METHODOLOGY FOR STUDYING NEONATAL MORTALITY OF CARIBOU IN REMOTE AREAS

by

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Abstract: Previous studies of neonatal mortality of large, remote caribou herds have been limited to carcass searches in calving grounds and sequential age-ratio counts on calving grounds and post-calving areas. For the past 3 years, radio-telemetry techniques have been used to assess neonatal mortality among caribou (R.t. granti) calves in the Porcupine herd in northeastern Alaska. Helicopters were used to capture calves 1-5 days of age and motion-sensitive transmitters were attached to each calf to detect mortality. Study-induced deaths (abandonment and death due to subsequent predation or malnutrition/starvation) is inherent in this method, but can be distinguished from natural deaths through close post-capture monitoring. Capture, handling, and marking procedures were modified after the first year to reduce study-induced deaths. Radio-collared calves were monitored daily by using fixed-wing aircraft. Deaths were inspected as rapidly as possible after detection. Death sites were inspected for evidence indicating cause and carcasses were necropsied when sufficient material remained. Radio-collared cows and their attendant calves were monitored to measure differences in mortality between the radio-collared calf samples and the unmarked calves of the radio-collared cows.

Résumé: Les études antérieures de la mortalité néonatale au sein de grands troupeaux de caribou des régions isolées se sont limitées à la recherche de carcasses sur les aires de mise bas et au décompte séquentiel des groupes d'âge sur les aires de mise bas et sur les aires post-natales. Depuis trois ans, des techniques radio-télémétriques ont été utilisées pour évaluer la mortalité néonatale parmi les veaux des troupeau Porcupine, dans le nord-est de l'Alaska. Pour détecter la mortalité, des veaux de 1 à 5 jours d'âge furent capturés à l'aide d'hélicoptères et furent munis d'émetteurs sensibles aux mouvements. La mortalité induite par l'étude (abandon et inanition subséquente) est inhérente à cette méthode mais peut être distinguée de la mortalité naturelle par un suivi soutenu immédiatement après la capture. La capture, la manipulation et la marche à suivre pendant le marquage ont été modifiées après la première année, afin de réduire la mortalité induite par l'étude. Les veaux porteurs de colliers émetteurs furent suivis quotidiennement par avion. Les veaux morts furent inspectés le plus tôt possible après détection. Les sites de mortalité furent inspectés afin de trouver des indices permettant d'identifier les causes de décès. De plus, les carcasses furent autopsiées lorsqu'on pouvait retrouver suffisamment de restes. Les femelles porteuses de collier et leurs veaux furent suivis pour mesurer la différence de taux de mortalité entre l'échantillon de veaux porteurs de collier et les veaux non marqués accompagnant des femelles porteuses de collier. Les veaux porteurs de collier furent aussi suivis pour étudier les déplacements des caribous dans les aires de mise bas, les agrégations post-natales, l'émigration des terrains de vêlage, l'utilisation des aires d'hiver et le taux de survie hivernale des jeunes d'un an dans le troupeau.

Neonatal mortality is a major factor in determining the annual increment for many animal populations. In caribou, neonatal mortality is often high immediately following parturition and rapidly declines to a relatively low rate for the remainder of the first year (Skoog 1968). Case studies have shown that low calf survival during the first year has either contributed to population declines or has prevented recovery following declines (Bergerud 1971, Gasaway et al. 1983). Parturient females and post-parturient females with young calves are sensitive to human disturbances (de Vos 1960, Lent 1964 and 1966, Bergerud 1974). Studies conducted annually since 1974 have shown that female caribou with young calves avoid the Prudhoe Bay oil field and Trans-Alaska Pipeline corridor in Alaska (Cameron et al. 1979, Cameron and Whitten 1980). Displacement of female caribou and young calves from traditional calving areas may cause increased calf mortality and ultimately lead to population declines (Calef and Lent 1976, Klein 1980). The large northern caribou populations of North America occur in remote areas, migrate over great distances, and are often widely dispersed, all of which complicate collection of detailed information on calf mortality. Also, carcasses are usually quickly consumed by predators or scavengers or can become covered by snow, making searches for carcasses unproductive (Bjarvall and Franzén 1981).

