Capture, Handling and Release of Bears Standard Operating Procedure

Wildlife Care Committee

Government of the Northwest Territories

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1. Purpose

- To provide recommendations for the capture, handling, and release of bears using '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 some of the methods and techniques recommended in this standard operating procedure (SOP) are neither supported nor contraindicated by scientific evidence. This is because animal-based measures of humaneness and welfare are currently lacking. Consequently, under these circumstances, recommendations are based on other factors, including opinion and intuition. Therefore, personnel involved with the capture and handling of bears in the Northwest Territories (NWT) **should not** view this SOP as prescriptive, and assume that all recommendations represent best practice. Instead, personnel **should always** strive to integrate animal-based measures (e.g. physiological and behavioural parameters) into their research and/or management activities to provide direct evidence for what bears 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 NWT (GNWT) and any other personnel involved with the capture and handling of bears in the NWT, such as contracted capture crews.

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 bears.

- One development is the area of noninvasive approaches to studying wildlife. Noninvasive 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, has proven to be valid in many cases, and to provide numerous benefits over capture and handling, including minimal or no disturbance to study animals. Recent examples of noninvasive approaches applied to bears include studies by Swenson et al. (2011), Sawaya et al. (2012), Herreman and Peacock (2013), De Groot et al. (2013), Lafferty et al. (2015), and Schmidt et al. (2017). 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 and movements. However, in situations where alternative, noninvasive approaches can provide the needed information, these **should** be used instead.

- 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 bears and, consequently, affect the fitness of future offspring warrants consideration and investigation.

4. Background

- Three species of bears are present in the NWT, the grizzly bear (*Ursus arctos*), black bear (*U. americanus*) and polar bear (*U. maritimus*).

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

- As part of the assessment, the SARC identifies threats and positive influences on 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 SARC has assessed: grizzly bear, which was listed as Special Concern in April 2017 (SARC 2017) and polar bear, which was listed as Special Concern in December 2012 (SARC 2012). The black bear has not been assessed by the NWT SARC.

- All three species have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

- Under SARA, COSEWIC is identified as an independent body of experts responsible for identifying and assessing wildlife species considered to be at risk in Canada. COSEWIC reports the results of its assessments to the Canadian government and the public. However, it remains up to the federal Minister of the Environment to decide if wildlife species designated by COSEWIC are to be legally protected.

- Species can be designated 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 threatened or endangered because of a combination of biological characteristics and identified threats
    - *Data Deficient*: A category that applies when the available information is insufficient (a) to resolve a wildlife species' eligibility for assessment or (b) to permit an assessment of the wildlife species' risk of extinction
    - *Not at Risk*: A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances

- The national status of grizzly bears was assessed by COSEWIC in May 2012 as Special Concern (COSEWIC 2012). Reasons for this designation included their high sensitivity to human disturbance, their high mortality risk in areas of human activity and where roads create access, and evidence of population fragmentation in the southern parts of their range where some populations are increasingly isolated and subject to demographic stochasticity.

- The national status of polar bears was assessed by COSEWIC in April 2008 as Special Concern (COSEWIC 2008). Reasons for the designation included overharvest in several of the 13 subpopulations of polar bear. Further, bears in some subpopulations show declining body condition and changes in denning location linked to decreased availability of sea ice. Continuing decline in seasonal availability of sea ice makes it likely that range contraction will occur in parts of the species range.

- The national status of black bears was assessed by COSEWIC in April 1999 as Not at Risk. Reasons for the designation included the large population of black bears that occur over a large range of habitat, and no indication of population decline.

- Because the Special Concern status of grizzly bears and polar bears has implications for research and management of this species across Canada, investigators must ensure their capture and handling protocol meets all requirements under SARA. Contact Environment Canada, as one of the SARA authorities, for more information as required. As with any other wildlife species in the NWT, all staff, investigators, and contractors must ensure their capture and handling protocol for bears meets all requirements of the Government of the Northwest Territories Environment and Natural Resources (GNWT-ENR). See www.enr.gov.nt.ca and follow the Research and Data tab for more information.

5. Methods

5.1 Noninvasive Sampling

Noninvasive sampling refers to a suite of techniques that can be used to gather biological information, including certain types of samples (e.g. feces, hair, saliva), without the need to physically capture bears. Many of these techniques have been validated and proven to be as reliable as more conventional approaches involving capture. Noninvasive sampling **should always** be considered as a potential alternative to the capture and handling of bears in the NWT.

5.1.1 Considerations

- A key reference for noninvasive sampling techniques is the book, edited by Long et al. (2008), and titled *Noninvasive Survey Methods for Carnivores*.

- Noninvasive sampling techniques that have been applied to bears include camera traps (McCallum 2013), hair traps (Woods et al. 1999, De Groot et al. 2013), fecal collections (Woods et al. 1999, Swenson et al. 2011) and saliva (Wheat et al. 2016).

5.2 Live Capture

Acceptable techniques for the live capture of bears in the NWT include remote drug delivery from ground or air, or culvert (or barrel) trap. Leg-hold snare is also widely used for the live capture of bears, but should be considered less acceptable than other techniques due to its high potential to cause significant injury to captured bears (Cattet et al. 2008a, Cattet et al. 2008b).

5.2.1 Considerations

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

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

- The capture method to be used **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 bears.

- 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 bears.

  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.

- Investigators **should** avoid capturing bears, especially pregnant bears, in the period from four weeks prior to den entry to the time of den emergence, October to April. Investigators **should** also avoid capturing lactating bears and their cubs-of-the-year.

  Any exceptions to this recommendation must be given careful consideration and must be consistent with the overall study objectives. Bears may be particularly sensitive to capture stress and/or immobilization drugs during breeding, pregnancy, early lactation (i.e., ≤6 months post-parturition), and in the periods immediately before and after winter dormancy (denning). Although the specific effects of capture and handling during these times has not been adequately evaluated, behavioural and physiological effects of other human activities, including research, have been documented in brown bears (Evans et al. 2012, Ordiz et al. 2013, Friebe et al. 2014), black bears (Laske et al. 2011, Ditmer et al. 2015, Stillfried et al. 2015), and polar bears (Lunn et al. 2004, Anderson and Aars 2007). Further, many of the drugs used in bears are not recommended for use in pregnant or lactating animals because they have not been

adequately evaluated under these conditions. These include Telazol®, as well as formulations of xylazine, medetomidine and atipamezole.

- 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.

  Thermal stress (hyper- and hypothermia) may occur in bears as a consequence of extreme ambient conditions, which include extremes in air temperature, wind, solar radiation, and/or precipitation. The probability of thermal stress may also be exacerbated by body size and condition. A suggested "safe" ambient temperature range for the capture of bears is from −20°C to +20°C but consideration **must** also be given to other weather features, including wind and precipitation. Measures **must** also be taken to prevent the development of thermal stress during capture, handling, and recovery, including avoidance of prolonged pursuit times, use of reversible anesthetic drug combinations, use of a tarp or canopy to minimize solar radiation, monitoring of body temperature during anesthesia, having cool water and isopropyl alcohol on hand for use if necessary, use of natural barriers to prevent wind exposure, and wrapping small bears (cubs) in sleeping bags or parkas.

5.2.2 Chemical Immobilization

Issue: Immobilization of a bear by administration of one or more drugs to either capture a free-ranging bear by remote drug delivery or facilitate the safe handling of a bear that has been captured by other means, e.g. culvert trap.

Recommendations:

- Anesthetic drug combinations whose effects can be counteracted (reversed) by administration of antagonist (reversal) drugs **should** be used instead of drug combinations whose effects cannot be counteracted.

  Bears anesthetized with "reversible" drug combinations can be promptly "reversed" if they respond poorly to anesthesia, and can be reversed following handling to hasten their return to a mobile state (Kreeger and Arnemo 2012). See Appendix A for recommended drug protocols and volumes. These and other drug protocols are described in the wildlife chemical immobilization literature (e.g. Arnemo et al. 2001, Cattet et al. 1997, Cattet et al. 2003a, Wolfe et al. 2008, Radandt 2009, Fahlman et al. 2011, Coltrane et al. 2015, Wolfe et al. 2016, Fandos Esteruelas et al. 2017). The dosages and corresponding volumes in Appendix A are intentionally provided as ranges because selection of an appropriate dosage should be based on other factors in addition to the estimated body weight, e.g. age of animal, time of year, method of capture, etc. In general, bears captured by remote drug delivery from a helicopter often require higher drug dosages (mg/kg of body weight) than bears captured culvert trap or leg-hold snare (Cattet et al. 2003c).

