Brief Communication

The use of a long-acting tranquilizer (zuclopenthixol acetate) and live video monitoring for successful long-distance transport of caribou (*Rangifer tarandus*)

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Abstract: Long-distance transport of caribou (*Rangifer tarandus*) can result in morbidities and mortalities. This case report describes the use of a long-acting tranquilizer, zuclopenthixol acetate (ZA) and live video monitoring (LVM) to transport caribou over 2300 kilometers. Two groups of captive caribou were transported from Fort St. John, British Columbia to Dryden, Ontario (n=14; 28.5 h transport) and Anchorage, Alaska (n=11; 32 h transport). The day prior to transport, caribou were administered ZA at 1 mg/kg via deep intramuscular (IM) injection. Digital video cameras allowed for live observation of caribou during transport. Still images of videos from each compartment in the Ontario transport were analyzed for percentage (%) lying versus standing over three time periods (Day 1, Night, and Day 2). Overall, caribou spent 57% of the transport lying down, with the highest percentage occurring at night (73%). As group size and animal density decreased there was a trend for caribou to spend more time lying down. Three animals developed extrapyramidal effects to the ZA and were effectively treated with midazolam at 0.2 mg/kg IM. There were no significant visible injuries or mortalities during or up to 6 weeks post-transport. Zuclopenthixol acetate and LVM were used to successfully transport caribou over long distances and should be considered in future translocations to improve animal welfare during transport.

Key words: caribou; conservation; long-acting tranquilizer; *Rangifer tarandus*; tranquilizer; video monitoring; welfare, wildlife translocation; wildlife transport; zuclopenthixol acetate.

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Introduction

Caribou (*Rangifer tarandus*) are declining throughout their historical range and are a species at risk in Canada (SARA, 2002). Conservation actions including translocation of caribou via vehicle transportation are likely to become more frequent as additional recovery actions are taken to reverse the decline of this federally listed and culturally important species.

The capture, handling and translocation of caribou via long-distance vehicle transport is challenging and can result in injuries and mortalities (Slater *et al.*, 2014). In particular, capture myopathy (CM) poses a significant risk to caribou and other wildlife during handling and transport (Paterson, 2014; Slater *et al.*, 2014; Breed *et al.*, 2019). Globally, CM accounts for the highest number of mortalities associated with wildlife translocation (Breed *et al.*, 2019). Although the full pathophysiological mechanisms behind CM are unknown, it is generally characterized by increased muscular activity resulting in hyperthermia, metabolic lactic acidosis, rhabdomyolysis, myoglobinuria and multi-organ failure (Read *et al.*, 2000; Paterson, 2014; Wolfe & Miller, 2016; Breed *et al.*, 2019). It is often the result of marked physical exertion associated with prolonged or high intensity pursuit, manual restraint and confinement, in addition to psychological distress (Paterson, 2014; Wolfe & Miller, 2016; Kreeger & Arnemo, 2018; Breed *et al.*, 2019). Trauma and injury, stress-associated abortion, disruption of normal behaviours, introduction of infectious diseases to an area, and interference with social dynamics are other potential complications of wildlife translocations (Diverio *et al.*, 1993; Diverio *et al.*, 1996; Jago *et al.*, 1997; Grigor *et al.*, 1998; Corn & Nettles, 2001; IUCN/SSC, 2013; Slater *et al.*, 2014; Wolfe & Miller, 2016; Kreeger & Arnemo, 2018).

As wildlife translocations increase in frequency, wildlife professionals continue to refine practices that optimize animal welfare to improve overall translocation success. The advent and use of tranquilizers in conjunction with careful handling practises can contribute to the success of a translocation event (Read & McCorkell, 2002; Paterson, 2014). Long-acting tranquilizers administered post-capture have been found to lower the incidence of CM and mortalities from 20% to 2% (Breed *et al.*, 2019). As early as the 1980s, tranquilizers have been used throughout South Africa to facilitate long-distance transport and holding of wildlife (Hofmeyr, 1981; Gandini *et al.*, 1989; Knox *et al.*, 1989; Diverio *et al.*, 1993; Diverio *et al.*, 1996; Read & McCorkell, 2002). Short and long-acting tranquilizers can be used to minimize anxiety, stress, flight distances and excitement in animals, and allow them to adapt to new situations more readily (Diverio *et al.*, 1996; Read *et al.*, 2000; Huber *et al.*, 2001; Fick *et al.*, 2006; Paterson, 2014). Duration of action varies from hours to weeks (Kreeger & Arnemo, 2018), and thus can be tailored to the duration of transport or holding period. Selection of appropriate tranquilizers and dosages specific to the species and duration of transport is important, but to our knowledge there are no published reports to date on their use in caribou.