The common technique used to evaluate caribou calf mortality is aerial surveys to measure the chronology and over-all magnitude of mortality on an annual basis (Kelsall 1968, Davis et al. 1980). The gregarious nature of parturient and post-parturient females and the relatively high level of calving synchrony exhibited by migratory caribou, contribute to the utility of aerial survey methods (Bergerud 1974, Dauphine and

McClure 1974). However, obtainment of accurate estimates of calf mortality is often complicated by difficulties in identification of age and sex classes from the air and by frequent mixing of barren females and non-productive yearlings with productive females (Miller and Broughton 1974). Also, comparative cow-calf ratios developed from aerial survey data do not provide information on causes of mortality or the spatial and temporal distribution of that mortality.

Intensive searches for calf carcasses, using helicopters for low-level flight over calving and post-calving areas, have provided data on causes and spatial distribution of neonatal caribou calf mortality (Miller and Broughton 1974, Miller et al. 1983). This technique provides data on deaths that are found, but does not necessarily provide an inference base for overall calf mortality within a given year. Bjarvall and Franzen (1981), successfully used radio-transmitters for a calf mortality study in a small domestic reindeer herd in Sweden. This technique had not been applied to the study of neonatal caribou calf mortality in North America. Advantages of radio-telemetry techniques are the ability to relocate individually marked calves to determine their movements and activities, and more importantly, to recover carcasses soon after death to accurately determine causes of death (Cook et al. 1967). Detailed information on chronology and location of deaths can be obtained and inferences can be made for over-all mortality of calves in the population if sample size is adequate.

Lent (1961) demonstrated that neonatal caribou calves could be captured using ground crews provided fixed-wing aircraft access sites coincided with caribou concentrations and appropriate terrain features (hills, creeks, and snow drifts) for ambush sites. However, large remote herds usually calve where fixed-wing access is limited and terrain features do not promote use of ground crews. Also, maternal cows are generally wary and often flee with their calf when approached by ground crews. Because of these difficulties, Lent (1964) identified the need for helicopter support during studies of post-calving caribou in remote areas. Helicopter-assisted capture of caribou calves in Alaska was initiated by Alaska Department of Fish and Game and the University of Alaska, Fairbanks, in 1980 to obtain captive animals for pen studies. Initially, helicopters were used for access to the capture area and to approach within 50 m of a cow-calf pair. The helicopter landed and the calf was pursued on foot. Between the time the helicopter landed and pursuit began, the distance had doubled as the dam fled with her calf. The ensuing chase usually covered 200-300 m and a successful capture was unlikely. A total of 5-6 captures was a full day's work. The technique was later modified to increase capture efficiency by having the runner ride on the skid or basket and jumping off at a running start to pursue the calf.

This paper describes techniques used to capture, process, and monitor calf mortality in the Porcupine caribou herd, a large, remote caribou herd in North America. Methods were improved during the past 3 years as experience was gained in capturing and processing calves. The methods used each year will be discussed and the efficiency of the various methods will be compared. This project is part of an ongoing baseline studies program of the coastal plain of the Arctic National Wildlife Refuge in northeastern Alaska. These studies are mandated by Section 1002(c) of the Alaska National Interest Lands Conservation Act of 1980, which also requires evaluation of the potential effects of oil and gas exploration, development and production within the coastal plain of the refuge on the Porcupine caribou herd. This investigation is a joint project between the Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service.

Capture of Calves

The helicopter capture technique with the runner riding on the skid was used to capture neonatal calves on the calving grounds of the Porcupine caribou herd. Capture procedures were standardized in 1983 and 1984, when a 4-person crew (including pilot) was used in the capture operations. One person served as data recorder/measurer, while the 2 remaining crew members alternated in running after calves.

Departure from the skid occurred as soon as the calf was nearby (within 10 m), the ground speed was matched to the runner's ability, and the height was less than 1 m. Caution must be exercised in departures from the skid, as excess height (greater than 1 m) or speed can result in an injury, therefore, good judgement by the runner is essential. Runners should always use the skid next to the pilot, so that the pilot can position the runner near the calf. All efforts to capture calves should strive for rapid, easy chases. Prolonged foot or helicopter chases should be avoided and chases should be terminated after 2 min.