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

  If a drug combination is prepared by adding one drug to a commercial preparation of another drug (e.g. the addition of medetomidine to a vial of Telazol®), the manufacturer's label **should** be covered with a highly visible adhesive label to avoid confusion between drug preparations.

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

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

- Empty darts **should** not be filled with drug while in a moving helicopter or motorized vehicle.

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

- Appropriate safety gear (gloves and eye protection) **must** be used when drawing up drugs and filling darts.

- Drug-filled darts, that are not used, **should** be emptied at the end of each day, and the drug that is removed **should** be set aside in a "wasted-drug" vial for disposal.

  Many drug solutions are acidic and can cause corrosion of the dart components. Drug may also leak from darts with time. Drug that has been sitting in a dart for a prolonged period (e.g. several hours) is likely contaminated, and **should not** be injected into an animal.

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

- Adequate steps **must** be taken to ensure that drugs administered to bears do not enter the human food chain.

  Health Canada's Veterinary Drugs Directorate takes the view that persons administering drugs to wildlife "assume full responsibility for safety in the intended species and any drug-residue-related violations in food derived from treated animals." Thus, bears **must** be clearly marked to indicate they have been chemically immobilized, or anesthetized, and the individuals or agency performing the capture **must** provide contact information on the collar or ear tag (Cattet 2003). Many of the drugs used to immobilize bears do not have established drug withdrawal times. An exception is Telazol®, which has a drug withdrawal time of 45 days. However, this is applicable only if Telazol® is administered without other drugs. If Telazol® is administered as a combination with other drugs, such as xylazine or medetomidine, or if other drugs are

administered without Telazol®, Health Canada recommends a drug withdrawal time of one year. The Wildlife Health Committee of the Western Association of Fish and Wildlife Agencies has provided recommended drug withdrawal times for various drugs used in wild animals (WAFWA Wildlife Health Committee 2009), but these withdrawal times have not been recognized by Health Canada.

5.2.3 Techniques for Live Capture:

5.2.3.1 Remote Drug Delivery

Issue: The administration of anesthetic drugs by use of remote drug delivery systems, which generally include a blowpipe or a projector (i.e., a modified shotgun, rifle, or pistol), and drug-filled darts.

Issue: A suitable capture technique for situations in which a bear must be physically handled to record measurements, collect biological samples, and/or affix a radio telemetry device.

Recommendations:

- The method of remote drug delivery should be selected for its effectiveness under the intended capture scenario, and for its safety to the user and target animal.

- Blowpipes or pistols (CO_2- or air-powered) may be used to deliver small volumes (≤3 ml) of drug to bears over short distances (≤15 m) under the right conditions e.g. animal can be approached closely by vehicle.

- For larger drug volumes (>3 mL) and/or longer distances (>15 m), CO_2-powered rifles or powder-charged rifles with power adjustment capability **should** be used.

- For bears restrained by leg-hold snare or held captive in a culvert trap, drug **must** be delivered using the least traumatic method possible without compromising human safety.

- Slow-injection darts **should** be used in preference to rapid-injection darts.

  Darts can be described as rapid- or slow-injection depending on the mechanism of injection, and the time required to discharge its content 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 (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. 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 may leak their contents, so appropriate precautions must be taken to avoid accidental drug exposure, e.g. slide a plastic test-tube or syringe container down over the coupling between needle and drug chamber. Slow-injection darts may also leak air after pressurization resulting in partial or no injection of drug. For these reasons, slow injection darts should only be pressurized immediately before firing.

- The dart needle **must** be long enough to ensure drug injection occurs primarily 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 bear and the type of dart used. With slow-injection darts, Bergvall et al. (2015) recommended a needle length of 40 mm (1.57 inches), in preference to 30 mm (1.18 inches), 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 needle length **not exceeding** 40 mm **should** be used with rapid-injection darts for capture of bears by remote drug delivery.

- When using barbed dart needles, the position of the barb **should** be marked on the dart barrel or needle hub (e.g. with a waterproof marker pen or filed down) 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 (the rump) are the safest sites for injection in lean bears. However, with fat bears, it may be necessary to aim toward the larger muscles of the shoulders and neck where the covering layer of fat is markedly thinner than over the rump. Be mindful that darts can occasionally cause damage or bounce off if the needle length allows penetration to the level of the scapula. If a rapid-injection dart is used, detonation of the internal charge may cause the needle to be retracted from muscle before the drug is fully expelled from the dart. Consequently, some of the drug will be deposited into the subcutaneous space or fat layer between the skin and muscle. A tell-tale sign of this occurrence is when the dart is seen dangling from the skin of the target animal. Conversely, if the dart needle has remained imbedded in the muscle, as often

occurs with slow-injection darts, the dart body will remain firmly positioned and oriented in line with the path of entry.

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

  Remote drug delivery is typically employed from a helicopter, but occasionally can be employed on the ground, e.g. capture of a problem bear from a motorized vehicle. In either situation, it is important to be able to observe the bear and, if necessary, control its movement away from hazardous terrain during pursuit and induction. The latter term, induction, refers to the time between drug administration and safe immobilization.

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

- Remote drug delivery of free-ranging bears **should not** be attempted if the terrain is such that a partially anesthetized animal has a high probability of entering a potentially hazardous location, e.g. close to deep water, close to a cliff face.

- Final, close pursuit for the purpose of delivering drug into a free-ranging bear **should** be kept short (≤1 min of strenuous running), and **must** always be terminated when the target animal shows signs of fatigue, e.g. panting, loss of coordination and stumbling.

  The risk of injury or death is increased greatly when animals are exhausted (Kreeger and Arnemo 2012). 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 include a bear that has been hit by one or 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 bear would cause serious injury or death.

- When more than one dart is required to safely immobilize a bear, 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 should be taken to avoid unnecessary stimulation of the target animal. For example, if the bear 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 minutes following the first dart, re-administer the entire original dose.

- If a free-ranging bear does not show any sign 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 should become 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 free-ranging animal is lost following darting, effort **must** be made to track the animal and assure its safety without compromising human safety.

  If absolutely necessary, reversal drugs may also be administered by remote delivery in situations where capture personnel cannot safely approach an immobilized bear.

- Whenever possible, effort **should** be made to find darts that miss their target.

  This is particularly important in areas frequented by humans, such as near communities, where there is potential for someone to find a "lost" dart.

- Capture of more than one bear per capture event (e.g. adult female with dependent offspring, breeding pairs) **must** be attempted only if there are enough personnel in the capture crew to ensure that each animal can be continuously observed and its physiological function monitored closely throughout the handling period.

  Otherwise, unattended bears are susceptible to physiological complications that might easily be prevented or treated if they were monitored. If more than one capture is planned, the second bear **should not** be darted until the first bear has been immobilized and its welfare has been assured. For helicopter-assisted captures, this would require landing the helicopter and assessing the physiologic status of the first bear prior to capturing the second bear provided this will not compromise the safety of capture personnel. This approach will not work for polar bear family groups because dependent offspring often remain in close contact to their immobilized mother and, therefore, must also be immobilized before the mother's status can be assessed.

- When a free-ranging breeding pair is targeted for capture, the male **should** always be immobilized first.

  Females generally leave the capture area, while males are more likely to return, endangering the immobilized female or capture crew.

- If capturing a family group, the adult female **should** be immobilized first.

  If there is no intent to capture the dependent young, no attempt should be made to herd the cub(s) back to the capture site. Harassment of the offspring by aircraft may

decrease the probability the family will re-unite. Since dependent polar bears usually remain close to their mother when she is immobilized, it may be necessary to immobilize the offspring before it is possible to evaluate the welfare of the mother. In the case of yearling, or older, offspring, they should be immobilized by remote drug delivery from a helicopter, and this should occur as soon as the mother is immobilized; the goal being to immobilize the offspring as quickly and safely as possible (Doug Holtby, Helicopter pilot, Ontario Natural Resources and Forestry – personal communication). The helicopter should approach from a high altitude (≥100 m above ground level) and hover above the family group. The pilot should then descend the helicopter vertically into shooting position approximately 5-10 m above the family group. If there is more than one offspring, the shooter should be prepared to dart each bear on the first approach; that is, the required number of darts should be filled with the required dose and ready to load into the delivery system. If the offspring flee during the vertical descent of the helicopter, the pilot should be prepared to herd the young back to the mother and attempt another vertical descent. If the offspring continue to run each time a vertical descent is attempted, it may be necessary to use the same approach technique as is used for an adult (Doug Holtby, Helicopter pilot, Ontario Natural Resources and Forestry – personal communication).

- Cargo nets alone, or ropes and hobbles, **should** not be used to sling a bear beneath a helicopter.

