

12-18-2010

# The Effects of Nutrient Availability and Season on the Somatotropic Axis in Free-Ranging Alaskan Moose (*Alces alces*)

Amanda A. Parillo

*University of Connecticut - Storrs*, [amanda.parillo@uconn.edu](mailto:amanda.parillo@uconn.edu)

---

## Recommended Citation

Parillo, Amanda A., "The Effects of Nutrient Availability and Season on the Somatotropic Axis in Free-Ranging Alaskan Moose (*Alces alces*)" (2010). *Master's Theses*. 23.  
[http://digitalcommons.uconn.edu/gs\\_theses/23](http://digitalcommons.uconn.edu/gs_theses/23)

This work is brought to you for free and open access by the University of Connecticut Graduate School at DigitalCommons@UConn. It has been accepted for inclusion in Master's Theses by an authorized administrator of DigitalCommons@UConn. For more information, please contact [digitalcommons@uconn.edu](mailto:digitalcommons@uconn.edu).

The Effects of Nutrient Availability and Season on the  
Somatotropic Axis in Free-Ranging Alaskan Moose

Amanda Ashley Parillo

B.S., University of Connecticut, 2007

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Science

at the

University of Connecticut

2010

APPROVAL PAGE

Master of Science Thesis

The Effect of Nutrient Availability and Season on the Somatotropic Axis in Free-Ranging

Alaskan Moose

Presented by

Amanda Ashley Parillo, B.S.

Major Advisor \_\_\_\_\_  
Steven A. Zinn

Associate Advisor \_\_\_\_\_  
Thomas A. Hoagland

Associate Advisor \_\_\_\_\_  
Isaac M. Ortega

Associate Advisor \_\_\_\_\_  
Julie P. Richmond

University of Connecticut

2010

## ACKNOWLEDGEMENTS

First and foremost I thank Dr. Julie Richmond. I met Julie when I was an undergraduate, my senior year. I was never really a farm animal person, which made her interest in wildlife research particularly appealing to me. Her enthusiasm for the work that she was doing inspired me. She allowed me to accompany her to Mystic on some of her many journeys, which opened me up to a new world of experiences I never thought I would have. She is one of the best mentors I have ever had; the other, of which, is Dr. Steven Zinn. He has the ability to tell it like it is, and that is one of the things I appreciate most about him. He was a great mentor throughout the entire research process, assisting me with whatever questions I may have had the entire way. The other members of my committee were equally as helpful. Dr. Thomas Hoagland helped me a great deal with all of the statistics needed for my studies. Dr. Morty Ortega was always there and interested in helping me in any way he could. I thank you all for all of your help and support throughout this process.

All of the research I have done would not have been possible without my three collaborators, Kevin White, Bruce Dale, and John Crouse, of the Alaska Department of Fish and Game. I am grateful to them for all of the samples and data they have given me. Thank you all for your patience and willingness to collaborate with a graduate student from so far away. I truly am grateful to have learned so much about these amazing creatures, and without you, that wouldn't have been possible.

I thank the University of Connecticut (UConn) Department of Animal Science, UConn Research Foundation, and the Alaska Department of Fish and Game for the financial support they provided throughout my graduate career.

I thank my lab mates, Katherine Hebert and Kathleen Carey, who provided me with moral support, as well as some entertainment when needed for those long nights spent doing lab work. Their enthusiasm for learning new things was infectious. Thank you both for reminding me why I want to go into the research field.

I thank my fellow graduate students, Elizabeth Ackell and Nidhish Francis, who provided me not only with moral support, but were willing to help me out with anything I needed, no matter how small, throughout the entire research process.

I thank Stephen Tutto, who put up with all my complaints and frustrations, and never doubted for a second that I would be able to achieve anything I put my mind to. Whenever I needed anything, he was always there for me. Thank you for your love and support. Without you, this would not have been possible.