Selection of calves for capture is an important consideration of study objectives. When a group of cows with calves was approached in 1982, the rear calf was usually captured. Slow calves may be weak, debilitated, diseased, or very young (less than 1-day-old) and may not yet have formed a strong mother-young bond. In order to avoid biasing the sample, the procedure for calf selection was standardized in 1983 and calves were selected for capture by designating the calf on the extreme near side (right or left) when a group was approached.

Processing Calves

When a calf was captured, the helicopter landed and sat idling within 20-50 m, while the remainder of the capture crew assisted in processing the calf. Sterile surgical gloves were worn by all personnel handling captured calves, and new gloves were used for each handling. Other procedures recommended by White *et al*. (1972) for minimizing the potential for increasing neonatal mortality due to marking and handling were used (e.g. small markers, processing and releasing calves at capture sites, etc.) throughout the study. Calves were sexed (Bergerud 1961); weighed; and measured for total body length, right hind foot length, and new hoof length (Haugen and Speake 1958).

Characteristics of the umbilicus (moist, dry, intact, absent) and hooves (degree of wear) were noted as described by Miller and Broughton (1974).

Ages of calves were estimated using general criteria described for white-tailed deer (Odocoileus virginianus) by Haugen and Speake (1958), elk (Cervus canadensis) by Johnson (1951), and caribou by Miller (1972). Samples of feces were collected from calves with diarrhea. Each calf was examined for abnormalities. Notes were kept on cow-calf behavior during capture/processing, and release of the calf.

An expandable white elastic collar supporting a mortality sensing transmitter (Telonics Inc. Mesa, AZ), weighing approximately 270 g was installed around the neck of each calf in 1982 and 1983). Collar color was changed to brown in 1984 to avoid the potential of targeting study calves for predation by golden eagles (Aquila chrysaetos). Mortality mode for transmitter units was a doubling of normal pulse rate following a 1-h motion free period. Estimated battery life was 15 months. Each collar was constructed from 3.75 cm wide elastic band. Adjustment of the initial collar size at installation was done by fastening the left and right ends of the elastic collar band together with aluminum 'pop' rivets. Processing efficiency was increased after the first calf captured in 1982 by preriveting the collars at a circumference of 25 cm. The remaining collars were installed by stretching the collars over the calf's head (Mauer et al. 1983). Three separate expansion folds per collar were sewn with incremental amounts of cotton thread stitching. Each expansion fold provided an additional 7 cm of collar circumference. The maximum expansion circumference of each collar was 53 cm. Collars were constructed to breakaway after the last expansion loop was used.

Using the techniques described above, calves were captured quickly, efficiently, and safely. Actual capture/processing time in 1982 for 20 calves averaged 10.6 min (5.0 min search/capture, 5.6 min processing). As experience was gained in using the technique, capture/processing time declined to an average 7.5 min (3.7 min search/capture, 3.8 min processing) in 1983, and 6.6 min (3.7 min search/capture, 2.9 min processing) in 1984.

Calves were closely monitored immediately after release using PA-18 aircraft or helicopter-supported ground observers to determine if they reunited with their mothers. Reunion attempts were classified by the following criteria: rejection-cow returns to calf but strikes calf with forelegs and/or runs away with calf attempting to follow; qualified reunion-cow returns to calf, approaches slowly, smells calf, then both leave the area with the calf at heel; reunion-cow returns to calf, calf suckles, and both move away with calf at heel. A cow/calf pair was considered bonded if the cow and calf remained together at least 48 h after capture (Franzmann et al. 1980).

