

# **Studying the Winter Nutritional Status of Moose and its Relationship to Moose Survival, the Population Trend, and Climate Change in a Declining Population in Northeastern Minnesota**

## **Background**

Winter nutritional restriction of moose and other northern ungulates may be physiologically assessed by serial collection and chemical analysis of fresh urine in snow (snow-urine). Controlled studies of captive ungulate species have demonstrated that urinary urea nitrogen:creatinine (UN:C) ratios have significant value as a metric of winter nutritional status. This technique allows the biologist's team to non-invasively and cost-effectively sample large numbers of moose (100s of specimens) at the population level over vast landscapes throughout winter to investigate ecological relationships between varying levels of nutritional restriction and survival, population dynamics, habitat, and other environmental factors. It has enhanced our understanding of nutritional restriction relative to aspects of winter mortality of elk and bison in Yellowstone National Park, and to moose population dynamics on Isle Royale impacted by a winter tick (*Dermacentor albipictus*) epizootic and influenced by regional differences in habitat.

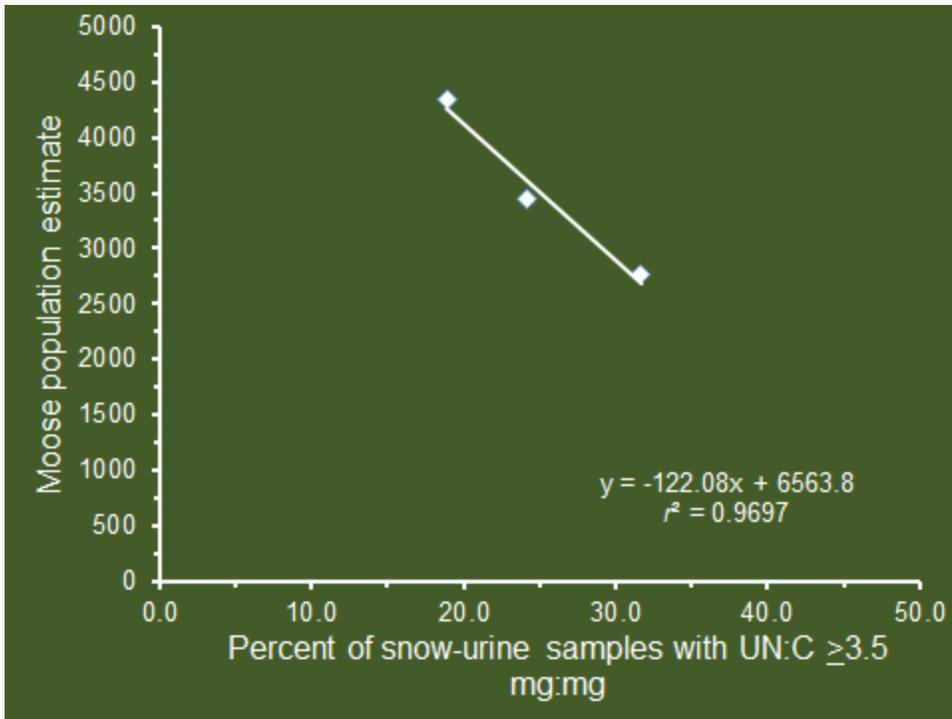
## **Preliminary Results, 2013 to 2015**

We have entered our 4<sup>th</sup> winter of this study. Below are several examples of the strong relationships (see Figures 10–12) preliminary analyses have revealed with three winters (2012–13 to 2014–15) of data from these nutritional assessments.

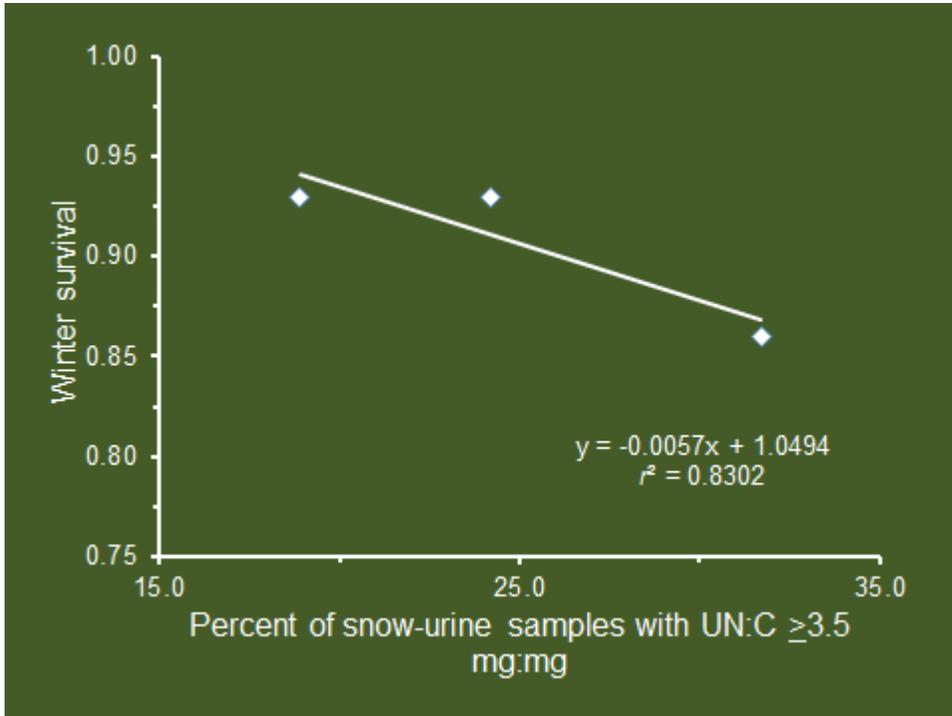
**\*Importantly**, note that urea nitrogen:creatinine (UN:C) ratios of 3.5 mg:mg or higher (*x-axis* on the first 2 graphs, *y-axis* on the 3<sup>rd</sup> graph) are reflective of *severe nutritional restriction* and accelerated net catabolism of body protein in moose.