Lastly, I thank my parents, Judy and Joe Parillo. They were there whenever I needed a little more encouragement, or just to talk. Their love and support was imperative to the completion of my Masters degree. Thank you both for everything.

## TABLE OF CONTENTS

Approval Page.....	ii
Acknowledgements.....	iii
Table of contents.....	v
List of figures.....	vii
List of tables.....	ix
Introduction.....	1
Review of literature.....	5
Alaskan moose life history.....	5
Reproduction.....	6
Reproduction and body condition.....	7
Reproduction and forage quality.....	8
Season and forage.....	9
Reproduction and season.....	10
Alaskan populations.....	11
Somatotrophic axis.....	14
Growth hormone.....	15
Insulin-like growth factor-1.....	16
Insulin-like growth factor binding proteins.....	17
Nutrition and the somatotrophic axis.....	20
Photoperiod and the somatotrophic axis.....	22
Objectives.....	26
Experiment 1: Introduction.....	27
Materials and Methods.....	27
Experiment 2: Introducion.....	29
Materials and Methods.....	29
General Materials and Methods.....	30
Hormone Analysis.....	30
Experiment 1: Results.....	39
Experiment 2: Results.....	47

Experiment 1: Discussion.....	56
Experiment 2: Discussion.....	65
Literature Cited.....	70
Appendix.....	85

## List of Figures

Figure 1: Topographical map of Alaska. The black circle is Gustavus, AK, the black square is Nelchina, AK, and the black star is Skwentna, AK.

Figure 2: Comparison of Body Fat between winter and fall in three different moose populations of Alaska; Percentage of Body fat =  $5.61 + (2.05 \times \text{maximum rump fat})$ . Rump fat was greater in fall than winter ( $P < 0.01$ ), but similar among populations ( $P > 0.24$ ). Different seasons are indicated by open ( $\circ$ winter) and closed ( $\bullet$ fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference between seasons or among populations.

Figure 3: Comparison of Growth hormone (GH) concentrations between winter and fall in three different moose populations of Alaska; Growth hormone concentrations were similar among populations ( $P > 0.15$ ) and between seasons ( $P > 0.29$ ). Different seasons are indicated by open ( $\circ$ winter) and closed ( $\bullet$ fall) circles. Significant differences are considered to have a P-value of less than 0.05.

Figure 4: Comparison of Insulin-like growth factor (IGF) -1 concentrations between winter and fall in three different moose populations of Alaska; IGF-1 concentrations were similar across populations ( $P > 0.22$ ). However, IGF-1 concentrations were greater in fall compared with winter ( $P < 0.01$ ). An interaction between population and season was also found ( $P < 0.02$ ) such that seasonal differences in Skwentna were greater than in Gustavus and Nelchina). This indicates that the Skwentna population was more greatly affected by the change in season than the Gustavus population was. Different seasons are indicated by open ( $\circ$ winter) and closed ( $\bullet$ fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference.

Figure 5: Comparison of Insulin-like growth factor binding protein 3 (IGFBP-3) between fall and winter in three different moose populations in Alaska; IGFBP-3 concentrations were greater in Gustavus than Skwentna ( $P < 0.01$ ) and greater in fall than winter ( $P < 0.01$ ). An interaction between population and season ( $P < 0.02$ ) was also found, with changes in season more greatly affecting IGFBP-3 concentrations in the Gustavus population than in the Nelchina and Skwentna populations. Different seasons are indicated by open ( $\circ$ winter) and closed ( $\bullet$ fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference.

Figure 6: Comparison of Insulin-like growth factor binding protein 2 (IGFBP-2) between fall and winter in three different moose populations in Alaska; IGFBP-2 concentrations were greater in Gustavus than Skwentna ( $P < 0.01$ ), however there were no differences found between fall and winter ( $P > 0.41$ ). An interaction was found between population and season ( $P < 0.05$ ), with changes in season more greatly affecting the Nelchina and Skwentna populations than the Gustavus population. Different seasons are indicated by



open (○winter) and closed (●fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference.

