

URINARY METABOLITES FOR ENHANCING ECOLOGICAL INTERPRETATIONS: A WORKSHOP¹

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ABSTRACT: This paper provides outlines of 5 sessions in which an overview of various aspects of the use of urinalysis to monitor changes in nutritional condition of free-ranging ungulates was presented at the 35th North American Moose Conference and Workshop, Grand Portage, Minnesota, May 15 - 20, 1999. The sessions included in the workshop were: (1) Establishing the value of urinary urea N:creatinine as a nutritional index in ungulates: research and considerations; (2) Urinary purine derivatives as an index of dietary intake; (3) Scaling physiological models up to the population level; (4) Ecological interpretations for Yellowstone elk and bison populations; and (5) Ecological interpretations for the Isle Royale moose population. Presentations were followed by an audience discussion with the panel of presenters.

ALCES VOL. 36: 269-272 (2000)

Key words: bison, creatinine, elk, Isle Royale, moose, physiological models, purine derivatives, urea, urinary metabolites, Yellowstone

Urinary metabolites have been used to assess and monitor the condition of free-ranging ruminant species over the past few years. An advantage of this technique, particularly for areas such as national parks and other protected areas, is that population condition can be determined non-invasively. The technique can also be used on harvested populations when a quantitative indicator of population condition is desired. Estimates of nutritional condition are based on trends in urinary metabolites over a winter from randomly collected snow urine. Additional information is also often available about the population from which snow urine is collected. This information can include calf:cow:bull ratios, population size, harvest, age-specific pregnancy rates, and

other population level parameters. These properties of a population are often used to develop an age- and sex-structured model of the population being studied or managed. Population level characteristics could be used to further enhance interpretation of trends in urinary metabolites, and thus to improve management of free-ranging populations of moose and other ungulates. This can be achieved by using a model of ruminant physiology to simulate the production of urinary metabolites by each age- and sex-class in the population. The physiological model is used to predict the production of urinary metabolites by a population that has similar characteristics to the field population. The individually based physiological model is scaled up to the population level by

¹Summary of workshop presentations at the 35th North American Moose Conference and Workshop, Grand Portage, Minnesota, May 15 - 20, 1999. Non-refereed.

performing multiple simulations with individuals of each age class and sex in the population. Because the model simulates production of urinary metabolites as a function of dietary energy intake and mobilization of tissue energy reserves, we now can predict changes in body condition at the population level. This paper provides outlines of 5 sessions in which an overview of various aspects of the use of urinalysis to monitor changes in nutritional condition of free-ranging ungulates was presented at the 35th North American Moose Conference and Workshop, Grand Portage, Minnesota, May 15 - 20, 1999. Outlines of the sessions are provided in the following sections. The author responsible for each presentation is identified at the beginning of each section and may be contacted directly for more information related to the particular topic.

Establishing the Value of Urinary Urea N:Creatinine as a Nutritional Index in Ungulates: Research and Considerations

Glenn DelGiudice presented his work establishing the physiological basis for analysis of urinary metabolites in wild ruminants with results from controlled experiments on white-tailed deer (*Odocoileus virginianus*) (DelGiudice *et al.* 1987, 1990, 1994a) and free-ranging populations of deer, elk (*Cervus elaphus*), and bison (*Bison bison*) (DelGiudice 1995, DelGiudice *et al.* 1995). The strengths and weaknesses of using urinary urea nitrogen: creatinine ratios to assess nutritional restriction in free-ranging ruminants were discussed.

Urinary Purine Derivatives as an Index of Dietary Intake

Robert A. Garrott presented his work on urinary excretion of purine derivatives in elk (primarily allantoin), beginning with controlled experiments to establish reference

values (Vagnoni *et al.* 1996, Garrott *et al.* 1997) and including work on collection and analysis of allantoin: creatinine ratios in urine from free-ranging elk in Yellowstone National Park (White *et al.* 1995b, Garrott *et al.* 1996). Preliminary analysis of a small sample of moose urines obtained from the Moose Research Center in Alaska showed that there were no detectable levels of allantoin in these samples suggesting uric acid may be the primary purine derivative in moose.

Scaling Physiological Models up to the Population Level

Ron Moen presented a brief overview of a model of ruminant physiology that is able to simulate both nutritional condition and excretion of urinary metabolites (Moen and DelGiudice 1997, Moen *et al.* 1997, Moen and Pastor 1998a, b). The physiological model can be used to predict the excretion of urinary metabolites by a population of free-ranging ruminants when integrated with a population model. The integration of physiological and population models to provide population-level estimates of urinary metabolite excretion, body composition, and the extent of seasonal nutritional restriction was described. The integration of the physiological model with the population model and application of the model to elk and bison in Yellowstone National Park is described in a manuscript submitted to Wildlife Monographs.

Ecological Interpretations of Urinary Metabolite Analysis for Yellowstone Elk and Bison Populations

Glenn DelGiudice presented the additional ecological interpretations that emerge from application of the physiological model at the population level. This work is based on urine collections from elk and bison populations in Yellowstone National Park before and after the severe fires in 1988

(DelGiudice *et al.* 1991, 1994b) submitted in a manuscript to Wildlife Monographs.

Ecological Interpretations of Urinary Metabolite Analysis for the Isle Royale Moose Population

Rolf Peterson presented ecological interpretations from analysis of urinary metabolites, changes in the moose population of Isle Royale over the past 10 years (DelGiudice *et al.* 1997), and predictions of moose body condition after Ron Moen presented results of applying the physiological model to the moose population on Isle Royale.

SUMMARY

The workshop concluded with a discussion and question and answer session on the potential for future development of the urinalysis techniques described in the workshop. Participants felt that the analysis of snow-urine can increase our understanding of the physiological responses of free-ranging ruminants to changes in winter severity and forage availability. Scaling physiological models up to the population level may help resolve some of the questions that have arisen about the urinalysis technique (DelGiudice 1995, DelGiudice *et al.* 1995, Saltz *et al.* 1995, White *et al.* 1995a, b). Identification of the purine derivatives that are excreted by moose in urine warrants further investigation.

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