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PANEL TRAPPING AND REVERSIBLE IMMOBILIZATION OF WILD ROOSEVELT ELK WITH TELAZOL® AND MEDETOMIDINE

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We used a portable panel trap to capture and chemically immobilize eight adult Roosevelt elk (Cervus elaphus roosevelti) using Telazol® (500 mg) and medetomidine (20 mg). Atipamezole (100 mg) antagonized the effects of medetomidine intramuscularly. Mean induction and anesthesia (to administration of reversal) times were 7.25 ± 2.7 and 70 ± 13.8 min., respectively. Mean recovery times after reversal were 6 ± 2.7 min. Elk weights based on girth measurements ranged from 215-294 kg and all elk were >3yrs old. Heart rates averaged 61.3 and ranged from 43-96 bpm. Mean O_2 saturation was 71.8 ± 7.2%, with all elks' % O_2 increasing during anesthesia. Physiological monitoring indicated a surgical or deep plane of anesthesia; however, inductions and reversals were smooth and unremarkable and all elk were alive at >12 months. Three additional free ranging elk have been immobilized successfully using an identical protocol. With refinement of dosages and under similar conditions, this combination shows promise as a reversible, non-opiate alternative for immobilizing wild elk.

INTRODUCTION

The most reliable method for immobilizing elk (Cervus sp.) is with an ultra-potent opioid in combination with a sedative (Kreeger 2002). Opiate derivatives are highly effective for inducing reversible anesthesia in large ungulates, but exposure to these controlled substances can be lethal to humans (Haigh and Haigh 1980), and their availability limited to veterinarians in clinical or zoological settings (Arnemo et al. 1994). Due to the toxicity of these schedule II narcotics and special regulations governing their accessibility and storage, field biologists needing to immobilize wild elk often use less effective drugs requiring large volumes and having adverse side effects.

Telazol® (TLZ) and ketamine (KET) are commonly used drugs in wildlife immobilization that can be utilized as primary anesthesia agents in elk. These schedule III cyclohexanes are far less toxic to humans but are not reversible, can have significant undesirable side effects, and are difficult to deliver in sufficient volumes (Pond and O'Gara 1996). The use of KET in free ranging ungulates has been limited because the required dose volume may limit the ability to remotely dart and recover immobilized animals (Walter et al. 2005). TLZ is nearly three times more potent than KET (Kreeger et al. 2002), a potentially important consideration in field immobilizations where injection volumes need to be reduced and reliability of anesthesia increased.

Alpha-2 adrenoceptor agonists (alpha-2) are reversible sedatives often used as adjuvants to hasten and smooth induction and recovery and to reduce the dose of primary agent required to achieve anesthesia (Kreeger et al. 2002). Medetomidine hydrochloride (MED) is the most powerful alpha-2 agonist available for wildlife immobilization and is ten times more potent than the more commonly used xylazine (XLZ). Its use with KET is reported in European species of captive and wild ungulates (Arnemo et al. 1994, Arnemo 1995, Janovsky 2000, Ryeng et al. 2001), but a MED-TLZ combination has not been reported in North American elk, and may be important as a low volume, non-narcotic alternative for immobilizing these large and highly mobile herbivores.

Helicopter net-gunning is the primary method for capturing wild elk in California (CDFG 2007[1]). This technique is highly effective in areas where open terrain and vegetation allow animals to be easily observed and helicopters to safely operate. On significant portions of Roosevelt elk range where dense canopy forests prevent the use of helicopters, information on the ecology of this species is limited. Where commonly used methods of capture are impractical and the need for increased understanding of elk exists, the development of alternative capture techniques is important for research and management.

STUDY AREA

The study was conducted on the South Fork Salmon River drainage in Siskiyou County, California (N 41° 05.565',W 123° 03.110') (Figure 1). This region is part of the Klamath Ranges (Hickman 1993) and is mainly publicly owned and administered by the Klamath National Forest. The south fork Salmon river is identified in the Klamath National Forest Elk Management Strategy (USFS 2007[2]) as critical elk winter range where populations are estimated at ~300 (CDFG unpublished data).