  When more than one bear is immobilized per capture event, it may be necessary to move animals in close proximity to each other to ensure they can be monitored closely or, in the case of breeding bears, it may be necessary to separate the animals during recovery. For movement of bears over short distances, it is recommended the anesthetized bear is secured on a lightweight rigid platform (e.g. portable climbing ledge) and then lifted and carried to a more suitable location (Cattet et al. 1999). The platform and strapped-down bear can be further secured within a cargo net. When appropriate, additional protection from the wind (e.g. from a tarp) can be considered to mitigate potential impacts of wind chill that would be increase with air speed of the helicopter. Use of a blindfold is also recommended to protect the eyes and decrease the potential of external stimulation.

5.2.3.2 Culvert (or Barrel) Trap

Issue: A technique where bait is used to attract a bear into a large, horizontally-positioned barrel that is open at one end and closed at the other.

- The bait is attached to a trigger mechanism at the closed end of the trap and, when pulled, releases a door that covers the open end, trapping the bear inside.

- This technique is often employed in areas accessible by road, such as around communities or industrial sites. However, lightweight culvert traps that are designed to be carried by a helicopter are also manufactured by some companies, e.g. Teton Welding & Machine in Choteau, MT.

- Non-target species may be trapped inadvertently since this method of capture is not selective for bears.

Recommendations:

- Personnel using culvert traps **must** be trained in their safe use.

- Individual traps **must** be inspected and serviced as needed before being used.

- Trap doors **should** be lightweight, durable, and designed to prevent injury to body parts, or other bears (e.g. dependent offspring), that may be struck when the trigger is pulled.

- Culvert traps **must** be built in such a way that bears cannot bite or hook their teeth around internal parts of the trap.

- Culvert traps **must** be prepared and set in well-shaded areas, and access routes **must** be clearly marked to prevent persons from inadvertently encountering a bear in the vicinity of the trap.

- Culvert traps **should** always be set with a clear line of sight to permit assessment from a safe distance.

- Active traps **must** be inspected routinely at least once daily and likely more frequently at higher temperatures. Trap alarms that send messages by email or Short Message Service (SMS) may also be used, but these **must not** be used in place of daily trap-site inspections.

  Inspections should be more frequent if traps are set near communities or campgrounds where they may attract the attention of curious people or pets. The likelihood of injury to trapped bears may increase with the duration of captivity.

- Drugs **should** be administered to bears in culvert traps using the least traumatic method possible without compromising human safety.

  Dart pistols or rifles must not be used unless the dart velocity can be precisely controlled to ensure the dart impact occurs at low velocity.

- Bears **should** be recovered from anesthesia prior to translocation.

  Adequate recovery can be determined by assessing if the animal is capable of standing, and retaining its balance. This may require temporarily moving the trap or transport container to a cool, quiet area where the bear can recover with minimal stress before translocation.

- During translocation by road, bears **must** be protected from flying material (e.g. stones, sand) and excessive jarring.
- Bears **should** not be held captive in a culvert trap or transport container longer than 24 hours.

  Captivity is extremely stressful to most wild animals. If a bear must be held captive for a prolonged period (e.g. 6-24 hours) to permit recovery from anesthesia or to transport to a release site, it must be provided water to prevent dehydration.

5.2.3.3 Leg-Hold Snare

Issue: A technique that generally involves attracting bears to a bait site at which an Aldrich leg snare is set on an approaching trail or at the bait site.

- This technique is typically employed in heavily-wooded areas where remote drug delivery by helicopter is not possible.

- This technique **should** be considered less acceptable than capture by culvert trap due to its high potential to cause significant injury (Cattet et al. 2008a, Cattet et al. 2008b).

Recommendations:

- Snare site selection **should** always take into account human use and activities in the trapping area with the intent of preventing the public from finding and approaching snare sites.

- Access routes and snare sites **must** be clearly marked with signage and flagging tape to prevent persons from inadvertently encountering a trapped bear or a bear in the vicinity of the site.

- Snares **must** be prepared and set by experienced persons only.

- Snare sites **must** always be set with a clear line of sight to permit visual assessment of a snared bear from a safe distance.

- When multiple snares are set at a single location, individual snare locations **should** be marked for inspection from a distance (i.e., flagging tape at tree sites) and snares **should** be set far enough apart to prevent captured bears from making physical contact with each other.

- Cable clamps **should** be used to ensure the anchor end of the snare is as short as possible

- Cub stops **should** be put on snares to avoid catching small bears or large bears by only one or two toes.

- Active snare sites **must** be inspected at least once daily and, if possible, more frequently.

  The likelihood of serious injury to snared bears may increase with the duration of restraint by snare. Trap alarms should also be used, but it is still necessary to examine traps visually because alarms may fail. Deployment of electronic timers or trail cameras at snare sites can be used to record the duration of time that a trap has been sprung.

- The position of the snare on a captured bear and the possibility of other bears in the area **must** be assessed from a safe distance before approaching a snared bear.

  This may require use of a helicopter where tree cover is extensive.

- Snared bears **must** be immobilized using low velocity remote drug delivery methods only, e.g. blowpipe, pistol, or rifle at low power setting.

  A pole syringe (jab-stick) should not be used because approaching a snared bear, especially at a close distance, may cause injury, or exacerbate existing injury, as the bear attempts to 'fight or flight'.

- Contingency plans and required materials (e.g. appropriate drugs) **must** be in place to release non-target species from snares.

5.2.4 Recommendations for Approaching an Immobilized Bear:

- Bears immobilized by remote drug delivery **must** be approached quietly and slowly to assess their response to noise and touch.

  Minimal stimulation of the immobilized bear is critical because peak drug effects generally occur sometime after immobilization (Caulkett et al. 1994, Plumb 2015). Excessive stimulation of a lightly anesthetized bear may be sufficient to cause it to regain mobility.

- If a helicopter is used, the pilot **must** be instructed to land a safe distance from the animal while maintaining clear view of the downed animal.

  Although the distance between helicopter and bear 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 some cases, it may be necessary to land quickly within meters of an immobilized bear, e.g. one that has collapsed in water. 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).

- Only two people **should** approach the immobilized bear initially. It is recommended to approach an immobilized bear from behind and use of a long stick to gently poke the animal can assist with assessment of immobilization. One person is responsible for

assessing the animal while the other person carries a firearm to provide emergency support for the approach person.

The person carrying the firearm must be familiar with the "normal" behaviour of a drugged bear; in particular, what movements are acceptable, e.g. slight twitching of limbs, movement of tongue, etc.

- During the approach, the helicopter **should** remain idling and other members of the handling crew **must** remain at the helicopter to await instruction from the approach person.

  Once the animal is determined to be safely immobilized, the approach person signals the pilot to shut down the helicopter and other members of the handling crew to approach.

- Bears captured by culvert trap or leg-hold snare **should** be approached in the same manner as bears captured by remote drug delivery.

  However, the initial approach should only be close enough to allow evaluation of the security of the restraint and the approximate size of the captured animal. If the captured bear is a dependent young animal (cub-of-year or yearling), or an adult female possibly accompanied by a consorting male, the capture crew should leave the trap-site area immediately and not approach again until it is established that no free-ranging bears are in close vicinity. Assessment of the capture area for the presence of other bears may require the use of aircraft where tree cover is extensive.

5.2.5 Recommendations for Initial Handling of an Immobilized Bear:

- Noise and touching of the immobilized bear **must** be kept to a minimum.

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

  Although latex or nitrile gloves may be impractical in 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 less frequent than accidental drug exposure, it is important to be aware that bears may potentially transmit some diseases (zoonoses) to humans, including rabies.

- All personnel involved with direct handling of bears **must** be immunized against rabies (CDC 2009)

  Rabies antibody titers should be checked every two years, and records of titer levels should be maintained (CDC 2008).

- The eyes of anesthetized bears **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 visual stimulation.

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

  If using darts that require some assembly (e.g. Dan-Inject 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 bears **must** be positioned so the animal's breathing is not impinged, i.e., keep neck straight and ensure nostrils and mouth are not blocked.

  Position the anesthetized bear on its chest and abdomen (ventrally recumbent) with its head held higher than its thorax and its nose pointing down to avoid aspiration of fluids. Ensure the ground under the bear is flat with no protruding surfaces, e.g. rocks. Consider using a reflective and/or insulated ground sheet. 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 bear are rolled in parallel to avoid twisting the animal along its spinal axis. Anesthetized bears should never be moved (rolled or picked up) by grasping or pulling their skin and hair.