The first 2 graphs below indicate that severe winter nutritional restriction of moose in northeastern Minnesota is inversely related to 1) the population's point estimate, and 2) winter survival of the GPS-collared adult moose (see Figures 10 and 11).

**\*Note**, in terms of statistical rigor, a minimum of 6 data points is required, or in our case, 6 winters of data. But importantly, the data from these 3 winters show that the nutritional assessments are closely tracking the survival rates of the GPS-collared adult moose and the population point estimates (from the annual survey, DelGiudice 2015) very closely. Observing strong evidence of physiological links at this early point is very encouraging, but caution in interpretation is still warranted.

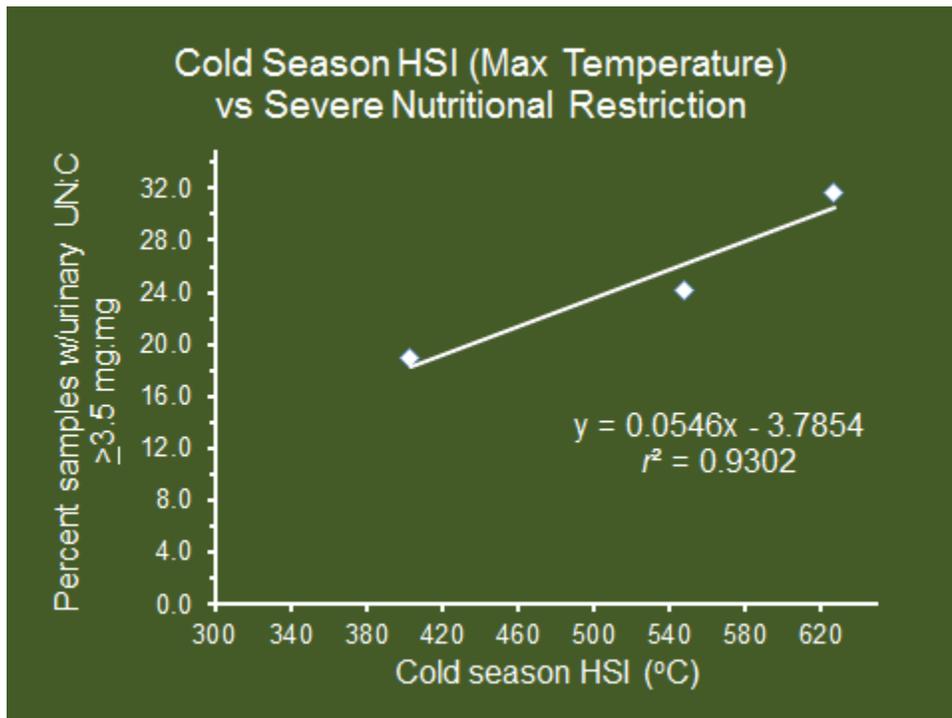


**Figure 10.** Relationship depicted indicates that as winter nutritional restriction of moose increased, the population decreased in northeastern Minnesota, 2013 to 2015.



**Figure 11.** Relationship depicted indicates that as winter nutritional restriction of moose increased, the winter survival rate of the GPS-collared adult moose decreased in northeastern Minnesota, 2013 to 2015.

In the graph below (see Figure 12), the 3 winters of data show that the heat stress index (HSI) for moose is directly and strongly related to the percent of moose urine samples with UN:C ratios indicative of severe winter nutritional restriction. Again, for statistical rigor we want a minimum of 6 winters of data, but this graph shows that so far the HSI data (based on daily maximum ambient temperatures  $\geq -5^{\circ}\text{C}$  [ $23^{\circ}\text{F}$ ]) are closely tracking the incidence of severe nutritional restriction in these moose at the population level.



**Figure 12.** Relationship depicted shows that as the cold season (1 November–31 March) heat stress index (HSI) for moose (accumulation of daily maximum temperature degrees  $\geq -5^{\circ}\text{C}$  [ $23^{\circ}\text{F}$ ]) increased, the severity of nutritional restriction of moose also increased in northeastern Minnesota, 2013 to 2015.

Glenn D. DelGiudice, Ph.D.  
Research Scientist, Moose & Deer Project Leader  
Forest Wildlife Populations & Research Group  
MNDNR

Bill Severud, Ph.D. Graduate Student  
Department of Fisheries, Wildlife, and  
Conservation Biology  
University of Minnesota-St. Paul

Adjunct Professor and Graduate Faculty Advisor  
Department of Fisheries, Wildlife, and Conservation Biology  
University of Minnesota-St. Paul  
Phone: (651)-296-0702 • Email: [glenn.delgiudice@state.mn.us](mailto:glenn.delgiudice@state.mn.us)