Study-induced deaths (abandonment by dam) or predisposition to predators) is inherent with radio-collaring techniques involving very young calves. Transfer of foreign scent, either from the capture crew members or from previously captured calves may cause study-induced abandonment because cows identify their calves primarily by scent (Pruitt 1960, Lent 1966, Skoog 1968). Care was taken to minimize transfer of human scent by wearing disposable, sterile latex gloves, and by holding calves at arm's length or pressed to the ground. In 1982 and 1983, collars were retrieved from calves that died soon after capture and these collars were used again on newly captured calves. Some collars were reused more than once. Reused collars were rinsed in cold water, but may have still had scent from a previous calf. Apparent abandonment was 7 out of 60 in the original collaring effort in 1983, but out of 9 among recollars. In 1984, 12 of 30 calves were abandoned after the first day of capture and these abandonments were assumed to result from the use of a large sling (a commercial canvas 'log carrier') for weighing calves. It was difficult to keep a struggling calf in the sling and holes were eventually cut for the forelegs. The large surface area may have collected and transferred scent from one calf to another. In 1982, burlap sacks were used to wrap each calf and a scale was hooked through the ends of the sack for weighing. The process was awkward, but sacks were used once and discarded and abandonment was low. In 1983, attempts were made to use large sterile gauze pads to wrap around the calves, but these were too fragile. A leather belt with the end run around the calf's chest and back through the buckle to form a tight noose was subsequently used to weigh calves in 1983. This method was fast and efficient and probably transferred minimal scent. After the sling proved unsatisfactory on the first day in 1984, the belt system was used thereafter.

In 1984, collars were again reused, but were first rubbed with moss and soil and stored in a large plastic bag with moss and soil in an attempt to mask human and other calf scents. Dickinson *et al*. (1980) reported using vegetation to mask human scent in a neonatal mortality study of desert mule deer (*Odocoileas hemionus*) in southwest Texas. When capture was resumed in 1984, the abandonment rate dropped to 5 of 42. None of the calves receiving descented used collars were abandoned. After these experiences, it is recommended that similar descenting procedures be used on all collars to remove scent from handling as well as from previous calves. This descenting may reduce the approximate 10% abandonment rate that appears to be inherent under the best conditions.

During calf capture some cows may aggressively defend their calves. Generally, the runner can approach aggressive cows and capture their calves while they retreat. However, aggressive defense may vary from herd to herd. No problems were encountered during calf captures in the Porcupine Herd, but in 1 instance of 20 captures in the Delta Herd a cow acted so aggressively that the capture of her calf was abandoned. If cow aggressiveness is a problem, the helicopter could be used to separate the cow from her calf, as must often be done in the capture of moose calves (Gasaway, pers. comm.).

Monitoring Radio-collared Calves

In 1982, logistical problems prevented an adequate monitoring program. Study induced abandonment can be a significant source of mortality, and must be distinguished from natural mortality. The attempts at long-term surveillance of released calves with ground observers were not entirely satisfactory. Observers stationed on high points overlooking the capture area had difficulty detecting collars from a distance, even with spotting scopes. Observers could not be sure to which cow the calf belonged and they quickly lost visual track of which calves had been captured when 2 or more were handled. Successful reunions took up to 6 h and some apparent reunions occurring soon after release ultimately resulted in abandonment. Thus direct observation immediately after handling from the helicopter or by ground observers was not feasible under field conditions.

The most effective monitoring was done using fixed-wing aircraft equipped with radiotracking gear. The capture of calves in 1982 proceeded without the aid of follow-up ground or air observation other than by the capture crew itself. Abandonment was suspected when a dead calf was later found at or very near to the capture site. When ground observers experienced difficulty during the first captures in 1983, the tracking plane was used to monitor released calves. Monitoring flights began about 1-h after initial capture and continued at 1 to 2-h intervals between resightings of individual calves. Each calf was quickly located by its radio signal and an overflight at approximately 100 m above ground level (AGL) usually determined immediately if the calf had reunited with the dam. If there was confusion, additional overflights at lower altitudes determined if a calf was indeed with its mother. If the calf was alone, the distance to other caribou, behavior/condition of the calf, and presence of lone adult cows that appeared to be lingering in the area were recorded. Most successful reunions took place within 1 to 5 min of release, but some took at least 6-h post-capture. No reunions were documented more than 12-h post-capture. Unattended calves survived 18 to 72-h unless killed earlier by predators of study personnel.

