Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

Capture, Handling and Release of Caribou Standard Operating Procedure

Wildlife Care Committee
Government of the Northwest Territories

Prepared for the GNWT by:
Marc Cattet

Reviewed by the 2017/2018 NWT Wildlife Care Committee

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1. Purpose

- To provide recommendations for the capture, handling, and release of caribou using safe, effective and "acceptably humane methods" while maintaining minimal risk to staff and allowing appropriate research or management to be conducted.

- The term "acceptably humane methods" should be recognized as conditional in that not all of the methods and techniques recommended in this standard operating procedure (SOP) are currently supported nor contraindicated by scientific evidence. This is because the identification of animal-based measures of humaneness and welfare is an evolving field of area with some areas of uncertainty and lack of scientific information. Consequently, under these circumstances, recommendations are based on other factors, including professional opinion, experience and intuition. Therefore, personnel involved with the capture and handling of caribou in the Northwest Territories (NWT) **should** view the recommendations in as guidance on best practices using the best available information. Personnel **should always** strive to integrate animal-based measures (e.g. physiological and behavioral parameters) into their research and/or management activities to provide direct evidence for what caribou are experiencing. Animal-based approaches are required not only to validate some of the current methodologies, but also to facilitate improvements to this SOP.

- See Hampton et al. (2016) for an insightful perspective on the limitations and refinement of procedural documents as they relate to wildlife welfare.

2. Application

- This SOP applies to employees of the Government of the Northwest Territories (GNWT) and any other personnel involved with the capture and handling of caribou in the NWT.

3. Rationale for Revision

- The most recent revisions to the SOP were prompted by a few research developments over the past decade that warrants consideration by personnel planning to capture and handle caribou. In some cases, the information required to meet research/management objectives can only be obtained through capture and handling, e.g. deployment of radio collars for monitoring distribution. However, in situations where alternative, non-invasive approaches can provide the needed information, these **should** be used instead.

- One development is the area of non-invasive approaches to studying wildlife. Non-invasive genetic and physiological sampling, through the collection and laboratory analysis of biological materials (primarily hair, feather, and feces) deposited on the

landscape by free-ranging animals, can address a number of research and monitoring questions without having to capture and handle animals. Recent examples of non-invasive approaches applied to caribou include studies by Ball et al. (2010), Ashley et al. (2011), Joly et al. (2015), and Carlsson et al. (2016).

- Another development in research is the growing body of evidence that shows the perception of "predation risk" by female animals can affect the fitness of future offspring. Maternally-derived stress may modify offspring phenotypes through epigenetic mechanisms collectively termed "maternal stress axis programming". The perception of predation risk has been identified as an important cause of maternally-derived stress, and a driver of phenotypic plasticity, in the ecological studies of various mammals (Sheriff et al. 2010), birds (Saino et al. 2005) and fish (Mommer and Bell 2014). In other studies, researchers have proposed that capture and handling could heighten the perceived predation risk in a study species (Macleod and Gosler 2006, Wasserman et al. 2013). Although these two lines of investigation have yet to be linked, the possibility that capture and handling, especially when experienced multiple times (repeat captures), could heighten the perception of predation risk in female caribou and, consequently, affect the fitness of future offspring warrants consideration and investigation.

- Another reason for revising the SOP now is to add detailed information regarding the maintenance, use, and inspection of net guns and associated equipment. This is important given that capture by net gun remains the most common method used for caribou in the NWT. Much of this new information is presented in Appendix A.

4. Background

- Three subspecies of caribou (*Rangifer tarandus*) are present in the NWT: woodland caribou (*R. t. caribou*), barren-ground caribou (*R.t. groenlandicus*) and Peary caribou (*R. t. pearyi*). A fourth genetic group is present but needs more study to determine full sub-species status. This group is presently referred to as Dolphin-Union caribou (*R.t. groenlandicus* x *pearyi*). Woodland caribou are further subdivided into two ecotypes, boreal woodland caribou and northern mountain woodland caribou.

- The Species at Risk Committee was established under the *Species at Risk (NWT) Act*, which came into force in February 2010, to assess the biological status of species that may be at risk in the NWT. The *Species at Risk (NWT) Act* is complementary to the federal *Species at Risk Act* (*SARA*) and addresses concerns at the territorial level.

- As part of the assessment, the Species at Risk Committee identifies threats and positive influences to species and their habitats. They may also recommend conservation actions. The assessments provide the basis for recommending whether a species should be added to the NWT List of Species at Risk.

- Species can be listed under the NWT List of Species at Risk either as

Extinct – no longer exists anywhere
Extirpated – no longer exists in the wild in the NWT
Endangered – facing imminent extirpation or extinction
Threatened – likely to become endangered if nothing is done
Special Concern – may become endangered or threatened because of threats and biological factors

- Species may also be assessed, but not listed, and categorized instead as:
  Not at Risk – not currently at risk of extinction
  Data Deficient – not enough information to determine status

- The NWT Species at Risk Committee has assessed: (i) boreal woodland caribou, which were listed as Threatened on February 27, 2014; (ii) Peary caribou, which were listed as Threatened on February 27, 2014; and (iii) Dolphin-Union caribou, which were listed as Special Concern on March 19, 2015. Barren-ground caribou were assessed as Threatened in April 2017, but a decision on listing had not been made at the time of the update of this SOP. They are scheduled to be assessed in March 2017, and northern mountain woodland caribou are scheduled to be assessed in March 2020.

- Under the federal *Species at Risk Act (SARA)*, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the biological status of Canadian species, and a decision is made on whether to list them on Schedule 1 of federal *SARA*.

- Species can be listed either as
  Extinct: a wildlife species that no longer exists.
  Extirpated: a wildlife species that no longer exists in the wild in Canada, but exists elsewhere.
  Endangered: a wildlife species that is facing imminent extirpation or extinction.
  Threatened: a wildlife species likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.
  Special Concern: a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
  - Barren-ground caribou were assessed by COSEWIC as Threatened in 2016.
  - Peary caribou were listed under *SARA* as Endangered in 2004.
  - Dolphin-Union caribou were listed under *SARA* as Special Concern in 2004.
  - Boreal woodland caribou were listed under *SARA* as Threatened in 2003.
  - Northern mountain woodland caribou and listed under *SARA* as Special Concern in 2005.

- Details on each subspecies of caribou in the NWT can be found at www.enr.gov.nt.ca/programs.

- Details on *SARA* status of caribou can be found at the *SARA* Public Registry (www.registrelep-sararegistry.gc.ca) and details on COSEWIC can be found at www.cosewic.gc.ca.

- Habitat alterations, hunting, disturbance by humans (including construction of roads and pipelines), and predation (by wolves, coyotes, and bears) have all contributed to the decline of many caribou herds. Factors beyond our control, such as weather and climate change, are also influential. One of the current challenges in caribou management is to learn more about how these factors interact and how to decrease their threat to caribou populations.

- The status of caribou may have implications for research of this species in the NWT. As of 2017, investigators *do not yet* need a *SARA* permit to study *SARA* listed caribou populations in the NWT. Contact Environment Canada, as one of the *SARA* authorities, for more information as required. As with any other wildlife species in the NWT, all investigators must ensure their capture and handling protocol meets all requirements of the Government of the Northwest Territories Environment and Natural Resources (GNWT-ENR). See www.nwtwildlife.com and follow the *Research and Data* tab for more information.

5. Methods

5.1 Live Capture

Techniques for the live capture of caribou include net gun, remote drug delivery, water capture, drive (or funnel) traps, and drop nets. Capture by net gun is the most common method of capture used for caribou in the NWT. Remote drug delivery, water capture, drive (or funnel) traps and drop nets are primarily used in other jurisdictions. The use of drugs during caribou captures has been limited in the past due to community concerns relating to consumption of meat from captured animals.

5.1.1 Considerations:

- The primary focus of all capture events **must** be on the safety of both the personnel and the caribou.

- Investigators **must** be familiar with the advantages and drawbacks of different methods of capture.

- Capture method(s) **must** be selected to minimize trauma and stress to the animal with consideration given to the capture environment and study requirements.

- Capture techniques **must** be applied by experienced individuals only.

Inexperienced persons with appropriate training may also apply capture techniques provided they are under the direct supervision of an experienced person. Although the

distinction between "experienced" and "inexperienced" is somewhat subjective, it is the responsibility of the NWT Wildlife Care Committee (NWTWCC) to seek assurance that investigators and personnel have the necessary training and experience to perform procedures required for the capture and handling of caribou.

- Mentoring by experienced persons is **strongly recommended** as the best approach to become proficient at animal capture.

- Personnel administering drugs for capture or restraint **must** have recognized and current training in the chemical immobilization of wildlife and **must** use methods of drug delivery and drugs that are appropriate for caribou.

  Current training implies that personnel have completed and passed the Canadian Association of Zoo and Wildlife Veterinarians' wildlife chemical immobilization course, or another recognized course, within the past five years.

- Live capture of caribou **should not** take place in the period from five weeks pre-calving to three weeks post-calving. Further, caribou **should not** be captured when "in velvet."

- Taking these factors into consideration, it is recommended that barren-ground and boreal woodland caribou captures are not done after April 15. All other factors specific to individual situations also need to be considered before that time

These restrictions generally limit capture to the months from December to March. Any exceptions to this recommendation must be given careful consideration and must be consistent with the overall study objectives. Caribou may be particularly sensitive to capture or handling stress, and sometimes drugs, during late pregnancy and early lactation. Although the potential for negative effects of capture and handling during these times has not been adequately examined in caribou, negative effects including failed or delayed conception, fetal loss, and post-natal offspring mortality have been demonstrated for other species (Alibhai et al. 2001, Ballard and Tobey 1981, Côté et al. 1998). It should be noted, however, that Omsjoe et al. (2009) did not detect lower calving success in Svalbard reindeer (*R. t. platyrhynchus*) cows captured the previous winter (April and May) when compared with cows that had not been captured the previous winter. Likewise, there was no relationship between the strength of the acute stress response to capture (measured as cortisol concentrations) and the probability of pregnant females having a calf at foot the subsequent summer. In contrast, Haskell and Ballard (2007) discovered that survival and productivity data from radio-collared females (captured in September) and calves were negatively biased, and consequently recommended that researchers should consider potential effects of neck collars on vital rates. As an alternative approach to live capture, Joly et al. (2015) used hormone levels in caribou feces collected throughout the western Arctic herd's range in late winter, to determine sex-specific late-winter diets, pregnancy rates, group composition, and endocrine-based measures of physiological and nutritional stress.