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

  - Reflex activity: the presence and strength of reflexes (e.g. palpebral, ear twitch, and tongue withdrawal 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 ≥4 breaths per minute in an anesthetized bear. Each breath should be quiet and characterized by full expansion and relaxation of the rib cage. If the respiratory rate is less than four 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 colour, and capillary refill time. Although pulse or heart rate is affected by many factors (age, activity, drugs, etc.), it should remain between 40 and 120 beats per minute in an anesthetized bear. 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 36°C and 40°C. Administration of a reversal drug is the most effective treatment if hyperthermia (>40°C) develops, because it enables the bear 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 bear, the thickness of its hair coat (and subcutaneous fat stores), and the rate of temperature increase. Hypothermia (<36°C) may also develop in some bears, especially in cubs 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.

5.2.6 Recommendations for Monitoring Physiological Function:

- The physiologic response to anesthesia **must** be monitored throughout handling until the bear is administered the reversal (antagonist) drug, or left to recover (if using Telazol® or Zoletil® alone). 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 invaluable for the 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 pulse rate and trends in the hemoglobin oxygen saturation (in %) of blood (Kreeger and Arnemo 2012). Small, battery-powered, portable pulse oximeters are available commercially for use in the field. The recorded 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 colour, and variation in probe placement (Cattet et al. 1999, Fahlman et al. 2010). 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 colour 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, Fahlman et al. 2010). 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 2-5 liters per minute is required for most bears and the efficacy of treatment should be monitored with a pulse oximeter (Caulkett and Cattet 2002, Fahlman et al. 2010). The availability of medical grade oxygen provides an invaluable aid to assisting field anesthesia of bears, especially when used in conjunction with a pulse oximeter (Cattet et al. 2003b, Fahlman et al. 2010). This equipment is available from most paramedic 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. Additional data recorded may include time of darting, number of darts used, start and end times of handling.

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

5.3 Sample Collection and Measurements

Recommendations:

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

- Extraction of a premolar for the purpose of aging **must** only be done if 'age in years' is data critical to the study objectives.

  Otherwise, age or age class should be estimated based on body size and appearance.

- Local or regional anesthesia **should** be provided to manage pain resulting from premolar extraction. However, investigators **must** receive training by a licensed veterinarian before applying either of these procedures.

  Extraction of a tooth produces strong, long-lasting, painful stimuli associated with tearing of the periodontal ligament and sensory nerve supply. Where premolar extraction is justified, local or regional anesthesia should be provided to manage pain during the procedure and in the hours following handling (Holstrom et al. 2004). Although different local anesthetics are available, 0.5% bupivacaine is recommended for the long duration of analgesia it provides, i.e., 6-10 hours. Local anesthesia is accomplished by injecting anesthetic (e.g. 1 mL of bupivacaine) into the periodontal space and gingiva surrounding the premolar approximately 10 minutes prior to extraction. Regional anesthesia is accomplished by using either an infraorbital nerve block for an upper premolar, or a mental nerve block for a lower premolar, approximately 10 minutes prior to extraction. Of the two techniques, regional anesthesia is technically more difficult but provides more complete pain relief. Both techniques require prior instruction and training by a licensed veterinarian, but can be perfected easily with practice.

- Local anesthesia **should** be considered for other sampling procedures (aside premolar extraction) that are likely to elicit pain, e.g. tissue biopsy.

  Local (or regional) anesthesia is generally not required for most routine sampling procedures (blood collection, ear punch, skin/fat biopsy) because the pain elicited by these procedures is of short duration (when compared to tooth extraction) and adequately controlled by the immobilizing drug. However, where zolazepam-tiletamine (Telazol® or Zoletil®) is used alone as the immobilizing drug, local anesthesia may be required because of the poor analgesic effect of this drug (Caulkett et al. 1999). In such case, 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 **should** be used for genetic (DNA) sampling, e.g. hair follicle extraction, oral swab.

  Additional use of tissue biopsies, such as contaminant levels or stress indicators, is strongly encouraged.

  If an ear tag is applied, the tagging area of the bear's ear **should** be cleaned (e.g. wiped with isopropyl alcohol), 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.

- If a commercial ear-tag applicator is used instead of a biopsy punch, the jaw and pin portion of the applicator **must** be sanitized (e.g. isopropyl alcohol) before and after each use. You **should** also clean the tagging area of the animal's ear.

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

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

  Bears should not be suspended in a cargo net, or by "cuffs" attached to their four limbs, because of the potential for adverse health effects, e.g. regurgitation and aspiration (Kreeger and Arnemo 2012). Instead, bears should be weighed by first positioning them sternally 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 (Cattet et al. 1999). If required, a portable climbing ledge can also be suspended safely beneath a helicopter for the purpose of moving a bear a short distance to safer terrain.

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

  This should include a thorough examination for injuries caused by the capture procedure. For example, wounds to claws and teeth are common in some type of culvert traps with extensive mesh, while edema (swelling), cuts, abrasions and fractures may occur with leg-hold snares.

- Antibiotics **must** not be administered routinely to captured bears. There are a growing number of reports of antibiotic resistance in bacteria living in wildlife (Cristóbal-

Azkarate et al. 2014). This is a cause for concern as antibiotic resistance in wildlife represents a potential public health threat.

- Antibiotics **must** 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).

5.4 Identification, Marking and Telemetry Collars

Recommendations:

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

- Tattoo dyes **must** be cleaned well (e.g. rinsed in isopropyl alcohol) between uses to prevent transmission of disease between bears.

  Tattooing is a common method of permanent identification in bears, although the legibility of tattoos is variable over long periods. Tattoos are applied either to the inside of the lip or to the inside of the thigh at the groin where hair cover is sparse.

- 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 bears. Although some researchers recommend the telemetry collar weigh ≤2% of bodyweight (Beausoleil and Lackey 2015, Arnemo and Evans 2017), there are no evidence-based rules for what a collar should weigh, relative to a bear's bodyweight. However, a few studies in other species have reported negative effects on movements,

behaviour, and survival when comparing use of heavier collars versus lighter collars (Brooks et al. 2008, Rasiulis et al. 2014).

- All collars **should** incorporate connecting material that will eventually rot off, allowing the collar to drop from the animal.

  Collars with self-removing or breakaway devices should also incorporate "rot off" material (e.g. cotton spacers), in case the devices fail to function (Garshelis and McLaughlin 1998). Further, investigators should consider using expandable collars (Vashon et al. 2003).

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

- Collars **must** be fitted tightly enough that they are not easily shed, but loose enough to allow for weight gain without impeding normal neck movement or causing abrasion.

  The best fit is usually achieved when the collar is as tight as possible, but still able to be pulled over the head (Beausoleil and Lackey 2015, Arnemo and Evans 2017). A collar that is snug, but not too tight, at the width of the zygomatic arch (i.e., finger's width between the collar and zygomatic arch on either side) will generally ensure that the collar will be loose enough to accommodate the seasonal increase in body mass. If bears are fitted with collars when they are in poor condition (e.g. in a year following a food-failure year), investigators should ensure there is enough space between the collar and the neck to accommodate a large gain in body mass in a good food year. Further, male polar bears and some male grizzly bears cannot be fitted with telemetry collars due to the width of their neck in relation to their skull. However, ear tag transmitters can be applied to these animals instead.

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

  Conventional VHF collars should not be fitted on bears if funding is not sufficient to ensure that radio locations will be recorded at a rate (i.e., number of locations per unit time) that will adequately meet the study objectives.

- If ear tag transmitters must be used to meet the study objectives, the transmitter weight **should** be as light as possible (<30 g) and only one transmitter should be applied per bear.

  Larger ear tag transmitters are likely to cause chronic irritation and abrasion of the "tagged ear". Ear tag transmitters should not be applied to both ears of a bear for the purpose of attempting to ensure the transmission life is of adequate length. Instead, investigators should purchase high quality transmitters and perform controlled outdoor testing prior to deploying the transmitters on a bear.

- The implantation of radio transmitters beneath the skin or in the abdominal cavity (peritoneum) **should** be avoided because of the invasiveness of these procedures, and the risk of adverse health effects as a consequence of the implantation procedure, the integrity of the radio transmitter implant, and/or migration of the (intraperitoneal) implant within the abdominal cavity (Arnemo et al. 2007, Quinn et al. 2010, Léchenne et al. 2012, Blundell et al. 2014).

- If implantation of radio transmitters is deemed necessary, it **must** be performed by an experienced veterinarian using proper surgical technique (Mulcahy 2013, Arnemo and Evans 2017, Horning et al. 2017).

5.5 Reversal Drugs and Release of Bears

Recommendations:

- Antagonist (also called "reversal") drugs **must** not be administered until all equipment has been repacked and removed, and all personnel except the person administering the drug and the person(s) providing firearm cover have cleared the area.