In 1982, the monitoring schedule was not sufficiently frequent to detect deaths in a timely manner. The 4-h delay period prior to activation of the mortality signal was too long and logistical limitations did not permit frequent relocation and monitoring surveys (weekly versus daily surveys). The 4-h delay period resulted in confusion when a transmitter emitted 'alive' signals, after the calf was dead. These false 'alive' signals were caused by avian scavengers moving the transmitter while feeding on the carcass. In order to obtain more precise data on mortality, the 1-h delay period was used on the motion sensitive collars in 1983 and 1984. Also, calves were monitored on a much more frequent basis and visual fixes were obtained as often as possible so that recently dead calves might be detected, even if their collars were kept on normal mode by the action of predators or scavengers. Due to the sample size in 1983 and 1984 (60 calves) and commitments of flying time to other projects, daily visual locations were possible for only about 30 of the marked calves. However, all calves were monitored daily for mortality signals. Often all frequencies were monitored a second time during return flights to base (Barter Island) to detect any further deaths. In this manner, mortality signals could be checked immediately upon detection, and each calf was checked visually at least every 48 h so that all deaths were located as soon as possible. 'False' mortality signals from inactive calves occurred infrequently; the live calf would stand as the plane flew over and the signal would change back to 'live' mode. This was a minor inconvenience compared to the resultant losses of data using the 4-h delay period in 1982. Several deaths were detected during the visual searches when the signal was still on normal mode. These were particularly valuable finds, as predator was often still present.

Monitoring Control Calves

Initial productivity of the Porcupine herd was estimated by determining the parturition rate among radio-collared cows and by recording calf:cow ratios during delineation of the calving grounds or in conjunction with calf collaring. Radio-collared cows were monitored regularly (alternating days) in late May, June, and July of each year to determine their reproductive status. Presence or absence of distended udders, antlers, and/or calves were noted and locations were plotted on 1:63,360 topographic maps. The monitoring of the radio-collared cows was designed to provide a control group of unmarked calves for examining the extent of study-induced deaths among marked calves, to determine if mortality among the marked sample was comparable to mortality of unmarked calves, and to document the chronology of calving among the Porcupine herd. Small sample sizes (9 in 1982, 18 in 1983, 23 in 1984), and the aggregation of cows and calves after calving limited the success of this effort. Barren cows, apparent pregnancy, and eventual calving were documented among the collared cows. Early calf losses (2-3 weeks) were also documented, but deaths after 3 weeks of age were difficult to document due to large aggregations and the resultant confusion in determining the presence or absence of a calf with a certain cow.

Another problem was the wide-spread distribution of collared cows. They calved throughout the calving grounds, whereas the sample calves were captured in relatively restricted areas. Also, calving occurred over a much longer time period for collared cows (3-4 weeks), while sample calves were captured in 3 to 6 days at the peak of calving. Considerable resources (funds and personnel) are necessary to adequately monitor collared cows. In late June, large group size may preclude extending the monitoring of the control group through post-calving aggregation and movement from the calving grounds. However, the monitoring of collared cows does provide data on mortality among an unmarked calf sample, incidence of barren cows, and distribution and chronology of calving.

When calving was widespread or peak of calving varied on an east-west or north-south gradient, initial productivity was determined for only that portion of the herd using the calf capture area. Calf:cow ratios for the entire herd were estimated during July in conjunction with the herd census and compared with initial calf production to provide an overall estimate of neonatal mortality. These results were then compared to the mortality between the collared calves and the calves of collared cows. The collection of the above data was complicated by widespread calving distribution in 1982, and lack of a suitable aggregation in 1984.

Examination of Dead Calves

All deaths were investigated as soon as possible using helicopters to retrieve the carcasses. Each carcass and death site was examined for information on the cause of death. Photographs were taken to document each site. Evidence of predators/scavengers at the carcass site was noted and collected. If field necropsy was not possible, carcasses were placed in plastic garbage bags, labeled, and frozen for later study. Laboratory necropsies were performed on carcasses when sufficient remains were present. Necropsy procedures followed those described by Dau (1981). In cases where only hair and bones remained, measurements of weight, right hind foot length, and new hoof length were recorded whenever possible. The location of retrieved carcasses was plotted on 1:63,300 scale topographic maps. Criteria for determining the category (Cook et al. 1971) and identifying the cause of each death (Table 1) were developed from descriptions of predator kills and feeding characteristics in the literature (Murie 1948, Thompson 1949, Johnson 1951, Borg 1962, Atwell 1964, Mech 1970, Wiley and Bolen 1971, Alford and Bolen 1972, Cole 1972, White 1973, Miller and Broughton 1974, Bolen 1975, Henne 1975, Miller 1975, Mysterud 1975, Buskirk and Gipson 1978) and experience gained throughout the study. These criteria were developed for northeast Alaska and may need further refinement if used for different study locations. Case history data were maintained for each calf. Carcasses of unmarked calves found during the study were processed in the same manner as radio-collared calves. Lone cows were routinely overflown to determine if a calf carcass was present. Calf carcasses found in this way provided additional data on causes of neonatal calf mortality, but were not used to assess overall mortality.

