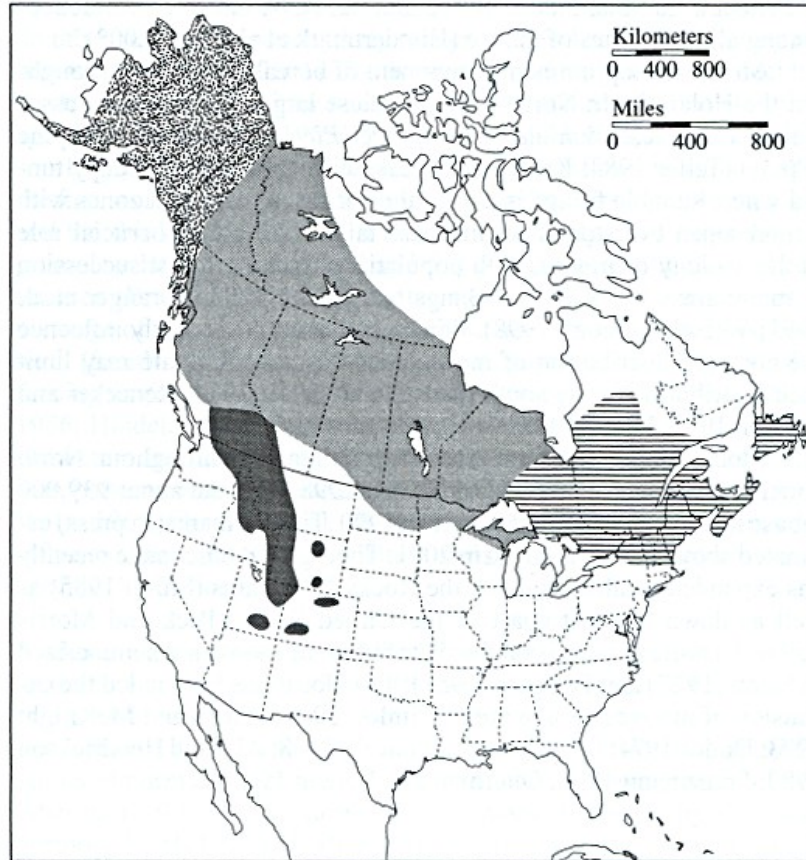




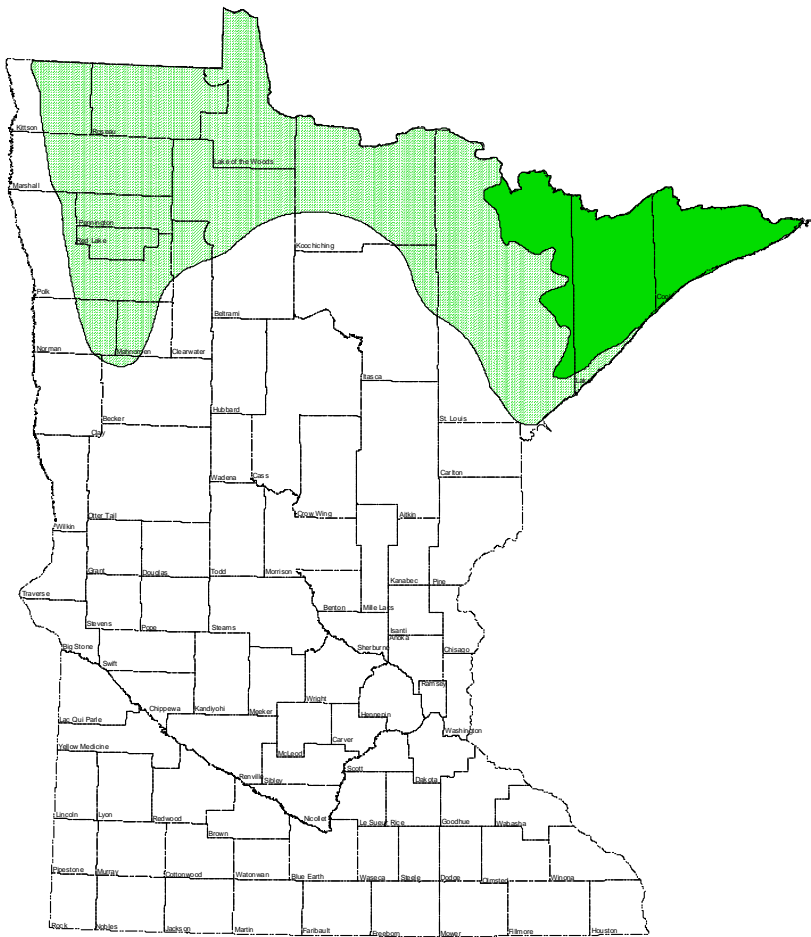




**Moose Mortality in Northeastern Minnesota
as a Function of Temperature**

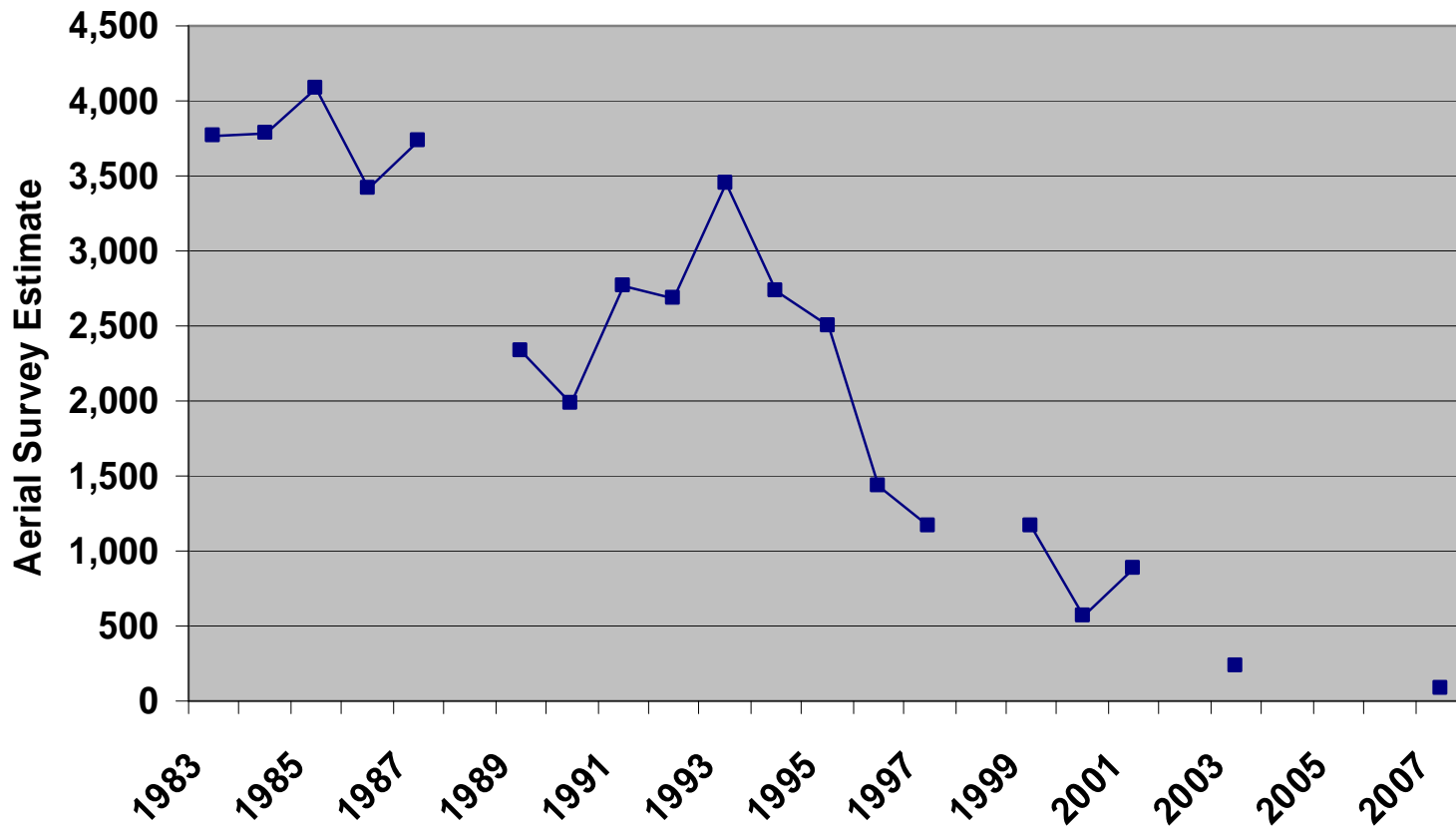


-  *A.a. americana*
-  *A.a. andersoni*
-  *A.a. gigas*
-  *A.a. shirasi*





Northwestern Moose Population





Number 166



WILDLIFE MONOGRAPHS

December 2006

A Publication of The Wildlife Society



Pathogens, Nutritional Deficiency, and Climate Influences on a Declining Moose Population

