

 Northwest Territories Environment and Natural Resources	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

Table of Contents

Section:	Page
1. Purpose	2
2. Application	2
3. Background	2
4. Methods	3
4.1 Live Capture	3
4.1.1 Considerations	3
4.1.2 Techniques for Live Capture	4
4.1.2.1 Net Gun	4
4.1.2.2 Remote Drug Delivery	6
4.1.2.3 Water Capture	10
4.1.2.4 Drive Traps (or Funnel Traps)	10
4.1.2.5 Drop Nets	11
4.1.3 Recommendations for Approach	11
4.1.4 Recommendations for Initial Handling	12
4.1.5 Recommendations for Monitoring of Physiological Function	14
4.2 Sample Collection and Measurements	15
4.3 Identification, Marking and Telemetry Collars	16
4.4 Reversal Drugs and Release of Caribou	17
4.5 Post-Capture Monitoring	18
4.6 Killing Specimens	18
4.6.1 Recommendations	18
4.6.2 Euthanasia	19
4.7 Morbidity and Mortality	19
4.8 Human Safety	20
5. Literature Cited	22
Appendix A Drug Volume Table for Caribou	25
Appendix B Caribou Capture Data Form	26
Appendix C Field Necropsy Data Form	27
Appendix D Description of Incisor Wear by Field Age Class	29

 Northwest Territories Environment and Natural Resources	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

1. Purpose

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

2. Application

- This standard operating procedure (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. Background

- Three subspecies of Caribou (*Rangifer tarandus*) are present in the NWT: Woodland Caribou (*R. t. caribou*), Barrenground Caribou (*R. t. groenlandicus*) and Peary Caribou (*R. t. pearyi*). A fourth genetic group is present but need more studies to determine full sub-species status. This group is presently referred to as Dolphin-Union Caribou (*R. t. groenlandicus x perryi*).
- The Committee On the Status of Endangered Wildlife In Canada (COSEWIC) has assessed some subspecies of caribou in the NWT. The federal Species at Risk Act (SARA) has legislated (COSEWIC) as one of its key components functioning as advisory body to the Federal government. The law gives COSEWIC the mandated responsibility for assessing the biological status on Canadian species in detail, and to provide the basis for the wildlife protection and recovery measures spelled out in the rest of the SARA.
- This process creates two lists: COSEWIC list and SARA list. Updating the former is the result of a COSEWIC assessment, and amending the later is the result of a formal designation under Schedule 1 of 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.

 Northwest Territories Environment and Natural Resources	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- Peary Caribou has been assessed by COSEWIC in 2004, and are listed under SARA as “*Endangered*”.
- Dolphin-Union Caribou has been assessed by COSEWIC in 2004, and are listed under SARA as “*Special Concern*”.
- Woodland Caribou has been assessed by COSEWIC in 2002, and two ecotypes occurring in the NWT are listed under SARA as:
 - Boreal Woodland Caribou (also called Boreal Caribou) – “*Threatened*”
 - Northern Mountain Woodland Caribou (also called NM Caribou) – “*Special Concern*”.
- Details on each subspecies of caribou in the NWT can be found on www.wildlife.com web page.
- Details on SARA status of caribou can be found on the SARA Registry web page and details on COSEWIC can be found on 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 boreal caribou populations.
- The status of caribou may have implications for research of this species in the NWT. As of 2006, 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* tab for more information.

4. Methods

4.1. 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.

4.1.1 Considerations:

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- 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 5 years.
- Live capture of caribou **should not** take place in the period from 5 weeks pre-calving to 3 weeks post-calving. Further, caribou **should not** be captured when “in velvet.”
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). Further, most of the drugs used in caribou are not recommended for use in pregnant or lactating animals because they have not been adequately evaluated under these conditions (e.g., Telazol® [tiletamine HCl + zolazepam HCL] - Fort Dodge Laboratories, Inc.; Cervizine 300® [xylazine HCl] - Wildlife Pharmaceuticals, Inc.; Zalopine® [medetomidine HCl] - Orion Corporation; and Antisedan® [atipamezol HCl] – Novartis Pharmaceuticals Canada, Inc.).