SUMMARY

The relatively low costs and ease of capture associated with this technique are considerably more favorable than those of other capture techniques, except perhaps capture at water crossings. The latter is not feasible for most herds in Alaska, whereas capture of calves on calving grounds can probably be applied universally. When permanent, expandible attachment systems and 3+ year batteries become available, calf capture may become a preferred method for radio-collaring caribou. Even in populations with high neonatal calf mortality, the relative ease of capturing 30+ calves per day inexpensively might be preferable to the difficulty and expense of capturing adults.

Table 1. Criteria used for determining category of observed deaths of neonatal caribou calves in northeast Alaska.

Criterion	Category
I Carcass lacks sign of being bitten, chewed or disturbed by predators.	I Predation-excluded
1. Milk curds absent in abomasum and intestinal tract; lack of mesentery and subcutaneous fat; rumen may be packed with vegetation.	1. Starvation
a. No reunion with dam observed following release and subsequently observed unattended by dam prior to death.	a. Probable study-induced abandonment
b. Reunion with dam observed following release, but later observed unattended by dam prior to death.	b. Probable natural abandonment
2. Milk curds present or absent from abomasum or intestinal tract; mesentery and subcutaneous fat present; absence of any signs of starvation.	2. Exposure
3. Disease syndrome present, or disease syndrome noted at capture.	3. Disease
4. None of the above.	4. Undetermined
II Carcass bitten, chewed, and/or partially eaten.	II Predation/scavenging involved
A. Lack of blood in wounds; lack of frothy blood in nares and trachea; no bruises surrounding tooth marks; or no subcutaneous hemorrhages present.	A. Scavenging
1. Bones gnawed and chewed; feeding pattern generally not restricted to the upper portion of carcass.	1. Mammalian scavenger (return to I.1 to determine cause of death)
2. Bones not chewed; feeding limited to upper portions of carcass.	2. Avian scavenger (return to I.1 to determine cause of death)
3. Neither of the above; or some characteristics present from both.	3. Undetermined.

B. Blood in wounds; frothy blood in nares and trachea; bruises surrounding wounds and subcutaneous hemorrhages present.	B. Predation
1. Debilitating physical disorder, or disease syndrome present.	1. Predator kill & other factors.
2. No debilitating physical disorder, or disease syndrome present.	2. Predator kill.
a. Talon wounds on back and sides of body; talon wounds on neck; only upper portion of carcass fed upon; ribs broken off at backbone. Leg bone usually intact.	a. Golden eagle kill.
b. Teeth wounds on neck, sides or legs; carcass fed upon extensively; bones chewed; carcass parts scattered.	b. Mammalian predator
c. Extensive trauma to carcass; large portions of carcass missing; bones broken or crushed; skull crushed; in older calves, rumen not consumed.	c. Brown bear
d. None of the above.	d. Undetermined predator.

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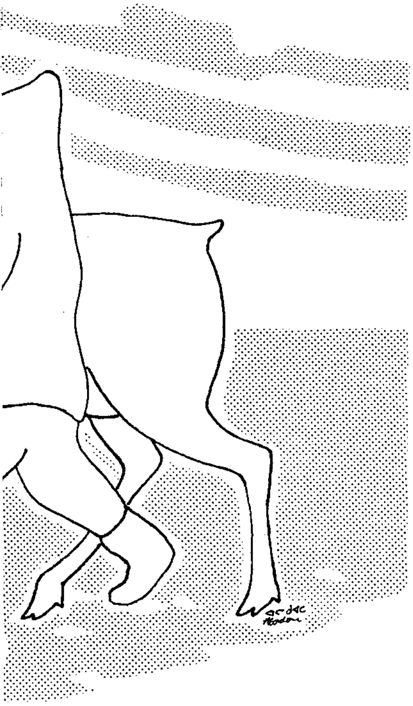

CARIBOU MANAGEMENT

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CENSUS TECHNIQUES

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