Dennis L. Murray, Eric W. Cox, Warren B. Ballard, Heather A. Whitlaw, Mark S. Lenarz,
Thomas W. Custer, Terri Barnett, and Todd K. Fuller

Supplement to The Journal of Wildlife Management

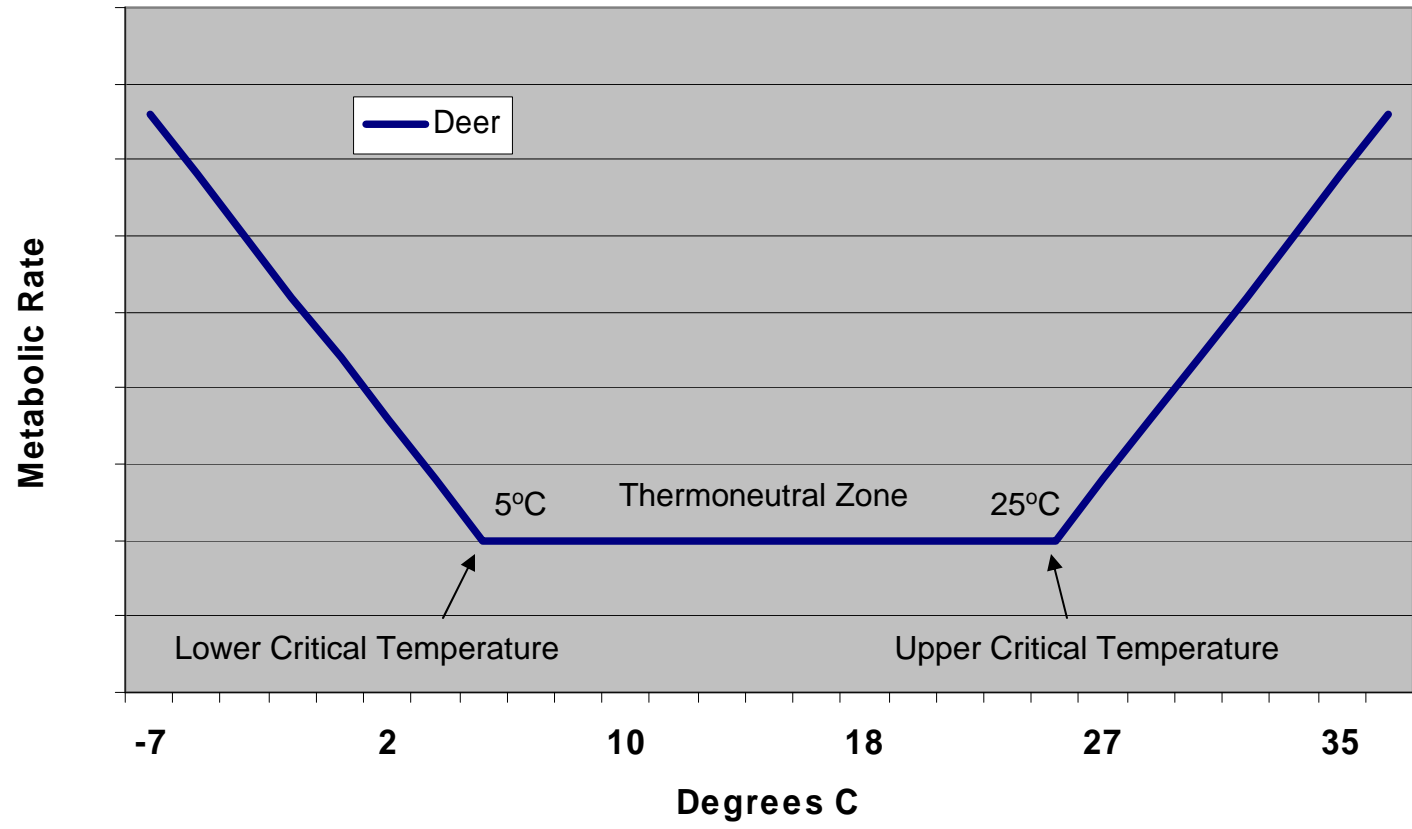


If the population growth rate of moose in northern Minnesota is reduced by warming temperatures,

there should be a functional relationship between moose survival and some measure of heat stress.