Zuclopenthixol acetate (ZA) is a thioxanthene tranquilizer commonly used in ungulate translocation throughout South Africa (Huber *et al.*, 2001; Laubscher *et al.*, 2016; Pohlin, 2020). It exerts its tranquilization effects primarily by antagonizing excitatory dopaminergic receptors within the central nervous system (Lundbeck Canada Inc., 2016). Dissolution of the active ingredient in vegetable oil causes the formation of a depot in the muscle following intramuscular (IM) injection, which results in the slow release of the active ingredient and a prolonged clinical effect that has been reported to last for 72-96 h (Read *et al.*, 2000; Huber *et al.*, 2001; Read & McCorkell, 2002; Fick *et al.*, 2006; Laubscher *et al.*, 2016).

The use of tranquilizers in North American wildlife translocations has not been widely reported in the literature (Read *et al.*, 2000; Read & McCorkell, 2002; Wolfe & Miller, 2016). In North American ungulates, ZA has only been reported in the handling and transport of white-tailed deer

(Read & McCorkell, 2002) and wapiti (Read *et al.*, 2000), with measurable beneficial effects through reduction of anxiety and other stress-associated behaviours.

The use of a short acting tranquilizer (azaperone) prior to the long-distance transport (29-31 h; 2100-2300 km of transport) of both free-ranging and captive caribou was previously used in combination with frequent, in-person visual checks, but mortalities and significant morbidities occurred (Slater *et al.*, 2014). Therefore, a new approach was undertaken and this case report describes the use of ZA and live video monitoring (LVM) to successfully transport captive caribou over long distances via ground transport.

Material and methods

In April 2017, two groups of captive caribou were transported over 2300 km from Fort St. John, British Columbia to Dryden, Ontario (ON; n=14) or Anchorage, Alaska (AK; n=11). Transported caribou were habituated to human presence; adult females had been hand raised in AK during 2009 and transported to British Columbia (BC) in 2013 (Slater *et al.*, 2014) for use in a long-term nutrition project to better understand foraging behaviour of caribou in different habitat types across Canada (Denryter *et al.*, 2017, Denryter *et al.*, 2020). In 2017, thirteen female (12 adults, 1 calf) and 1 adult male were transported to a new study site (ON), while the remaining 11 females (4 adults, 7 calves) were transported to a wildlife sanctuary (AK). All caribou in the ON transport had prior trailer transport experience (average = 86 h; range = 4 - 178 h). In contrast, only the four adult caribou in the AK transport had some prior trailer transport experience (average = 11 h; range = 8 - 46 h), but the majority of animals (7/11) had none. Caribou with prior trailer transport experience were part of the long-term nutrition project that required transport to field sites in northeastern British Columbia during July through October 2013 – 2016 (Denryter *et al.*, 2017, Denryter *et al.*, 2020). Animals with no trailer transport experience were all under 12 months of age and had been born at the Fort St. John facility. The caribou ranged in age from 10-11 months to 8 years.

Caribou were sedated the morning prior to transport with medetomidine (ME) via IM hand injection or remote drug delivery. Dosage of ME ranged from 0.15 – 0.34 mg/kg, with an average of 0.19 +/- 0.04 mg/kg. Dosages varied due to estimations of current weights and two caribou required additional ME due to poor effect or delivery method failure. After caribou were sedated, a weight was obtained if not weighed within 30 days via a ground based loadcell scale (Model TW-700 WB; Triner Scale and Manufacturing Company, Inc, Olive Branch, Mississippi).

Zuclopenthixol acetate (Clopixol-Acuphase®, Lundbeck Canada Inc.; 50 mg/ml concentration) was then administered at 1 mg/kg via deep IM injection into the hindleg muscle group (*M. biceps femoris, M. semitendinosus* and *M. semimembranosus*). Medetomidine was then reversed with atipamezole at 5 times the ME dose and all animals were monitored until recovered from sedation.