- Once the reversal drug is administered, the persons remaining at the bear **must** 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.

- Bears captured by snare **should** be observed from a safe distance until they recover and move away from the site. Other bears approaching the recovering bear and snare site **should** be chased off using noise, unless they are other members of a family group.

- When using non-reversible drug combinations (e.g. Telazol®), every effort **should** be made to observe the recovering bear until it is ambulatory and coordinated in its movements.

- Where a bear has been captured by leg-hold snare, all other active snares in the area **should** be removed before the anesthetized bear is administered reversal drug or left to recover. If snares cannot be removed, they **must** be de-activated by closing all snare loops.

- When non-anesthetized bears are released from culvert traps, the release **must** be triggered remotely or from inside a vehicle.

  Persons must not open the trap door while standing upon or behind the trap.

- When releasing bears captured by remote drug delivery from helicopter, capture personnel should not depart from the capture area until the bear is standing and stable on its feet.

- A safe area should be selected for reversal and recovery (e.g. in shade if working in treed areas, away from lots of downed trees, and away from water and large boulders). The surrounding areas should be assessed for any potential hazards and measures should be taken to avoid the hazards as much as possible.

5.6 Post-Capture Monitoring

Recommendations:

- Bears 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.

  Although animals sometimes die during capture and handling, death may also occur within hours to days following release (Spraker 1993, Fowler 2008). If a bear dies following its release, the determination of cause of death is important for two reasons (Nielsen 1999). First, if the bear 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 bear 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, bears **should** be visualized from high altitude to minimize stress associated with the noise and proximity of the aircraft. However, sighting a bear 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 bear 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 off from the animals that once wore them.

5.7 Euthanasia

Recommendations:

- The investigator **must** be prepared to kill any bear that has been severely injured, is suffering, and its death appears imminent, as a result of the capture or handling procedures.

- The technique(s) used to kill a bear **must** be humane, in that they **must** reduce pain and distress to the greatest extent possible.

- A detailed report of the euthanasia **must** be written and every effort **must** be made to salvage the hide, skull, and other parts legally required, and submit these with the report to a wildlife officer as soon as possible.

- 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 for humanely killing bears are as follows:

  a) Gunshot of appropriate caliber for the size of the animal
     - A shot to the brainstem of an animal produces a quick and humane death, but is best attempted when the animal is fully immobilized by injury or chemical immobilization.

     - In free-ranging situations, or where the intact brain is required for diagnostic testing (e.g. rabies), gunshot to the heart and lung area may be more appropriate.

  b) Exsanguination (bleeding)
     - This method is considered humane if performed on a deeply anesthetized animal.

     - The technique requires bleeding the anesthetized bear by slicing deeply across the throat to sever the carotid arteries.

  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/25 ml water.

     - Use of this method requires prior training by a veterinarian or experienced person.

- This method is considered humane when performed on a deeply anesthetized animal.

5.8 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 or delegate as soon as possible. Depending on the significance of the finding, it may be helpful to consult with the Wildlife Veterinarian by satellite phone at the time of the incident to identify appropriate samples, measurements, and/or images to collect.

- Dead bears **must** receive a detailed necropsy to determine the cause of death and **must** be reported to the GNWT-ENR Wildlife Veterinarian or delegate as soon as possible.

  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 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.

- A detailed report of the death **must** be written and every effort **must** be made to salvage the hide, skull, and other parts legally required, and submit these with the report to a conservation officer as soon as possible.

- In situations where a bear is seriously injured, or dies, as a consequence of the capture or handling procedures, further captures must be suspended until the incident has been reviewed by the GNWT-ENR Wildlife Veterinarian, and continuation of capture operations has been approved.

5.9 Human Safety

Recommendations:

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

  Bears 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 bear **must** be identified and communicated to all capture personnel, including the helicopter pilot when using remote drug delivery by helicopter as the capture technique.

- 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 five years) in the chemical immobilization of wildlife 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.

  An experienced pilot is not only essential for the safety of the capture crew, but also to ensure that captures can be performed quickly and efficiently.

- 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 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.

- Personnel carrying firearms **must** have the legal authorization to use a firearm, e.g. an Authorization to Carry a Restricted Weapon is required by a person carrying a handgun.

- 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.

5.10 Capturing Bears in Association with Human-Wildlife Conflicts

- Bears are typically regarded as "problem wildlife" when their activities threaten human lives or property. In contrast to research and other management activities, the capture and handling of bears in association with human-wildlife conflict is often an emergency situation where control of the offending bear must be achieved as quickly as possible. In such cases, animal safety may need to be compromised to some extent (e.g. capture at sensitive times such as immediately prior to den entry, capture at high ambient temperature, prolonged chase, etc.), especially when human life is threatened. In some circumstances, it may be more acceptable to humanely kill the offending bear than to attempt a difficult capture where the probability of injury and excessive stress is high.

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.

6. Literature Cited

American Veterinary Medical Association (AVMA). 2013. AVMA Guidelines for the Euthanasia of Animals: 2013 Edition. American Veterinary Medical Association, Schaumburg, IL. 102pp.
(Last accessed at www.avma.org/KB/Policies/Documents/euthanasia.pdf on Jan 1, 2018)

Anderson, A. and J. Aars. 2007. Short-term Behavioural Response of Polar Bears (*Ursus maritimus*) to Snowmobile Disturbance. Polar Biology DOI 10.1007/s00300-007-0376-x.

Arnemo, J.M., S. Brunberg, P. Ahlqvist, R. Franzén, A. Friebe, P. Segerström, A. Söderberg, and J.E. Swenson. 2001. Reversible Immobilization and Anesthesia of Free-ranging Brown Bears (*Ursus arctos*) with Medetomidine-tiletamine-zolazepam and Atipamezole: A Review of 575 Captures. Conference Proceedings of the American Association of Zoo Veterinarians 2001:134-136.

Arnemo, J.M. and A.L. Evans. 2017. Biomedical Protocols for Free-ranging Brown Bears, Gray Wolves, Wolverines and Lynx.
https://brage.bibsys.no/xmlui/handle/11250/2444409

Arnemo, J.M., Å. Fahlman, K. Madslien, S. Brunberg, B. Ytrehus and J.E. Swenson. 2007. Long-term Evaluation of Telonics Intraperitoneal Radiotransmitters in Free-ranging Brown Bears (*Ursus arctos*). Proc AAZV, AAWV, AYA/NAG Joint Conference: 96.

Beausoleil, R.A. and C. Lackey. 2015. Responding to Human-bear Conflict and Capture-handling of Black Bears: A Field Techniques Guide for Agency Biologists and Officers. Version 3.0 (Please contact either of the authors for a copy of this manual.)

Bergvall, U.A., P. Kjellander, P. Ahlqvist, Ö. 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.

Blundell, G.M., A.A. Hoover-Miller, C.A. Schmale, R.K. Berngartt and S.A. Karpovich. 2014. Efficacy of Subcutaneous VHF Implants and Remote Telemetry Monitoring to Assess Survival Rates in Harbor Seals. Journal of Mammalogy 95:707-721.

Brooks, C., C. Bonyongo and S. Harris. 2008. Effects of Global Positioning System Collar Weight on Zebra Behaviour and Location Error. Journal of Wildlife Management 72:527-534.

Cattet, M.R.L. 2003. A CCWHC Technical Bulletin: Drug Residues in Wild Meat – Addressing A Public Health Concern. (http://digitalcommons.unl.edu/icwdmccwhcnews/46/)

Cattet, M., J. Boulanger, G. Stenhouse, R.A. Powell and M.J. Reynolds-Hogland. 2008a. An Evaluation of Long-term Capture Effects in Ursids: Implications for Wildlife Welfare and Research. Journal of Mammalogy 89:973-990.

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., N.A. Caulkett, S.C. Polischuk and M.A. Ramsay. 1997. Reversible Immobilization of Free-ranging Polar Bears with Medetomidine-zolazepam-tiletamine and Atipamezole. Journal of Wildlife Diseases 33:611-617.

Cattet, M., N.A. Caulkett and N.J. Lunn. 2003a. Anesthesia of Polar Bears using Xylazine-zolazepam-tiletamine or Zolazepam-tiletamine. Journal of Wildlife Diseases 39:655-664.

Cattet, M.R.L., N.A. Caulkett and G.B. Stenhouse. 2003b. Anesthesia of Grizzly Bears using Xylazine-zolazepam-tiletamine or Zolazepam-tiletamine. Ursus 14:88-93.

Cattet, M.R.L., N.A. Caulkett, K.A. Streib, K.E. Torske and M.A. Ramsay. 1999. Cardiopulmonary Response of Anesthetized Polar Bears to Suspension by Net and Sling. Journal of Wildlife Diseases 35:548-556.