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- 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 cut-off temperatures. 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.

4.1.2 Techniques for Live Capture:

4.1.2.1 Net Gun

Is: A suitable capture technique for short-duration handling, generally less than 10 minutes.

- Enables rapid capture and release of target animal.
- Requires use of a helicopter.

Recommendations:

- Administration of sedative or anesthetic-type drugs **should** be considered in some situations as a beneficial adjunctive procedure to capture by net gun.

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, Oakley et al. 2004).
- 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.
- Stampinging 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.

 Northwest Territories Environment and Natural Resources	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

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

These help prevent injury (broken limbs, sprains, etc) to either the target animal or animals running with it, and slows down fleeing caribou. Hummocky ground, wind sculptured snow-drifts, boulder fields, 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 a target animal to move out into the open.
- Final, close pursuit for the purpose of netting a caribou **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 (Kock et al. 1987, Nielsen 1999, Spraker 1993, Valkenburg et al. 1983). Because adequate rest periods for fatigued animals are not known, and are likely to be highly variable among individuals, it is strongly recommended that any further attempt at capture of a fatigued animals is not made until the following day.
- 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 as a result prolonged hazing.
- 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).

 Northwest Territories Environment and Natural Resources	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

4.1.2.2 Remote Drug Delivery

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

Is: A suitable capture technique for long-duration (>10 min) handling.

Recommendations:

- Blowpipes and CO₂- 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, Valkenburg et al. 1999).
- For remote drug delivery over longer distances (>10 m), CO₂-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. – unpublished report). The potential for penetration increases as projectile mass and impact velocity increase, and as the projectile diameter decreases (MacPherson 1994).
- Slow-injection darts **should** be used in preference to rapid-injection darts.

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 (or sometimes springs) to expel drug more slowly (1-3 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. – unpublished report). 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. – unpublished report). 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

 Northwest Territories Environment and Natural Resources	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

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.

Although a needle 1.8 - 2.5 cm (0.75 - 1.00 inches) long should be sufficient for most animals (Nielsen 1999), the appropriate length 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. 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 wound cavity can exceed the needle length by a significant amount, especially when using rapid-injection darts (Cattet et al. - unpublished report). For example, a .50-calibre dart fitted with a 2.5 cm (1.00 inch) end-ported needle fired perpendicularly into the gluteal muscles (rump) of a caribou from a helicopter at a distance of 8-10 meters will compress the tissue at the injection site so that the needle tip will penetrate approximately 4.5 cm (1.8 inches). If a rapid-injection dart is used, its forceful expulsion of drug will penetrate another 2.5 - 3.5 cm (1.0 - 1.4 inches) beyond the tip of the needle. So, together with compression and injection, the 2.5 cm needle can cause a wound 8.0 cm (3.1 inches) deep. Using a slow-injection dart of similar volume and needle length, the injection wound would be approximately 4.5 cm (1.8 inches) deep.

- When using barbed dart needles, the position of the barb **must** be marked on the dart barrel (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 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.

 Northwest Territories Environment and Natural Resources	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- Final, close pursuit for the purpose of delivering drug into a caribou **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 (Kock et al. 1987, Nielsen 1999, Spraker 1993). 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 have caused 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 et al. 2002). 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 5 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.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- 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 (Cattet et al. 2005, Kreeger et al. 2002, Nielsen 1999). See Appendix A for recommended drug protocols and volumes. Other drug protocols are described in the chemical immobilization literature (Caulkett and Haigh 2004, Kreeger et al. 2002). The dosages and corresponding volumes 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, it is necessary to 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 and is still under pressure.
- Adequate steps **must** be taken to ensure that drugs used in caribou do not enter the human food chain.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

*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.*

4.1.2.3 Water Capture

Is: A procedure whereby caribou may be captured safely by boat while they are swimming across a river or lake (Karns and Crichton 1978).

- 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 (2-3 minutes) and generally limited to fitting a radio collar, as measurements, blood collection, or examination is not permitted with this method of capture.