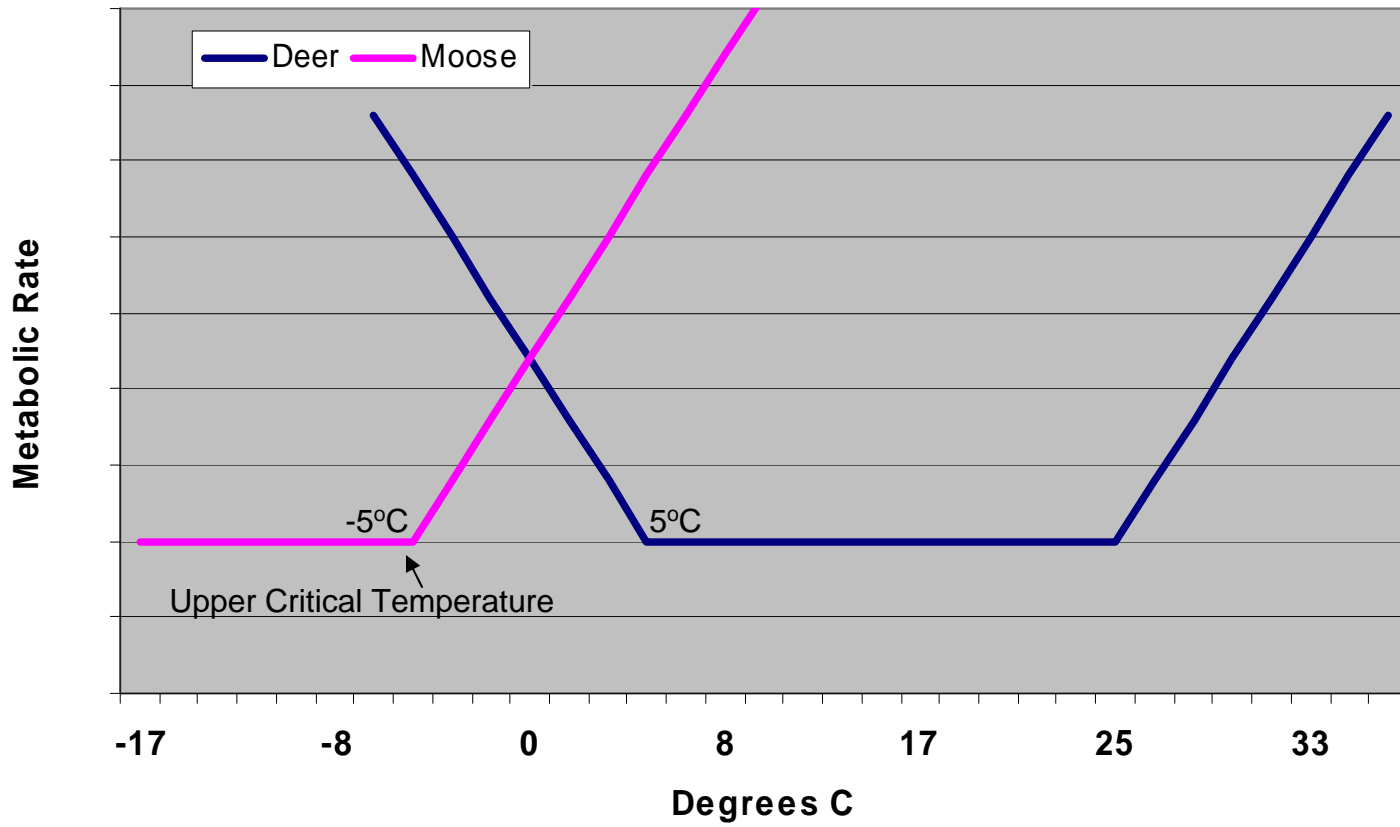


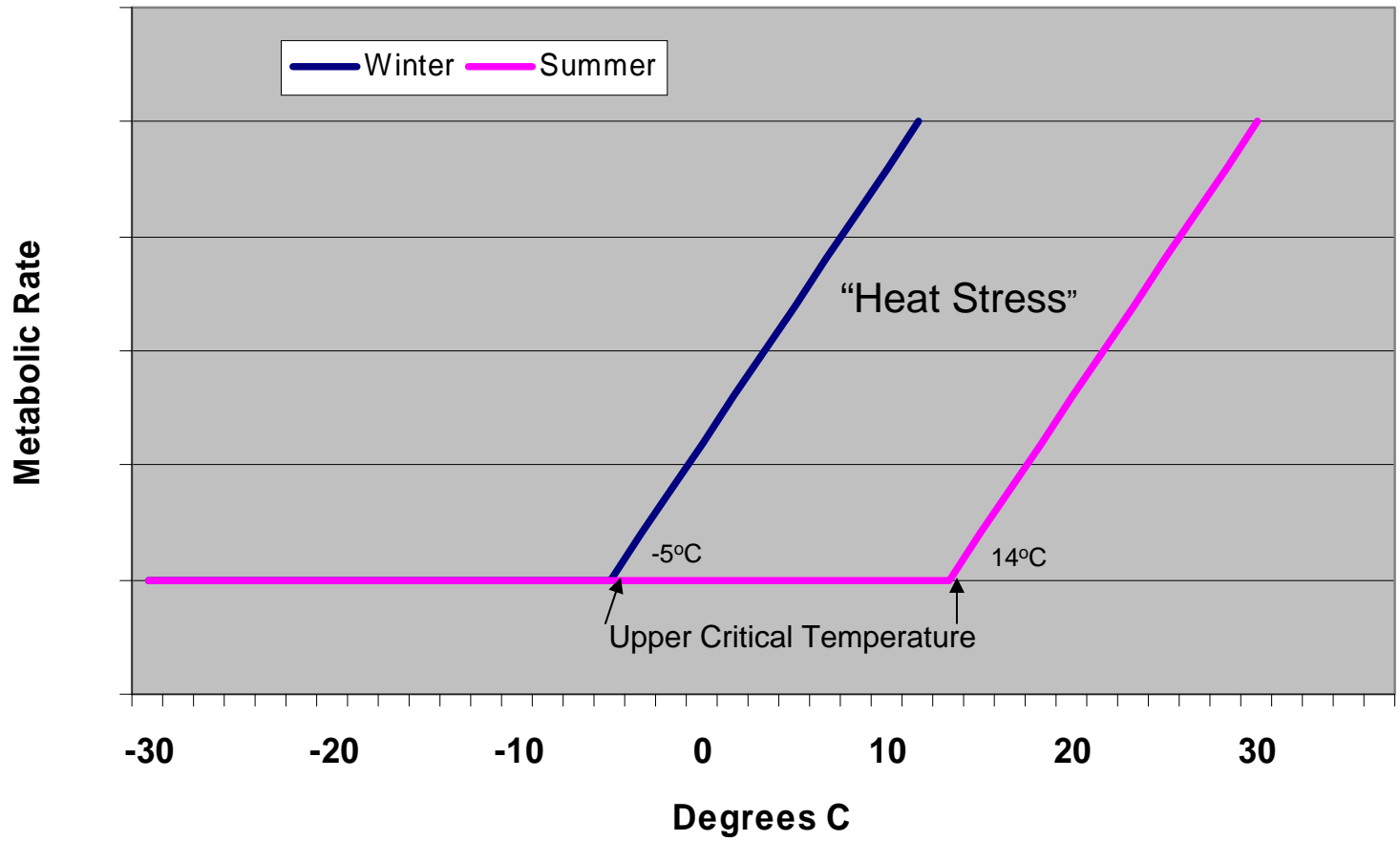
Thermoregulation in Winter





Thermoregulation in Winter







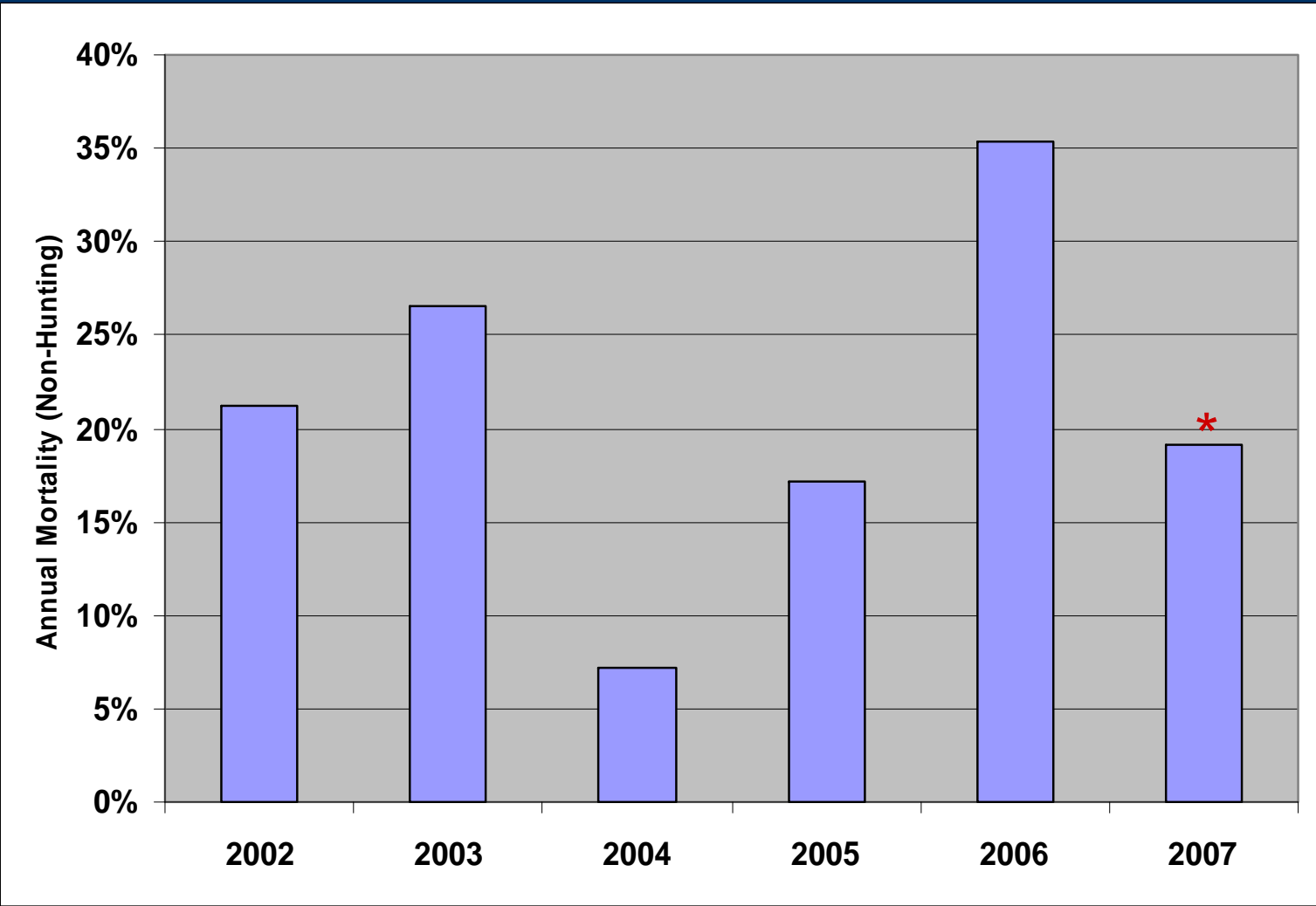
In domestic cattle, heat stress causes:

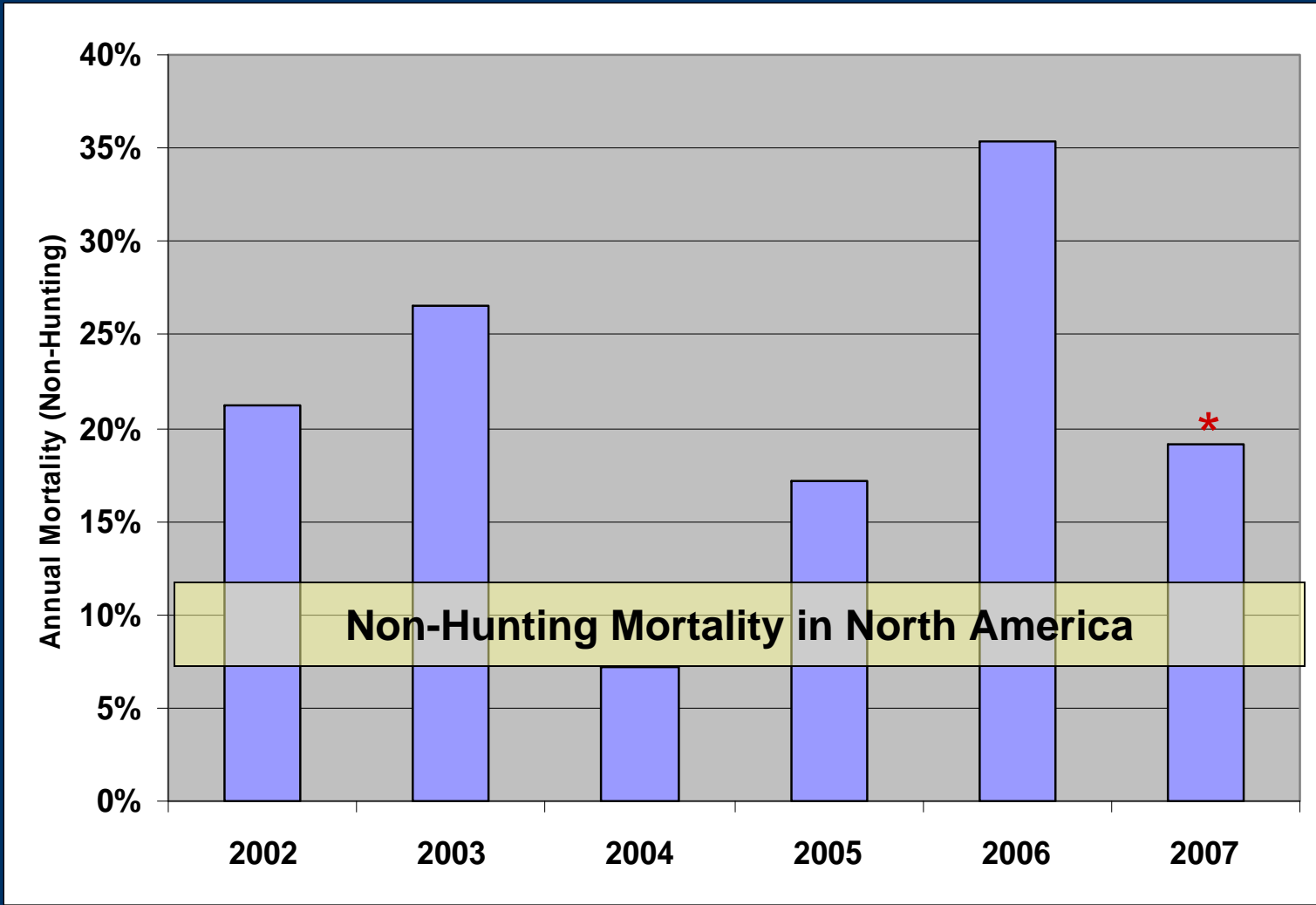
- Decreased food intake
- Reduced weight gain
- Decreased milk production
- Impaired immune system

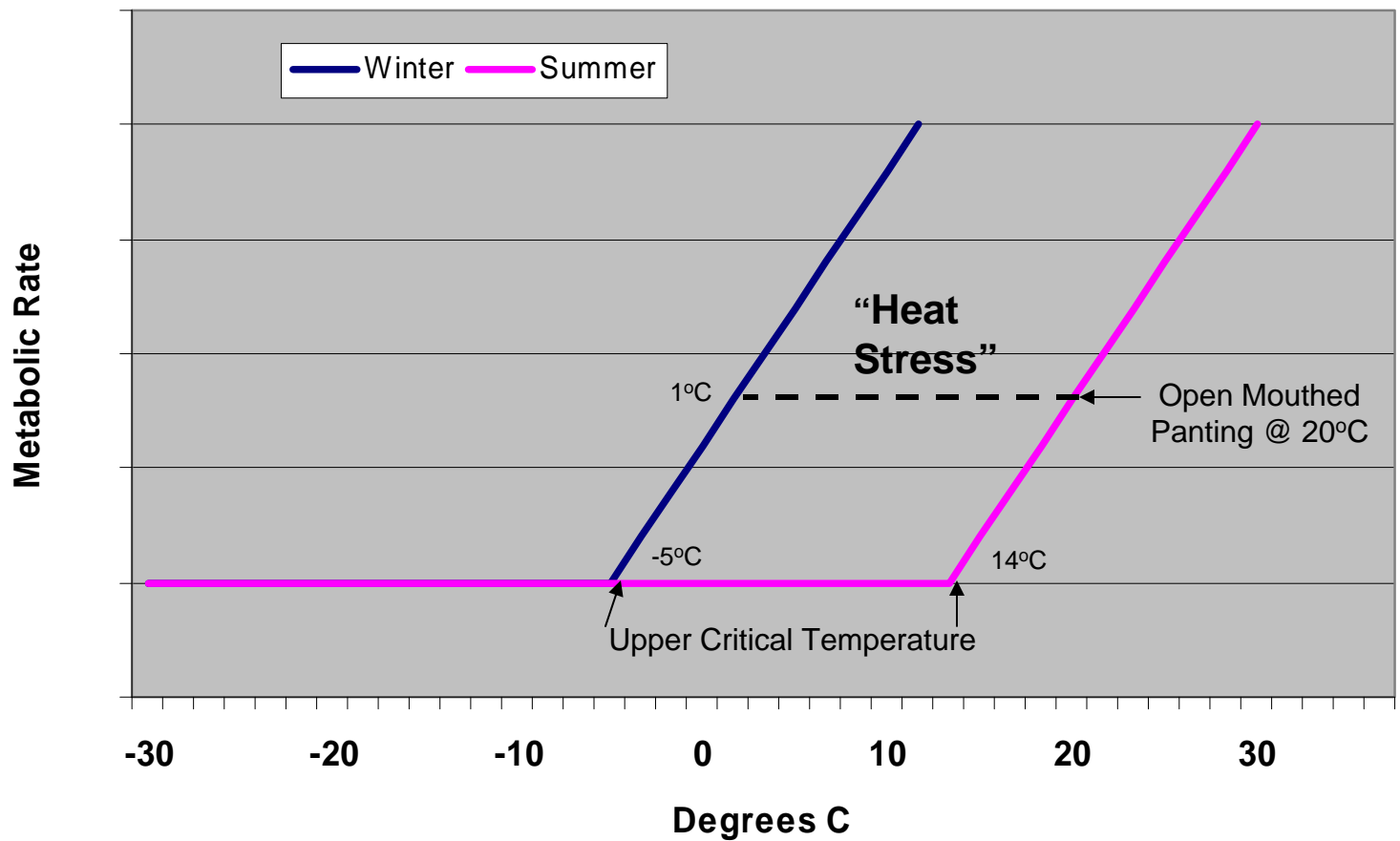


Moose Research in northeastern Minnesota

- Between 2002 and 2005, we captured and radio collared 114 moose.
- As of 12/3/2007, 29 moose have died from anthropogenic causes (hunting, vehicle accidents)
- 54 have died from non-anthropogenic causes (disease, parasites, or predation)