Cattet, M.R.L., K. Christison, N.A. Caulkett and G.B. Stenhouse. 2003c. Physiologic Responses of Grizzly Bears to Different Methods of Capture. Journal of Wildlife Diseases 39:649-654.

Cattet, M.R.L. and M.E. Obbard. 2010. Use of Hyaluronidase to Improve Chemical Immobilization of Free-ranging Polar Bears (*Ursus maritimus*). Journal of Wildlife Diseases 46:246-250.

Cattet, M., G. Stenhouse and T. Bollinger. 2008b. Exertional Myopathy in a Grizzly Bear (*Ursus arctos*) Captured by Leghold Snare. Journal of Wildlife Diseases 44:973-978.

Caulkett, N.A. and M.R.L. Cattet. 2002. Anesthesia of Bears. *In:* Heard, D. (ed). Zoological Restraint and Anesthesia. International Veterinary Information Service Document No. B0143.0302. (www.ivis.org)

Caulkett, N.A., M.R.L. Cattet, J.M. Caulkett and S.C. Polischuk. 1999. Comparative Physiologic Effects of Telazol®, Medetomidine-ketamine and Medetomidine-telazol® in Captive Polar Bears (*Ursus maritimus*). Journal of Zoo and Wildlife Medicine 30: 504-509.

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.C. Haigh. 2004. Anesthesia of North American Deer. *In:* Heard, D. (ed). Zoological Restraint and Anesthesia. International Veterinary Information Service Document No. B0171.0404. (www.ivis.org)

Centers for Disease Control (CDC). Human Rabies Prevention – United States, 2008. Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR 2008 / 57(RR-03); 1-26, 28.

Centers for Disease Control (CDC) and Prevention. 2009. Rabies Vaccine: What You Need To Know. US Department of Health and Human Services Centers for Disease Control and Prevention, Vaccine Information Statement. 2pp. (www.cdc.gov/vaccines/hcp/vis/vis-statements/rabies.pdf)

Coltrane, J.A., S. Farley, D. Saalfeld, D. Battle, T. Carnahan and J. Teisberg. 2015. Evaluation of Dexmedetomidine, Tiletamine and Zolazepam for the Immobilization of Black Bears. Wildlife Society Bulletin 39:378-382.

COSEWIC. 2008. COSEWIC Assessment and Update Status Report on the Polar Bear *Ursus maritimus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. vii + 75pp.

COSEWIC. 2012. COSEWIC Assessment and Status Report on the Grizzly Bear *Ursus arctos* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiv + 84pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm)

Cristóbal-Azkarate, J., J.C. Dunn, J.M.W. Day and C.F. Amábile-Cuevas. 2014. Resistance to Antibiotics of Clinical Relevance in the Fecal Microbiota of Mexican Wildlife. PLoS ONE 9(9): e107719.

De Groot, P.V.C., P.B.Y. Wong, C. Harris, M.G. Dyck, L. Kamookak, M. Pagès, J. Michaux and P.T. Boag. 2013. Toward a Non-invasive Inuit Polar Bear Survey: Genetic Data from Polar Bear Hair Snags. Wildlife Society Bulletin 37:394-401.

Ditmer, M.A., J.B. Vincent, L.K. Werden, J.C. Tanner, T.G. Laske, P.A. Iaizzo, D.L. Garshelis and J.R. Fieberg. 2015. Bears Show a Physiological but Limited Behavioural Response to Unmanned Aerial Vehicles. Current Biology 25:2,278-2,283.

Evans, A.L., V. Sahlén, O.-G. Støen, Å. Fahlman, S. Brunberg, K. Madslien, O. Fröbert, J.E. Swenson and J.M. Arnemo. 2012. Capture, Anesthesia, and Disturbance of Free-ranging Brown Bears (*Ursus arctos*) during Hibernation. PLoS ONE 7(7): e40520. doi:10.1371/journal.pone.0040520.

Fahlman, Å., J.M. Arnemo, J. Pringle, S. Brunberg and G. Nyman. 2011. Physiologic Evaluation of Capture and Anesthesia with Medetomidine–zolazepam–tiletamine in Brown Bears (*Ursus arctos*). Journal of Zoo and Wildlife Medicine 42:1-11.

Fahlman, Å., J. Pringle, J. Arnemo, J.E. Swenson, S. Brunberg and G. Nyman. 2010. Treatment of Hypoxemia during Anesthesia of Brown Bears (*Ursus arctos*). Journal of Zoo and Wildlife Medicine 41:161-164.

Fandos Esteruelas, N., M. Cattet, A. Zedrosser, G.B. Stenhouse, S. Küker, A.L. Evans and J.M. Arnemo. 2017. A Double-blinded, Randomized Comparison of Medetomidine-tiletamine-zolazepam and Dexmedetomidine-tiletamine-zolazepam Anesthesia in Free-ranging Brown Bears (*Ursus arctos*). PLoS ONE 12(1): e0170764. doi:10.1371/journal.pone.0170764.

Fowler, M.E. 2008. Restraint and Handling of Wild and Domestic Animals (3rd Edition). Wiley-Blackwell, Ames, IA. 470pp.

Friebe, A., A.L. Evans, J.M. Arnemo, S. Blanc, S. Brunberg, G. Fleissner, J.E. Swenson and A. Zedrosser. 2014. Factors Affecting Date of Implantation, Parturition, and Den Entry Estimated from Activity and Body Temperature in Free-ranging Brown Bears. PLoS ONE 9(7): e101410. doi:10.1371/journal.pone.0101410.

Garshelis, D.L. and C.R. McLaughlin. 1998. Review and Evaluation of Breakaway Devices for Bear Radio Collars. Ursus 10:459-465.

Gibeau, M.L. and P.C. Paquet. 1991. Evaluation of Telazol® for Immobilization of Black Bears. Wildlife Society Bulletin 19:400-402.

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.

Herreman, J. and E. Peacock. 2013. Polar Bear Use of a Persistent Food Subsidy: Insights from Non-invasive Genetic Sampling in Alaska. Ursus 24:148-163.

Holstrom, S.E., P. Frost-Fitch, and E.R. Eisner. 2004. Veterinary Dental Techniques for the Small Animal Practitioner (3rd Edition). W.B. Saunders Company, Philadelphia. 689pp.

Horning, M., M. Haulena, P.A. Tuomi, J.E. Mellish, C.E. Goertz, K. Woodie, R.K. Berngartt, S. Johnson, C.R. Shuert, K.A. Walker, J.P. Skinner and P.L. Boveng. 2017. Best Practice Recommendations for the Use of Fully Implanted Telemetry Devices in Pinnipeds. Animal Biotelemetry 5:1-15.

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.

Lafferty, D.J.R., M.L. Laudenslager, G. Mowat, D. Heard and J.L. Belant. 2015. Sex, Diet, and the Social Environment: Factors Influencing Hair Cortisol Concentration in Free-ranging Black Bears (*Ursus americanus*). PLoS ONE 10(11): e0141489. https://doi.org/10.1371/journal.pone.0141489.

Laske, T.G., D.L. Garshelis and P.A. Iaizzo. 2011. Monitoring the Wild Black Bear's Reaction to Human and Environmental Stressors. BMC Physiology 2011, 11:13 www.biomedcentral.com/1472-6793/11/13.

Léchenne, M.S., J.M. Arnemo, C. Bröjer, H. Andrén and E.O. Ågren. 2012. Mortalities Due to Constipation and Dystocia Caused by Intraperitoneal Radio-transmitters in Eurasian Lynx (*Lynx lynx*). European Journal of Wildlife Research 58:503-506.

Long, A.R., P. MacKay, J. Ray and W. Zielinski (Editors). 2008. Noninvasive Survey Methods for Carnivores. Island Press, Washington DC, MD. 385pp.

Lunn, N.J., I. Stirling I., D. Andriashek and E. Richardson. 2004. Selection of Maternity Dens by Female Polar Bears in Western Hudson Bay, Canada and the Effects of Human Disturbance. Polar Biology 27:350-356.

Macleod, R. and A.G. Gosler. 2006. Capture and Mass Change: Perceived Predation Risk or Interrupted Foraging? Animal Behaviour 71:1,081-1,087.

McCallum, J. 2013. Changing Use of Camera Traps in Mammalian Field Research: Habitats, Taxa and Study Types. Mammal Review 43:196-206.