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 in order to minimize effects of waves and noise on the caribou after being released.

4.1.2.4 Drive Traps (or Funnel Traps)

Is: 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.

Recommendations:

- A large handling crew **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.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

4.1.2.5 Drop Nets

Is: 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 (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 2 persons per animal).

4.1.3 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.
- 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).
- 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 2002). 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).

4.1.4 Recommendations for Initial Handling During Live Capture:

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- Noise and touching of anesthetized caribou **must** be kept to a minimum at all times.
- All personnel involved with handling immobilized caribou **should** wear latex gloves to protect themselves from exposure to drugs and reduce risk of disease transmission.

Although 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 (Cattet et al. 2005, Kreeger et al. 2002). 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.
- All personnel involved with direct handling of caribou **must** also be immunized against rabies.
- 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., Cap-Chur darts, blow darts), slowly unscrew 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 the animal 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 fluids. Ensure the ground under the animal is flat with no protruding surfaces, e.g., rocks. Should the animal need to be rolled, it is preferable to roll 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

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

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 6 breaths per minute, artificial ventilation (chest compressions, ventilation via endotracheal tube and resuscitation bag) and 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 50 and 130 beats per minute in an anesthetized caribou. In addition, mucous membranes (i.e., gums, anus, vulva) should be pink and the capillary refill time should be < 3 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 drug 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 ($> 40.5^{\circ}\text{C}$) 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 ($< 37^{\circ}\text{C}$) may also develop in some caribou, especially smaller-sized or aged animals

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

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.

4.1.5 Recommendations for 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. 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, Cattet et al. 2005, Kreeger et al. 2002). 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. 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 consequence of elevated body temperature where the oxygen demand of body tissues exceeds the supply (Caulkett and Haigh 2004).

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

Oxygen therapy is the most effective treatment for hypoxemia (Read et al. 2001). 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 5 - 10 liters per minute is required

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

for most caribou 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 B.

4.2 Sample Collection and Measurements

Recommendations:

- All handling, including sample collection and measurements, **must** be completed quickly and quietly with the objective of minimizing handling time to release 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 D).

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.

- There aren't any notes here regarding the collection of a lower leg bone for morphometrics and bone marrow fat determination
- 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 5 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.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- If an ear tag is applied, the hole **should** be made with a sterile biopsy punch (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 in order 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 sternally or on their 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).

4.3 Identification, Marking and Telemetry Collars

Recommendations:

- Investigators **must** aim to minimize any adverse effects of identification or marking procedures on the behavior, physiology, or behavior 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.*

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- Telemetry collars **should** be as light in weight as possible (<5% of body mass) and **should** be selected for long duration battery life and remote drop capability to minimize re-capturing of collared caribou.
- All collars **should** incorporate connecting 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 these fail to function.
- 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 will be based on a number of 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.

4.4 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.

4.5. Post-Capture Monitoring

Recommendations:

- Caribou fitted with radio collars **should** be observed visually at least once within the three days immediately following capture and handling, and ideally within 24 hours of release.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

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.

4.6 Killing Specimens

4.6.1 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.
- 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 or physical restraint.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- 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 in order 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) Pithing
 - This method requires bending the animal's head forward and thrusting a knife or pick into the base of its skull (through the foramen magnum) and destroying the brainstem.
 - 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.

4.6.2 Euthanasia:

- 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 of euthanasia are described under the "**Killing Specimens**" section.*

4.7. **Morbidity and Mortality**

Recommendations:

- Any injury, disease, or abnormality observed during or following capture or handling **must** be documented and reported to the GNWT-ENR Wildlife Veterinarian as soon as possible. An investigation **should** be conducted wherever possible.

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.

- Dead caribou **must** receive a detailed necropsy to determine the cause of death and be reported to the GNWT-ENR wildlife veterinarian as soon as possible.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

If the necropsy is performed in the field, appropriate tissue samples should be collected and frozen or fixed in 10% buffered formalin 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 1999). A template for a field necropsy data form is provided in Appendix C. 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.

