Paper presented at The First Arctic Ungulate Conference,
Nuuk, Greenland, 3-8 September, 1991.

Expanded abstract

Predicting energy expenditure of caribou using activity counts: potential use in disturbance studies

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Rangifer, 13 (2): 117-119

Estimation of daily activity of animals using mercury tilt switches in traditional radio-collars and satellite collars is widely accepted. In northern latitudes scientists rely almost exclusively on the use of radio-collars to gather data on caribou (*Rangifer tarandus*)(Pank *et al.* 1985; Fancy *et al.* 1990; Fancy & Whitten, 1990), muskoxen (*Ovibus moschatus*) (Reynolds, 1989; Klein & Bay 1990), and polar bears (*Ursus maritimus*) (Messier *et al.* 1992) during winter. There are disadvantages in using standard and satellite telemetry to acquire activity data, however. Standard radio-collars must be monitored continuously and activity estimated from changes in pulse rate and are useful only to differentiate between degrees of activity (Garshelis *et al.* 1982; Gillingham & Bunnell 1985). Satellite collars transmit activity data to satellites when those satellites are overhead, a limited portion of the day (Fancy *et al.* 1988; Harris *et al.* 1990). Also, satellite collars can only discriminate between two levels of activity and data cannot be stored (Fancy *et al.* 1988).

A programmable radio collar introduced by Wildlink Inc. (MN) records mercury tilt switch counts (AC) in each of 36 intervals of equal length (Note: the collars have since been upgraded and have a year of memory and battery life). A triggering transmitter enables remote programming of interval length and downloading of data (Kunkel *et al.* 1991; Mech *et al.* 1990). Counts collected in an interval correspond to the activity that took place in that interval (e.g. low counts, low levels of activity). Our objectives were to 1) calibrate the Wildlink activity counter for caribou, 2) test the Wildlink radio-collar for use in investigating the effects of low-level jet aircraft overflights on caribou.

We conducted 26 h behavioral observations on captive caribou fitted with Wildlink radio-collars at the University of Alaska Faibanks Large Animal Research Station (LARS). Daily activity budgets were determined from observations and from Wildlink AC. We related Wildlink AC to 1) heart rate (HR) collected simultaneously using subcutaneously implanted HR transmitters (J. Stuart Enterprises) and 2) an energy expenditure (EE) index developed by Fancy & White (1986; Table 1). HR and EE are summed over time using the time interval set for AC (Fig. 1). We investigated the potential

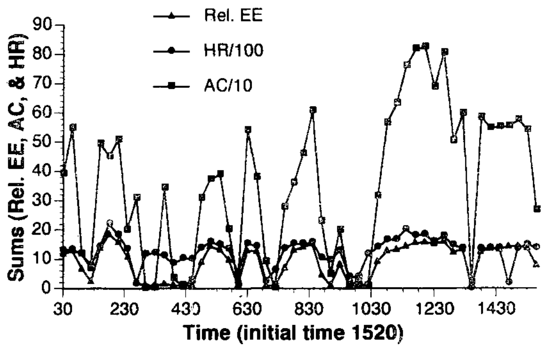

Fig. 1. The relationship between rel. EE, HR, and AC through time.

of using this collar to give short time-step, quantitative indices of EE in caribou and have developed a prediction equation estimating EE from AC (Fig. 2):

$$Y = 0.02X + 2.08$$

There was a significant amount of variation between animals in terms of counts/activity but patterns were similar (Fig. 2). Overall, 30 and 60 min intervals accurately predicted rest/activity cycles in caribou whereas a 60 min interval accurately predicts both interval and daily EE. As the AC intervall length increases the ability to predict *relative* EE from AC increases as well (Fig. 3). However, resolution may be decreased. A shorter interval (1 to 10 min) may be needed to detect short-term responses to acute disturbance. Head movement during a lying bout elevates AC resulting in decreased predictability of EE (i.e. relatively high counts during a period of low activity). Similar problems have been documented when using standard radio telemetry (Gillingham & Bunnell, 1985).

Kunkel *et al.* (1990) found that the Wildlink activity monitoring system may be used to reliably achieve estimates of energy budgets. The use of Wildlink AC for monitoring caribou activity and response to disturbance is also promising. The Wildlink radio-collar is sensitive enough to detect severe response (i.e. abnormally high peak of activity) to an acute disturbance or a long-term response (i.e. resulting in a phase-shift of the daily cycles) to chronic disturbance. Therefore, we believe that the collar will be particularly useful when comparing disturbed to undisturbed caribou. This technique will also be useful when comparing activity cycles of disturbed caribou before and after disturbance.

