

# Effect of adverse weather on neonatal caribou survival — a review

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**Abstract:** This paper reviews the relationship between adverse weather and neonatal caribou (*Rangifer tarandus* spp.) survival in North America by examining the available literature and our own findings. The viewpoint that adverse weather on the calving ground can result in major losses of newborn barren-ground caribou (*R. t. groenlandicus*) calves is largely unsupported. Published reports of calf mortality caused by adverse weather are questionable because causes of death were rarely determined by postmortem examinations. Circumstantial evidence associated with the small samples of dead calves does not support published assumptions that the mortality was weather related, or that high losses due to adverse weather are common events. The applicability of results from physiological testing are questionable, because the calves were restrained and the behaviour of unrestrained animals was ignored in the conclusions drawn from the tests. The relationship between adverse weather and calf mortality is more speculation than documentation yet often has been uncritically cited. In our view, healthy newborn barren-ground caribou are well adapted physiologically and behaviourally to cope with all but the most severe adverse weather.

**Key words:** adverse weather, mortality, newborn barren-ground caribou, Northwest Territories, Canada.

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## Introduction

Adverse weather has been indicated as a principal cause of death of newborn caribou (*Rangifer tarandus* spp.) (e.g., Banfield, 1951; Kelsall, 1968; Skoog, 1968; Bergerud, 1978). Most studies of the possible importance of inclement weather as a mortality factor of newborn caribou calves were in Canada (Cottle, 1959; McEwen, 1959, 1960; Kelsall, 1957, 1960, 1968; Lentz and Hart, 1960; Hart *et al.*, 1961; Pruitt, 1961; Bergerud, 1971; Miller and Broughton, 1974). Skoog (1968) put forth additional information on the supposed relationship between adverse weather and calf mortality in Alaska.

We had the opportunity to describe the effect of adverse weather during a study of calf mortality in the Beverly herd of barren-ground caribou (*R. t. groenlandicus*) during each June

1981, 1982, and 1983. In conjunction with our field studies, we intensively reviewed previous descriptions of calf mortality. Under closer examination we found that the validity of weather related mortality has not been well documented, especially the supposed catastrophic effects of inclement weather at or about the time of calving.

In this paper, we review the earlier accounts of mortality of newborn caribou calves supposedly caused by adverse weather, to demonstrate that the relationship is more tenuous than usually realized. Although our own study of caribou calf mortality was not carried out specifically to address this subject, the matter was part of our overall consideration. Therefore, we also present some of our data to further support our contention that the role of adverse weather in caribou calf mortality has been overemphasized.

## Earlier field studies of calf mortality and adverse weather

Banfield (1951:36, 1954:44) did not directly study the effects of adverse weather on newborn caribou in Canada although he concluded that «Weather also plays an important role as a mortality factor for the caribou population. The greatest losses are suffered by newborn calves when exceptionally severe weather conditions occur during the calving season». Banfield (1951, 1954:44) seemingly based his conclusion on an observation of a resident of Eskimo Point, Northwest Territories, in June 1947 who estimated, «...an 80 percent calf loss in the Keewatin District herds that season.». The estimate was unsubstantiated by recording sample sizes of dead calves, how the cause of death was determined, or how extrapolations to the calf crops were made.

Kelsall (1957, 1960, 1968) is most frequently cited regarding adverse weather as a major cause of mortality of newborn caribou. Kelsall (1957:37-38) based his original thinking, at least partially, on a sample of six dead calves found after a period of «rough weather» in June 1951 (although he does not describe the cause of death of those calves) and circumstantial evidence about weather conditions at or about calving in 1948 through 1951.

Kelsall (1960:51) seemingly used the sample of six dead calves from June 1951 as a basis for, «...considerable mortality among young calf caribou, which they (field personnel) ascribed, directly or indirectly, to adverse weather.». Kelsall (1960:51) also suggested that finding 30 intact skeletons of young calves in spring 1954 that apparently had died in spring 1953 did not implicate wolves but «...might be correlated with blizzard conditions which had prevailed in 1953 during the height of calving.». We suggest that other causes of death could also just as likely have been implicated as could adverse weather.