The Klamath Mountains consist of steep diverse terrains where coastal watersheds are separated by high elevation ranges exceeding 2700 m in some wilderness areas, extending to the Pacific Ocean in the form of narrow river valleys. The floral uniqueness of this area has been described by Ricketts (1999)[3] as one of the most botanically diverse regions on the globe. The Klamath Ranges are characterized as deeply forested landscapes with a diversity of tree species that can include hemlock (Tsuga heterophylla), grand fir (Abies grandis), Douglas fir (Pseudotsuga menziesii), chinquapin (Chrysolepis chrysophylla), noble fir (Abies procera),

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[1]California Department of Fish and Game. 2007. Wildlife Restraint Handbook. State of California – Resource Agency. Wildlife Investigations Laboratoy. 1701 Nimbus Road, Rancho Cordova, CA. 95670.

[2]United States Forest Service. 2007. Klamath National Forest Elk Management Strategy. United States Department of Agriculture. 1312 Fairlane Road, Yreka CA. 96097.

[3]Ricketts, T.H., E. Dinerstein, D.M. Olson, and C.J. Louks. 1999. Terrestrial ecoregions of North America, a conservation assessment. Washington, D.C.: Island Press.

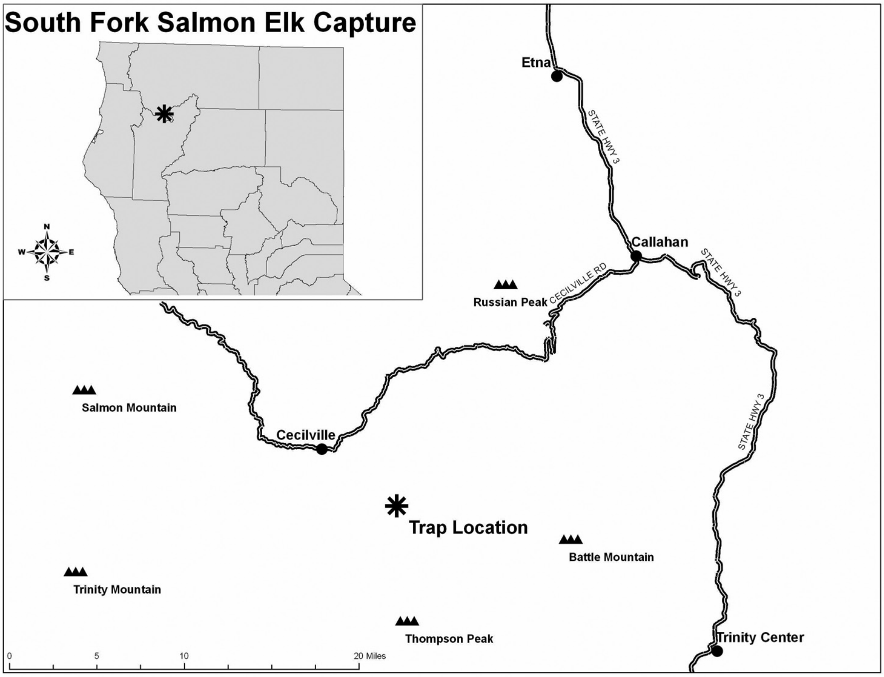

Figure 1. Study area and trap location for panel trapping elk during January and February 2007, Siskiyou County, California.

and red fir (Abies magnifica), with some common shrub species including wedgeleaf ceanothus (Ceanothus cuneatus) and mahogany (Cercocarpus sp.). Its rich faunal composition includes sensitive species such as the northern spotted owl (Strix occidentalis caurina), northern goshawk (Accipiter gentilis), Humboldt marten (Martes americana humboldtensis) and Pacific fisher (Martes pennanti pacifica), as well as more common species such as black-tailed deer (Odocoileus hemionus columbianus), black bear (Ursus americanus), mountain lion (Felis concolor) and Roosevelt elk (Cervus elaphus roosevelti). Precipitation occurs in the form of rainfall and snow, averaging >90 cm at the lower elevations annually.