The following morning caribou were loaded into a livestock trailer (ON transport = 16.15 m Wilson Trailer model PSAGL-400; AK transport = 7.32 m gooseneck trailer; Figure 1) and placed in compatible groups of 3-6 animals, apart from the adult bull that was housed individually. The trailers were sealed by a Canadian Food Inspection Agency veterinarian and all federal, state, and provincial permits were in place prior to transport. Snow and food (alfalfa hay, fresh browse) were provided and topped up during transport as needed. Trailers were modified to reduce light but maintain ventilation. While compartment size, group size and animal densities were not consistent, caribou had enough space to lie down. Four infrared (IR), digital video cameras (RanchCams®, Dallas-Fort Worth Metroplex, Texas) were installed to monitor caribou via wireless link to a split screen monitor that was mounted in the chase or transport vehicle. Wireless digital cameras were selected to prevent interference from radio waves and allow a line of sight receiving distance up to 1 kilometer. Cameras had a wide-angle lens (120 degrees), were weatherproof (Ingress Protection rating 67; IP67) and functional under all light levels (full sunlight to total darkness). This allowed for both live observation of caribou during transport (Figure 2) and recording of videos for post-transport analysis. Live observation was used to assess caribou behaviour including any side effects to ZA, to identify subjective changes in environmental conditions such as temperature and humidity and adjust ventilation as needed based on caribou response to environmental changes, topping up food and water and adapting driving techniques for greater animal comfort.

The method used to analyse recorded videos was similar to that described by Earley *et al.* (2013), whereby still images of videos throughout the transport were analyzed at intervals for lying versus standing behaviour to get a representative sample of these behaviours. Briefly, random still images of available recorded videos from each compartment for the ON transport were analyzed for the percentage (%) of lying versus standing by caribou within each compartment. Data was grouped into three time periods: Day 1 (D1), Night (N) and Day 2 (D2). Day 1 was defined as time of loading to the last daytime image (9:36 to 18:56; 9h20min) on D1. Night was defined as the first to last night time image based on cameras switching between colour and infrared (18:57 to 4:56; 10h59min). Day 2 was defined as first daytime image on D2 to unloading (6:57 to 14:14; 7h17min). Seventy images from each compartment and time period were analysed for a total of 210 images for each compartment spanning the duration of transport. The interval between analysis of still images was no less than 1 minute from the previous image to allow enough time between images for a change in lying or standing behaviour to occur. Since individual caribou could not be reliably identified in each compartment (except the bull), the data is a summary of percentage of time lying by all visible caribou within a compartment in

Figure 1. Livestock trailer used to transport caribou from British Columbia to Ontario (16.15 meter Wilson Trailer model PSAGL-400 on left) and Alaska (7.32 meter gooseneck trailer on right) in April 2017. Trailers were modified to reduce light but maintain ventilation and equiped with video cameras to remotely monitor caribou in real-time during transport.

Figure 2. Still images obtained from recorded videos used to monitor caribou within each compartment (1-4) and to retrospectively analyse caribou lying behaviour during long distance transport (<2300km; 28.5 h) from British Columbia to Ontario, Canada, April 2017. Note the small group sizes and low animal density to provide ample room for animals to lie down. Compartment 3 illustrates transport at night when cameras switched to infrared, with the bull caribou resting in lateral recumbency for a portion of the transport.

each image, grouped by time period. Animal density was calculated based on compartment dimensions and standardized animal sizes as follows: Adult male = 1.5; adult female = 1.0; female calf = 0.5. This resulted in the following space allowances for the ON transport: Compartment 1 = 2.51m^2 /animal (7.54m^2/3 adult females); Compartment 2 = 1.89m^2 /animal (11.31m^2/6 adult females); Compartment 3 = 2.51m^2/animal (3.77m^2/adult male caribou); Compartment 4 = 2.15m^2 /animal (7.54m^2/3 adult females + 1 female calf). Comparable analysis for the AK transport was not possible due to large gaps in recorded videos during transport due to technical issues with the recording device.

Results

Time of loading was 19.5-23 h post ZA administration for both transports, with caribou displaying markedly reduced flight distances. Ontario animals, most of whom were hand-raised adults with extensive trailer experience, loaded smoothly while AK animals, most of whom were dam-raised with little trailer experience, were excited at the time of loading and required the use of a tarp held between people and loud voices to encourage animals to load

Table 1. Summary of lying behaviour of caribou by compartment and time period (Day 1, Night, Day 2) during long distance transport (>2300km; 28.5 hours) from British Columbia to Ontario, Canada, April 2017. Each time period and compartment had 70 still images spanning each time period analyzed for a total of 210 observations per compartment.