Kelsall (1960:45) attributed four of nine calf deaths to adverse weather in June 1957 which is confusing in light of Kelsall and Loughrey's (1958:27) observations during the same calving period of, «Fifteen caribou evidently killed or eaten by wolves were found, including five adults, one yearling, and nine calves». Possibly, the 1958 calf sample was 18: 11 suspect wolf kills; 4 deaths due to adverse weather (exposure or starvation); and 3 unknowns, though postmortem examinations are not reported. If this is

correct, it would further reduce the basis for the speculation about the supposed relative importance of adverse weather, at least, when based on direct evidence from samples of dead calves.

Kelsall (1960:56) states, «More than 100 dead calves found appeared to have died during the adverse weather of June 1 to 3 and June 5 to 10. (1958)... At Camp 26, where Wilk, Thomas and Pruitt discovered about 90 dead calves, most of the mortality had occurred during the first ten days of June.». Those 90 carcasses were found until 26 June but, «...most of them were thought to have died during the adverse weather experienced up until June 11.». The causes of death were discussed for 85 of them and only «35 percent» of them (30) were attributed directly to adverse weather (p. 45). It is, however, difficult to determine adequately the «time of death», except when the carcass is relatively fresh and only then, if detailed necropsies were performed — which is never specified. Kelsall (1960:48) mentions the skinning of five carcasses by de Vos but not detailed postmortem examinations.

The field workers determined the cause of death by finding the carcass after periods of inclement weather and not finding any external evidence for each calf's death by other causes. Our study of calf mortality on the Beverly calving ground in June 1981 — 83 and studies on the calving ground of the Porcupine caribou herd in Alaska (Mauer *et al.*, 1983; Whitten *et al.*, 1984, 1985) emphasized the need for detailed necropsies to determine the cause of death. Determination of death from exposure by an external examination of a carcass is impossible. Even after performing a detailed necropsy, the diagnosis of exposure would often still be questionable, as it is made by elimination of other causes.

de Vos (1960) is often cited in relation to adverse weather contributing to deaths of newborn caribou although in fact his only relevant statements were, «In this particular study inclement weather did not appear to affect calf mortality seriously. On June 12, four dead calves were found which appeared to have succumbed during a blizzard three days previously.». de Vos' camp was one of the three camps that Kelsall (1960) used to provide data on the importance of adverse weather in 1958, and in fact de Vos' camp was only about 5 km from the camp where the 85 carcasses were found

(D.C. Thomas, pers. comm.; and map no. 2 of Kelsall, 1960:137).

Also relevant is Pruitt's (1961) findings referred to by Kelsall (1960:48) that suggested that only, «...about 4.5 percent (or possible less) of the fawns (calves) born on this particular hillside...» in June 1958 died during that period of adverse weather. Pruitt's (1961:551) subsequent conclusion has gone unheeded: «It is clear that near-blizzard conditions prevailed during most of the period of observation.» — (yet mortality was very low).

Altman (1962:16) stated that, «It is enigmatic that caribou are born well before the warmest time of the year on the barren grounds, and yet, may be highly susceptible to inclement (sic) weather.». He suggested that one possible explanation was that if caribou were born earlier the influence of adverse weather would be more likely and if born later they would not make sufficient growth to survive the first winter.

Kelsall (1968:236-242) in his final consideration of weather (especially wind chill) in relation to newborn calf mortality reiterated his previous reports and those by Lentz and Hart (1960) and Hart *et al.* (1961). Kelsall (1968) included additional data for June 1959 when no dead calves were obtained. Kelsall's (1968:239) statement that, «Numerous dead calves were found following severe storms in all three of the later years, (1957-59) with losses in 1959 being relatively minor, and those in 1957 quite severe» was based apparently on the samples of four of nine calves in June 1957; 30 of 85 calves in June 1958; and none in June 1959. Also, we think, that Kelsall's circumstantial evidence from weather records and counts of cow-calf ratios obtained in the above studies do not necessarily support the conclusion that mortalities of newborn calves in those years must be attributed directly to adverse weather.