METHODS

Trap Construction

A panel trap was constructed on winter range where adequate densities of elk were present. Six 2.74 m (height) x 3.65 m (length) portable steel tube panels were attached to form an 8 m diameter circular trap (Figure 2). The entrance was 101.6 cm wide with a steel tube swing door reinforced with plywood that closed from the inside. Plywood sheets (1.21 m x 2.43 m) were attached to the top of each panel to extend the height of the trap to 3.65 m (Figure 3). Wood posts (.15 x .15 x 2.4 m) inserted into the ground were placed at the entrance and rear of the trap to help anchor it to the ground and to prevent the door from swinging to the outside.

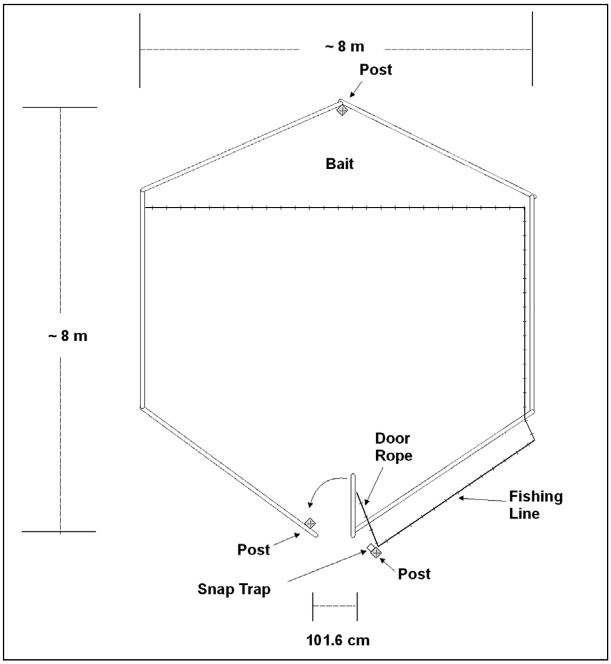

Figure 2. Illustration of portable elk panel trap design used on the south fork Salmon River in winter 2007.

Figure 3. Construction of a panel trap used for capturing elk in the winter of 2007 on the south fork Salmon River, Siskiyou County, California (Photo by RJS).

Burlap was wrapped on the outside of the trap to limit visibility (Figure 4), and caution was taken not to disturb trapped elk. A remote 12 v digital video recorder (MemoCam®) was placed inside the trap at a height of 2.5 m to record patterns of elk use. Elk were baited inside and outside the trap with pure alfalfa (Medicago sativa) and apples. The trap was set when the door was held open with a rope attached to a large snap-trap placed on a post outside the trap (Figure 5). The door would close when elk would enter to feed, moving through a fishing line stretched from the snap-trap across the inside of the trap at knee height, releasing the rope and closing the door (Figure 6). A 5 kg weight was attached to the door with a cable and pulley

Figure 4. A completed panel trap wrapped in burlap for capturing elk near the south fork Salmon River during January and February 2007 in Siskiyou County, California (Photo by RJS).

that would quickly pull and hold the door shut once it was released (Figure 7).

Chemical Immobilization

Standard doses of TLZ (500 mg, 250 mgs/ml) reconstituted with MED (20 mg, 20 mgs/ml) and sterile water (1.0 ml) were delivered into the gluteus muscles of elk with a 2cc pneu-Dart® and pistol projector (Pneu-Dart® model 190). Induction times were recorded from dart impact to lateral recumbency (head down). The first sign of anesthesia (i.e., stumbling or licking) was also recorded. Total anesthesia times were recorded from initial lateral recumbency to when the antagonist was administered. Immobilized elk were monitored for clinical complications such as bloat, regurgitation and respiratory depression. Eyes were covered and an ophthalmic ointment applied to prevent corneal drying.