- Capture efforts **must** be conducted within a pre-defined safe temperature range and procedures **must** be taken to prevent, or detect and treat, large changes in body temperature during handling or recovery.

Under extreme cold conditions, some caribou may be highly susceptible to thermal stress (e.g. hypothermia, frost-bite), especially when captured by remote drug delivery. In addition, exposure to extreme cold poses risk to the safety of field personnel. A recommended lower temperature limit for capture by net-gun is -30°C, and for capture by remote drug delivery is -20°C. Wind chill also needs to be considered in setting safe ambient conditions. Caribou in winter coat are also sensitive to heat stress when restrained under warm conditions and, therefore, capture is not recommended at a temperature (with wind chill) above -5°C. Measures that can be taken to prevent the development of thermal stress during handling or recovery include the use of reversible anesthetic drug combinations (if drugs are to be used), the erection of a tarp or canopy to minimize direct exposure to the sun, and the use of natural barriers to prevent wind exposure.

5.1.2 Techniques for Live Capture:

5.1.2.1 Net Gun

Issue: A suitable capture technique for short-duration handling, generally less than 15 minutes.

- Enables rapid capture and release of target animal.

- Requires use of a helicopter.

Recommendations:

- See Appendix A for detailed information regarding net guns, including additional recommendations.

- Net guns **must** only be used to capture a single caribou at a time.

Attempts to capture two or more caribou within a single net are likely to result in injury, or possibly death.

- At least two capture guns with loaded nets, or a gun with detachable barrel and multiple nets, **should** be available to the gunner for each capture.

This provides a back-up that can be used to reduce chase duration if the first net missed the target animal or to re-net an animal if the first net did not provide adequate restraint.

If a caribou is not netted properly (i.e., antlers only) and does not go down shortly after netting, a second net should be deployed.

- Consideration should be given to using attachable transmitters fitted onto nets to enable tracking of netted caribou that run into wooded areas and can no longer be seen.

- Stampeding of caribou while hazing (herding) **must** be avoided.

Hazing must be done in a controlled manner with the goal of moving animals at a slow pace while gradually separating out target animals.

- Pursuit and capture **must** occur on smooth, open terrain with good footing, and, whenever possible, deep soft snow **should** be used.

This will help prevent injury (broken limbs, sprains, etc.) to the target animal and animals running with it. Deep, soft snow will slow down fleeing caribou. Hummocky ground, wind sculptured snow-drifts, boulder fields, packed snow, open water and glare ice represent different terrains on which the chances of injury are increased. When caribou are standing in heavily treed areas and reluctant to move into adjacent open areas where the net gun can be employed, noise-scaring devices (e.g. cracker shells) may be used to stimulate movement out into the open.

- Physical trauma is the most common source of injury during net-gunning (Ferguson 2015). Every effort must be made to choose capture locations that minimize risk of injury. The capture crew should evaluate the conditions at the capture site prior to initiating a capture. In the event of physical injury, the crew needs to re-evaluate if the environmental conditions are suitable for continuing captures.

- Final, close pursuit **should** be kept short (≤1 min of strenuous running), and **must** always be terminated when the target animal show signs of fatigue, e.g., panting, loss of coordination and stumbling.

The risk of injury (including capture myopathy) or death is increased greatly when animals are exhausted (Beringer et al. 1996, Haulton et al. 2001, Spraker 1993, Valkenburg et al. 1983). Because the length of an adequate rest period for fatigued animals is not known, and is likely to be highly variable among individuals, it is strongly recommended that any further attempt at capture of a fatigued animal is not made until the following day.

Definitions:

Chase Start: Time of active pursuit
Chase Stop: Time of capture/net launch

- Chases per herd **should** be limited to no more than 3 chases per group. Where multiple individuals are captured from the same herd or group, the capture crew **must** avoid causing fatigue in non-target animals from prolonged hazing and **must** terminate chases if animals are showing signs of fatigue.

It is the responsibility of the entire capture crew to ensure that chase limits are observed.

Chase times must be recorded for each chase attempt and clearly documented.

- Caribou **must** be hobbled, blindfolded, handled, and released as quickly as possible following capture.

- Attempts to capture and hobble two caribou with separate nets prior to handling and sampling **must not** be done unless there is an additional handler present to attend to the first captured caribou while the helicopter and net gunner pursue a second caribou.

- Where multiple individuals are to be captured from the same herd or group, the capture crew **must** avoid causing fatigue and stress in non-target animals from prolonged hazing.

- Administration of sedative or anesthetic-type drugs **should** be considered as a beneficial adjunctive procedure to capture by net gun in situations where invasive and/or painful procedures will be applied to the captured animal.

Drug therapy can be used to reduce capture stress, especially if caribou struggle excessively or are severely entangled in the net, where painful procedures are to be employed (e.g., application of ear tags), or for longer duration handling (Cattet et al. 2004, Gustine et al. 2011).

- Caribou fleeing at high speed, or with prominent antler development, **should not** be netted.

The likelihood of death from partial or complete dislocation of the neck increases with antler growth and speed of pursuit. Even with caribou lacking antlers and netted while fleeing at moderate speed, mild to moderate injury to neck and shoulders is probably of common occurrence. In many cases, injury is likely limited to bruising and muscle strain. However, in some cases, antler or teeth may break, or the jaw may become dislocated or fractured. Deep, soft snow should be used whenever possible to slow down fleeing caribou (Valkenburg et al. 1983).

5.1.2.2 Remote Drug Delivery

Issue: Immobilization by administration of anesthetic drugs using remote delivery systems, i.e., modified rifle, shotgun, or pistol, blowpipe, and darts to contain drug.

Issue: A suitable capture technique for long-duration (>15 min) handling.

Recommendations:

- Blowpipes and CO_2- or air-powered pistols **should** be used to deliver drugs to target animals over short distances, e.g. ≤10 m.

These types of remote drug delivery systems typically propel darts at a lower velocity than rifles or shotguns, and are less likely to cause trauma (Bush 1992, Kreeger and Arnemo 2012, Valkenburg et al. 1999).

- For remote drug delivery over longer distances (>10 m), CO_2-powered rifles or powder-charged rifles with power adjustment capability **should** be used to reduce the potential for partial or full penetration of the skin by the dart body.

Skin penetration by the dart body is unlikely to occur with lightweight 0.50-calibre (12.5 mm diameter) darts that impact the animal at a velocity <50 m/s (Cattet et al. 2006). However, the potential for penetration increases as projectile mass and impact velocity increase, and as the projectile diameter decreases (MacPherson 1994, Kreeger and Arnemo 2012).

- Slow-injection darts **should** be used in preference to rapid-injection darts (Lian et al. 2017).

Darts can be described as rapid- or slow-injection depending on the time it requires to discharge its contents upon impact with the target animal. Rapid-injection darts use an explosive charge that detonates upon impact to advance the plunger and expel the drug quickly, often within a fraction of a second. Slow-injection darts use pressurized air or gas to expel drug more slowly (one to three seconds). The forceful injection of drug with rapid-injection darts penetrates considerably deeper than the tip of the needle and can cause severe tissue damage (Cattet et al. 2006). Forceful repulsion of the dart during injection can cause tearing of subcutaneous tissue and partial injection of drug into the space created between muscle and skin. Further, rapid-injection darts are often fitted with large bore, end-ported, barbed needles that frequently cause contamination of the wound tract with small portions of tissue and hair, and require expansion of the wound to facilitate removal of the barb. With slow-injection darts, drug injection is less forceful and the resulting wound does not penetrate as deeply (Cattet et al. 2006). In addition, the side-ported needle typically used with this type of dart does not require a large barb to anchor it beneath the skin. However, slow-injection darts that must be pressurized prior to loading into a rifle are more prone to leaking their contents, a potential hazard that should be considered when using highly potent drugs.

- The dart needle **must** be long enough to ensure drug injection occurs largely into muscle, but not too long to cause injury to deeper tissues or too short to result in injection of much of the drug into the subcutaneous connective tissue and fat.

The length of needle should be selected based on the size and body condition (reflected by the amount of subcutaneous fat) of the caribou and on the type of dart used. With slow-injection darts, Bergvall et al. (2015) recommended a needle length of 40 mm, in preference to 30 mm, for the chemical immobilization of wild fallow deer (*Dama dama*) on the basis that the longer needle consistently resulted in a shorter induction time. With rapid-injection darts, needle length cannot be selected simply on the basis of estimating fat thickness at the targeted site of injection because the depth of the injection can exceed the needle length by a significant amount, especially when using end-ported needles (Cattet et al. 2006). Until science-based information indicates otherwise, a shorter needle length, in the range of 18-30 mm, should be used with rapid-injection darts.

- When using barbed dart needles, the position of the barb **must** be marked on the dart barrel or needle hub (e.g. with a waterproof marker pen) before use.

This ensures the dart needle can be excised from the skin with minimal trauma.

- Darts **must** be directed into large superficial, thick muscle masses with minimal fat covering to ensure good drug absorption and avoid injury to other tissues.

The gluteal muscles (or rump) are generally the safest site for most caribou, but the neck of mature bulls is also a suitable target area.

- Remote drug delivery **should** be employed from a mobile platform, such as a helicopter or snowmobile.

It is important to be able to observe and, if necessary, control animal movement away from hazardous terrain during pursuit and induction, the latter being the time that ensues between drug administration and safe immobilization of the animal.

- Remote drug delivery **should not** be attempted in areas where the possibility of losing sight of a darted caribou is likely, e.g. where tree cover is heavy.