Mommer, B.C. and A.M. Bell. 2014. Maternal Experience with Predation Risk Influences Genome-wide Embryonic Gene Expression in Three-spined Sticklebacks (*Gasterosteus aculeatus*). PLoS ONE 9(6): e98564. doi:10.1371/journal.pone.0098564

Mulcahy, D.M. 2013. Legal, Ethical and Procedural Bases for the Use of Aseptic Techniques to Implant Electronic Devices. Journal of Fish and Wildlife Management 4:211-219.

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.

Ordiz, A., O.-G. Støen, S. Sæbø, V. Sahlén, B.E. Pedersen, J. Kindberg and J.E. Swenson. 2013. Lasting Behavioural Responses of Brown Bears to Experimental Encounters with Humans. Journal of Applied Ecology 50:306-314.

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.

Quinn, J.H., P.M. Gaffney, K. Gilardi, M. Murray, D.A. Jessup and C.K. Johnson. 2010. Complication Associated with Abdominal Surgical Implantation of a Radio Transmitter in an American Badger (*Taxidea taxus*). Journal of Zoo and Wildlife Medicine 41:174-177.

Radandt, T.G. 2009. Recovery of Grizzly and American Black Bears from Xylazine, Xolazepam, and Tiletamine. Ursus 20:114-119.

Rasiulis, A.L., M. Festa-Bianchet, S. Couturier and S.D. Côté. 2014. The Effect of Radio-collar Weight on Survival of Migratory Caribou. 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.

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.

Sawaya, M.A., J.B. Stetz, A.P. Clevenger, M.L. Gibeau and S.T. Kalinowski. 2012. Estimating Grizzly and Black Bear Population Abundance and Trend in Banff National Park using Noninvasive Genetic Sampling. PLoS ONE 7(5): e34777. https://doi.org/10.1371/journal.pone.0034777.

Schmidt, J.H., K.L. Rattenbury, H.L. Robison, T.S. Gorn and B.S. Shults. 2017. Using Non-Invasive Mark-resight and Sign Occupancy Surveys to Monitor Low-density Brown Bear Populations Across Large Landscapes. Biological Conservation 207:47-54.

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.

Species at Risk Committee. 2012. Species Status Report for Polar Bear (*Ursus maritimus*) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT. 153pp.

Species at Risk Committee. 2017. Species Status Report for Grizzly Bear (*Ursus arctos*) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT. 153pp.

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.

Stillfried, M., J.L. Belant, N.J. Svoboda, D.E. Beyer and S. Kramer-Schadt. 2015. When Top Predators Become Prey: Black Bears alter Movement Behaviour in Response to Hunting Pressure. Behavioural Processes 120:30-39.

Swenson, J.E., P. Taberlet and E. Bellemain. 2011. Genetics and Conservation of European Brown Bears *Ursus arctos*. Mammal Review 41:87-98.

Vashon, J.H., M.R. Vaughan, A.D. Vashon, D.D. Martin and K.N. Echols. 2003. An Expandable Radio Collar for Black Bear Cubs. Wildlife Society Bulletin 31**:**380-386.

Wasserman, M.D., C.A. Chapman, K. Milton, T.L. Goldberg and T.E. Ziegler. 2013. Physiological and Behavioural 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.

Western Association of Fish and Wildlife Agencies' (WAFWA) Wildlife Health Committee. 2009. A Model Protocol for Purchase, Distribution and Use of Pharmaceuticals in Wildlife. Western Association of Fish and Wildlife Agencies. 10pp.

Wheat, R.E., J.M. Allen, S.D.L. Miller, C.C. Wilmers and T. Levi. 2016. Environmental DNA from Residual Saliva for Efficient Noninvasive Genetic Monitoring of Brown Bears (*Ursus arctos*). PLoS ONE 11(11):e0165259.doi:10.1371/journal.pone.0165259.

Wolfe, L.L., C.T. Goshorn and S. Baruch-Mordo. 2008. Immobilization of Black Bears (*Ursus americanus*) with a Combination of Butorphanol, Azaperone and Medetomidine. Journal of Wildlife Diseases 44:748-752.

Wolfe, L.L., H.E. Johnson, M.C. Fisher, W.R. Lance, D.K. Smith and M.W. Miller. 2016. Chemical Immobilization in American Black Bears using a Combination of Nalbuphine, Medetomidine and Azaperone. Ursus 27:1-4.

Woods, J.G., D. Paetkau, D. Lewis, B.N. McLellan, M. Proctor and C. Strobeck. 1999. Genetic Tagging of Free-ranging Black and Brown Bears. Wildlife Society Bulletin 27:616-627.

Appendix A – Drug Volume Tables for Capture and Reversal of Bears

Black Bears:

Drug Protocol		Telazol[a]	XZT[b]	XZT Reversal	MZT[c]	MZT Reversal
Drugs		Zolazepam + tiletamine (ZT)	Xylazine (X) + ZT [~1:2 ratio]	Atipamezole	Medetomidine (M) + ZT [1:26 ratio]	Atipamezole
Formulation		Add 1.8 ml sterile water per vial of ZT	Add 1.0 ml X (300 mg/ml) + 1.1 ml sterile water per vial of ZT	Prepared for injection	Add 1.2 ml M (20 mg/ml) + 1.2 ml sterile water per vial of ZT	Prepared for injection
Concentration		260 mg/ml	349 mg/ml	20 mg/ml	213 mg/ml	20 mg/ml
Volume per Vial		2.2 ml	2.5 ml	10 ml	2.8 ml	10 ml
Dosage (mg/kg)		6.0 – 8.0	5.0 – 7.0	0.2	1.7 – 1.9	0.4
Body Mass		**Total Volume (ml)**				
kg	**Lb.**					
10	*22*	0.2 – 0.3	0.1 – 0.2	0.1	0.1	0.2
20	*44*	0.5 – 0.6	0.3 – 0.4	0.2	0.2	0.4
30	*66*	0.7 – 0.9	0.4 – 0.6	0.3	0.2	0.6
40	*88*	0.9 – 1.2	0.6 – 0.8	0.4	0.3	0.8
50	*110*	1.2 – 1.5	0.7 – 1.0	0.5	0.4	1.0
75	*165*	1.7 – 2.3	1.1 – 1.5	0.8	0.6 – 0.7	1.5
100	*220*	2.3 – 3.1	1.4 – 2.0	1.0	0.8 – 0.9	2.0
125	*276*	2.9 – 3.8	1.8 – 2.5	1.3	1.0 – 1.1	2.5
150	*331*	3.5 – 4.6	2.1 – 3.0	1.5	1.2 – 1.3	3.0
175	*386*	4.0 – 5.4	2.5 – 3.5	1.8	1.4 – 1.6	3.5
200	*441*	4.6 – 6.2	2.9 – 4.0	2.0	1.6 – 1.8	4.0
225	*496*	5.2 – 6.9	3.2 – 4.5	2.3	1.8 – 2.0	4.5
250	*551*	5.8 – 7.7	3.6 – 5.0	2.5	2.0 – 2.2	5.0

[a] Adapted from Gibeau and Paquet (1991). **Note:** The immobilizing effects of Telazol® cannot be counteracted by administration of reversal drugs.
[b] Adapted from Radandt (2009).
[c] Adapted from Caulkett and Cattet (1997).

Grizzly Bears:

Drug Protocol		Telazol[a]	XZT[b]	XZT Reversal	MZT[c]	MZT Reversal
Drugs		Zolazepam + tiletamine (ZT)	Xylazine (X) + ZT [~1:2 ratio]	Atipamezole	Medetomidine (M) + ZT [1:26 ratio]	Atipamezole
Formulation		Add 1.8 ml sterile water per vial of ZT	Add 1.0 ml X (300 mg/ml) + 1.1 ml sterile water per vial of ZT	Prepared for injection	Add 1.2 ml M (20 mg/ml) + 1.2 ml sterile water per vial of ZT	Prepared for injection
Concentration		260 mg/ml	349 mg/ml	20 mg/ml	213 mg/ml	20 mg/ml
Volume per Vial		2.2 ml	2.5 ml	10 ml	2.8 ml	10 ml
Dosage (mg/kg)		9.0 – 11.0	6.0 – 8.0	0.2	2.5 – 2.7	0.4
Body Mass		**Total Volume (ml)**				
kg	**Lb.**					
25	*55*	0.9 – 1.1	0.4 – 0.6	0.3	0.3	0.5
50	*110*	1.7 – 2.1	0.9 – 1.1	0.5	0.6	1.0
75	*165*	2.6 – 3.2	1.3 – 1.7	0.8	0.9 – 1.0	1.5
100	*220*	3.5 – 4.2	1.7 – 2.3	1.0	1.2 – 1.3	2.0
125	*276*	4.3 – 5.3	2.1 – 2.9	1.3	1.5 – 1.6	2.5
150	*331*	5.2 – 6.3	2.6 – 3.4	1.5	1.8 – 1.9	3.0
175	*386*	6.1 – 7.4	3.0 – 4.0	1.8	2.1 – 2.2	3.5
200	*441*	6.9 – 8.5	3.4 – 4.6	2.0	2.3 – 2.5	4.0
225	*496*	7.8 – 9.5	3.9 – 5.2	2.3	2.6 – 2.9	4.5
250	*551*	8.7 – 10.6	4.3 – 5.7	2.5	2.9 – 3.2	5.0
275	*606*	9.5 – 11.6	4.7 – 6.3	2.8	3.2 – 3.5	5.5
300	*661*	10.4 – 12.7	5.2 – 6.9	3.0	3.5 – 3.8	6.0
325	*717*	11.3 – 13.8	5.6 – 7.4	3.3	3.8 – 4.1	6.5
350	*772*	12.1 – 14.8	6.0 – 8.0	3.5	4.1 – 4.4	7.0

