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Brief communication

Oil and the Porcupine Caribou Herd – Can we quantify the impacts?

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Introduction

The Porcupine caribou herd (*Rangifer tarandus granti*) is a large international herd of migratory caribou that annually travels from their taiga wintering grounds in Alaska and Yukon to calving and summer grounds adjacent to the Beaufort Sea. Their summer range is east of the range of the smaller Central Arctic Herd, where considerable oil development has occurred.

In 1980 with the passage of the Alaska National Interest Lands Conservation Act in the U. S., a decision on the future protection of much of the concentrated calving and post-calving grounds of the herd was delayed. Studies were initiated to assess the potential for hydrocarbon development and the impacts of that development on the environment. These environmental studies, along with the lessons of Prudhoe Bay and the Central Arctic Herd, form the basis for environmental impact assessment.

Impact Assessment

In the last two decades, impact assessment was approached from two largely separate fronts; effects on the population and effects on animal energetics. Disruptions and displacements caused by development projects must be assessed at the population level. Therefore, as more is learned about specific populations, it is important to combine the two approaches and assess energetic impacts at the population level. The amount of research and monitoring that was devoted to the Porcupine Caribou Herd and the lessons from the Central Arctic Herd facilitate assessment of the potential impacts of development before development.

Key demographic variables such as parturition rate, calf survival and recruitment rate can vary significantly from year to year. For example, in the Porcupine herd, parturition rate varied from 72% to 86% and calf survival to 1 month of age varied from 66% to 91% over the last 6 years (Fancy *et al.,* 1994). Other factors being equal, this range can translate into in an increasing population or a rapidly declining population. This variation in key parameters has occurred in the absence of any significant development within the herd's range. The key, therefore, is the ability to predict these variables based on natural variation in range condition and the added potential impacts of proposed development. In other words, our ability to translate energetic or body condition indices to the population level is directly related to the strength of the functional relationships that can be derived. Thus, in this paper, we report on a number of ongoing studies to derive these relationships and discuss what projects are in place to further refine and test these relationships.

Progress to date

Relation between body fat reserves and pregnancy rate

In early November 1990 - 1993, 125 adult cows were captured, weighed, and an index taken of body fat (body condition score [BCS], Gerhart *et al.,* 1992) taken. The product of body weight and BCS was called the Body Reserve Index (BRI). Blood samples were analyzed and pregnancy determined (van de Wetering *et al.*, 1994). As outlined by Sasser *et al.* (1989) animals with a positive pregnancy test for PSPB and a negative diagnosis for progesterone were considered to have suffered an early intra-uterine mortality.

Significant logistical regressions were determined between BRI and both pregnancy rate (P of β_1=0.003 Fig. 1a) and early intra-uterine mortality (P of β_1=0.008; Fig. 1b).

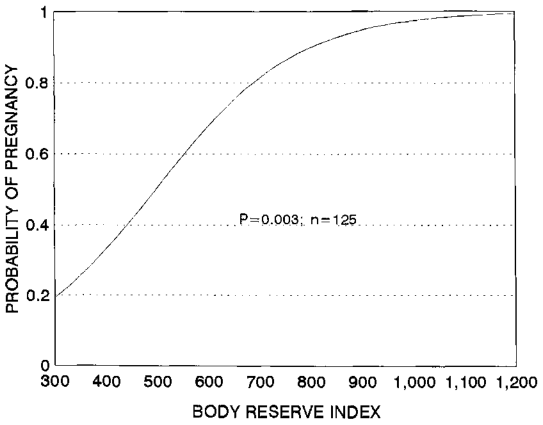

Fig. 1a. Logistic regression relating probability of parturition for adult female caribou to autumn Body Reserve Index, Porcupine Caribou Herd, 1990 - 1993 (β_0= -3.602, β_1 = 0.097, P<0.001).

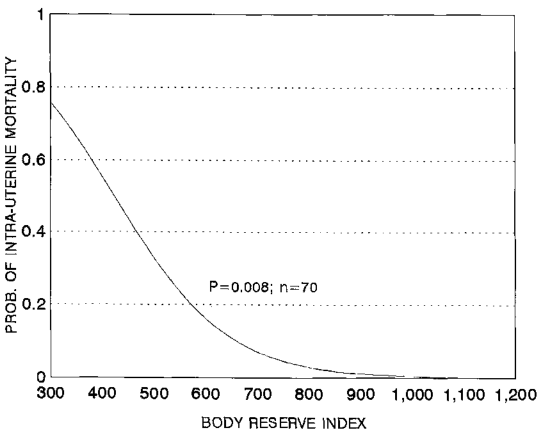

Fig. 1b. Logistic regression relating probability of intrauterine mortality for adult female caribou to autumn Body Reserve Index, Porcupine Caribou Herd, 1990 - 1993 (β_0= 3.9439, β_1 = 0.00932, P<0.01).