- Final, close pursuit **should** be kept short (≤1 min of strenuous running), and **must** always be terminated when the target animal show signs of fatigue, e.g. panting, loss of coordination and stumbling.

The risk of injury or death is increased greatly when animals are exhausted (Beringer et al. 1996, Haulton et al. 2001, Spraker 1993, Valkenburg et al. 1983). Because adequate rest periods are not known, and are likely to be highly variable among individuals, it is preferable that any further attempt at capture of a fatigued animal is not made until the following day at earliest. A "fatigued animal" could even be a caribou that has been hit by one, or possibly two darts, but shows no signs of drug effect. Although such an animal may become anesthetized after the capture effort is terminated, and therefore vulnerable to predation, thermal stress, or some other complication, it remains more likely that continued pursuit of the darted animal would cause serious injury or death.

- When more than one dart is required to safely immobilize a caribou, adequate time **should** be given between injections to allow drug effects to occur.

In most situations, allow 10-15 minutes to elapse between the time of injection of the first dart and injection of the second dart (Kreeger and Arnemo 2012). During this time, effort must be taken to avoid unnecessary stimulation of the target animal. For example, if the caribou was darted from a helicopter, the pilot should move the helicopter as far as possible from the animal while still allowing visual monitoring for drug effects. If the animal shows some drug effect, but does not go down, re-administer 50% of the original

dose. However, if the animal shows no drug effect within 10-15 minutes following the first dart, re-administer the entire original dose.

- If there is little or no evidence of drug effect after two darts, the immobilization effort **should** be aborted as this strongly suggests a problem with either the drug delivery system (e.g. failed injection, needle too short) or the drug quality (e.g. inappropriate storage or formulation).

Nevertheless, the animal should be visually monitored from a safe distance to determine the extent of drug effects, if any are apparent. Although there should be no further attempt at capture that day, effort should be made again over the next 24 hours to relocate the animal and assess its status.

- If a target animal is lost following darting, effort **must** be made to track the animal and assure its safety without compromising human safety.

Capture crews may sometimes also use remote delivery of reversal drugs in situations where they are unable to safely approach or reach a drugged target animal.

- Whenever possible, effort **should** be made to find darts that missed their target. This is particularly important in areas frequented by humans, such as near communities or in some parks, where there is potential for someone to find a "lost" dart.

- Capture of more than one animal per capture event **must** be avoided.

Special Considerations Concerning Drugs Are:

- Anesthetic drug combinations that can be reversed with an antagonist drug (reversal agent) **should** be used instead of drugs that cannot be reversed.

Reversible drug combinations provide capability to remove anesthetic effects in animals showing adverse physiological response and enable quicker recovery following handling (Kreeger and Arnemo 2012). See Appendix B for recommended drug protocols and volumes. These and other drug protocols are described in the chemical immobilization literature (e.g. Arnemo and Aanes 2009, Arnemo et al. 2011, Evans et al. 2013, Lian et al. 2016, Risling et al. 2011). The dosages and corresponding volumes in Appendix B are intentionally provided as ranges because selection of an appropriate dosage should be based on other factors in addition to the estimated body mass, e.g. age of animal, time of year, method of capture, etc.

- All drug vials **must** be clearly labeled with drug name(s), concentration, and date of preparation.

If a drug combination is prepared in a vial obtained from a drug manufacturer, cover the original label with a highly visible (e.g. fluorescent) adhesive label to avoid confusion between drug preparations.

- Drugs **must** be protected against exposure to extreme temperatures, high humidity, or intense light.

- When not in use, drugs at field sites **should** be stored in a labeled, locked, crush-proof, leak-proof container that is lined with absorbent material.

- Darts **should not** be loaded with drug in a helicopter or motorized vehicle that is in motion.

- All used drug **must** be recorded, including amounts lost in darts that missed the target.

- Unused preloaded darts **should** be emptied at the end of each day.

- If cleaning used darts that require disassembly, the tailpiece (flight) **must** be removed first in case the drug chamber contains some drug that is still under pressure.

- Adequate steps **must** be taken to ensure that drugs used in caribou do not enter the human food chain.

Animals should be clearly marked (e.g. permanent tattoo) to indicate they have received a drug and the individuals or agency performing the capture should provide contact information in indelible ink on the collar (Cattet 2002). In addition, researchers **must** consult with communities within the study area, inform them that drugs will be used, and advise them of what to do.

5.1.2.3 Water Capture

Issue: A procedure whereby caribou may be captured safely by boat while they are swimming across a river or lake (Ferguson and Elkie 2004, Karns and Crichton 1978, Lian et al. 2017).

- Involves moving a boat slowly alongside a swimming animal and then using a shepherd's crook or snare pole to capture and restrain the animal for short procedures, e.g. placement of a radio collar. If the pole or swivel end is kept along the windpipe with the rope or cable over the back of the neck, the animal's movements can be controlled without choking it.
- Handling is short (two to three minutes) and generally limited to fitting a radio collar, as no net removal or hobbling is required and additional measurements taken during handling are usually limited due to position of caribou in the water.

Recommendations:

- There **must** be no less than three people to employ this capture method.
  One person is required to pilot the boat and the other two to handle the animal.
- When releasing an animal, close attention **must** be paid to boat speed and direction to minimize effects of waves and noise on the caribou after being released.

5.1.2.4 Drive Traps (or Funnel Traps)

Issue: A procedure that employs a large, stationary trap constructed of nylon netting (e.g. mist net) strung between supporting poles to capture large numbers of animals at one time. Caribou can be driven into the trap by helicopter or snowmobile (Lian et al. 2017).

Recommendations:

- A large handling crew (two persons/animal) **must** be present to ensure all trapped caribou are restrained and handled immediately.
- Caribou with large antlers **must** be restrained as soon as possible to prevent injury to handling personnel or other animals.
- Captured caribou **must** be blindfolded and hobbled to reduce stress and prevent injury. Administration of sedative-type drugs (e.g. xylazine or medetomidine) **should** also be considered to alleviate stress.

5.1.2.5 Drop Nets

Issue: A procedure that involves suspending a net well above (~3 m) the ground in a circus tent conformation, with blasting caps taped to all support ropes (Bergerud et al. 2007, Ramsey 1968). Animals are attracted to below the net with bait. A battery and solenoids are used remotely to detonate the caps and sever the support ropes dropping the net on a target animal.

Recommendation:

- This technique **should** only be used to capture a single caribou at a time

Attempts to capture two or more animals may result in injury without the presence of a large handling crew (ideally two persons per animal).

5.1.3. Recommendations for Approach during Live Capture:

- Caribou captured by net gun, drive trap, or drop net **must** be approached and subdued as quickly as possible to avoid entanglement and injury. As the animal is being untangled from the net, a blindfold and hobbles **must** be applied.

Persons restraining and handling caribou need to stay clear of the striking area of the limbs and maintain control of the head to prevent injury by antlers.

When handling the caribou, the antlers should be controlled at all times.

- Sedative-type drugs with good pain-killing effect **should** be provided to alleviate stress or pain in situations where potentially painful procedures are employed, e.g., application of ear tags.

- When using remote drug delivery by helicopter, the pilot **must** be instructed to land a good distance from the animal while maintaining clear view of the downed animal.

Although the distance between helicopter and caribou will be variable depending on terrain, the goal is to reduce stimulation of the immobilized animal while maintaining the safety of the capture crew. In rare cases, it may be necessary to land quickly within meters of a downed caribou as in a situation where its mouth and nose are buried in snow. In other cases, it may even be possible to land the helicopter during induction and observe the darted animal from a distance until it becomes immobilized (Roffe et al. 2001). When approached, the caribou's nose and mouth must be observed to ensure a clear airway and any snow obstructing airflow must be cleared away.

- Caribou immobilized by remote drug delivery **must** be approached quietly and slowly to assess the animal's response to noise and touch.

Minimal stimulation of the immobilized animal is critical because peak drug effects generally occur sometime after immobilization (Caulkett et al. 1994, Plumb 2015). So, the possibility exists that sensory stimulation caused during the approach may be sufficiently strong to override the action of the drug and trigger a response by the caribou (Nielsen 1999).

5.1.4. Recommendations for Initial Handling during Live Capture:

- Noise and touching of caribou **must** be kept to a minimum.

- All personnel involved with handling immobilized caribou **should** wear nitrile or latex gloves to protect themselves from exposure to drugs and reduce risk of disease transmission.

Although nitrile or latex gloves may be impractical some situations, such as in frigid temperatures, it is important to protect your hands with an impermeable barrier because wildlife drugs can be absorbed across the skin and, therefore, represent a serious health hazard (Kreeger and Arnemo 2012). Although disease transmission is probably more infrequent than accidental drug exposure, it is important to be aware that caribou may potentially transmit some diseases (zoonoses) to humans, including rabies and brucellosis.

- The eyes of anesthetized caribou **must** be lubricated and covered.

Apply a non-medicated eye lubricant (e.g., methylcellulose) to the cornea to prevent drying and apply a blindfold to protect the eyes and prevent any visual stimulation.

- Hobbles **should** be applied in situations where they are required to reduce the potential for kicking of handling personnel.

- The dart(s) **must** be removed from anesthetized caribou at the onset of handling.

If using darts that require some assembly (e.g. Dan-Inject darts), first remove the tailpiece to vent the rear chamber before removing the dart. This will eliminate any possibility of drug spraying from the dart during removal if the needle port was occluded by tissue during injection. In most cases, treatment of the dart wound should require no more than wiping away excess blood, removing imbedded hair, clipping surrounding hair, and flushing the area with liberal amounts of sterile water to clean the wound. Antiseptic ointments, such as Hibitane® Veterinary Ointment, may also be applied although the effectiveness of these preparations in preventing infection in wild animals is unknown. Only a qualified veterinarian should treat more serious dart wounds, e.g. wounds that require sutures, restoration of intra-thoracic pressure, excision of darts that have fully penetrated the skin, etc.

- Anesthetized or restrained caribou **must** be positioned so breathing is not impinged, i.e., keep neck straight and ensure nostrils and mouth are not blocked.

