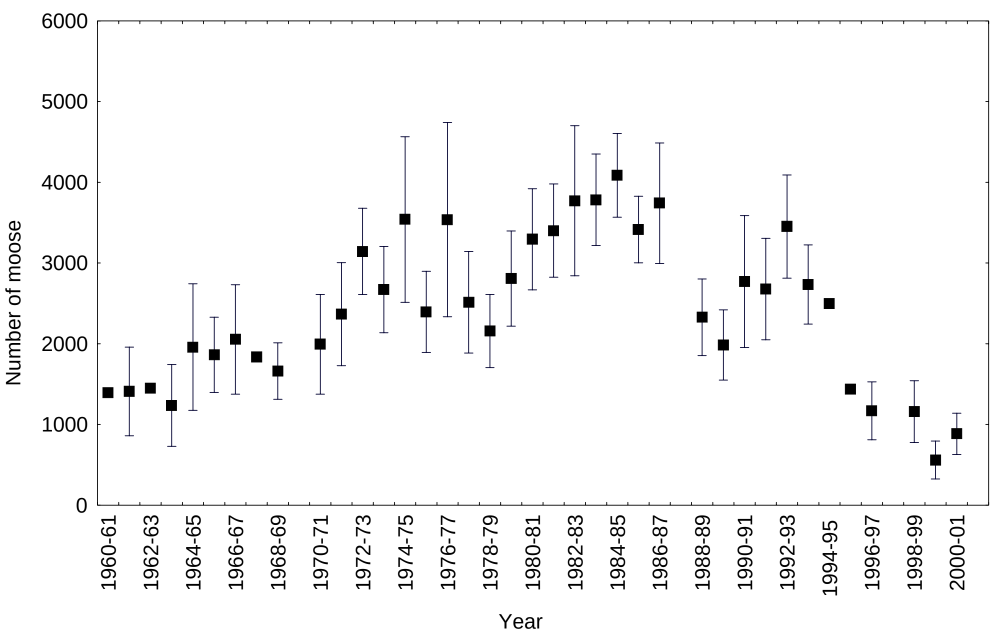
The moose research project was initiated in 1995 to investigate the reasons for the sharp decline in moose numbers during the early 1990s.

**Northwest Minnesota Moose Population 1960 to 2001**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**Three study areas** were chosen to examine what was perceived, at that time, to be three different densities and rates of decline. They were:

- **Red Lake Wildlife Management Area (WMA) in the Beltrami Island State Forest**
- **Agassiz National Wildlife Refuge**
- **Viking Area agricultural lands** up to and including **Thief Lake WMA**

**152 moose (52 calves, 100 cows) were radio collared** between 1995 and 1998. The radio collars had motion sensors that sent out a different signal rate when the collar (or moose) had not moved for 4 to 6 hours. This signal is often called a "mortality signal" indicating that an animal had died and needed to be found to determine the cause of death. Between May 1995 and July 2000, ***76 of the radio collared moose died***. Thanks to the reporting efforts of the public an ***additional 84 dead moose that were not radio collared were examined*** by the research crew. The mortality results are summarized in the following Table.

**Percent of moose mortalities by apparent cause of death, 1995-2000.**

| | **Radio Marked Moose** | **Non-Radio Marked Moose** |
|---|---|---|
| **Cause** | **Percent** | **Percent** |
| Liver Fluke | 32 | 7 |
| Disease/starvation | 25 | 33 |
| Unknown | 25 | 5 |
| Predation | 7 | 0 |
| BrainWorm | 5 | 20 |
| Vehicle Collision | 4 | 26 |
| Poaching | 2 | 3 |
| Starvation | 0 | 1 |
| Natural Accident | 0 | 5 |
| **Total** | **100** | **100** |

***Deaths attributed to brain worm and vehicle collision are much higher for the non-radioed animals.*** This reflects a bias toward more easily observed causes of death, since most of the non-radioed moose were found by the public, rather than by radio tracking. The deaths due to accidents, vehicle collisions and poaching were combined as a sample of the "healthy, normal population" to compare health parameters to the other causes of death. Many aspects were looked at for their possible relationships to these apparent causes of death.