4.8. 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.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

Some situations may require particular 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.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

5. Literature Cited

- Alibhai, S.K., Jewell, Z.C., 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.
- 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.
- Bush, M. 1992. Remote drug delivery systems. *Journal of Zoo and Wildlife Medicine* 23:159-180.
- 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., Bourque, A., Elkin, B.T., Powley, K.D., Dahlstrom, D.B., and N.A. Caulkett. 2005. Evaluation of the potential for injury with remote drug delivery systems. *Wildlife Society Bulletin* (submitted for publication).
- Cattet, M.R.L., Caulkett, N.A., Wilson, C., Vandenbrink, T., 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.
- Cattet, M., Shury, T., and R. Patenaude. 2005. *The Chemical Immobilization of Wildlife – 2nd Edition*. Canadian Association of Zoo and Wildlife Veterinarians. 231 pp.
- Caulkett, N.A., Cribb, P.H., 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.C. Haigh. 2004. Anesthesia of North American deer. *In: Heard, D. (ed). Zoological Restraint and Anesthesia*. International Veterinary Information Service Document No. B0171.0404. (Available online at www.ivis.org)

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

- Côté, S.D., Festa-Bianchet, M., and F. Fournier. 1998. Life-history effects of chemical immobilization and radiocollars on mountain goats. *Journal of Wildlife Management* 62:745-752.
- Fowler, M.E. 1995. *Restraint and Handling of Wild and Domestic Animals* (2nd Edition). Iowa State University Press, Ames, Iowa. 383 pp.
- 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.
- 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.
- Kock, M.D., Jessup, D.A., Clark, R.K., and C.E. Franti. 1987. Effects of capture on biological parameters in free-ranging bighorn sheep (*Ovis canadensis*): evaluation of drop-net, drive-net, chemical immobilization, and the net-gun. *Journal of Wildlife Diseases* 23:641-651.
- Krausman, P.J., Bleich, V.C., Cain, III, J.W., Stephenson, T.R., DeYoung, D.W., McGrath, P.W., Swift, P.K., Pierce, B.M., 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., Arnemo, J.M., and J.P. Raath. 2002. *Handbook of Wildlife Chemical Immobilization – International Edition*. Wildlife Pharmaceuticals, Inc., Fort Collins, Colorado. 412 pp.
- MacPherson, D. 1994. *Bullet Penetration: Modeling the Dynamics and the Incapacitation Resulting from Wound Trauma*. Ballistic Publications, El Segundo, California. 303 pp.
- Munson, L. 1999. Necropsy of wild animals. Wildlife Health Center, School of Veterinary Medicine, Davis, California. 28 pp. (Available online at <http://www.vetmed.ucdavis.edu/whc/pdfs/munsonnecropsy.pdf>)
- Nielsen, L. 1999. *Chemical Immobilization of Wild and Exotic Animals*. Iowa State University Press, Ames, Iowa. 341 pp.
- Oakley, M., Jung, T.S., Kienzler, M., Farnell, R., LaRocque, L., McLelland, J., and P. Merchant. 2004. Intranasal sedation of woodland caribou captured by net gun reduces stress. Poster presentation at the 10th North American Caribou Workshop at Girdwood, Alaska, May 4th to 6th, 2004.

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

Pietsch, G., Finstad, G., Bevins, J., and Prichard, A.K. 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. 2002. *Veterinary Drug Handbook* (4th Edition). Iowa State Press, Ames, Iowa. 972 pp.

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

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

Roffe, T.J., Coffin, K., and J. Berger. 2001. Survival and immobilizing moose with carfentanil and xylazine. *Wildlife Society Bulletin* 29:1140-1146.

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., Boertje, R.D., and J.L. Davis. 1983. Effects of darting and netting on caribou in Alaska. *Journal of Wildlife Management* 47:1233-1237.