If the animal is anesthetized, try to keep it ventrally (sternally) recumbent with the head held higher than the thorax and the nose pointing down to avoid aspiration of saliva or rumen contents (Lian et al. 2017). Ensure the ground under the animal is flat with no protruding surfaces, e.g. rocks. Should a caribou need to be rolled, it should be rolled across the sternum as opposed to across the back. When rolling, two or more persons must work together to ensure the head and tail ends of the caribou are rolled in parallel to avoid twisting the animal along its spinal axis. Caribou should never be moved (or picked up) by grasping their skin and hair.

- The physiologic response to chemical immobilization (anesthesia) **must** be assessed, and the assessment **should** include the following measures:

    - Reflex activity (e.g., palpebral, ear twitch, and tongue withdrawal reflexes): the presence and strength of reflexes is used to evaluate the level of immobilization (deep vs. light) and need for additional drug or reversal.

    - Respiratory function: evaluated by respiratory rate, depth, and sound. Although respiratory rate is affected by many factors (age, activity, drugs, etc.), it should remain ≥6 breaths per minute in an anesthetized caribou. Each breath should be quiet and characterized by full expansion and relaxation of the rib cage. If the respiratory rate is less than six breaths per minute, artificial ventilation (chest compressions, ventilation via endotracheal tube and resuscitation bag) and/or administration of a reversal drug may be required, if other signs point toward respiratory depression, i.e., blue or gray mucous membranes, oxygen saturation trend is continually downwards.

    - Cardiovascular function: evaluated by pulse or heart rate, mucous membrane color, and capillary refill time. Although pulse or heart rate is affected by many factors (age, activity, drugs, etc.), it should remain between 35 and 80 beats per minute in an anesthetized caribou (Lian et al. 2017). In addition, mucous

membranes (i.e., gums, anus, vulva) should be pink and the capillary refill time should be <2 seconds. If the pulse or heart rate increases or decreases outside of the recommended range, respiratory function should be re-assessed immediately and corrected, if necessary. Reversal drugs should also be available to administer, but should not be given unless other signs point toward cardiovascular distress or collapse, i.e., blue or gray mucous membranes, prolonged capillary refill time (>2 seconds), dilated pupils.

- Body temperature: evaluated rectally using an electronic digital thermometer. A spare thermometer should always be carried in case the active thermometer malfunctions. The rectal temperature should range between 37°C and 40.5°C. Administration of a reversal drug is the most effective treatment if hyperthermia (>40.5°C) develops, because it enables the caribou to use its normal cooling mechanisms, e.g. panting. Other cooling methods, including dousing with cold water and cold water enemas, may or may not be effective depending on the size of the animal, the thickness of its hair coat (and subcutaneous fat stores), and the rate of temperature increase. Hypothermia (<37°C) may also develop in some caribou, especially smaller-sized or aged animals that are captured under cold ambient conditions. Treatment should be directed toward active warming of the animal first (heating pads, place in sleeping bag, drying wet hair coat), and not administering a reversal drug until the body temperature has returned to within the recommended range.

5.1.5. Recommendations for the Monitoring of Physiological Function During Live Capture:

- The physiologic function of anesthetized caribou **must** be monitored throughout handling until the reversal (antagonist) drug is administered. Assessments **should** be made and recorded every 10-15 minutes.

Attention to physiologic function can provide advanced warning of developing complications (e.g. hyperthermia) and provide opportunity for preventative measures. Conditions such as hyperthermia are easier to prevent than to treat and regular monitoring is key. Further, detailed records of physiologic function are an invaluable aid for investigation of any post-handling mortality.

- A pulse oximeter **should** be included as a standard component of the capture equipment.

It provides a useful means of evaluating respiratory and cardiovascular functions by measuring the hemoglobin oxygen saturation (in %) of blood and the pulse rate (Allen 1992, Kreeger and Arnemo 2012). Small, battery-powered, portable pulse oximeters are available commercially for use in the field. The absolute oxygen saturation values are often inaccurate for various reasons including calibration of the instrument for use in domestic species, decreased blood perfusion of peripheral tissues, variation in skin color, and variation in probe placement (Hendricks and King 1994). However, monitoring for trends

in oxygen saturation is valuable; if readings steadily decrease, it is likely the animal is in some sort of physiological crisis (Kreeger and Arnemo 2012). When using a pulse oximeter, the probe should be applied at a consistent location (e.g. the tongue) and left in place until a stable signal is obtained before recording the oxygen saturation and pulse values. Concurrent evaluation of mucous membrane color will enable detection of hypoxemia, i.e., oxygen saturation is <85%, pulse rate increasing, and mucous membranes are becoming blue. Hypoxemia refers to low oxygenation of blood and, if prolonged, eventually leads to hypoxia, which is the diminished availability of oxygen in body tissues. Although the most obvious cause of hypoxemia is respiratory depression, it probably arises more frequently in captured wildlife as a result of elevated body temperature where the oxygen demand of body tissues exceeds the supply (Caulkett and Arnemo 2014).

- Supplementary oxygen **should** be available to treat hypoxemia and prevent hypoxia.

Oxygen therapy is the most effective treatment for hypoxemia (Read et al. 2001, Fahlman et al. 2012). Supplementary oxygen can be carried readily in the field in pressurized "D" cylinders (weigh approximately 6 kg when full and are safe to carry aboard a helicopter) and administered to animals by use of a mini-regulator and nasal cannula. A flow rate of one to two liters per minute is required for most caribou (Evans et al. 2013) and the efficacy of treatment should be monitored with a pulse oximeter. The availability of medical grade oxygen provides an invaluable aid to assisting field anesthesia of caribou, especially when used in conjunction with a pulse oximeter. This equipment is available from most ambulance supply companies and is recommended as a standard component of the capture equipment. This equipment is also useful for supportive care of field personnel following significant drug exposure.

- All capture data, including drug doses and measures of physiological function, **must** be recorded on data forms at the time of capture and handling.

These data are invaluable in investigating health complications or the death of a caribou during or following handling. A template for a capture data form is provided in Appendix C.

5.2. Sample Collection and Measurements

Recommendations:

- All handling, including sample collection and measurements, **must** be completed quickly and quietly with the objective of releasing the animal as soon as possible.

- Samples and measurements **must** be consistent with the experimental design and details provided in the animal handling protocol.

- Incisor teeth **must not** be extracted from live caribou. Age or age class **should** be estimated based on dentition wear, body size, and physical appearance (Appendix E).

The requirement for accurate age estimation does not outweigh the invasiveness of incisor extraction and functional importance of a full complement of incisors for foraging.

- The first two incisor teeth **should** be extracted from dead or euthanized caribou for accurate age estimation.

Collection of the entire lower jaw is preferred, however if not possible, collection of incisor teeth will suffice.

- Local anesthesia **should** be considered for sampling procedures that are likely to elicit pain, e.g. ear punch, skin/fat biopsy.

In situations where analgesia is required, infiltration of the biopsy/punch site with 2-3 ml of lidocaine (with 2% epinephrine) approximately five minutes before tissue collection will provide sufficient pain control and minimize bleeding.

- Least invasive procedures **must** be used for genetic (DNA) sampling, e.g. hair follicle extraction, oral swab.

Tissue biopsy for DNA analysis is unacceptable unless the biopsy samples are also required for other analyses, e.g. contaminants, stress indicators.

- If an ear tag is applied, the hole **should** be made with a sterile biopsy punch (4-6 mm diameter) and the tissue plug **should** be preserved for any analyses that require tissue samples.

The ear tag stud is manually directed through the biopsy hole prior to securing the tag with the applicator.

- Sampling of blood and tissue **should** be performed only after appropriate training and adequate experience. Proper collection and handling and preservation protocols **must** be followed to obtain useful field data.

- If the handling protocol requires weighing captured animals, the weighing **must** be done in the least stressful manner possible.

Caribou should not be suspended upside down by the hobbles attached to their four limbs because of the potential for adverse health effects, e.g. regurgitation and aspiration (Kreeger et al. 2002). Instead, it is recommended that caribou are weighed by first positioning them on their sternum or left side on a lightweight rigid platform (e.g. portable climbing ledges weigh 4-6 kg) and then suspending the platform from a pole, bipod, or tripod.

- At some point during handling, the animal **must** be checked for wounds, injuries, and general condition and this information **must** be recorded on the field data sheet.

- Antibiotics **must not** be administered routinely to captured caribou. Antibiotics **should** only be administered under the advice or direct supervision of a veterinarian.

The effectiveness of these drugs in free-ranging wildlife is often unproven and largely unknown (Pietsch et al. 1999). In addition, antibiotic residues (metabolites) often remain in tissues for long periods of time posing a public health risk to persons consuming caribou meat (Cattet 2002).

5.3 Identification, Marking and Telemetry Collars

Recommendations:

- Investigators **must** aim to minimize any adverse effects of identification or marking procedures on the behaviour or physiology of individual study animals.

- Primary consideration **must** be given to identification or marking techniques that are not invasive, do not require recapture for identification, will remain visible for the duration of the study, and will not compromise the animal's welfare.

Ideally, techniques used should comply with the following criteria:

- Should be quick and easy to apply;
- Should be readily visible and distinguishable;
- Should be persistent, remaining for the duration of the research;
- Must not cause long-term adverse health effects;
- Must be recorded accurately on field data sheets; and
- Must allow for seasonal changes in size and growth.

- Telemetry collars **should** be as light in weight as possible and **should** be selected for long duration battery life and remote drop capability to minimize re-capturing of collared caribou. With respect to collar weight, Rasiulus *et al.* (2014) determined that the difference in weight between satellite collars weighing 1.63 kg, approximately 1.6% of the body mass of an adult female caribou (80–100 kg), and VHF collars weighing 514 g, approximately 0.5% of body mass, was enough to decrease adult female survival during a population decline.

Collars should not be kept on indefinitely and must have a self-release mechanism.

- All collars **should** incorporate some mechanism to release them from the animal without recapture; this can be achieved with a break-away mechanism or connection material that will eventually rot off, allowing the collar to drop from the animal.