[a] Adapted from Cattet et al. (2003b). **Note:** The immobilizing effects of Telazol® cannot be counteracted by administration of reversal drugs.
[b] Adapted from Cattet et al. (2003b).
[c] Adapted from Fandos Esteruelas et al. (2017).

Polar Bears:

Drug Protocol		Telazol[a]	XZT[b]	XZT Reversal	MZT[c]	MZT Reversal
Drugs		Zolazepam + tiletamine (ZT)	Xylazine (X) + ZT [~1:2 ratio]	Atipamezole	Medetomidine (M) + ZT [1:26 ratio]	Atipamezole
Formulation		Add 1.8 ml sterile water per vial of ZT	Add 1.0 ml X (300 mg/ml) + 1.1 ml sterile water per vial of ZT	Prepared for injection	Add 1.2 ml M (20 mg/ml) + 1.2 ml sterile water per vial of ZT	Prepared for injection
Concentration		260 mg/ml	349 mg/ml	20 mg/ml	213 mg/ml	20 mg/ml
Volume per Vial		2.2 ml	2.5 ml	10 ml	2.8 ml	10 ml
Dosage (mg/kg)		7.0 – 9.0	6.0 – 8.0	0.2	2.1 – 2.4	0.4
Body Mass		**Total Volume (ml)**				
kg	**Lb.**					
25	*55*	0.7 – 0.9	0.4 – 0.6	0.3	0.2 – 0.3	0.5
50	*110*	1.3 – 1.7	0.9 – 1.1	0.5	0.5 – 0.6	1.0
75	*165*	2.0 – 2.6	1.3 – 1.7	0.8	0.7 – 0.8	1.5
100	*220*	2.7 – 3.5	1.7 – 2.3	1.0	1.0 – 1.1	2.0
125	*276*	3.4 – 4.3	2.1 – 2.9	1.3	1.2 – 1.4	2.5
150	*331*	4.0 – 5.2	2.6 – 3.4	1.5	1.5 – 1.7	3.0
175	*386*	4.7 – 6.1	3.0 – 4.0	1.8	1.7 – 2.0	3.5
200	*441*	5.4 – 6.9	3.4 – 4.6	2.0	2.0 – 2.3	4.0
225	*496*	6.1 – 7.8	3.9 – 5.2	2.3	2.2 – 2.5	4.5
250	*551*	6.7 – 8.7	4.3 – 5.7	2.5	2.5 – 2.8	5.0
275	*606*	7.4 – 9.5	4.7 – 6.3	2.8	2.7 – 3.1	5.5
300	*661*	8.1 – 10.4	5.2 – 6.9	3.0	3.0 – 3.4	6.0
325	*717*	8.8 – 11.3	5.6 – 7.4	3.3	3.2 – 3.7	6.5
350	*772*	9.4 – 12.1	6.0 – 8.0	3.5	3.5 – 3.9	7.0
375	*827*	10.1 – 13.0	6.4 – 8.6	3.8	3.7 – 4.2	7.5
400	*882*	10.8 – 13.8	6.9 – 9.2	4.0	3.9 – 4.5	8.0
450	*992*	12.1 – 15.6	7.7 – 10.3	4.5	4.4 – 5.1	9.0
500	*1102*	13.5 – 17.3	8.6 – 11.5	5.0	4.9 – 5.6	10.0
550	*1213*	14.8 – 19.0	9.5 – 12.6	5.5	5.4 – 6.2	11.0

[a] Adapted from Cattet et al. (2003a). **Note:** The immobilizing effects of Telazol® cannot be counteracted by administration of reversal drugs.
[b] Adapted from Cattet and Obbard (2010).
[c] Adapted from Cattet et al. (1997).

Appendix B – Example Bear Capture Data Form

PERSONNEL: _____

DATE: (dd-mm-yy, i.e., 01-May-18) _____

ANIMAL DATA:

Species: ☐ Grizzly ☐ Black ☐ Polar **Recapture?** ☐ Yes ☐ No **Relocated?** ☐ Yes ☐ No **Location:** **UTM:**	**Sex:** ☐ M ☐ F ☐ Unk. **Age class:** ☐ Cub of year ☐ Yearling ☐ Sub-adult ☐ Adult **Lactating?** ☐ Yes ☐ No	**GNWT Bear ID** _____ **Other ID** _____ **Family group or other bears at site:** ID # | Sex | Age class _____ | _____ | _____ _____ | _____ | _____

CAPTURE INFORMATION:

Capture: ☐ Heli Dart **Method:** ☐ Culvert Trap ☐ Snare: _____ snare site name: _____	**Delivery:**☐ pole syringe **System:** ☐ blowpipe ☐ pistol ☐ rifle	**Dart:** ☐ low velocity **System:** ☐ high velocity ☐ slow injection ☐ rapid injection

LOCATION DATA:

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

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

Collar: brand: freq: rot off? [Y / N]	**Ear Trans:** freq. Initial. Time:
Drop-off: brand: #days: Recapture? [Y / N] Serial#: Initial. time (ATS only):	
Transponder: [Y / N] If yes, brand: ID#: Implant location: _____**Transponder:** # Location:	
Tattoo # **Inside of thigh or lip:** left or right **Quality and location of previous tattoo(s):**	

DRUG INFORMATION: VITAL STATISTICS:

	Inject #1	Inject #2	Inject #3	Inject #4	Reversal
Drug					
Amount (mg)					
Volume (cc)					
Time					
Inj. site / Miss					

Time	Pulse	Resp.	Temp°C	SpO_2 (O_2 flow)

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	Straight-line length: (nose to tip of tail) _____cm Body contour length: (to base of tail) _____cm Chest girth: (behind shoulders) _____cm	**Testicle size:** Left (L) ____cm (W) ____cm Right (L) ____cm (W) ____cm

SAMPLES COLLECTED:

CHECK LIST:

Tooth (*circle*): LLPm1 LRPm1 ULPm1 URPm1 **Blood:** ☐ red ☐ purple	☐ Ear plug ☐ Hair ☐ Feces ☐ Claw tip

RECORDED:

☐ Dart recovered ☐ Hibitane ☐ Eye ointment ☐ Transmitter magnets off	☐ Collar/Ear Tag freq. ☐ Transponder # ☐ Tattoo # & location ☐ Body measurements	☐ Animal data ☐ Capture data ☐ Location data ☐ Body weight ☐ Testicular size

Body condition (1-5):

Level of tooth wear (light, moderate, or heavy):

Additional teeth abnormalities (e.g. breakage or previously removed molars):

Any evidence of external injuries or abnormalities?

COMMENTS: _____
_____
_____
_____

Appendix C – Example Field Necropsy Data Form

GENERAL INFORMATION:

Date:	**Location:**	**Personnel:**
Species:	**Sex:** ☐ M ☐ F ☐ Unk.	**Age Class:** ☐ COY ☐ Yearling ☐ 2-year old ☐ Subadult (3-4 years) ☐ Adult
Euthanasia: ☐ Yes ☐ No If yes, method of euthanasia: _____		

CARCASS INFORMATION:
Identification number (e.g. collar, PTT ID or ear tag):

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 Groin tattoo?		
Orifices (mouth, ears, etc.) Lip tattoo?		
Other (eyes, limbs, etc.) Evidence of an ear tag?		
Dart wound assessment		

Internal Assessment:

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

TISSUE COLLECTION:

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

Specimens collected for other tests: _____

Additional tissues to collect:
☐ **Premolar**
☐ **Hair**
☐ **Baculum**
☐ **External Fat**
☐ **Internal Fat**
☐ **Skin biopsy**
☐ **Ear tip**