Physiological monitoring occurred at approximately 15 and 45 minutes into anesthesia. Heart rate and relative (%) oxygen saturation were recorded using pulse oximetry (Nellcor Inc.) with the sensor applied to the tongue. Rectal temperature and presence of the ear twitch, swallow, palpebral, and corneal reflexes were recorded. Elk weights were estimated using

Figure 5. Door release device used for trapping elk on the south fork Salmon River during January and February 2007, Siskiyou County, California. (Photo by RJS)

Figure 6. Placement of fishing line (in front of bait) inside the elk panel trap during January and February 2007 on the south fork Salmon River, Siskiyou County, California. (Photo by RJS)

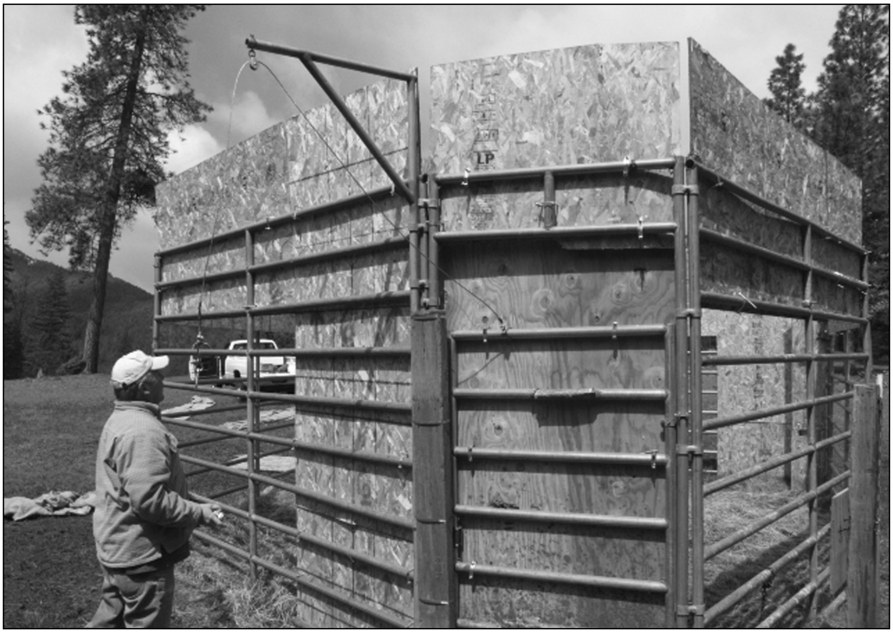

Figure 7. Panel trap door showing cable and pulley attachment (without weight) on the south fork Salmon River during winter 2007, Siskiyou County, California. (Photo by RJS)