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

 Northwest Territories Environment and Natural Resources	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Primary Author: Dr. Marc Cattet	Version 2 - 2011

Appendix A – Drug Volume Table for Caribou

Drug Protocol		One		Two		Three	
Drugs		Xylazine (X) + ketamine (K)	Atipamezole	X + zolazepam + tiletamine (ZT; Telazol or Zoletil)	Atipamezole	Medetomidine (M) + K	Atipamezole
Formulation		1 ml X (@ 100 mg/ml) + 3 ml K (@ 100 mg/ml)	10 ml solution per vial	0.8 ml X (@ 300 mg/ml) + 1.3 ml sterile water per vial of ZT	10 ml solution per vial	4 ml M (@ 10 mg/ml) + 5.3 ml K (@ 100 mg/ml)	10 ml solution per vial
Concentration (mg/ml)		25X + 75K	5	99X + 197ZT	5	4.3M + 56K	5
Dosage (mg/kg)		2–3X + 6–9K	0.2	2–3X + 4–6ZT	0.2	0.15–0.20M + 2.0–2.7K	0.8
Body mass		Total Volume (ml)					
kg	lb						
50	110	4.0 – 6.0	2.0	1.0 – 1.5	2.0	1.8 – 2.4	8.0
60	132	4.8 – 7.2	2.4	1.2 – 1.8	2.4	2.1 – 2.9	9.6
70	154	5.6 – 8.4	2.8	1.4 – 2.1	2.8	2.5 – 3.4	11.2
80	176	6.4 – 9.6	3.2	1.6 – 2.4	3.2	2.9 – 3.8	12.8
90	199	7.2 – 10.8	3.6	1.8 – 2.7	3.6	3.2 – 4.3	14.4
100	221	8.0 – 12.0	4.0	2.0 – 3.0	4.0	3.6 – 4.8	16.0
110	243	8.8 – 13.2	4.4	2.2 – 3.3	4.4	3.9 – 5.3	17.6
120	265	9.6 – 14.4	4.8	2.4 – 3.6	4.8	4.3 – 5.8	19.2
130	287	10.4 – 15.6	5.2	2.6 – 4.0	5.2	4.6 – 6.3	20.8
140	309	11.2 – 16.8	5.6	2.8 – 4.3	5.6	5.0 – 6.7	22.4
150	331	12.0 – 18.0	6.0	3.0 – 4.6	6.0	5.3 – 7.2	24.0
160	353	12.8 – 19.2	6.4	3.2 – 4.9	6.4	5.7 – 7.7	25.6
170	375	13.6 – 20.4	6.8	3.4 – 5.2	6.8	6.1 – 8.2	27.2
180	397	14.4 – 21.6	7.2	3.6 – 5.5	7.2	6.4 – 8.7	28.8
190	419	15.2 – 22.8	7.6	3.9 – 5.8	7.6	6.8 – 9.1	30.4
200	441	16.0 – 24.0	8.0	4.1 – 6.1	8.0	7.1 – 9.6	32.0

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Dr. Marc Cattet	Version 1 - Approved on April 18, 2005

Appendix C – Field Necropsy Data Form

GENERAL INFORMATION:

Date:	Location:	Personnel:
Species:	Sex: <input type="checkbox"/> M <input type="checkbox"/> F <input type="checkbox"/> Unk.	Age Class: <input type="checkbox"/> Young <input type="checkbox"/> Young Medium <input type="checkbox"/> Medium <input type="checkbox"/> Medium Old <input type="checkbox"/> Old <input type="checkbox"/> Very Old
Incisor Wear (see Appendix ?): _____		
Euthanasia: <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, method of euthanasia: _____		

CARCASS INFORMATION:

State of preservation: <input type="checkbox"/> fresh <input type="checkbox"/> frozen <input type="checkbox"/> decomposed <input type="checkbox"/> whole carcass <input type="checkbox"/> partial carcass	
Nutritional condition:	Pregnant: <input type="checkbox"/> yes <input type="checkbox"/> 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		

	Standard Operating Procedure (SOP)	
	Capture, Handling & Release of Caribou	
Wildlife Care Committee	Dr. Marc Cattet	Version 1 - Approved on April 18, 2005

Fat Measurement

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

SAMPLE COLLECTION:

<u>Tissue</u>	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 D – 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

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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.