This includes collars with self-removing or breakaway devices, in case the release mechanism fails to function.

- A "drop-off schedule" which identifies the calendar dates that collars are expected to drop off **must** be developed in conjunction with collar deployments. This schedule **must** then be used to monitor and confirm that collars have indeed dropped from the animals that once wore them.

- The shape and flexibility of the collar **must** be selected to avoid causing debilitating injuries to study animals (Krausman et al. 2004).

- Collar size **must** be selected to minimize risks associated with being either too tight or too loose, and should be based on several factors including animal age, sex, condition and time of year.

- Data on caribou neck size ranges (by age, sex and season) **should** be collected and shared among researchers to provide a basis for selected collar size.

- Conventional VHF collars **should not** be deployed unless funds have been procured to monitor the collars for the length or majority of the battery life.

- Ear tag transmitters **must not** be used on caribou.

5.4 Reversal Drugs and Release of Caribou

Recommendations:

- Reversal (or antagonist) drugs **must** not be administered until all equipment has been repacked and removed, and all unnecessary personnel have cleared the area.

- Once the reversal drug is administered, the person(s) administering it **should** retreat to a safe location to monitor the recovery.

Every effort should be made to observe the animal until it is ambulatory and coordinated in its movements.

- Non-anesthetized caribou **must** be provided with a clear path for retreat before the hobbles are removed.

The person(s) releasing the hobbles must position themselves to avoid being kicked or struck by antlers. Remove the blindfold as soon as the hobbles are released.

5.5 Post-Capture Monitoring

Recommendations:

- Caribou fitted with radio collars **should** be observed visually at least once or, radio collar data assessed within 24-48 hours of capture and handling, in order to detect any unusual movements or mortalities.

This is especially important if the caribou showed any adverse or unusual response to capture and handling, e.g. hyper- or hypothermia, significant physical injury. Although animals sometimes die during capture and handling, death may also be delayed occurring within hours to days following capture (Spraker 1993, Fowler 1995). If an animal dies following capture, the opportunity to determine cause of death is important for two reasons (Nielsen 1999). First, if the animal died as a direct result of the procedures used during capture and handling, then a detailed necropsy should be followed by a review of the capture event and, if required, a revision of the methodology used. Second, if the animal died as a result of a pre-existing illness or disease exacerbated by the stress of capture and handling, then a detailed necropsy will help to assure continued confidence in the capture methodology used and may also provide new information regarding the health of the species.

- Ideally, caribou **should** be visualized from high altitude to minimize stress associated with the noise and proximity of the aircraft. However, sighting a caribou where tree cover is extensive may be difficult, if not impossible. In such case, movement of the animal **should** be confirmed by detecting change in its radiolocations.

Although most telemetric devices are equipped with motion-sensitive mortality sensors, these alone are not adequate for confirming movement of the released caribou and should not be used as a substitute for visual observation or radiolocation in the immediate period following capture. Activation of the sensor may not always occur within the programmed time because of intermittent movement of the collar following death caused by animals feeding on the carcass. Detailed examination of a carcass that has been scavenged extensively is unlikely to provide any insight into the cause of death.

- The "drop-off schedule" **must** be used to monitor and confirm that collars have indeed dropped from the animals that once wore them.

5.6 Humane Killing of Animals

5.6.1 Recommendations:

- Killing methods for collection of caribou **must** be humane.

- Investigators **should** be trained in the proposed collection method(s) to ensure effective humane kills.

- The technique used **must** reduce pain and distress to the greatest extent possible.

- Consideration **should** also be given to techniques that least interfere with the conduct of necropsies or diagnostic testing.

- Detailed information on acceptable and unacceptable methods of humane killing have been developed and compiled by the American Veterinary Medical Association (AVMA 2013).

- Acceptable methods of killing caribou are as follows:
  a) Gun Shot
     - A shot to the brainstem of an animal produces a quick and humane death, but is best attempted when the animal is immobilized by injury, chemical immobilization, or physical restraint.
     - In free-ranging situations, or where the intact brain is required for diagnostic testing, gunshot to the heart and lung area may be more appropriate.

  b) Penetrating Captive Bolt
     - This method requires that animals be well restrained to properly place the captive bolt.
     - Because the penetrating captive bolt induces loss of consciousness, but does not ensure death, the animal must be bled with a deep slice across the throat to sever the carotid arteries immediately following stunning, i.e., exsanguination.

  c) Intravenous Administration of Potassium Chloride
     - The rapid injection of a potassium chloride (KCl) solution into the jugular vein, or directly into the heart, will cause a fatal heart attack.
     - Can be pre-made as a stock solution by adding 5 mg of KCI per 25 ml water.
     - Use of this method requires prior training by a veterinarian or experienced person.
     - This method is considered humane when performed on an anesthetized animal.

  d) Exsanguination (Bleeding)
     - This method is considered humane if performed on an anesthetized animal or on an animal stunned by penetrating captive bolt.

5.6.2 Humane Killing:

- The investigator **must** be prepared to humanely kill any animal in the field that is suffering intolerable pain, irreversible injury, or distress as a result of the capture or handling procedures, or the experimental intervention. The technique used **must** reduce pain and distress to the greatest extent possible.

Acceptable methods for humane killing are described under the **5.6.1 Recommendations** section. The capture crew must carry a firearm and ammunition that meets legal requirements for killing caribou in the NWT and to kill the animal humanely if warranted.

5.7 Morbidity and Mortality

Recommendations:

- Any significant injury, disease, or abnormality (ie. broken leg or neck, nerve injury) observed during or following capture or handling **must** be documented and reported to the GNWT-ENR Wildlife Veterinarian as soon as possible. If possible, the veterinarian should be contacted via satellite phone at the time of the incident. An investigation **should** be conducted wherever possible. If the GNWT Wildlife Veterinarian is unavailable, another wildlife veterinarian delegated by the GNWT Wildlife Veterinarian should be contacted.

Investigation may include collection of samples (blood, feces, etc.) for submission to a veterinary diagnostic laboratory for further evaluation, e.g., serum biochemistry, parasite identification. Ideally, the written report should include digital images.

- Minor injuries such as cuts or scrapes should be recorded, however, do not need to be reported at the time of the incident.

- Dead caribou for which the cause of death is not obvious **must** receive a detailed necropsy to determine the cause of death and all mortalities must be reported to the GNWT-ENR wildlife veterinarian as soon as possible. Whenever possible, the GNWT-ENR Wildlife Veterinarian should be contacted via satellite phone at the time of the incident.

All meat must be collected from the capture site for distribution to communities from animals where immobilization drugs were not used. The crew must be equipped with a tarp and appropriate equipment to butcher the animal and salvage the meat. The project lead needs to identify the most appropriate place to take the meat should mortality occur prior to the capture operation.

If the necropsy is performed in the field, appropriate tissue samples should be collected and frozen for submission to a veterinary pathology facility. Appropriate tissue samples should include brain, lung, heart, liver, kidney, spleen, lymph nodes, and muscle. Investigators should refer to a wildlife necropsy manual for details regarding required equipment, techniques, and sampling procedures (see for example, Munson 2006). A template for a field necropsy data form is provided in Appendix D. Documentation should also include a detailed history and digital images of the field necropsy to assist the veterinary pathologist diagnosing the cause of death. Alternatively, under some circumstances, it may be better to arrange shipment of the entire carcass to a veterinary pathology facility for detailed necropsy.

In cases where the cause of death is obvious (i.e. broken neck or leg), a necropsy should be performed and sample collection may be requested upon consultation with the ENR wildlife veterinarian or another wildlife veterinarian delegated by the GNWT Wildlife Veterinarian .

If there are two or more significant injuries or mortalities during a caribou capture operation, the GNWT-ENR Wildlife Veterinarian or their delegate should be contacted, capture should be suspended, and the incidents must be discussed prior to further captures. The ENR Wildlife Veterinarian will contact the Regional Superintendent and Wildlife Director

5.8 Human Safety

Recommendations:

- Appropriate handling and restraint techniques **must** be used for caribou, and personnel **must** have appropriate training and experience in their use to avoid injury.

  Caribou are capable of inflicting serious injury and transmitting disease to persons handling them.

- The risks involved in using drugs for the capture and immobilization of caribou **must** be identified and communicated to all personnel involved in the project (including the helicopter pilot).

- The investigator **must** ensure that an emergency action plan is in place.

  The emergency action plan provides step-by-step details on what to do in the event of an accident or emergency (e.g., human drug exposure, downed aircraft) and, if well designed and implemented, can reduce the severity of emergencies and save lives.

- At least two people on the handling team **must** be trained in first aid and cardiopulmonary resuscitation (CPR), local medical authorities **should** be informed of the potential hazards (accidental drug injection, animal bite), and an evacuation plan to medical facilities **must** be discussed prior to fieldwork.

- Personnel handling drugs **must** have current training (within 5 years) and inform other members of the team of the risks of human exposure and procedures for addressing drug exposure.

- When contracting helicopter services, project leaders **should** be able to insist on only using the most experienced pilots.

- Helicopter pilots assisting with wildlife capture operations **must** have demonstrated skills in their ability to pursue target animals and, when required, control animal movements in a gradual manner that imposes as little stress as possible on the target animal.

- The investigator **must** ensure that potentially hazardous conditions involved in fieldwork are identified to the personnel involved.

  Some situations may require specific experience or training, such as working around aircraft or firearms, or in extreme cold temperatures.

- Helicopter egress training **should** be encouraged for all capture crew participants. The use of appropriate safety clothing (i.e. Nomax coveralls, flight helmet) **should** be used.

- Personnel involved in capture and restraint **must** have current training and proficiency in the use of pertinent equipment, e.g., firearms, dart rifles, etc.

- Following completion of a training course, inexperienced personnel **should** develop and refine their skills by working with a mentor.

Although training courses can provide basic safety information, they cannot provide the breadth of knowledge acquired through field experience.

If at any time human health and safety is compromised, human safety takes precedence. Otherwise, all efforts must be made to ensure animal welfare is optimal and the standard operating procedures for animal care and handling are observed.