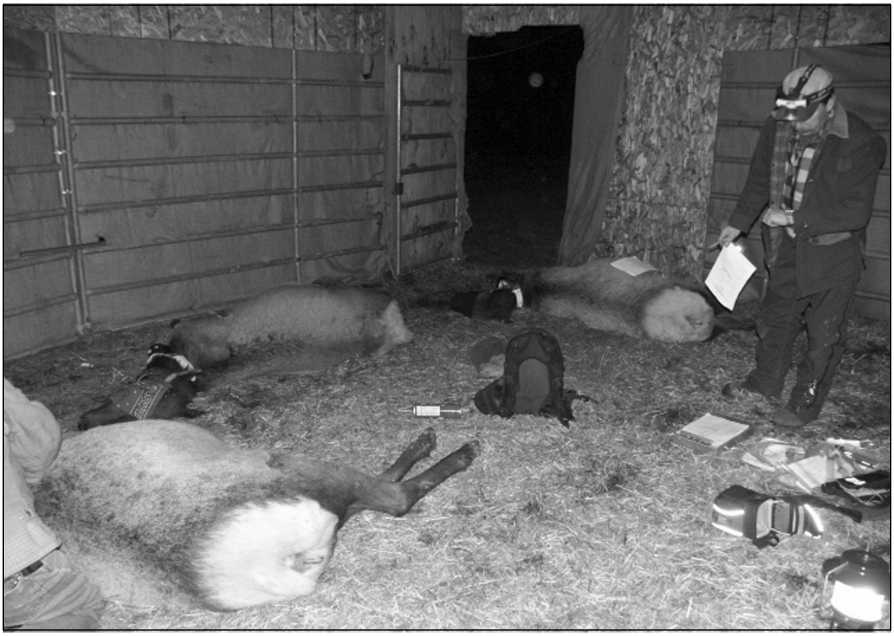

Figure 8. Three anesthetized elk captured in a panel trap at night during January and February 2007 near the South Fork Salmon River, Siskiyou County, California (Photo by RJS).

chest girth measurements (Cook et al. 2003) and age estimated using mandibular dentition (Quimby and Gaab 1957). Telemetry collars with mortality sensors were attached to each elk for monitoring survival (Advanced Telemetry Systems Inc.).

Atipamezole (100 mgs, 5 mgs / ml) was administered intramuscularly (IM) in the gluteus muscles to reverse the effects of MED. Reversal (to standing) and arousal (i.e., head up, ear twitch, or sternal recumbency) times were recorded from when the antagonist was administered. Trap exit times were recorded from when the antagonist was delivered. The ambient temperature during trapping ranged from -10° to -2°C.

RESULTS

During January and February 2007, a total of 35 elk were captured during three trap nights in which eight adults (seven females / one male) were immobilized with mean dosages of TLZ (2 mg/kg, ±0.11, range = 1.7 – 2.2) and MED (.08 mg/kg, ±.008, range .06 - .09). Up to three elk were darted and immobilized in succession (Figure 8). Once all elk were laterally recumbent the trap door was opened and remaining elk released with no elk injured. The mean time for first sign of sedation was 4.75 ± 2.2 min (Table 1). Induction, anesthesia, and reversal times were 7.25 ± 2.7 min., 70 ± 13.8 min., and 6 ± 2.7 min., respectively. Mean arousal times were 4.8 ± 2.1 min., and elk exited the trap in 9.5 ± 4.5 min. Mean SpO2 (%) and heart rate was 71.8 ± 7.4% and 61 ± 22 bpm (Table 2). All elk were >3 years old with an estimated mean weight of 243 ± 24.1 kg.

Inductions and reversals were generally smooth and unremarkable. Upon reversal, three elk were either briefly disoriented or stumbled after standing. During anesthesia one elk regurgitated and began to bloat; it was quickly placed sternal and eructated with no further complications. All but one elk had no reflexes and appeared in a surgical or deep plane of anesthesia (Kreeger et al. 2002). Observations in summer indicated that all females had calves

Table 1. Summary of induction, arousal, reversal and trap exit times (min) for eight adult Roosevelt elk panel trapped and immobilized with medetomidine (20 mgs) and Telazol® (500 mgs) in Siskiyou County, California during January – February 2007.

	Mean ± SD	Range
First sign of sedation (a)	4.75 ± 2.2	3-9
Induction (b)	7.25 ± 2.7	5-10
Total anesthesia (c)	70 ± 13.8	50-89
Arousal (d)	4.8 ± 2.1	2-9
Reversal (e)	6 ± 2.7	3-10
Trap exit (f)	9.5 ± 4.5	4-18

(a) Time from darting to first inductive response
(b) Time from darting to laterally recumbent.
(c) Time from laterally recumbent to antagonist.
(d) Time from delivery of antagonist to first sign of recovery
(e) Time from delivery of antagonist to standing.
(f) Time from delivery of antagonist to trap exit.

Table 2. Summary of physical measurements and physiological monitoring for eight adult Roosevelt elk that were panel trapped and immobilized with medetomidine (20 mgs) and Telazol® (500 mgs) in Siskiyou County, California during January and February 2007.