Time period (time)	**Compartment 1** (n=3AF; SA=2.51m^2)		**Compartment 2** (n=6AF; SA=1.89m^2)		**Compartment 3** (n=1AM; SA=2.51m^2)		**Compartment 4** (n=3AF, 1FC; SA=2.15m^2)		**Overall lying (%) by time period**
	Lying (%)	Average time (min) between images and range (min/max)	**Lying (%)**	Average time (min) between images and range (min/max)	**Lying (%)**	Average time (min) between images and range (min/max)	**Lying (%)**	Average time (min) between images and range (min/max)	
Day 1 (9:36 -18:56)	30	7(1/65)	19	8(1/58)	67	8(1/60)	31	8(1/59)	37
Night (18:57- 4:56)	75	9(1/101)	59	8(1/78)	84	8(1/102)	74	9(1/202)	73
Day 2 (6:57-14:14)	63	6(1/77)	54	6(1/42)	63	6(1/58)	56	5(1/37)	59
Overall by compartment	56	7(1/101)	45	7(1/79)	71	7(1/102)	54	7(1/202)	57

n denotes group size; AF denotes adult female; AM denotes adult male, FC denotes female calf; SA denotes space allowance (m^2/animal) onto the trailer. Duration of transport to ON and AK was 28.5 and 32 h, respectively, with no significant visible injuries or mortalities during either the transport process or within 6 weeks post-transport. Three adult females (1 in ON transport, 2 in AK transport) developed side effects to ZA within 20-24 h of injection consisting of abnormal, repetitive movements (persistent backing up when walking, rapid jaw movements, excessive pawing, panting, muscle twitching, and head held low to the ground). These animals were effectively treated with midazolam at 0.2 mg/kg IM, with resolution of side effects within 10-15 minutes of injection.

Caribou in both transports were subjectively assessed via LVM as displaying calm behaviours, including during brief re-fuelling stops and at unloading. Caribou were repeatedly observed lying down, ruminating and resting, as well as eating snow and food provided. Caribou lying behaviour throughout the ON transport are summarized in Table 1. The average time between still images was 7 min across all compartments with the maximum time between images (202 min) dependant on when videos were recorded onto the storage card or when images were obstructed due to technical issues with the cameras. The overall percentage of time lying (versus standing) was 45 - 71%, depending on the compartment, with an average of 57% across all compartments and time periods. Night was the period with the highest overall percentage of time spent lying (73%), followed by D2 (59%). A 36% increase in lying between D1 and N was also found.

A trend of lower group size and animal density was associated with more time spent lying for the ON transport. Compartment 3 (n=1; space allowance (SA) =2.51m^2/animal) had the highest percentage of time lying; 71% averaged across all times, followed by caribou in compartment 1 (n=3; SA=2.51m^2/animal; 56%) compartment 4 (n=4; SA=2.15m^2/animal; 54%) and compartment 2 (n=6; SA=1.89m^2/animal; 45%).

Discussion

Zuclopenthixol acetate and LVM were used to successfully transport caribou over long distances without any significant visible injuries or mortalities during or 6 weeks post-transport. Objective analysis of lying versus standing behaviour during the ON transport showed that on average these caribou spent more than half of the time lying down (57%). During both transports, caribou were subjectively assessed via LVM as remaining calm throughout the majority of the transport as well as during brief stops and at unloading. This indicates that the sustained release of ZA throughout transport was effective at mitigating anxious behaviours (stereotypic pacing, jumping) and health issues (trauma and CM). This contrasts with previous long-distance transports of free-ranging and captive caribou using similar transport equipment and distance, but with a short-acting tranquilizer (azaperone). During these transports, anxious behaviours including pacing and jumping were common and one mortality per transport occurred (Slater *et al.*, 2014). Free-ranging and captive caribou transported in 2012-13 had no prior trailer transport experience, which could have contributed to the health issues documented (Slater *et al.*, 2014). However, while all caribou in the ON transport had prior trailer transport experience, the majority of caribou in the AK transport (7/11) in 2017 had never been transported. Despite these differences, both transports where ZA was used were successful without any significant visible injuries or mortalities. This supports our observation that ZA kept caribou calm during the long distance transports regardless of prior trailer transport experience.