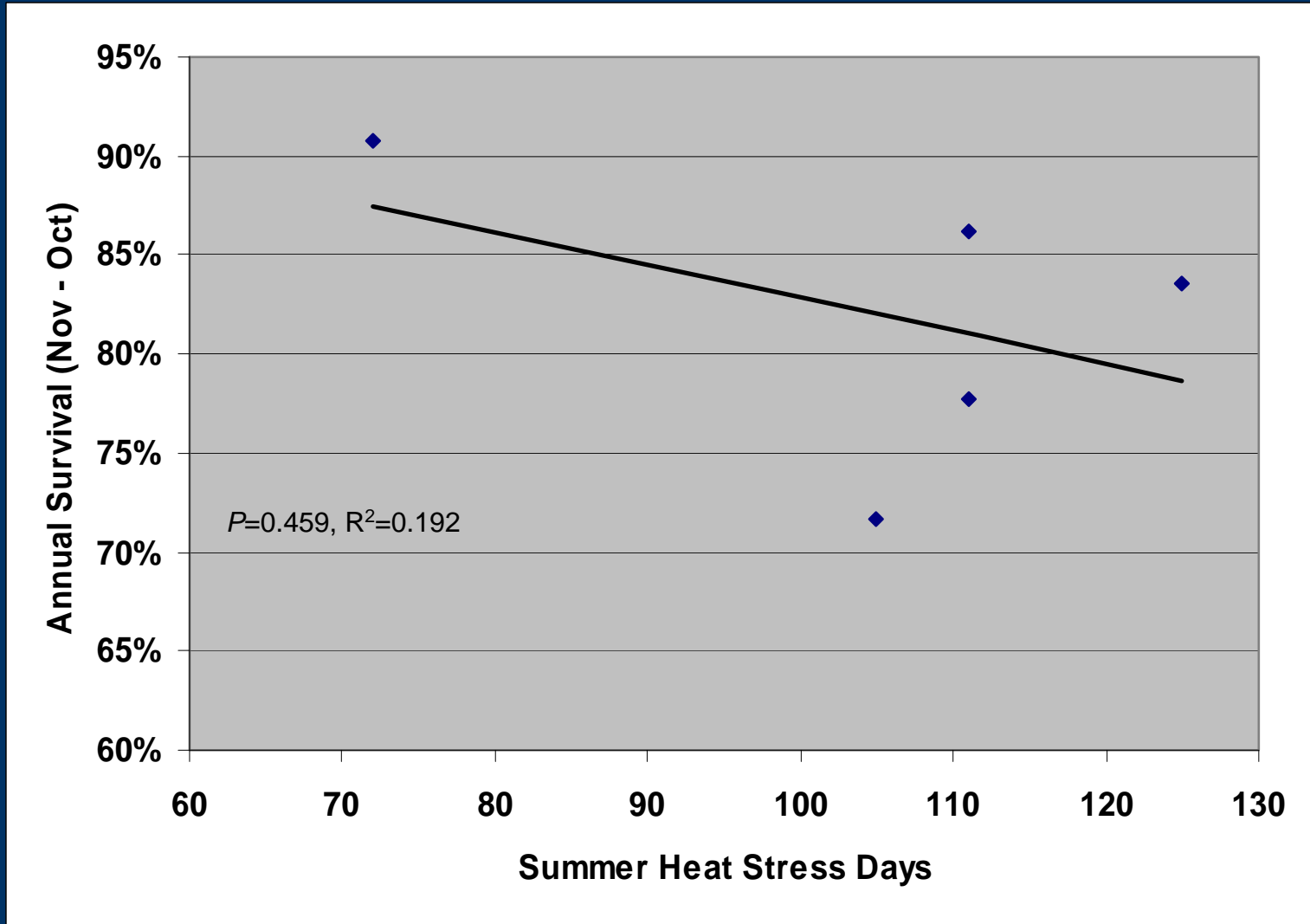


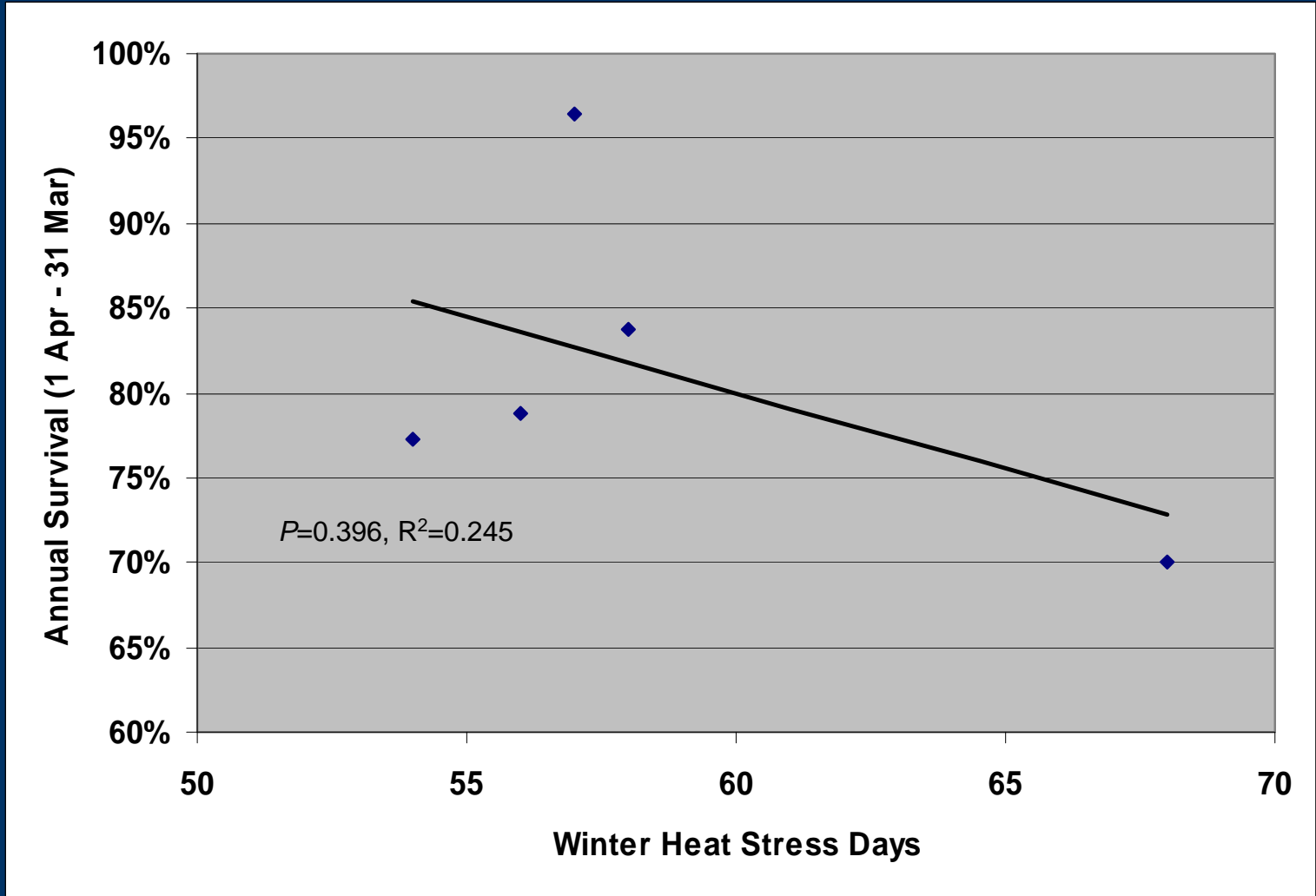






Tabulated the number of days $> 20^{\circ}\text{C}$ in summer (March – October)
And number of days $> 1^{\circ}\text{C}$ in winter (November – March).