Kelsall (1957:38) speculated that «It seems likely that there is a «chilling point» at which the bodily functions of the caribou calf are greatly impaired. The crucial conditions are probably brought about by various combinations of high winds, low (sic) moisture content, low temperatures (not necessarily below freezing), and continuous or frequent precipitation. There is no shelter on the calving grounds except from winds, which seem to make caribou nervous and keep them on the move for greater distances and longer periods than usual.».

Kelsall (1960:46) also identified two other possible consequences of adverse weather causing calf mortality. He speculated that calves would become separated from their maternal cows during blizzards. Kelsall (1960-46) also referred to calves mired in unseasonable deep snow as one of the examples of adverse weather and a late season indirectly causing calf mortality. Pruitt (1960:30) observed that caribou on the Beverly calving ground in 1958 avoided soft snow areas when travelling during the thaw. He noted that when caribou did attempt to cross deep soft snow areas, «...individuals frequently broke through the snow, went in up to their bellies and had trouble getting out.» (Pruitt, 1960:30). Pruitt (1960:30) also saw a wolf pick up a calf carcass that had become mired in soft snow and died.

### Field experiments to document effects of adverse weather on calf mortality

Kelsall's (1957) concerns for severe weather leading to the death of calves led to experiments to describe the influence of adverse weather on metabolic and thermal responses of newborn caribou (Hart *et al.*, 1961; Kelsall, 1968:238-240). Extrapolating Hart *et al.*'s (1961) study to healthy, free-ranging calves is questionable: the experimental calves were (1) captured and flown to holding areas; (2) held in small corrals, without forage, and fed a substitute diet of mainly evaporated milk; (3) tethered by a rope during tests; (4) some were blindfolded to prevent struggling during tests; and (5) tested while in the standing position. Only four calves were tested and all died apparently of direct results caused by adverse weather. Those four calves were tested during a heavy rain storm on 15 June 1959; two died during and two shortly after the tests. The four untested (control) calves free to find shelter around the camp during the storm all survived, which led Hart *et al.* (1961:855) to recognize the probable importance of behaviour. Additionally, Hart *et al.* (1961) and Cottle (1959:10) when discussing the 1959 wind chill study noted that the effect of the storm during the test period was not detected by subsequent repeated counts of cows with calves. The absence of a decrease in the calf to cow ratio suggested that behaviour of free-ranging calves

enables them to cope to some extent with the adverse weather conditions that led to the deaths of the four restrained, test calves.

### Other North American studies of calf mortality and adverse weather

McEwen (1959:37) also on the Beverly calving ground in 1959 saw 20 dead calves from the air on 16 June, following an exceptionally severe storm on 15 June with rain and winds of 80 km/h gusting to 121 km/h. He (McEwen, 1959:37) extrapolated the 20 dead calves seen on a 86 km<sup>2</sup> area to 533 dead calves on a supposed calving ground of 2778 km<sup>2</sup> and estimated a 2.6% mortality on 15 June (by assuming 19800 calves present). When he compared this loss to earlier losses McEwen (1959:37) concluded, «Although this is perhaps not a valid comparison, it does indicate that the effect of weather on calf mortality was lower than anticipated.»

In 1960 McEwen (1960:27) concluded that calf survival was high because of favourable weather throughout the calving period, with the exception of one day. He implied that the sighting of seven dead calves on 9 June, a «... slightly higher than daily average.» resulted from inclement weather on 8 June with 9.0 cm of rain and winds averaging 32 km/h.