Figure 7: Rump Fat; Rump fat was greater in fall than winter ( $P < 0.01$ ), but similar between years ( $P > 0.69$ ). Different seasons are indicated by open (○winter) and closed (●fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference.

Figure 8: Growth Hormone (GH) concentrations; Growth hormone concentrations were similar between seasons ( $P > 0.41$ ), however differences were found among years ( $P < 0.01$ ). No interaction was found between year and season ( $P > 0.47$ ). Different seasons are indicated by open (○winter) and closed (●fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference.

Figure 9: Insulin-like Growth Factor (IGF) – 1 concentrations; IGF-1 concentrations were greater in fall compared with winter ( $P < 0.01$ ), and were different among years ( $P < 0.01$ ). No interaction was found between year and season ( $P > 0.08$ ). Different seasons are indicated by open (○winter) and closed (●fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference.

Figure 10: Insulin-like growth factor binding protein 3 (IGFBP-3); IGFBP-3 concentrations were greater in fall compared with winter ( $P < 0.01$ ) and different among seasons ( $P < 0.01$ ). No interaction was found between year and season ( $P > 0.83$ ). Different seasons are indicated by open (○winter) and closed (●fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference.

Figure 11: Insulin-like growth factor binding protein 2 (IGFBP-2); IGFBP-2 concentrations were different among years ( $P < 0.04$ ), however there were no differences found between seasons ( $P > 0.55$ ). There was an interaction between year and season ( $P < 0.03$ ) indicating that changes in season had a greater effect on IGFBP-2 concentrations in certain years (2004, 2006, 2008 and 2009) than others (2005 and 2007). Different seasons are indicated by open (○winter) and closed (●fall) circles. Significant differences ( $P < 0.05$ ) are represented by different letters, with similar letters indicating no difference.

Figure 12: Moose Growth Hormone (GH) parallelism and linearity; Linear regression equations and correlation coefficients ( $R^2$ ) for each population are displayed on the graph. Each population is represented with a unique symbol. Both populations showed significant linear regression with correlation coefficients close to 1.0.

Figure 13: Moose Insulin-like growth factor (IGF)-1 parallelism and linearity; linear regression equations and correlation coefficients ( $R^2$ ) for each population are displayed on the graph. Each population is represented with a unique symbol. Both populations showed significant linear regression with correlations coefficients close to 1.0.

## List of Tables

Table 1: Gustavus and Nelchina population optimizations for insulin-like growth factor binding protein 3 (IGFBP-3); Each serum concentration for each population was measured twice, once per gel, in digital light units, and an average was taken (average IGFBP-3). As the concentrations of serum decrease, IGFBP-3 concentrations also decrease, indicating that serum was pipetted correctly.

Table 2: Coefficient of variation (inter-assay) for insulin-like growth factor binding protein – 3; Each serum concentration for each population was measured twice, once per gel, in digital light units, and an average was taken (average AU).

Table 3: Coefficient of variation (inter-assay) for insulin-like growth factor binding protein – 2; Each serum concentration for each population was measured twice, once per gel, in digital light units, and an average was taken (average AU).

Table 4: Coefficient of Variation (intra-assay) for Growth Hormone; Coefficient of variation was calculated by dividing the standard deviation of the reference sample replicates by the average of those replicates, and multiplied by 100.

Table 5: Coefficient of Variation (intra-assay) for Insulin-like growth factor (IGF)-1; Coefficient of variation was calculated by dividing the standard deviation of the reference sample replicates by the average of those replicates, and multiplied by 100.

Table 6: Percent recovery for Growth Hormone (GH); Percent recovery was calculated by dividing the measured concentration by the theoretical concentration, and multiplying it by 100. The average percent recovery for all populations was 103%.

Table 7: Percent recovery for insulin-like growth factor (IGF)-1; Percent recovery was calculated by dividing the measured concentration by the theoretical concentration, and multiplying it by 100.