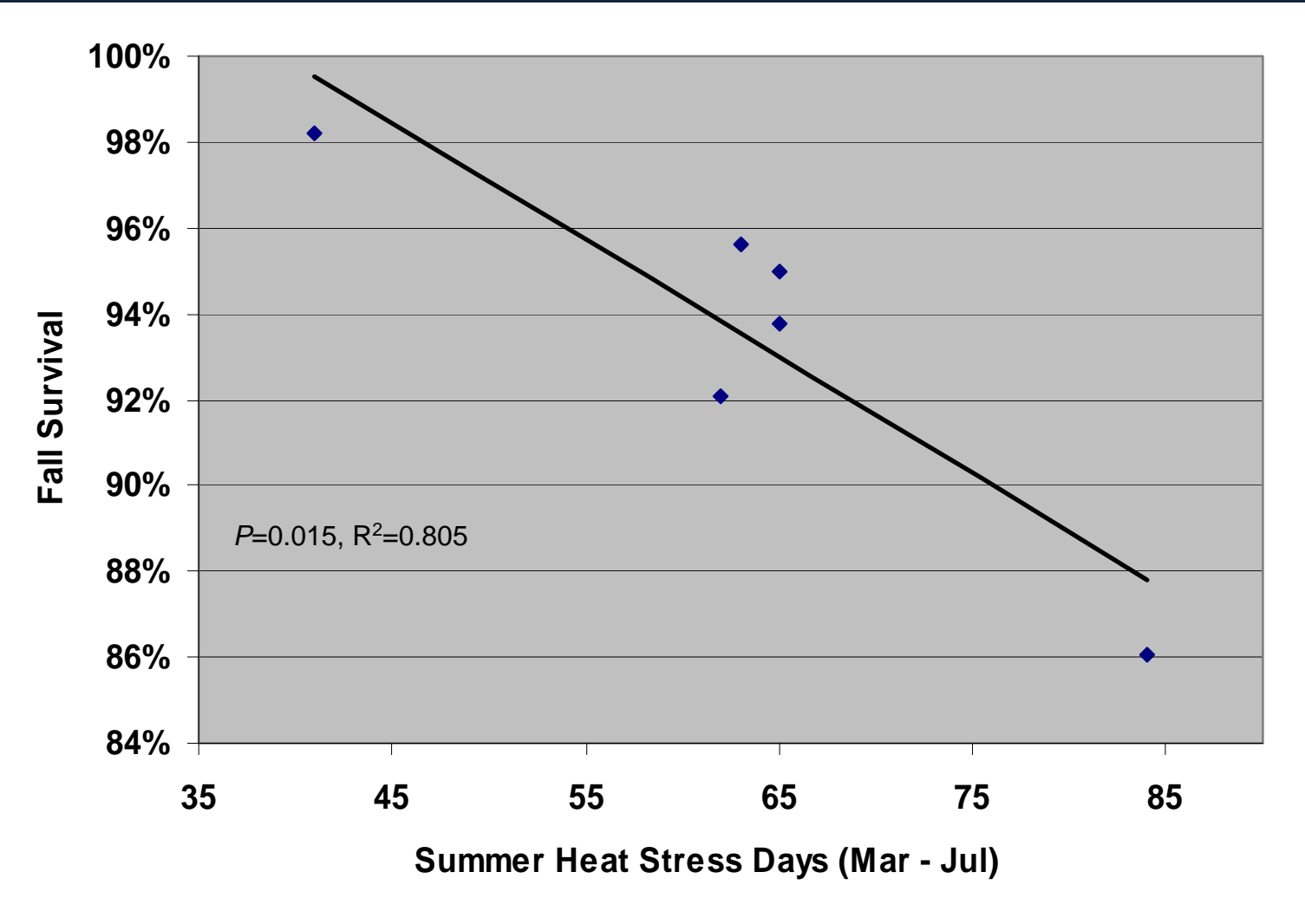


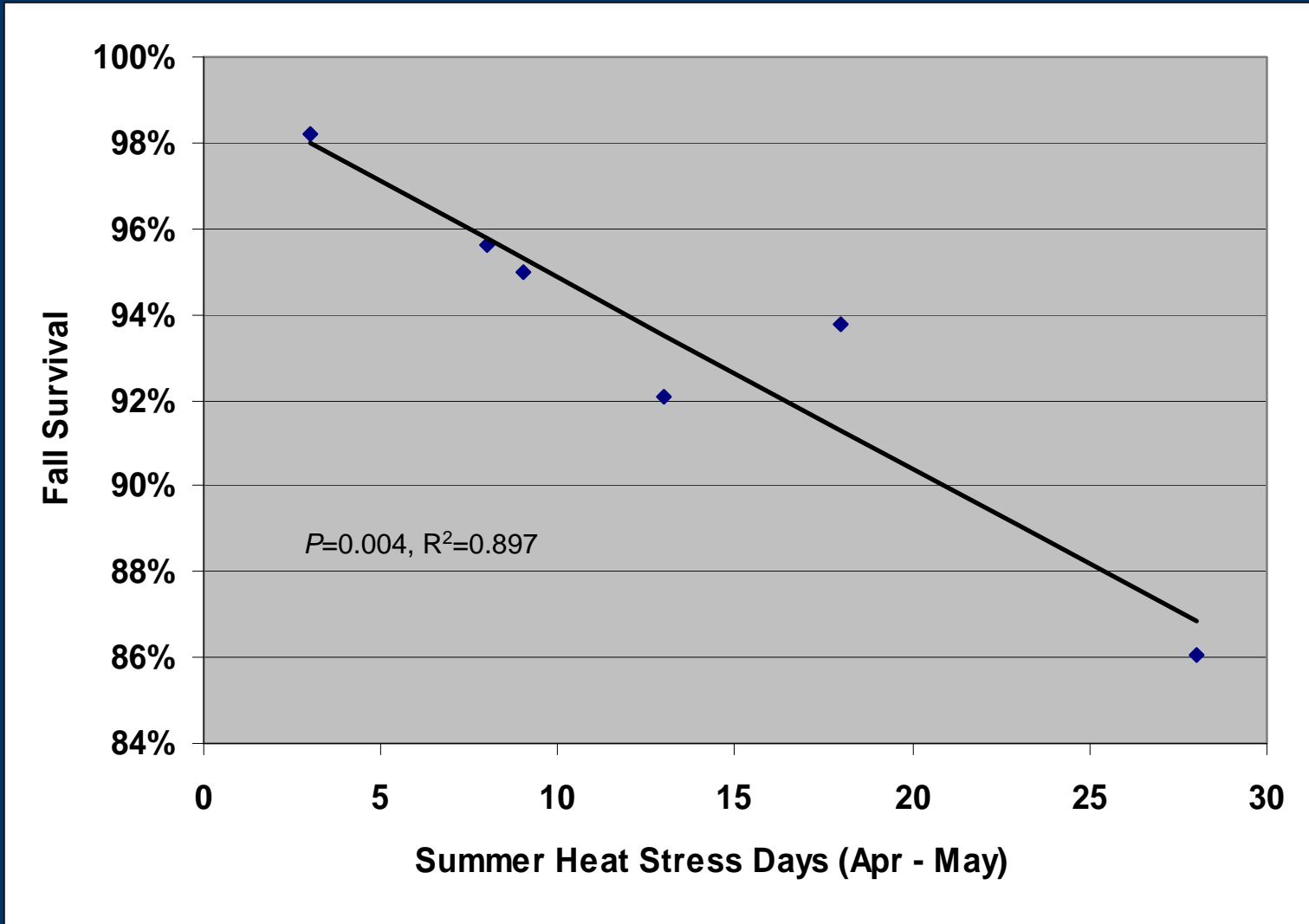


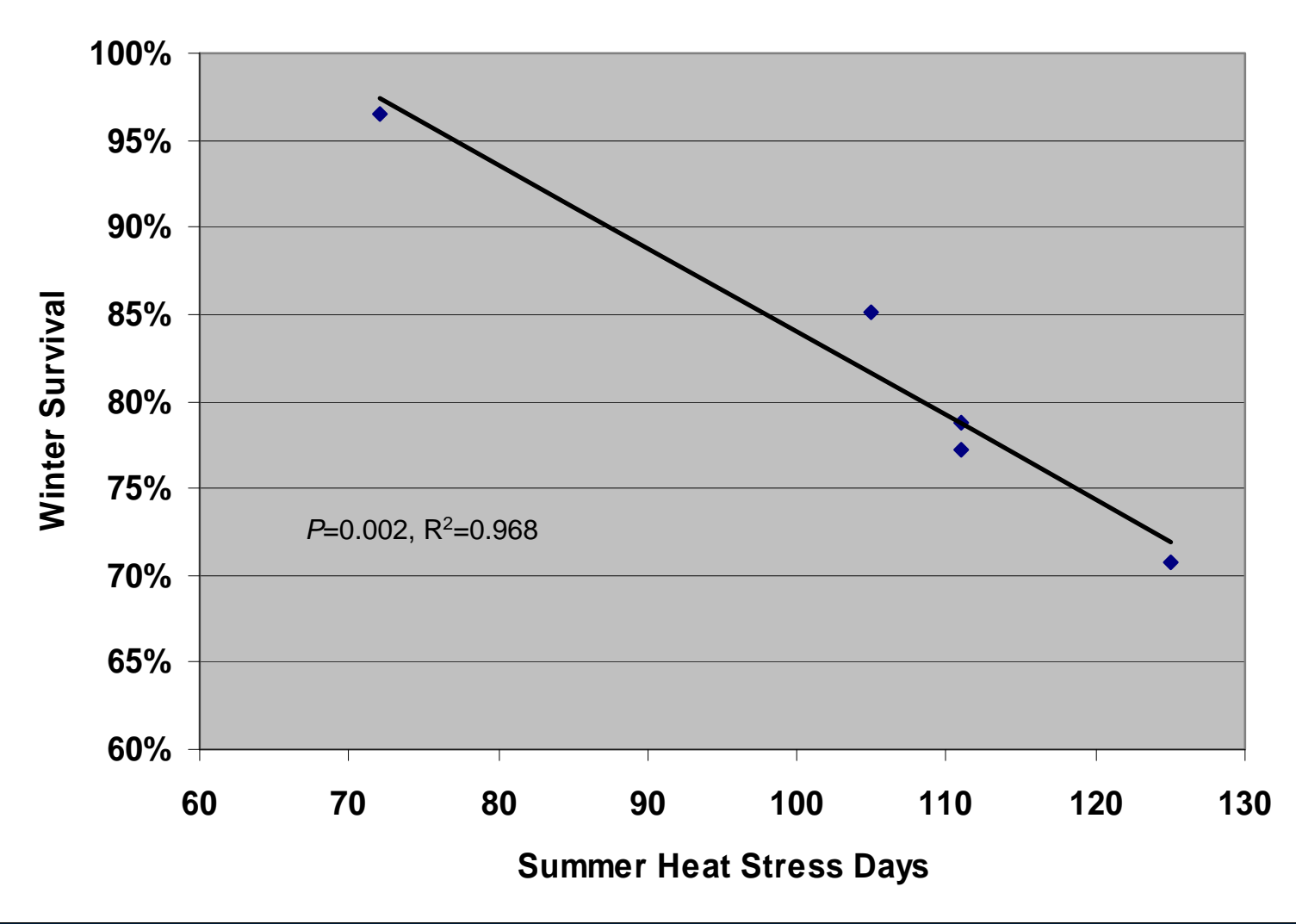
Seasonal Moose Survival

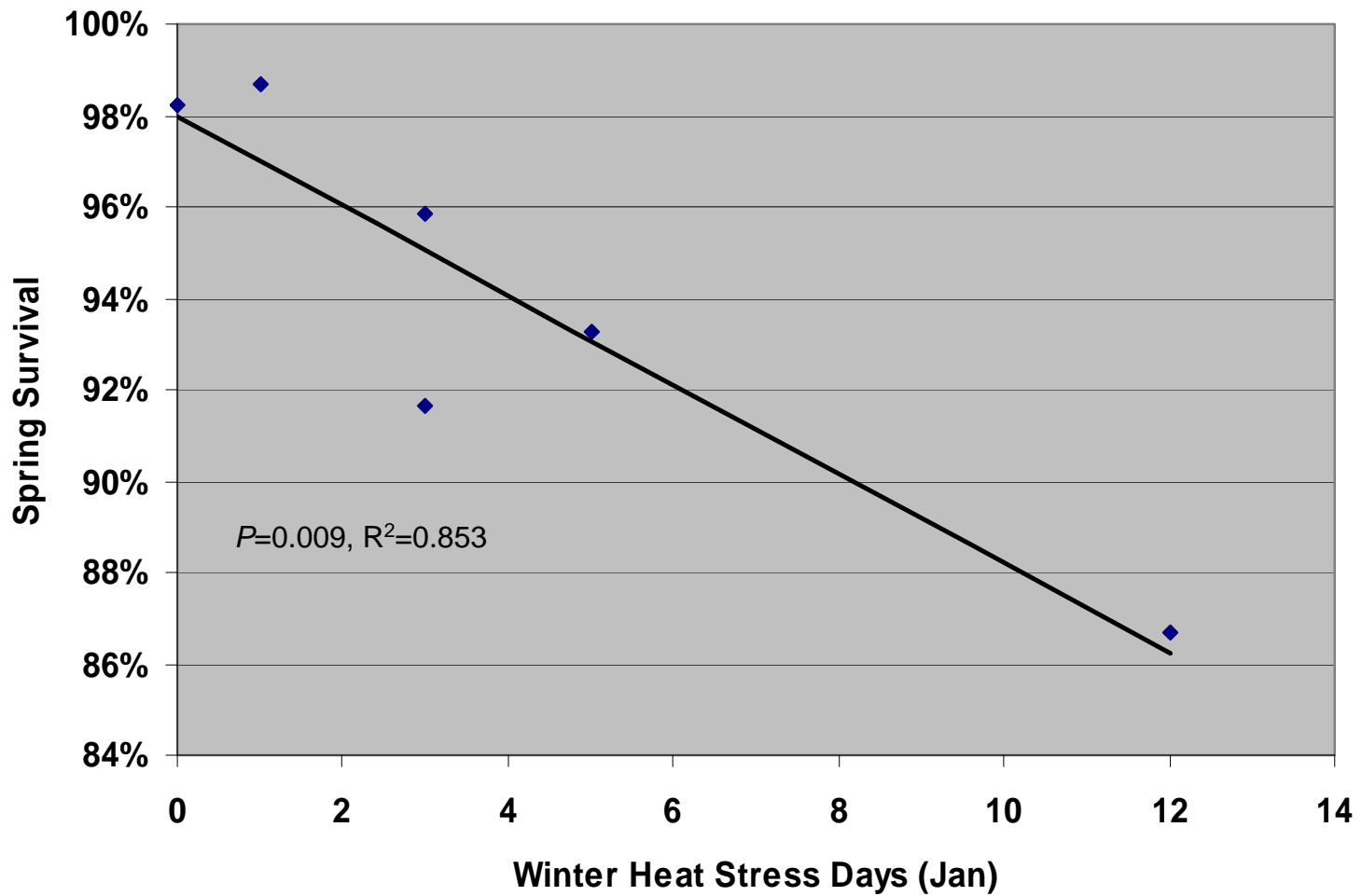


from Murray et al. 2006



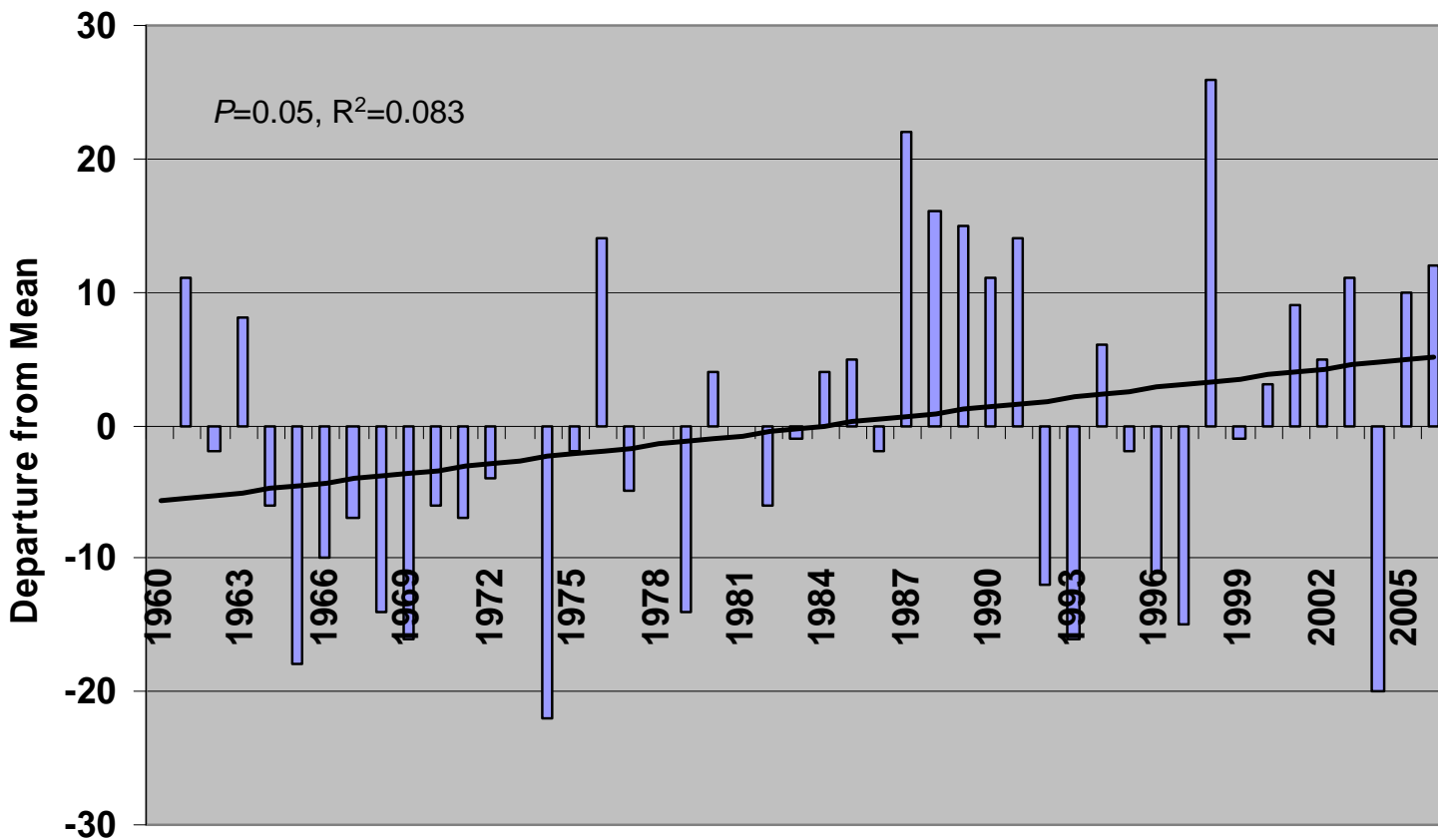






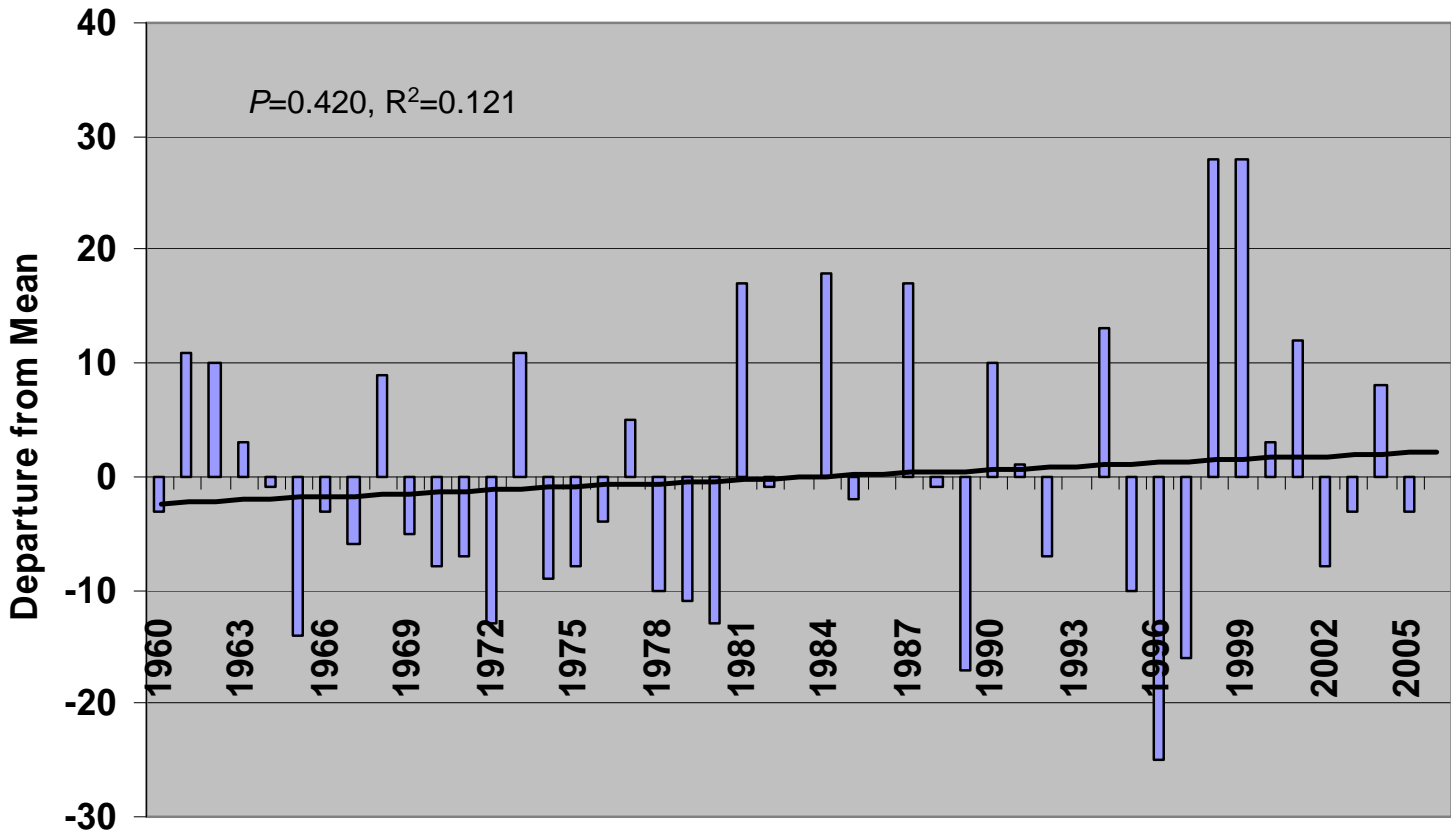


Summer Heat Stress Days (Mar - Oct) Tower, MN



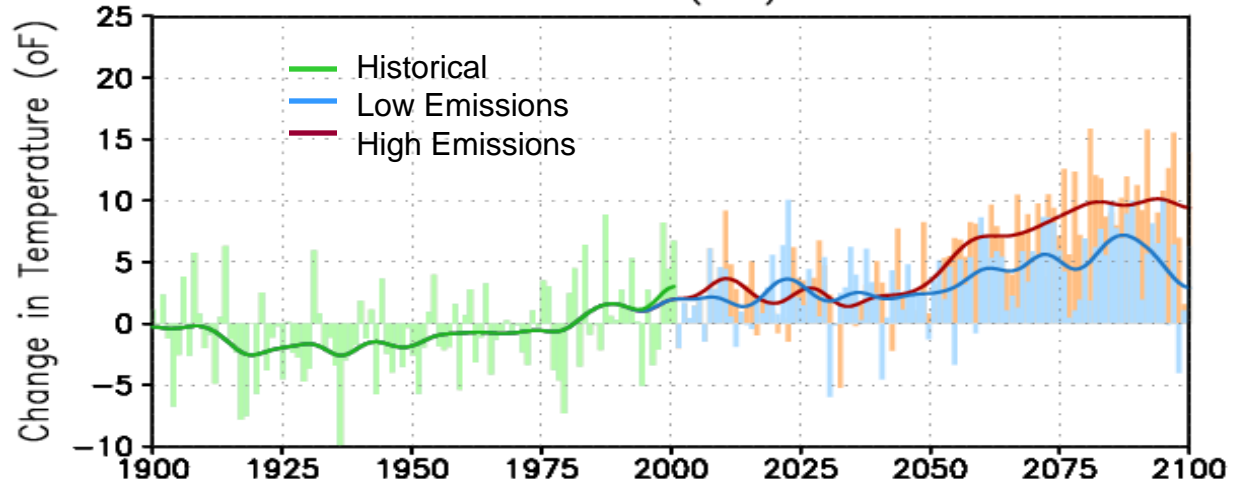


Winter Heat Stress Days (Nov - Mar) Tower, MN