Bergerud (1971) who worked on woodland caribou in Newfoundland (*R. t. terraenovae*; *R. t. caribou*, Banfield, 1961), concluded that there was no evidence that calves succumbed from exposure between 1957 and 1967. He reported that of six calving grounds the one with the coldest weather had the second highest 10-yr average rate (15.2%) of calf survival (Bergerud, 1971). However, Bergerud (1971) also pointed out that the maximum daily wind chill values for June in those 11 years were less than those given by Kelsall (1960) and Hart *et al.* (1961) as causing mortality of newborn caribou calves in the NWT. He also suggested, and we concur, that as newborn Newfoundland caribou calves are heavier than barren-ground caribou calves the former might be able to withstand greater exposure to inclement weather (Bergerud, 1971).

Bergerud (1978:86) when discussing North American caribou in general, states that: «Wind chill is the second most common cause of death of newborn calves during inclement weather (*cf.* Kelsall 1968).» «...(and) this cause of mortality can deplete an entire calf crop.» The above unsupported statement is then followed by

erroneous citation, «The Kaminuriak herd lost much of its 1962 calf crop from this factor (Miller, 1974).». Miller (1974:65-66), however, had only concluded that, «...we must assume that either the survival of calf crop in 1962 was very low, or the mortality of juveniles and subadults of that cohort was exceedingly high.» In other words, Miller (1974) had not concluded the possible importance of wind chill on calf mortality in 1962. Record snow thicknesses in the winter range (Parker, 1972:Table 5) and extremely poor physical condition of caribou during spring migration in 1962 (J. D. Robertson, pers. comm. in Miller, 1974:66) argue for the causes of calf mortality to have been initiated prior to calving. Bergerud (1980:560) subsequently correctly evaluated the problem of prevailing weather on the Kaminuriak calving ground in June 1962, when he stated that, «We do not know the severity of the weather on the calving grounds, in 1962.»

Bergerud (1974:557) concluded that, «The short calving season for caribou cannot be explained by a mortality due to weather of calves born too early in spring. Calf mortality due to windchill has been reported for the Canadian Arctic (Kelsall, 1968) but not for Alaska or Newfoundland (Lent, 1964; Skoog, 1968; and Bergerud, 1971).»

Skoog (1968:581-587) found no evidence for adverse weather at or about calving time causing significant losses of newborn caribou in Alaska. He accepted, however, reports of adverse weather causing high mortality among newborn calves, and concluded (Skoog, 1968:582-583) «There can be no doubt that severe weather and chilling can result in high mortality among newborn calves during some years.» He referred to turn-of-the century reports of high losses within calf crops of reindeer (Skoog, 1968:581-582) and the later Canadian reports (Banfield, 1954; Kelsall, 1957; Lentz and Hart, 1960). Skoog (1968:587) summarized his discussion about weather by saying, «I doubt, however, that weather conditions other than icing exert much influence over caribou populations, except occasionally when repeated losses of a majority of a calf crop may occur over a period of years. The Nelchina herd experienced no such losses during the period of this study.» Bos (1974:17) watched the difficulty with which newborn calves in the Nelchina herd followed their mothers across remnant snowbanks and specu-

lated, «Should newborn calves have to transverse large areas of deep soft snow, the likelihood of calf mortality would become very real.». Such mortality has not yet been recorded, however.

No subsequent studies of caribou calf mortality in Alaska have to date documented any high losses (and for the most part, not even any insignificant losses) of newborn caribou calves due to adverse weather (e.g., Bos, 1975; Davis and Preston, 1980; Davis *et al.*, 1978, Davis and Valkenberg, 1978; Mauer *et al.*, 1983; Whitten *et al.*, 1984, 1985).

