Section 3: The Porcupine Caribou Herd

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Documentation of the natural range of variation in ecological, life history, and physiological characteristics of caribou (*Rangifer tarandus*) of the Porcupine caribou herd is a necessary base for detecting or predicting any potential effects of industrial development on the performance (e.g., distribution, demography, weight-gain of individuals) of the herd. To demonstrate an effect of development, post-development performance must differ from pre-development performance while accounting for any natural environmental trends.

We had 2 working hypotheses for our investigations: 1) performance of the Porcupine caribou herd was associated with environmental patterns and habitat quality, and 2) access to important habitats was a key influence on demography.

We sought to document the range of natural variation in habitat conditions, herd size, *demography* (defined here as survival and reproduction), sources and magnitude of mortality, distribution, habitat use, and weight gain and loss; and to develop an understanding of the interactions among these characteristics of the herd.

In addition, we investigated ways that we could use this background information, combined with auxiliary information from the adjacent Central Arctic caribou herd, to predict the direction and magnitude of any potential effects of industrial oil development in the 1002 Area of the Arctic National Wildlife Refuge on Porcupine caribou herd calf survival on the herd's calving grounds during June.

Data, Methods and Assumptions

This work focused on the calving and post-calving seasons of the Porcupine caribou herd. The *calving season* was defined as the 3-week period that began with the birth of calves (spring). *Post-calving* was defined as the 3-week period that followed the calving season (early summer).

Porcupine caribou herd size was estimated by the Alaska Department of Fish and Game (ADF&G) from aerial photo-censuses during post-calving aggregations. Only censuses considered reliable by ADF&G were used. Variance in annual censuses due to multiple observers counting portions of the photo sets was relatively small when compared with each census (±2%) and was ignored in the display of annual censuses to the nearest 1,000 animals.

Demography and calf weight-gain were estimated from repeated locations and/or recaptures of radio-collared animals. Calving distributions were estimated from 767 calving sites of adult (≥3 year old) radio-collared female caribou obtained during 1983-2001 [average of 40 sites per year; fixed-kernel analyses using Least Squares Cross Validation (Silverman 1986, Seaman et al. 1996, 1998, 1999)]. *Concentrated calving areas* were defined as the annual kernel contour that included calving sites with greater than average density (Seaman et al. 1998). *Annual calving grounds* were defined as the 99% kernel utilization distributions obtained from annual calving sites. *Extent of calving* was defined as the aggregate extent of all annual calving grounds.

Vegetation types were mapped from Landsat-Thematic Mapper satellite imagery (Fig. 2.1; Jorgensen et al. 1994) and reduced from 17 to 7 classes for caribou habitat analyses (Fig. 3.1). We estimated the *Normalized Difference Vegetation Index* (NDVI) (Tucker 1979, Tucker et al. 1986) and snowcover from Advanced Very High Resolution Radiometer (AVHRR) data from National Oceanic and Atmospheric Administration (NOAA) polar orbiting satellites. Snowcover was estimated using a linear regression that we derived by correlating AVHRR infrared reflectance with estimates of snowcover extracted from aerial photographs collected in the 1002 Area during the snowmelt periods of 1987 and 1988 ($r^2 = 0.87$, $n = 80$). Cloud contaminated areas in the AVHRR images were identified (Baglio and Holroyd 1989) and excluded from analyses, as were large water bodies. AVHRR and Thematic Mapper images were transformed to an Albers Equal Area projection and re-sampled to 1-km² pixel size.

NDVI indexes the disproportionate reflectance of near-infrared radiation from green vegetation (Tucker and Sellars 1986) in the canopy of plant communities. Thus, relationships between NDVI and *total green plant biomass* or leaf area index (LAI) would be expected to be strongest for plant communities with reduced vertical distribution of green biomass and leaf area (e.g., communities dominated by sedges, grasses, or short shrubs that are common in the Arctic). Due to the size of the pixels (~1 km²) AVHRR data are linked more to landscape processes than to individual plant communities (Malingreau and Belward 1992).

Relatively good correlations have been obtained between above ground net primary productivity (ANPP) and seasonally integrated NDVI ($r^2 = 0.89$; Paruelo et al. 1997), LAI and NDVI when integrated across physiognomic categories ($r^2 = 0.97$; Shippert et al. 1995), and photosynthetic biomass and NDVI in small plots ($r^2 = 0.51$; Hope et al. 1993). Because NDVI indexed total green biomass and caribou are selective feeders (White 1983), we assumed that the biomass of forages eaten by caribou was positively correlated with total green biomass at the landscape scale.