Literature Cited

Alibhai, S.K., Z.C. Jewell and S.S. Towindo. 2001. Effects of immobilization on fertility in female black rhino (*Diceros bicornis*). Journal of Zoology London 253:333-345.

Allen, J.L. 1992. Pulse oximetry: everyday uses in zoological practice. The Veterinary Record 130:354-355.

American Veterinary Medical Association (AVMA). 2013. AVMA Guidelines for the Euthanasia of Animals: 2013 Edition. American Veterinary Medical Association, Schaumburg, Illinois, USA. 102pp. (Last accessed March 12, 2017 at www.avma.org/KB/Policies/Documents/euthanasia.pdf)

Arnemo, J.M. and R. Aanes. 2009. Reversible immobilization of free-ranging Svalbard reindeer (*Rangifer tarandus platyrhynchus*) with medetomidine-ketamine and atipamezole. Journal of Wildlife Diseases 45:877-880.

Arnemo, J.M., A.L. Evans, A.L. Miller and O. Os. 2011. Effective immobilizing doses of medetomidine-ketamine in free- ranging, wild Norwegian reindeer (*Rangifer tarandus tarandus*). Journal of Wildlife Diseases, 47:755-758.

Ashley, N.T., P.S. Barboza, B.J. Macbeth, D.M. Janz, M.R.L. Cattet, R.K. Booth and S.K. Wasser. 2011. Glucocorticosteroid concentrations in feces and hair of captive caribou and reindeer following adrenocorticotropic hormone challenge. General and Comparative Endocrinology 172:382-391.

Ball, M.C., L. Finnegan, M. Manseau and P. Wilson. 2010. Integrating multiple analytical approaches to spatially delineate and characterize genetic population structure: an application to boreal caribou (*Rangifer tarandus caribou*) in central Canada. Conservation Genetics 11:2,131-2,143.

Ballard, W.B. and R.W. Tobey. 1981. Decreased calf production of moose immobilized with anectine administered from helicopter. Wildlife Society Bulletin 9:207-209.

Bergerud, A.T., W.J. Dalton, H. Butler and R. Ferguson. 2007. Woodland caribou persistence and extirpation in relic populations on Lake Superior. Rangifer, Special Issue No. 17:57-78.

Bergvall, U.A., P. Kjellander, P. Ahlqvist, O. Johansson, K. Sköld and J.M. Arnemo. 2015. Chemical immobilization of free-ranging fallow deer (*Dama dama*): effect of needle length on induction time, Journal of Wildlife Diseases, 51:484-487.

Beringer, J., L.P. Hansen, W. Wilding, J. Fischer and S.L. Sheriff. 1996. Factors affecting capture myopathy in white-tailed deer. Journal of Wildlife Management 60:373-380.

Bush, M. 1992. Remote drug delivery systems. Journal of Zoo and Wildlife Medicine 23:159-180.

Carlsson, A.M., G. Mastromonaco, E. Vandervalk and S. Kutz. 2016. Parasites, stress and reindeer: infection with abomasal nematodes is not associated with elevated glucocorticoid levels in hair or faeces. Conservation Physiology 4(1): cow058; doi:10.1093/conphys/cow058.

Cattet, M.R.L. 2002. Drug residues in wild meat – addressing a public health concern. A CCWHC Technical Bulletin – Winter 2002. (Available online at http://wildlife1.usask.ca/ccwhc2003/newsletters/technical_bulletin9-1.PDF)

Cattet, M.R.L., A. Bourque, B.T. Elkin, K.D. Powley, D.B. Dahlstrom and N.A. Caulkett. 2006. Evaluation of the potential for injury with remote drug delivery systems. Wildlife Society Bulletin 34:741-749.

Cattet, M.R.L., N.A. Caulkett, C. Wilson, T. Vandenbrink and R.K. Brook. 2004. Intranasal administration of xylazine to reduce stress in elk captured by net gun. Journal of Wildlife Diseases 40:562-565.

Caulkett, N.A., P.H. Cribb and T. Duke. 1994. Cardiopulmonary effects of medetomidine-ketamine immobilization with atipamezole reversal and carfentanil-xylazine immobilization with naltrexone reversal: a comparative study in domestic sheep (*Ovis ovis*). Journal of Zoo and Wildlife Medicine 25:376-389.

Caulkett, N.A. and J.M. Arnemo. 2014. Cervids (Deer). *in* West, G., D. Heard and N. Caulkett (ed). Zoo Animal and Wildlife Immobilization and Anesthesia, 2nd Edition. Wiley-Blackwell, Hoboken, NJ. pp. 823-830.

Côté, S.D., M. Festa-Bianchet and F. Fournier. 1998. Life-history effects of chemical immobilization and radio collars on mountain goats. Journal of Wildlife Management 62:745-752.

Evans, A.L., M. Lian, C.G.D. Neves, Ø. Os, R. Andersen, R. Aanes, O. Strand, M. Tryland and J.M. Arnemo. 2013. Physiologic evaluation of medetomidine–ketamine anesthesia in free-ranging Svalbard (*Rangifer tarandus platyrhynchus*) and wild Norwegian reindeer (*Rangifer tarandus tarandus*). Journal of Wildlife Diseases 49:1,037-1,041.

Fahlman, Å., N. Caulkett, J.M. Arnemo, P. Neuhaus and K.E. Ruckstuhl. 2012. Efficacy of a portable oxygen concentrator with pulsed delivery for treatment of hypoxemia during anesthesia of wildlife. Journal of Zoo and Wildlife Medicine 43:67-76.

Ferguson, M.A.D. 2015. Gun-netting of Arctic tundra caribou: Inuit guided choices, and led to improvements and low impacts. 14th Arctic Ungulate Conference, 21-26 August, Røros, Norway.

Ferguson, S.H. and P.C. Elkie. 2004. Habitat requirements of boreal forest caribou during the travel seasons. Basic and Applied Ecology 5:465-474.

Fowler, M.E. 1995. Restraint and Handling of Wild and Domestic Animals (2nd Edition). Iowa State University Press, Ames, IA. 383 pp.

Gustine, D.D., P.S. Barboza, L.G. Adams, R.G. Farnell and K.L. Parker. 2011. An isotopic approach to measuring nitrogen balance in caribou. Journal of Wildlife Management 75:178-188.

Hampton, J.O., T.H. Hyndman, M. Laurence, A.L. Perry, P. Adams and T. Collins. 2016. Animal welfare and the use of procedures documents: limitations and refinement. Wildlife Research 43:599-603.

Haskell, S.P. and W.B. Ballard. 2007. Modeling the Western Arctic Caribou Herd during a positive growth phase: potential effects of wolves and radio collars. Journal of Wildlife Management 71:619-627.

Haulton, S.M., W.F. Porter and B.A. Rudolph. 2001. Evaluating four methods to capture white-tailed deer. Wildlife Society Bulletin 29:255-264.

Hendricks, J.C. and L.G. King. 1994. Practicality, usefulness, and limits of pulse oximetry in critical small animal patients. Veterinary Emergency and Critical Care 3:5-12.

Joly, K., S.K. Wasser and R. Booth. 2015. Non-invasive assessment of the interrelationships of diet, pregnancy rate, group composition, and physiological and nutritional stress of barren-ground caribou in late winter. PLoS ONE 10(6): e0127586. doi:10.1371/journal.pone.0127586

Karns, P.D. and V.F.J. Crichton. 1978. Effects of handling and physical restraint on blood parameters in woodland caribou. Journal of Wildlife Management 42:904-908.

Krausman, P.J., V.C. Bleich, J.W. Cain III, T.R. Stephenson, D.W. DeYoung, P.W. McGrath, P.K. Swift, B.M. Pierce, and B.D. Jansen. 2004. From the field: neck lesions in ungulates from collars incorporating satellite technology. Wildlife Society Bulletin 32:987-991.

Kreeger, T.J. and J.M. Arnemo. 2012. Handbook of Wildlife Chemical Immobilization – Fourth Edition. Published by authors. 448pp.

Lewis, K.P. and S.P. Mahoney. 2014. Caribou survival, fate, and cause of mortality in Newfoundland: a summary and analysis of the patterns and causes of caribou survival and mortality in Newfoundland during a period of rapid population decline (2003-2012). Technical Bulletin No. 009, Sustainable Development and Strategic Science. Government of Newfoundland and Labrador, St. John's, NL. 61pp.

Lian, M., Beckman, K.B., Bentzen, T.W., Demma, D.J., and J.M. Arnemo. 2016. Thiafentanil-azaperone-xylazine and carfentanil-xylazine immobilizations of free-ranging caribou (*Rangifer tarandus granti*) in Alaska, USA. Journal of Wildlife Diseases 52:327-334.

Lian, M., A.E. Evans, K.B. Beckmen, N.A. Caulkett and J.M. Arnemo. 2017. Restraint and immobilization. *in* Tryland, M., Kutz, S. (eds). Reindeer and Caribou. Health and Disease. Boca Raton, FL: Taylor & Francis Group. 500pp.

Macleod, R. and A.G. Gosler. 2006. Capture and mass change: perceived predation risk or interrupted foraging? Animal Behaviour 71:1,081-1,087.

MacPherson, D. 1994. Bullet Penetration: Modeling the Dynamics and the Incapacitation Resulting from Wound Trauma. Ballistic Publications, El Segundo, CA. 303pp.

Mommer, B.C. and A.M. Bell. 2014. Maternal experience with predation risk influences genome-wide embryonic gene expression in threespined sticklebacks (*Gasterosteus aculeatus*). PLoS ONE 9(6): e98564. doi:10.1371/journal.pone.0098564.

Munson, L. 2006. Necropsy of wild animals. University of California, Davis. Wildlife Health Center, Wildlife Conservation Society, New York, NY. 56pp.

Nielsen, L. 1999. Chemical Immobilization of Wild and Exotic Animals. Iowa State University Press, Ames, IA. 341pp.