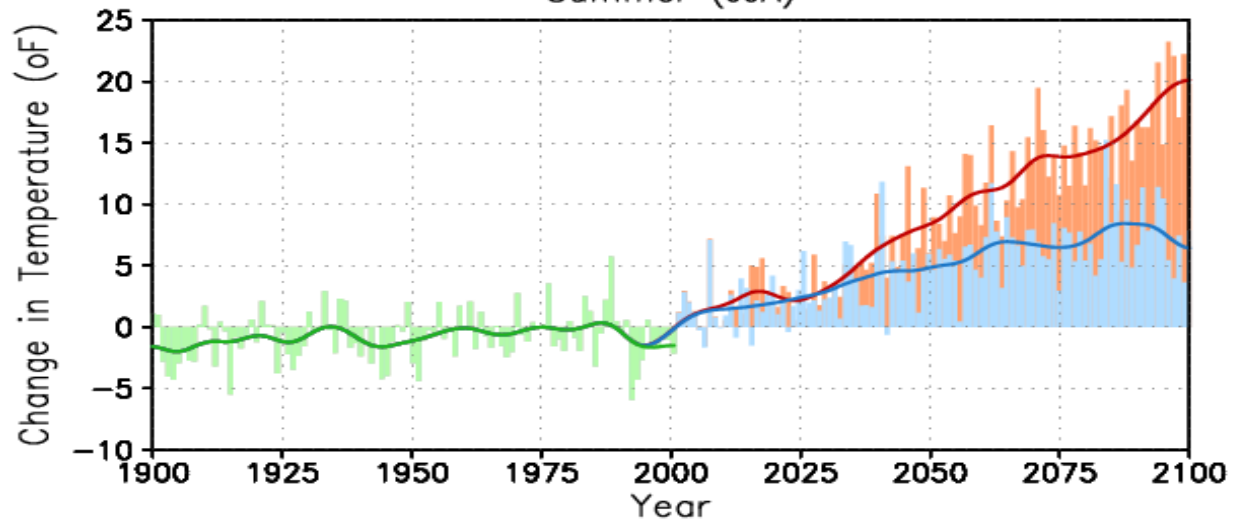




Change in Daily Average Temperature for Minnesota
Relative to 1961–1990 (oF)
Winter (DJF)



Summer (JJA)





Summary

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- Seasonal moose survival was significantly related to heat stress days in both the summer and winter over the last 6 years.
- The number of heat stress days in the summer and the winter has increased in the last 47 years.
- Climate models suggest that average daily temperature will continue to increase in both summer and winter.
- With continued high moose mortality, it is likely that we will see a northward shift in the southern distribution of moose in Minnesota.



Project Partners

- Minnesota DNR
- Fond du Lac band of Lake Superior Chippewa
- 1854 Treaty Authority
- USGS Biological Resources Division