Relation between weather and parturition rates

For the Porcupine Caribou Herd, Russell *et al.*, (1993a) presented 5 weather-related effects on the energetics of individual caribou. Winter snow depth, spring melt, late spring phenology, early July temperatures and late July/early August temperatures effect activity patterns, feeding rates and movement rates, which in turn alter energy balance to the individual. Fall body weights of adult females in the herd were monitored since 1986 (Allaye-Chan, 1991; Smits *et al.*, 1991; Russell, unpubl. obs.). All these weather factors are integrated by the animal, affecting the body condition during the rut. Table 1 summarizes weather observations taken from key locations within the range of the herd for the period 1986 - 1992. Deep snow, late melt, early phenology and high summer temperatures were ranked among years and totalled annually to provide an index of weather conditions for each year (Table 1). The sum of these ranks was highly correlated to birth rate (r^2=0.88, Fig.2).

Table 1. Weather variables within the range of the Porcupine Caribou Herd, 1987 - 1992.

Year	Winter snow[1] (cm)	Spring snow[2] (cm)	Spring Phenology[3]-	Early July temp[4]	Late July temp[5]
1987	68	49	4	12.5	11.5
1988	86	34	3	13.4	10.7
1989	76	0	6	13.0	17.5
1990	95	62	1	14.2	11.7
1991	85	0	5	5.2	9.5
1992	81	63	2	10.5	12.6

[1] - snow depth March 1 at Eagle Plains (Indian and Northern Affairs snow survey bulletins).
[2] - snow depth May 1 at Old Crow (Indian and Northern Affairs snow survey bulletins).
[3] - ranks based on stage of phenology at peak of calving, from satellite AVHRR data.
[4] - mean daily temp. (°C) at Shingle Point July 1-15.
[5] - mean daily temp. (°C) at Shingle Point July 16 - Aug 7.

Table 2. Weather variables as ranks, sum of ranks, fall body weights and parturition rates, 1987-1992.

Variable	1987	1988	1989	1990	1991	1992
Winter snow	6	2	5	1	3	4
Spring snow	3	4	5	2	5	
Phenology	4	3	6	1	5	2
Early July temperature	4	2	3	1	6	5
Late July temperature	4	5	1	3	6	2
Sum of Ranks	21	16	20	8	25	14
Fall Body Weight	95	88	92	88	98	89
Parturition Rate[1]	84	78	82	74	86	81

[1] parturition rate measured in spring of following year i.e. in the 1987 column rate refers to rate in spring 1988.

Porcupine caribou model

The further development of the Porcupine caribou models (combining the Energetics and Population models, Russell *et al.,* 1993b) led to hypothetical

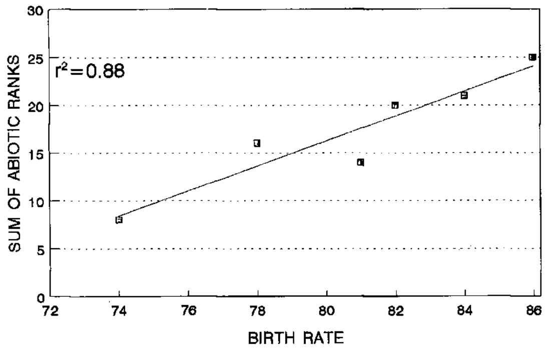

Fig. 2. Relationship between the sum of ranks of abiotic variables to the birth rate of the Porcupine Caribou Herd.

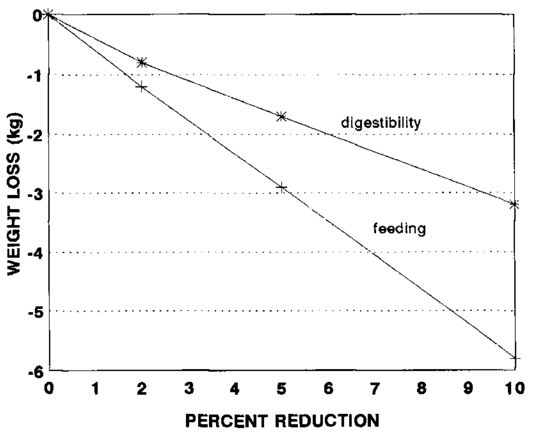

Fig. 3a. Simulated weight loss resulting from a 2%, 5% and 10% reduction in feeding and forage digestibility, June 1 – July 15.

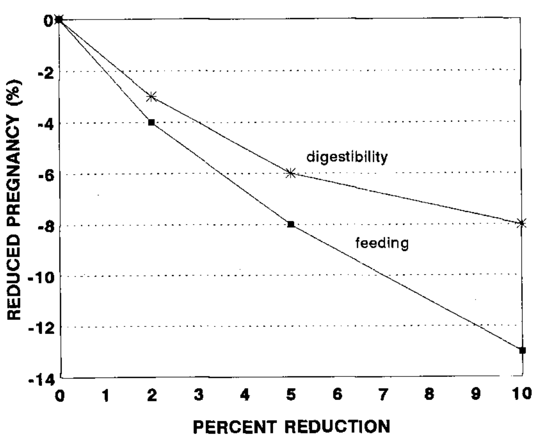

Fig. 3b. Simulated reduced pregnancy rate resulting from a 2%, 5% and 10% reduction in feeding and forage digestibility, June 1 – July 15.

development scenarios. For example, simulated reduced time spent feeding or poorer habitat resulted in lower autumn weights (Fig. 3a) and pregnancy rates (Fig. 3b).

Ongoing Work

Recent research relates birth weight and growth of calves to habitat use as well as condition and growth of mothers. Non-lactating females are also tracked to estimate the energetic investment in raising calves. These data will be used to refine and validate the Porcupine caribou model.

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