***Hunting was unlikely to be the cause of the population decline*** because hunting had been at a very low rate (3-25% per year and only every other year). The population usually grew in years after hunting seasons. Hunting seasons were closed in 1996 and yet the population has not recovered.

**Cows with calves:** (from DNR's annual census data)

<u>1984 to 1997</u> - varied from 54 to 94%.
<u>After 1997</u> - this percentage dropped below 50%.

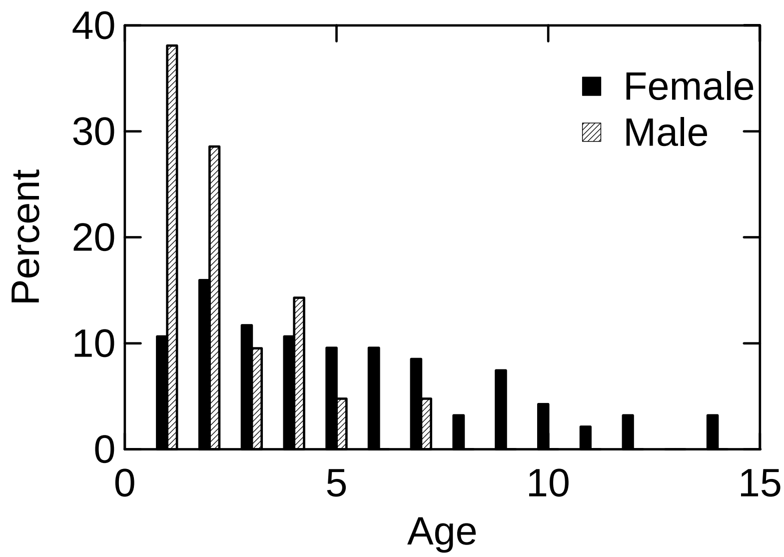
**Ratio of Bulls to Cows:** (from DNR's annual census data)

Prior to 1996 - percent of bulls to the number of cows varied between 57 to 94%.
After 1996 - percent of bulls increased to 129 to 165% after hunting seasons closed.

Bull to cow ratios were never below 50% which means there were an adequate number of bulls in the herd, and the population has not shown an increase with the increased percentage of bulls. This indicates that ***other factors besides availability of bulls is decreasing production.***

**Age:** Age was determined by counting cementum annuli of teeth removed from dead animals. From these data we inferred the ***age structure of the herd and found that it was skewed toward younger age classes*** as shown in the next figure. There were relatively few old cows and nearly all males were less than 5 years old. ***The lack of a high percentage of prime breeding ages (4-7 year olds) suggests a declining population.***

**Age Structure of Moose Herd in Northwestern Minnesota**




**Fecal samples** were collected at time of capture and in the snow from radio-tagged moose during subsequent winters. **Blood samples** were also taken at the time of capture. **Pregnancy rates** were checked by a combination of assays for fecal progestagens, blood serum progesterone and aerial observations of calves in late May. ***Pregnancy rate averaged 47.9%.*** There were no statistically significant differences among study areas, age class, or years but there was a trend for the lowest rate to be among yearlings and the highest rate at age 6 or 7. The lowest year was 38.5% in 1996 and the highest year was 58.6% in 1999. ***The highest pregnancy rate by area was 51% for the Agricultural area. Twinning rate was only 17%. These pregnancy and twinning rates are low compared to other populations.*** For example, pregnancy rates in other studies in Canada and Alaska vary between 60 to 100% and averaged 84%. Twinning rates averaged 38%. In our population the pregnancy rate for yearlings was less than 20% compared to a population in Montana where it was 32%. ***The low pregnancy and twinning rates in Northwest Minnesota suggest a nutritional limitation.*** If quantity of forage had been limiting, it should be replenished after several years of a low population, however, since the population has not recovered even after a series of very mild winters ***it would not appear that the amount of***

***forage is limiting.*** We also examined the quality of browse by collecting twigs from the plants that moose were found eating in the winter and ***found the amounts of nutrients and protein (6.7 to 9.3% protein) to be adequate.***