	Mean ± SD	Range
Estimated weight (kg)	243 ± 24.1	215-294
Estimated age	6 ± 1.4	3-7
Heart rate (bpm)	61 ± 22	43-96
SpO2 (%)	71.8 ± 7.4	62-84
Rectal temperature (f)	101.8 ± .5	100.8 – 102.7

and all elk were alive at >12 months.

DISCUSSION

Elk became habituated to baiting and would re-enter the trap after being previously caught and processed with >20 elk recorded inside the trap at one time (Figure 9). Elk caught in the trap did not become overly agitated but would move to the opposite side of the trap when approached. In a previous effort using a trap without plywood extensions (2.74 m height), the potential for injuries to elk during successful and non successful attempts to leap out of the trap was of great concern (RJS personal observation). The increased height of this trap seemed to

Figure 9. Photo of elk feeding inside the panel trap taken from a digital video recorder near the South Fork Salmon River showing at the center a collared elk previously trapped 10 days earlier.

discourage elk from attempting to jump, and the combination of trapping at night, reduction in visual disturbance, and the availability of nutritious feed may have provided conditions where elk remained relatively calm. We believe this technique provides a portable method for capturing elk on ranges where other methods of capture are ineffective.

TLZ is a powerful dissociative anesthetic with potential side effects that include lengthy anesthesia times, rough inductions and recoveries, tachycardia, and convulsions. Sedatives are used synergistically with TLZ to lessen its side effects and required dosages. Only three authors have reported the use of TLZ as the primary immobilizing agent in elk (Cervus elaphus). Janovsky et al. (2000) recommended the use of TLZ (2.4 mg/kg) and XLZ (2.3 mg/kg) for darting feral red deer, but reported mean inductions of >8 min, the need for additional dosages, and several fatalities. Rocky mountain elk (Cervus elaphus nelsoni) immobilized in clover traps using TLZ (2.5 mg/kg) and xylazine (0.35 mg/kg) required an additional dose and long recovery times (Milspaugh et al. 1995). In Oklahoma, Walter et al. (2005) immobilized 14 free ranging rocky mountain elk with TLZ (500 mg) and XLZ (200 mg), but reported five elk required additional dosages and one mortality. Elk from our study required lower mean doses of TLZ to quickly achieve full anesthesia without significant side effects, re-dosing, or mortality. It may be that the synergistic benefit of using a more powerful alpha-2 in this study increased the effectiveness of anesthesia, providing a reliable non-narcotic alternative for effectively immobilizing wild elk.

Reversible anesthesia is desired in wildlife immobilization to reduce anesthesia times, avoid side effects from prolonged down times, and decrease handling times in monitoring animals during lengthy recovery periods. When using cyclohexane – alpha 2 combinations in field situations, dosages need to be adequate to achieve safe levels of anesthesia while attempting to avoid the potential for residual drug effects upon recovery. Milspaugh et al. (1995) reversed the effects of a TLZ-XLZ cocktail at 20 min but reported a mean reversal time of 14 min when reversed intravenously and 124 minutes IM. Walters et al. (2005) reversed a combination of TLZ-XLZ in less than 40 minutes and reported a mean time to standing for elk at 27 minutes. In our study, the effects of MED were antagonized at 70 ±13 minutes, resulting in shorter and more consistent reversal times. Indeed, patterns of reversal and total anesthesia times from this study suggest that increasing anesthesia time allows for increased elimination of TLZ through liver metabolism (Kreeger et al. 2002), and reversal times are decreased (Figure 10). Recently, this protocol has been used in three free ranging elk with similar results (RJS personal observation). In this study, the use of TLZ in combination with MED provided reversible anesthesia in wild Roosevelt elk, optimally when the effects of MED were not immediately reversed.