Davis *et al.* (1978) found no calves that had died from exposure to adverse weather in a study of the Fortymile caribou herd in Alaska. While discussing the possible losses of calves to adverse weather they noted (Davis *et al.*, 1978:60), «Caribou investigators in Alaska have pointed out that conditions on Alaskan calving grounds are generally milder than those in northern Canada.». They further noted (Davis *et al.*, 1978:62) that, «It is interesting to note that the Delta caribou herd (the closest neighboring herd to the Fortymile) realized its highest recent initial calf production and survival during 1976. Department biologists surveyed that area because they were concerned that catastrophic calf loss might result from the low temperatures and heavy snowfall in spring 1976. We also documented highly successful calving in the Western Arctic herd in 1975 and 1976 under weather conditions that were harsher than those that occurred on the Fortymile calving grounds during this study.»»

### 1981-83 studies of calf mortality on the Beverly calving ground

We studied newborn calf mortality on the calving ground of the Beverly caribou herd during June 1981-83, the same calving ground studied by the Canadian Wildlife Service in the late 1950s. We assigned causes of death to 257 of the 287 calves that we necropsied: only nine (3.5%) calves had died from pneumonia and those cases were not associated with adverse weather.

Weather on the calving grounds during calving and early postcalving in 1981, 1982 and 1983, however, was favorable to calf survival: little precipitation fell; temperatures and winds were seasonally mild and moderate, respectively. The highest recorded wind speeds did not exceed 40

km/h but were accompanied by rain and cool temperatures.

An abrupt warming trend in the second week and the seasonal lack of rain on the calving ground in June 1983 created slush mires by melting deep snow banks along the shores of water bodies. Six dead calves were found on 10, 11, and 13 June which had drowned, died of fatigue, stress or shock while trying to cross these slush mires. Although these conditions for potential entrapment and subsequent death may occur in most years, they are probably rarely as bad as in June 1983. Unlike Kelsall (1960:46), we believe that late season would likely reduce the problem because the snow banks would stay hard packed or refreeze «nightly» during early June; thus, allowing the newborn calves to traverse them without difficulty. By late June, the older calves should be better able to cope with the slushy areas in a late season.

Even with a detailed field necropsy, determination of the primary cause from the proximate cause of death is not always possible, especially in cases initially involving separation of the calf from its maternal cow then death of the calf due to a malnutrition, pneumonia, exposure complex. The cases of calf separation and subsequent mortality (14 cases) were also not associated with the adverse weather.

### Discussion

The speculation about the importance of adverse weather at or about the time of calving in causing significant mortality of newborn caribou is based on limited quantitative data and, most importantly, the actual cause of death was not determined by detailed postmortem examinations.

Kelsall (1957, 1960, 1968) has been the author most cited as the source of data on adverse weather and calf mortality. The circumstantial evidence associated with Kelsall's small samples of dead calves does not necessarily support the assumption that the mortality was weather related, or that such high losses due to adverse weather are common events. The limited physiological experiments are questionable, especially the meaningfulness of the threshold values, because restraint or only parts of the animal were used and because behavioural considerations were ignored in drawing conclusions.

It appears from our review of the literature that caribou biologists have no sound factual basis for assuming that adverse weather frequently causes major losses of newborn barren-ground caribou. We are not suggesting that extreme adverse weather at or about the time of calving could not ever be an important cause of neonatal caribou mortality, but we do believe that such large-scale mortality remains to be documented. It seems likely that significantly high mortality among newborn barren-ground caribou probably only occurs when the additive effects of several unfavourable conditions combine: e.g., forage unavailability lowers the nutritional status of pregnant cows to the extent that their offspring are light, weak calves. We suggest that it appears that healthy newborn barren-ground caribou are well adapted physiologically and behaviourally to cope with all but the most extreme severities of adverse weather at or about the time of calving.

We think that Bergerud (1980:560) hit on the crux of the matter regarding the probable importance of adverse weather at or about the time of calving (especially at the peak of calving) when he stated that, «We do not clearly understand the relationships between maternal nutrition, calf size and vigor, and the subsequent ability of the calf to survive severe weather.».

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