***Low pregnancy rates were directly correlated to low bone marrow fat and a low blood condition index.*** The blood condition index was based on the blood samples that were collected when the animals were captured. Bone marrow fat was determined by taking a sample of bone marrow from the leg bone of dead moose. Bone marrow fat was lower for moose dying of natural causes than for those dying from accidents (vehicle collision, poaching and other natural accidents) implying that malnutrition contributed to moose mortality. ***Moose that eventually died within 18 months after capture had body condition index ratings of Poor at the time of capture, indicating that the malnutrition was a long term chronic condition. This type of malnutrition is consistent with a parasite-mediated condition.***

**Liver samples** were taken from dead moose to determine concentrations of 19 minerals and trace elements. Analysis of 106 liver samples revealed ***deficient levels of copper and selenium*** (based on threshold levels for domestic cattle and compared to several other moose studies). ***Copper deficiencies in livestock have been shown to contribute to low reproductive rates and may have an influence on low reproduction in Northwest Minnesota moose.*** The analysis, however, failed to find any correlations with apparent causes of death or other factors. In Sweden, the affects of acid rain on copper and molybdenum relationships resulting in copper deficiency has been proposed as one of the plausible causes for a moose population decline which resembles Northwest Minnesota's decline. One of the other plausible causes of the moose decline in Sweden is a viral disease. We sent tissue samples to Sweden but they did not find the same virus present in our samples.

Compared to other populations in Alaska and Canada, cows and yearlings in Northwest Minnesota had lower annual survival rates but calves had a higher annual survival rate (the chance of living for one more year). The adult cows in Northwest Minnesota had an annual survival rate of 79% compared to 75 to 94% in other studies. Calves had an annual survival rate of 66% compared to 2 to 27% in other studies. In most other places predators play a significant role in calf mortality but it was only 4% in Northwest Minnesota. The difference in the annual survival rate for calves is very significant. A moose calf in Northwest Minnesota has a 66% chance of surviving to be a yearling, where a moose calf in Alaska or Canada only has a 20+% chance of becoming a yearling. ***Whatever is limiting the population in Northwest Minnesota is not affecting calf survival.***

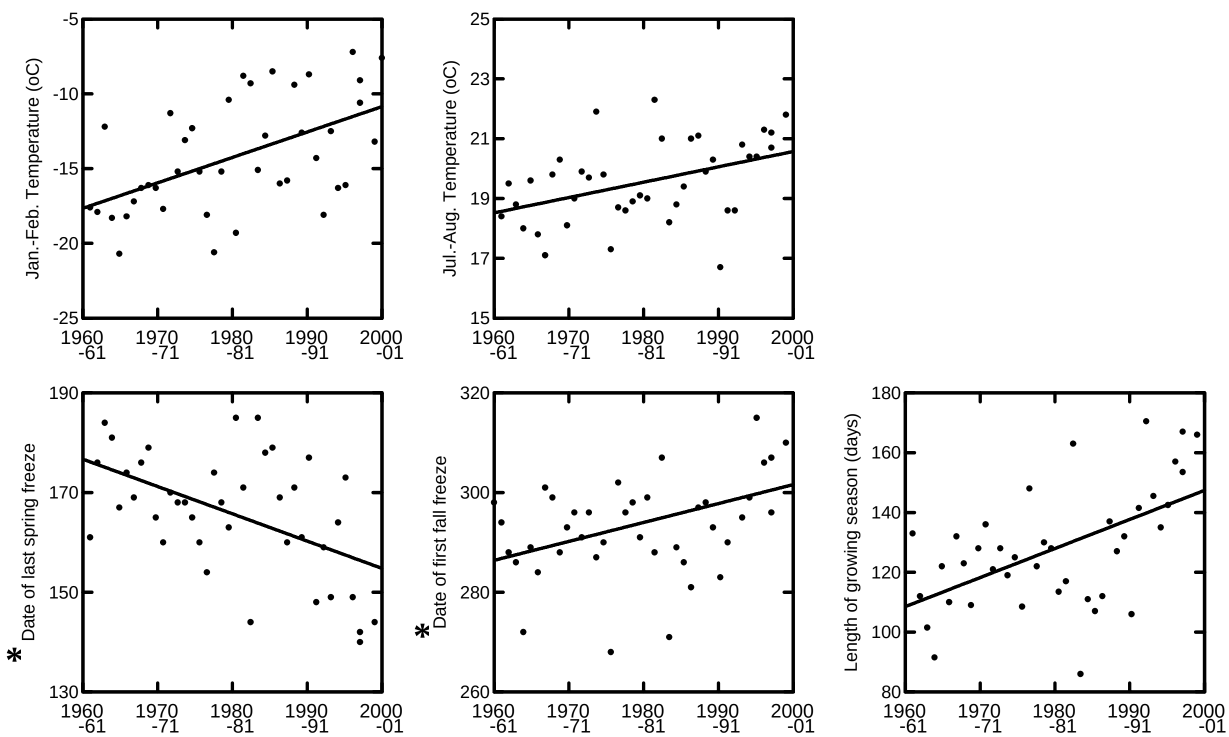
**Blood serum was checked for leptospirosis and brucellosis.** There were ***no positives for brucellosis***. There were differences between the study areas for leptospirosis, but no correlations to pregnancy status or pathology. Brains that were submitted to the Veterinary Diagnostic Lab, North Dakota State University, were examined for chronic wasting disease. ***No CWD was found***.