Medical concerns when using alpha-2 agonists include reduced rumen motility and associated side effects such as bloat and respiratory depression (Kreeger et al. 2002). Factors contributing to bloat in one elk from this study may have been the use of pure alfalfa for baiting, and allowing elk to remain laterally recumbent during anesthesia. Alfalfa is a concentrated legume that was not available in the study area and was highly desired by trapped elk, potentially adding greater risk of excess rumen gas accumulation. Allowing elk to remain laterally recumbent during processing likely increased the retention of gas within the rumen and prevented eructation. Adjusting the type and amount of bait used when trapping under similar conditions and quickly placing immobilized elk in a sternal position is important for reducing risk of alpha-2 complications when using this technique.

Hypoxemia is a commonly observed complication during the chemical restraint of wild ruminants and can predispose animals to arrhythmias, organ failure, and capture myopathy (Celly et al. 1997, Read et al. 2001). Arnemo (1995) reported mean 0^2 saturations at 89% ± 3 for free ranging moose (Alces alces) immobilized with MED and KET in early autumn. For

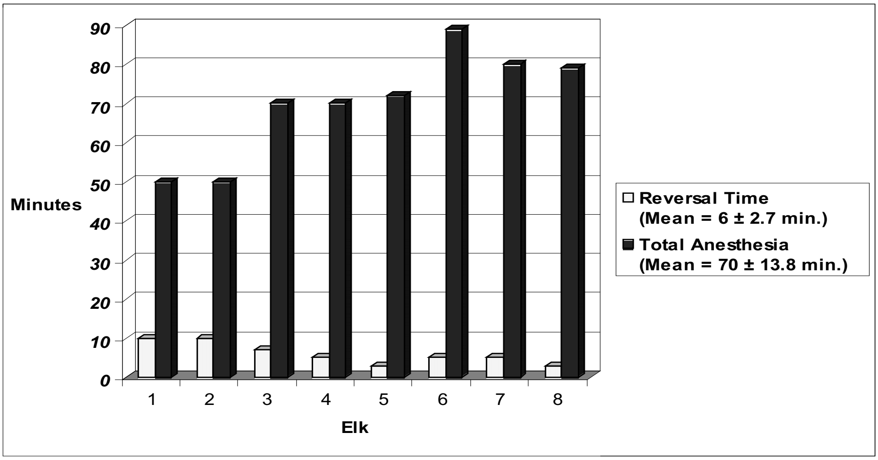

Figure 10. Comparing reversal times to length of anesthesia in eight elk immobilized with Telazol® (500mg) and medetomidine (20gm) during January and February 2007 on the south fork Salmon River, Siskiyou County, California.

captive red deer immobilized with TLZ and XLZ, 0^2 saturation increased following a short decrease at the beginning of anesthesia, and leveled off at 80-95% (Janovsky et al. 2000). Read et al. (2001) reported levels of 0^2 saturation similar to our study for wild and farmed elk (Cervus elaphus) immobilized with TLZ and XLZ, but found that upon administration of nasal oxygen insufflation that mean 0^2 saturations significantly increased to 95%. It may be important when using TLZ-MED combinations in field situations that a portable oxygen delivery system is available for artificial ventilation.

Absence of corneal, swallow, and palpebral reflexes indicate a surgical or deep plane of anesthesia (Kreeger et al. 2002). The associated risk from anesthesia requires monitoring and clinical care often not available in field situations. However, this risk to the animal must be balanced with the risk to personnel from the potential spontaneous arousal of a large ungulate which may occur when using an alpha-2 agonist as a major immobilizing agent (Kreeger et al. 2002). In a trap situation, a rapid induction may reduce animal injuries by allowing the quick release of unwanted animals. In confined elk, measured, stepwise reductions in dosages may be feasible as familiarity with the effects of the drugs on the elk increases. However, when free range darting; a rapid induction with deep anesthesia is crucial to preventing loss of the animal in dense forest and steep terrain. The absence of immediate or delayed mortality seen in this study suggests that the levels of anesthesia were safe and effective.

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