Omsjoe, E.H., A. Stien, J. Irvine, S.D. Albon, E. Dahl, S.I. Thoresen, E. Rustad and E. Ropstad. 2009. Evaluating capture stress and its effects on reproductive success in Svalbard reindeer. Canadian Journal of Zoology 87:73-85.

Pietsch, G., G. Finstad, J. Bevins and A.K. Prichard. 1999. The effect of antibiotic treatment on post-handling stress and survival of reindeer calves. Journal of Wildlife Diseases 35:735-740.

Plumb, D.C. 2015. Plumb's Veterinary Drug Handbook (8th Edition). Wiley-Blackwell, Hoboken, NJ. 1,296pp.

Ramsey, C.W. 1968. A drop-net deer trap. Journal of Wildlife Management 32:187-190.

Rasiulis, A.L., M. Festa-Bianchet, S. Couturier and S.D. Côté. 2014. The effect of radio-collar weight on survival of migratory caribou. The Journal of Wildlife Management 78:953-956.

Read, M.R., N.A. Caulkett, A. Symington and T.K. Shury. 2001. Treatment of hypoxemia during xylazine-tiletamine-zolazepam immobilization of wapiti. Canadian Veterinary Journal 42:861-864.

Risling, T.E., A. Fahlman, N.A. Caulkett and S. Kutz. 2011. Physiological and behavioural effects of hypoxemia in reindeer (*Rangifer tarandus*) immobilized with xylazine-etorphine. Animal Production Science 51:355-358.

Roffe, T.J., K. Coffin and J. Berger. 2001. Survival and immobilizing moose with carfentanil and xylazine. Wildlife Society Bulletin 29:1,140-1,146.

Saino, N., M. Romano, R.P. Ferrari, R. Martinelli and A.P. Møller. 2005. Stressed mothers lay eggs with high corticosterone levels which produce low-quality offspring. Journal of Experimental Zoology 303A:998-1,006.

Sheriff, M.J., C.J. Krebs and R. Boonstra. 2010. The ghosts of predators past: population cycles and the role of maternal programming under fluctuating predation risk. Ecology 91:2,983-2,994.

Spraker, T.R. 1992. Reintroduction of Caribou to the Central and Southern Kenai Peninsula, 1985-86. Alaska Department of Fish and Game Division of Wildlife Conservation Wildlife Technical Bulletin #9. 27pp.

Spraker, T.R. 1993. Stress and capture myopathy in artiodactylids. *in* Fowler, M.E. (ed). Zoo and Wild Animal Medicine (Current Therapy 3). W.B. Saunders Company, Philadelphia, PA. pp. 481-488.

Valkenburg, P., R.D. Boertje and J.L. Davis. 1983. Effects of darting and netting on caribou in Alaska. Journal of Wildlife Management 47:1,233-1,237.

Valkenburg, P., R.W. Tobey and D. Kirk. 1999. Velocity of tranquilizer darts and capture mortality of caribou calves. Wildlife Society Bulletin 27:894-896.

Wasserman, M.D., C.A. Chapman, K. Milton, T.L. Goldberg and T.E. Ziegler. 2013. Physiological and behavioral effects of capture darting on red colobus monkeys (*Procolobus rufomitratus*) with a comparison to chimpanzee (*Pan troglodytes*) predation. International Journal of Primatology 34:1,020-1,031.

Appendix A – Net Gun Maintenance, Use, and Inspection

(Contributed by Ian Ellsworth, Trinity Tactical Consulting Ltd.)

1.0 Net Gun Standards

Various makes and models of net guns are currently used for wildlife capture operations. However, regardless of differences among types of net guns, existing or new, all net guns being used in the Northwest Territories **must** meet the following minimum standards:

1. Have removable barrels that contain net canisters for quick reloading;
2. Be equipped with a minimum of three barrel/canister units and appropriate-sized nets;
3. Have a minimum of four spare weights complete with O-rings and tethers;
4. All weight tethers must utilize rubber tubing (capable of withstanding cold temperatures) at the junction of the weight eyelet; and
5. Have a safety mechanism that prevents the gun from being fired.

2.0 Maintenance

2.1 Pre-Capture

Net guns and accessory equipment **must** be inspected prior to capture operations to ensure everything is fully functional and reliable.

<u>Gun</u>

- Inspect for cracks or loose parts
- Ensure action is clean and free of oil or grease
- Ensure breech is clean and free of obstructions
- Ensure action operates smoothly and firing pin engages
- Check safety mechanism for proper operation
- Check trigger for proper operation

<u>Canister Units</u>

- Ensure barrels are clean and free of cracks and obstructions
- Check retaining bolts for tightness
- Inspect canister for cracks or defects
- Inspect flaps and Velcro fasteners

<u>Nets and Weights</u>

- Check for holes or tears in nets, and repair or replace as needed
- Ensure weights are not damaged and file burrs, if required
- Check O-rings for wear
- Check weight tethers for fraying or other damage
- Check rubber sleeves and fasteners for wear

2.2 Capture

As you use the net gun, you **must** regularly check nuts and bolts that may loosen with continued use. Similarly, you **must** continually check canisters and weights after each capture. Fiberglass canisters can break, rivets may tear away from closure flaps, and Velcro may lose its effectiveness. It is also necessary to inspect weights as O-rings will wear and weight tethers will fray and break with repeated use, and may need to be replaced. Nets **must** be dried out at the end of each capture day.

2.3 Post-Capture

Use the pre-capture list as your guide. In addition, you **should** thoroughly clean the gun and weights. Lubricate metal parts (except the bolt/firing pin) to inhibit rust. If you wish to lubricate the action, use graphite or an equivalent product that will not freeze in the cold. Dry out all nets prior to storage.

2.4 Equipment Inspection

All net-gunning equipment to be used during a capture season **must** be inspected by an experienced gunner prior to use. If any issues arise, the equipment **must** be repaired by a qualified technician. All inspections **must** be recorded, problems noted, and corrective actions listed on the Inspection Checklist.

3.0 Safety Equipment

The safety of all personnel during capture operations is paramount. So, all team members **must** receive a safety briefing prior to departure. Further, all personnel **must** wear an approved helicopter helmet and clothing appropriate to the weather during capture operations. Net gunners **must** wear a harness or safety belt with a minimum of two lanyards with safety clips attached to the harness or belt and secured to fixed anchoring points in the aircraft. Lanyard tension **must** be assessed and, if necessary, altered prior to each capture. Harnesses or safety belts **must** also be adjusted to the appropriate tension to limit forward and side-to-side motion. Harnesses, safety belts and lanyards **must** also be inspected daily and replaced at the first sight of any fraying or wear. Safety equipment that has passed an expiration date **should not** be used.

4.0 Ammunition:

All net-gun ammunition **must** be hand loaded by competent personnel or purchased from a commercial distributor if available. Used brass **should not** to be used for reloading of net-gun ammunition.

5.0 Net Gunning Sequence and Considerations:

5.1 Pre-Capture

The gunner will ensure:

- All equipment is ready
- Net weights are plunged into barrels and properly seated (O-rings help to secure the weights in the barrels)
- Spare canister units are accessible if a second shot is required
- Harness/safety belt and lanyards are properly adjusted

- Door is removed from the helicopter, unless it is a sliding door

5.2 Capture

The gunner will:

- Communicate with pilot to see if airspeed is sufficiently slowed to open the sliding door
- With the door open (or removed), place a cartridge into the chamber but **do not** close the action
- Get into shooting position and select a target animal, while controlling the muzzle direction at all times to ensure it is pointing outward from the cabin, but never directed toward the rotor blades or skid
- Once chase begins, close the action, disengage the safety, and keep finger outside of the trigger guard until ready to fire
- When animal is safely within range, deploy the net
- If a second shot is required, re-engage safety, open action, change canister, reload and follow preceding steps.
- If unable to shoot during the first pass and extended time is required to get into range, re-engage safety and open action to prevent accidental discharge. Keep muzzle pointed in safe direction and finger outside the trigger guard.
- If a misfire occurs, wait a minimum of 30 seconds before ejecting the cartridge. Always ensure the gun is pointed in a safe direction in case of delayed detonation (also called hang fire).

5.3 Post Capture

The gunner **must** inspect the net, weights and O-rings prior to reuse. Any worn parts **must** be replaced. It is quite common for O-rings to compress and fail to hold the weight in the barrel. This can result in a net unexpectedly falling out of the canister during a chase, resulting in a dangerous situation. If this should occur, the gunner **must** immediately release the canister unit or drop the entire net gun unit to the ground. Failure to do so may result in the net becoming entangled in the tail rotor.

Worn weight tethers are also a concern as they may break during a shot and end up hitting a rotor or other undesirable places if the muzzle is not pointed in a safe direction.

When reloading nets, ensure the net gun is unloaded, the action is open, and the safety is engaged. Also, ensure the action and barrels are kept out of the snow.