***There were no correlations between deer population and the decline in moose population, however, liver flukes, brain worm and winter ticks are deer parasites that have adverse affects on moose.*** During the time period of this study winter ticks were counted on skin samples but did not appear to have caused any mortality. ***Liver flukes and brain worm were a major apparent cause of death*** and may have been an even larger part of mortality as they may have contributed to the unidentified disease and starvation and the unknown deaths.

## SO…The BIG question is … what could have changed since 1984 that would make the above mortality factors more prevalent?

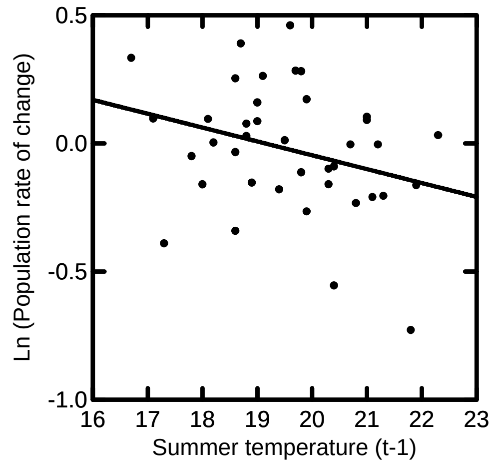
**Climatic factors** based on data from a weather station near Norris Camp were examined for changes in the past 41 years that may have affected these mortality factors. The results are graphed in the figures below. Correlations were not found between population change and precipitation or snow depths, however, ***population decreases often occurred the year after summers with higher mean summer temperatures. Winter and summer temperatures in the past 41 years have increased by about 12˚F and 4˚F, respectively*** and the growing season has lengthened by about 39 days. Other moose research has shown two temperature thresholds for moose. ***March temperatures above 23˚F and September temperatures above 57˚F require moose to expend energy to keep cool. Since the peak moose population year in 1984, there have been more years when March and September mean temperature exceed these thresholds than between 1960 and 1984.*** Warmer temperatures may have contributed to increased energy demands for moose to keep cool causing a disruption of energy balance. While the exact mechanism involved in this response is not understood, the additional heat stress may accentuate poor body condition due to parasite induced chronic malnutrition, resulting in lower reproductive rates that may also be impaired by copper deficiency.

**Climate Data for Norris Camp, 1960 to 2001**




*** NOTE:** date of last spring freeze & first fall freeze are based on the number of days after January 1 (Julian Date).

NOTE: Summer temperature (t-1) is the mean summer temperature one year prior to the population change on the vertical axis.




***The study concluded that climatic changes combined with increases in deer numbers and parasite transmission rates may have rendered Northwest Minnesota inhospitable to moose.*** The decline of the moose population in Northwest Minnesota does not appear to be from causes that management actions can change. Until the climatic factors that are making the moose range shrink to the North are reversed we will probably see fewer moose in Northwest Minnesota.

**Local Contacts**

| **Agassiz NWR** | **Red Lake WMA** | **Thief River Falls** | **Thief Lake WMA** |
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