A 60 min interval is most useful for predicting *relative* EE. The relationship between *relative* EE and AC may not be linear, however. Figure 3 shows as AC increases, EE levels off. This may be due to the animal reaching a maximum level of EE for a given period of time (30 or 60 min) and, also, to the sensitivity of the mercury tilt switch. AC's are collected with virtually every head movement, regardless of whether the animal is lying, standing, walking or running. As a result, AC may be relatively high during periods of low, moderate, or high EE. More analyses using nonlinear regression are planned to further investigate the potential of shorter intervals which may be useful in discerning less severe reactions to disturbance.

Table 1. Incremental costs of activities over resting metabolic weight (RMR; Fancy & White 1985).

Behavior	Incremental cost
lying - head down	1.00
lying - head up	1.07
standing	1.24
feeding	1.44
walking	1.81
running	1.93

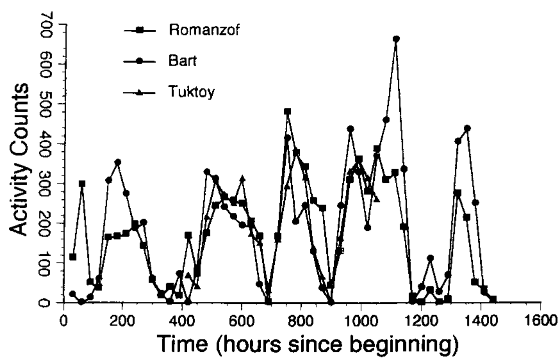

Fig. 2. Three male caribou cycle together during a 24 h behavioral watch. However, there is variability in activity counts between animals.

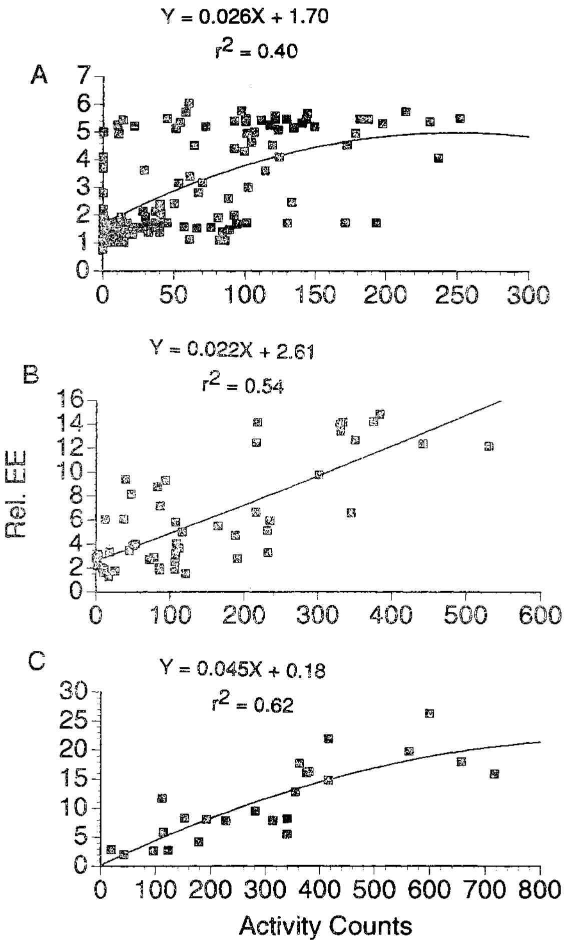

Fig. 3. As interval length increases predictive capability improves. A) 10 min, B) 30 min, and C) 60 min interval length using data from 17 July 1991.

Acknowledgements

Karen Higgs was available and willing to help with animal handling and organization of behavioral watches. Other employees of LARS conducted observations including *Kim DeRuyter* and *Sandy Kennedy*. *Bill Hauer* provided animals, equipment, and computer expertise. A number of students were enthusiastic and volunteered their time to observe caribou on many occasions and at many late hours. Particularly helpful were *Valerie Baxter, Mike Smith, Ian White, Jon Bishop, Damon Bender, Margot Monhollen* and *Todd Dwyer*. This study was funded by the U.S.A.F., N.S.B.I.T. program.

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Manuscript accepted 1 December, 1992.