The timing of ZA administration was an important consideration. While tranquilization begins approximately 1-2 h after ZA administration, the peak effect occurs 8-24 h later (Read *et al.*, 2000; Read & McCorkell, 2002; Fick *et al.*, 2006;). Administration of ZA occurred 19.5-23 h prior to loading to ensure that the peak effects were experienced during loading and the first few hours of transport. Loading and the first few hours of transport are known to be one of the most stressful periods for animals and studies in domestic livestock undergoing transportation have shown that blood cortisol concentrations are highest within the first 3 hours of transport (SCAHAW, 2002). Similar results have been found in red deer (Jago *et al.*, 1997) and likely occur in other species, making the timing of peak tranquilization important to overall transport success.

Recumbent resting (lying down) has been recommended as one of the most valuable indicators when assessing the welfare of transported animals (SCAHAW, 2002; Nielsen *et al.*, 2010). Standing for long periods during transport can cause muscle fatigue through prolonged periods of muscle contraction, compression of vessels and subsequent reduced muscular perfusion. This in turn leads to CM via tissue hypoxia, disruption of normal aerobic metabolism, production of lactic acid, and ultimately muscle necrosis (Spraker, 1993; Paterson, 2014). While domestic cattle spend approximately 50% of their time lying down, they often avoid this during transport due to animal density, floor composition and driving conditions (Nielsen *et al.*, 2010). Research on free-ranging reindeer activity budgets indicate that they spend 40.5% of a 24 hour period lying down (Collins & Smith, 1989). Transported caribou in the current study exhibited a higher percentage lying down during transport which lends support to the calming effects of the long acting tranquilizer resulting in caribou prioritizing resting over other behaviours.

Changes in lying behaviours over time suggest that caribou adapted to the transport, similar to studies with other species. Grigor *et al.* (1998) and Jago *et al.* (1997) found that red deer spent significantly more time standing and being active during the first hour of transport compared to subsequent hours. This is consistent with the findings from our study, with the majority of D1 spent standing (except the bull) followed by increasing time spent lying down throughout the remainder of the transport. To date there are few reports on the behaviour of ungulates throughout long-distance transport and the behavioural data obtained in this study provides important baseline information on caribou behaviours during transport when given ZA.

Transportation of animals at night can lower the risk of hyperthermia in species prone to overheating (common in caribou), as well as adverse responses to external stimuli such as traffic noise and light (FAWAC, 2007). Free-ranging reindeer in their natural environment were found to lie down 37% more at night versus the day (Collins & Smith, 1989). The transported caribou also increased their lying behaviour at night (average of 36% increase from D1), which indicates that the administration of ZA and providing enough space to lie down likely facilitated caribou displaying normal resting behaviours despite prolonged confinement during long-distance transport. The natural tendency for free-ranging *Rangifer* to rest more at night indicates that when possible, maximising night transport can help increase resting behaviours and overall animal welfare during transport.

As group size and animal density decreased, there was a trend for caribou to spend more time lying down. While samples sizes were too small to infer statistical significance, this trend points to potential beneficial effects of decreased group sizes and animal densities on transport behaviours. As group size and animal density increase, animals lying down are more likely to be disturbed by those standing or they may not have enough room to lie down. Long transport times in addition to inappropriate animal densities have been found to have both subjective and objective negative outcomes (Jago *et al.*, 1997; Grigor *et al.*, 1998; SCAHAW, 2002; Grandin & Gallo, 2007; Nielsen *et al.*, 2010). Studies on cattle have shown that longer duration of transport as well as increased animal density led to greater fatigue, stress, and transport-related injuries (Jago *et al.*, 1997; Grandin & Gallo, 2007). Therefore, several publications advise that cattle being transported long distances be provided enough space to allow them to lie down during transport (SCAHAW, 2002; Grandin & Gallo, 2007; Nielsen *et al.*, 2010). We also recommend providing enough space to allow animals to lie down, as well as small group sizes of known compatible animals or singly housed animals (adult males and non-compatible animals) and deep bedding be provided to promote resting behaviours in caribou during transport. This recommendation is consistent with guidelines provided by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) for the non-air transport of deer species (CITES, 2013).