Net Gun Inspection and Verification Checklist

COMPANY INFORMATION	
Inspectors name:	
Address:	
Telephone number:	
Unit ID (of Gun)	
Date of Inspection:	

	CHECKLIST	Comments/ Deficiencies
☐	Gun unit free of cracks, loose parts or other damage	
☐	Action/Breech/Trigger clean, free of obstruction and operable	
☐	Safety mechanism in working order	
☐	Barrels on all canister units clean, free of cracks and obstructions	
☐	Canister release mechanism operates smoothly on all canisters	
☐	Canisters free of cracks or other damage (inside/outside)	
☐	Canister flaps secure/adequate Velcro to hold net	
☐	All nuts/bolts on canisters tight	
☐	Weights undamaged and fit smoothly into barrels	
☐	O-rings capable of holding weights into barrels	
☐	Weight tethers free of fraying or wear	
☐	Nets free of holes/tears	
		Signature of Inspector
☐	I hereby declare that the above listed unit is serviceable	
☐	I hereby declare that the above listed unit is unserviceable based on the noted deficiencies and shall not be used until rectified and re-inspected	

Supplemental Notes:

Appendix B – Drug Volume Table for Caribou

Drug Protocol		**One**[A]		**Two**[B]		**Three**[C]	
Drugs		Xylaxine (X) + ketamine (K) [1:5 ratio]	Atipamezole	Xylazine (X) + zolazepam + tiletamine (ZT) [1:2 ratio]	Atipamezole	Medetomidine (M) + ketamine (K) [1:20 ratio]	Atipamezole
Formulation		0.5 ml X (@ 300 mg/ml) + 3.75 ml K (@ 200 mg/ml)	10 ml solution per vial	0.95 ml X (@ 300 mg/ml) + 1.5 ml sterile water per vial of ZT[D]	10 ml solution per vial	1.0 ml M (@ 20 mg/ml) + 2.0 ml K (@ 200 mg/ml)	10 ml solution per vial
Concentration (mg/ml)		35X + 176K	20	97X + 194ZT	20	6.7M + 133.3K	20
Dosage (mg/kg)		1.2–1.5X + 6–7.5K	0.2	0.75–1.25X + 1.5–2.5ZT	0.2	0.10–0.125M + 2.0–2.5K	0.5
Body mass		**Total Volume (ml)**					
kg	**lb**						
50	*110*	1.7 – 2.1	0.5	0.4 – 0.6	0.5	0.8 – 0.9	1.5
60	*132*	2.0 – 2.6	0.6	0.5 – 0.8	0.6	0.9 – 1.1	1.8
70	*154*	2.4 – 3.0	0.7	0.5 – 0.9	0.7	1.1 – 1.3	2.1
80	*176*	2.7 – 3.4	0.8	0.6 – 1.0	0.8	1.2 – 1.5	2.4
90	*199*	3.1 – 3.8	0.9	0.7 – 1.2	0.9	1.4 – 1.7	2.7
100	*221*	3.4 – 4.3	1.0	0.8 – 1.3	1.0	1.5 – 1.9	3.0
110	*243*	3.8 – 4.7	1.1	0.9 – 1.4	1.1	1.7 – 2.1	3.3
120	*265*	4.1 – 5.1	1.2	0.9 – 1.5	1.2	1.8 – 2.3	3.6
130	*287*	4.4 – 5.5	1.3	1.0 – 1.7	1.3	2.0 – 2.4	3.9
140	*309*	4.8 – 6.0	1.4	1.1 – 1.8	1.4	2.1 – 2.6	4.2
150	*331*	5.1 – 6.4	1.5	1.2 – 1.9	1.5	2.3 – 2.8	4.5
160	*353*	5.5 – 6.8	1.6	1.2 – 2.1	1.6	2.4 – 3.0	4.8
170	*375*	5.8 – 7.3	1.7	1.3 – 2.2	1.7	2.6 – 3.2	5.1
180	*397*	6.1 – 7.7	1.8	1.4 – 2.3	1.8	2.7 – 3.4	5.4
190	*419*	6.5 – 8.1	1.9	1.5 – 2.4	1.9	2.9 – 3.6	5.7
200	*441*	6.8 – 8.5	2.0	1,5 – 2.6	2.0	3.0 – 3.8	6.0

[A] Adapted from Spraker (1992)

[B] Adapted from Lewis and Mahoney (2014)

[C] Adapted from Arnemo et al. (2011) and Evans et al. (2013)

[D] Sold commercially as Telazol® or Zoletil®

Appendix C – Caribou Capture Data Form

PERSONNEL:_____

DATE: (dd-mm-yy, i.e., 18-Apr-05) _____

ANIMAL DATA:

GNWT ID# _____ **Other ID#** _____ **Recapture?** ☐ Yes ☐ No **Relocated?** ☐ Yes ☐ No	**Sex:** ☐ M ☐ F ☐ Unk. **Age class:** ☐ Young ☐ Young Medium ☐ Medium **Lactating?** ☐ Yes ☐ No ☐ Medium Old ☐ Old ☐ Very Old **Incisor Wear (see Appendix E):** _____ _____ **UTM:** _____ **Location:** _____

CAPTURE INFORMATION:

Capture Method ☐ Net Gun ☐ Remote Drug Delivery ☐ Other: _____	**Delivery System** ☐ pistol ☐ rifle ☐ other	**Dart System** ☐ slow injection ☐ rapid injection

LOCATION DATA:

General:		
Please use Datum NAD83 →	UTM east:	UTM north:

MARKINGS: ***Circle Y / N choices***

Collar: brand: freq: rotoff? [Y / N]	**Ear Trans:** freq. Initial. Time:
Drop-off: brand: #days: RC? [Y / N] Serial#:	Initial. time (ATS only):
Tattoo #	**Tattoo Location:**

DRUG INFORMATION:

	Inject	Inject	Inject	Inject	Reversal
Drug					
Amount (mg)					
Volume (cc)					
Time					
Inj. site / Miss					

VITAL STATISTICS:

Time	Pulse	Resp	Temp°C	SpO_2 (O_2

Induction Sequence (record approx. times)

Staggering	Rump down	Head down	Immobilized

Recovery Sequence (record approx. times)

Head up	Standing	Staggering	Running

BODY MEASUREMENTS: ***Indicate the units used, if different***

Weight: _____lb or kg
Estimate or Actual

Zoological length (body contours) _____cm
Chest girth (behind shoulders) _____cm
Other:

Testicle circumference:
Left (L) _____cm
Right (L) _____cm

SAMPLES COLLECTED:

Blood: ☐ red ☐ purple	☐ Hair ☐ Feces ☐ Other

CHECK LIST:

☐ Dart recovered ☐ Hibitane ☐ Eye ointment ☐ Transmitter magnets off

RECORDED:

☐ Collar/Ear Tag freq. ☐ Tattoo # & location ☐ Body measurements	☐ Animal data ☐ Capture data ☐ Location data ☐ Body weight ☐ Testicular size

COMMENTS: _____

_____

Appendix D – Field Necropsy Data Form

GENERAL INFORMATION:

Date:	**Location:**	**Personnel:**
Species:	**Sex:** ☐ M ☐ F ☐ Unk.	**Age Class:** ☐ Young ☐ Young Medium ☐ Medium ☐ Medium Old ☐ Old ☐ Very Old
Incisor Wear (see Appendix E): _____		
Euthanasia: ☐ Yes ☐ No If yes, method of euthanasia: _____		

CARCASS INFORMATION:

State of preservation: ☐ fresh ☐ frozen ☐ decomposed ☐ whole carcass ☐ partial carcass	
Nutritional condition:	**Pregnant:** ☐ yes ☐ no

NECROPSY OBSERVATIONS:

External assessment:

Location	**Description**	**Photos [Y / N]**
Skin		
Orifices (mouth, teeth, ears)		
Other (eyes, limbs, etc.)		

Internal assessment:

Location	**Description**	**Photo [Y / N]**
Muscle		
Bones and joints		
Lungs and trachea		
Liver		
Heart		
Spleen and lymph nodes		
Stomach(s)		
Intestines		
Urinary		
Reproductive system		
Brain		
Other observations		

Fat Measurement

Location	Description/Measurement	Collected [Y/N]
Rump Area (back fat)		
Kidney		
Other		

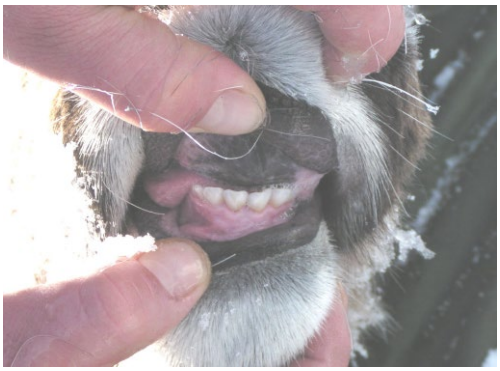
SAMPLE COLLECTION:

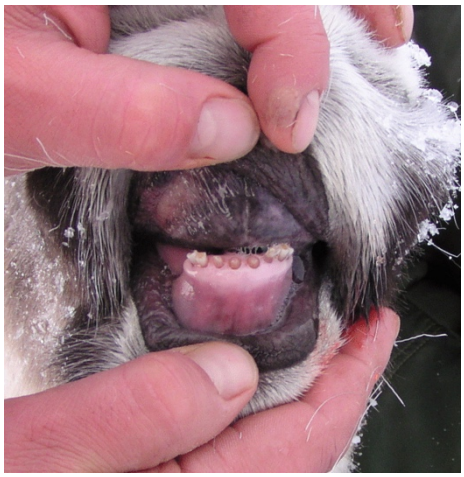
Tissue	Muscle	Lung	Liver	Heart	Stomach	Intestine	Kidney	Brain	Other
Formalin?									
Frozen?									

Teeth & Bone	Incisors	Lower Jaw	Lower Leg Bone	Other & Type
Y / N (If Y, number collected)				

Specimens collected for other tests: _____
_____
_____

Appendix E – Description of Incisor Wear by Field Age Class

Field Age Class	Description of Incisor Wear	Diagram or Photo
Young	Very white teeth with rounded caps (little or no wear).	
Young-medium	First incisors are flattening; second incisors are beginning to wear.	
Medium	All teeth in the incisor bar are flattening (appear to be a straight line across the top of the teeth).	
Medium-old	All teeth in the incisor bar are flattened significantly (teeth appear shorter).	Photo Not Available

Old	All teeth in the incisor bar are stubs, less than half the height of young caribou.	
Very old	All teeth in the incisor bar are worn to the gum line.	Photo Not Available

Cementum Ages Assigned to Field Age Class

Field Age Class	Cementum Age
Young	2 and 3 years
Young-medium	4 and 5 years
Medium	6 and 7 years
Medium-old	8 and 9 years
Old	10 and 11 years
Very old	12 years and older

Estimation of age class by tooth wear on live caribou in the field (for example collaring) as described in the first table is a reasonable representation of age in years. This avoids the pain caused to live caribou during tooth extraction, reduces handling time in the field and eliminates the lab time to section teeth.

For complete report, see Cooley.

AUTHOR: _____ DATE: _____
(Author, Title)

APPROVED: _____ DATE: _____
(Director, Wildlife)