Other authors have found beneficial effects of administering ZA to intensively handled wildlife. Read *et al.* (2000) assessed subjective and objective measurements of stress in an intensive handling situation of wild wapiti (elk) administered ZA compared to those administered a placebo. They found that wapiti administered ZA showed less subjective indicators of stress (increased activity or excitement when handled) in addition to decreases in objective stress measurements such as blood lactate concentration, white blood cell count, serum cortisol and rectal temperature (Read *et al.*, 2000). Laubscher *et al.* (2016) similarly found improvements in subjective indicators of stress in captive blue wildebeest treated with ZA compared to a placebo group, such as increased time eating, less head shaking (a stress response), and more resting behaviours. Based on the above research and previous experience with ZA in *Rangifer* (Slater, unpublished data) we elected not to have a control group to reduce the potential for transport related complications in non-tranquilized caribou.

Despite all caribou receiving ZA at 1mg/kg IM based on accurate weights, three animals developed extrapyramidal effects (EPE) consistent with those previously reported in other wildlife (Read *et al.*, 2000; Read & McCorkell, 2002; Kreeger & Arnemo, 2018). Generally, EPE are self-limiting as the medication is metabolized, but treatments previously recommended include biperiden, dexetimide, diazepam and xylazine (Kreeger & Arnemo, 2018). Midazolam, a benzodiazepine similar to diazepam, is a more useful drug for wildlife as the aqueous solution can be given via IM injection and is quickly absorbed, resulting in rapid sedation, muscle relaxation and anterograde amnesia (Ward *et al.*, 2011). Midazolam at 0.2mg/kg IM was effective at treating the EPE of ZA in caribou within 10-15 minutes of injection. Midazolam should be considered as an alternative to diazepam when IM injection is the preferred route of administration.

Species differences are known to occur with ZA dosage; it is contraindicated in cheetah due to adverse effects, but effective in leopards and domestic cats without any side effects reported (Huber *et al.*, 2001). Additionally, two of thirteen white-tailed deer in the Read & McCorkell (2002) study developed EPE at a dosage of 1 mg/kg ZA, while there were no reports of EPE when the same dosage (or higher) was used in wapiti (Read *et al.*, 2000), red deer (Diverio *et al.*, 1996) or blue wildebeest (Laubscher *et al.*, 2016). Our report points to a potential increased sensitivity to ZA in caribou and additional research is required to determine the optimal dosage of ZA in caribou.

Historically, ground transport of wildlife has required frequent stops to check on the condition of the animals and their environment. This can prolong the trip, result in repeated disturbance and additional stress since animals are repeatedly subjected to direct human observation. By deploying remote LVM equipment, transport personnel were able to reduce the number of stops required while non-invasively monitoring the animals. Live video monitoring allowed for timely identification and treatment of caribou with side-effects to ZA. It also helped to assess caribou behaviour, subjectively identify temperature and humidity changes and assisted in adjusting ventilation, topping up food and water and adapting driving techniques for greater animal comfort. There were technical issues with the video equipment that sometimes obstructed the view of compartments as well as prevented the recording of all videos. While this reduced the functionality of the equipment, the overall benefits of LVM of animals markedly outweighed the technical issues experienced. Video monitoring technology is often used for the transport of horses and other livestock (RanchCams®, 2019), but given the numerous benefits and successful application during the caribou transports, the use of LVM with recording capabilities to objectively analyse animal behaviour should be considered for wildlife translocations to help optimize animal welfare during transport and improve transport techniques. Surveillance systems to monitor animals during transport are strongly recommended by CITES (CITES, 2013).

Conclusions

The use of ZA and LVM was used to successfully transport caribou over long-distances with no significant visible injuries or mortalities during or within 6 weeks post-transport. Zuclopenthixol acetate at 1 mg/kg IM should be considered as an acceptable agent to help decrease stress and anxiety during loading and transport of caribou, for long-distance transport not exceeding 72 hours, and when treatment of animals is feasible if side effects occur. Further research is required to determine the optimal dosage of ZA for caribou. Side-effects to ZA were effectively treated with midazolam at 0.2 mg/kg IM. Trends in lying behaviour were found, with increased lying at night and when group sizes and animal densities were low. The behavioural data obtained in this study provides important baseline information on caribou resting behaviours during transport. Live video monitoring of caribou reduced the need to stop at regular intervals to check on animals, which decreased the overall transport time and allowed for timely identification and correction of issues. Live video monitoring equipment should be considered for wildlife translocations to help optimize animal welfare during transport.

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