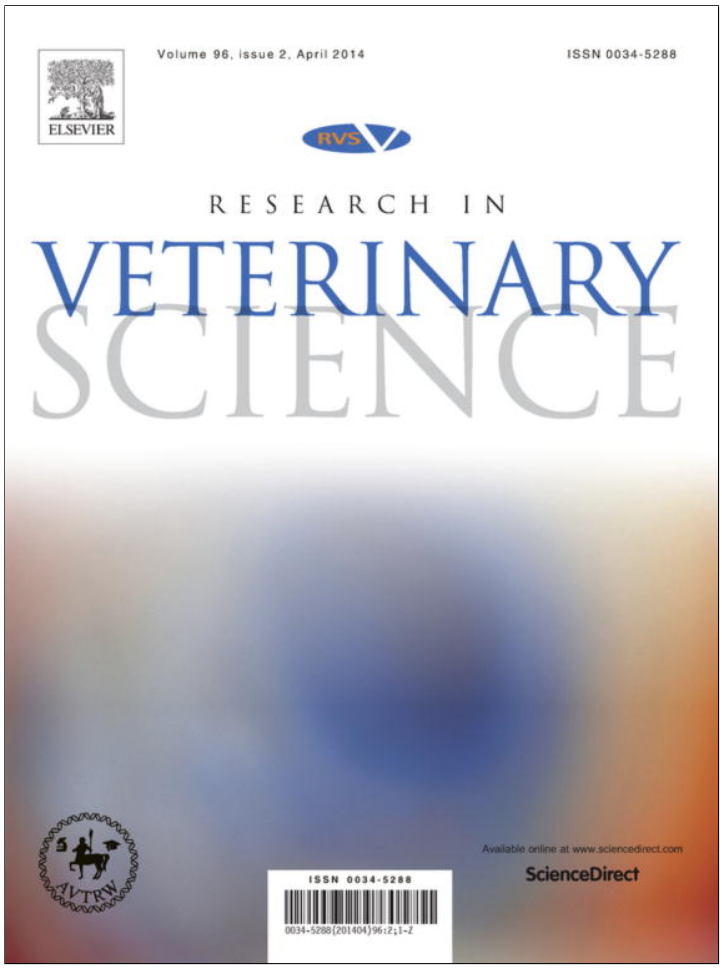

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Chemical immobilisation of free-ranging Pampas foxes (*Pseudalopex gymnocercus*): Assessment of ketamine–xylazine and tiletamine–zolazepam combinations

E.M. Luengos Vidal [a,b,*], D.F. Castillo [a,b], J. Baglioni [a], C. Manfredi [a], M. Lucherini [a,b], E.B. Casanave [a,b]

[a] Grupo de Ecología Comportamental de Mamíferos, Cátedra de Fisiología Animal, Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, Argentina
[b] Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET)

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ABSTRACT

Two protocols to immobilise free-ranging Pampas foxes for ear-tagging or radio-collaring were evaluated. One hundred fifteen foxes were injected with ketamine–xylazine (K–X) and thirteen with tiletamine–zolazepam (T–Z). The use of both T–Z and K–X combinations typically resulted in a smooth induction and recovery. In 86% of the cases K–X protocol was judged effective (mean ± SD, K: 10.7 ± 3.3 mg/kg, X: 1.0 ± 1.0 mg/kg) while T–Z protocol was judged effective in 92% of the cases (T: 3.6 ± 1.05 mg/kg, Z: 3.6 ± 1.05 mg/kg). The primary differences between the two drug combinations were that the time necessary for the complete recovery was longer with T–Z, and thermic problems were found more frequently with K–X. Additionally, our results suggest that thermic stress may be a relatively frequent complication for Pampas foxes. This study provides baseline data on some physiologic variables in Pampas foxes captured with different methods and drugs in field conditions.

1. Introduction

The chemical immobilisation of wild animals in the field, is an important tool for ecologists and wildlife managers (Proulx et al., 2012). Many projects on free-ranging populations such as telemetry, health and physiological assessments, require safe handling of animals (McKenzie, 1993; Luengos Vidal et al., 2012). The selection of a protocol for immobilisation in a given wild species should contemplate several factors including species to be immobilised, drug selection and availability, dosing considerations, and ambient weather conditions (Kreeger et al., 2002). The availability of drugs and capture equipment can be especially problematical in countries where the accessibility of drugs is limited (Curi and Talamoni, 2006).

The Pampas fox (*Pseudalopex gymnocercus*) inhabits the Southern Cone of South America and is one of the most common and widespread carnivores within its geographic range (Lucherini et al., 2004). In spite of this ubiquity, ecological knowledge of this canid is poor (Lucherini and Luengos Vidal, 2008). No studies have been published on the immobilisation of free-ranging Pampas foxes, and the information from captive animals is scarce (Cabral Gianotti et al., 2008). A similar paucity of data exists for the other foxes of the South American genus *Pseudalopex* (Curi and Talamoni, 2006; Acosta-Jamett et al., 2010).

Previous studies have demonstrated the effectiveness of a combination of ketamine hydrochloride (ketamine) and xylazine hydrochloride (xylazine) for immobilising *Pseudalopex* foxes (Travaini et al., 1992; Acosta-Jamett et al., 2010). This drug combination produces a smooth and rapid induction with the pressor and cataleptic effects of ketamine being complemented by the sedative and myorelaxing effects of xylazine, which also minimizes the adverse side effects of ketamine (Amend et al., 1972). However, this combination is known to cause prolonged sedation, an effect that has been attributed to xylazine (Kreeger and Seal, 1986; Kreeger et al., 2002). Kreeger et al. (2002) recommended the use of a combination of tiletamine–zolazepam (Telazol® or Zoletil®) to immobilise *Pseudalopex* foxes based on suggestions by Seal et al. (1970) who tested it on culpeos (*Pseudalopex culpaeus*) and Acosta-Jamett et al. (2010) who tested it on chillas (*Pseudalopex griseus*). Acosta-Jamett et al. (2010) compared telazol with Ketamine (K)–Xylazine (X) combination with telazol having the worse outcome. However, in general telazol has highly predictable immobilisation effects with minimal depression of physiologic functions and has a wide safety margin, which is very important in the field when body mass is difficult to estimate.

Thermoregulatory issues are among of the most common risks associated with chemical immobilisation of free-ranging animals

* Corresponding author at: Grupo de Ecología Comportamental de Mamíferos, Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, San Juan 670, 8000 Bahía Blanca, Argentina. Tel.: +54 9291 4054200.
E-mail address: luengos@criba.edu.ar (E.M. Luengos Vidal).

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(Fowler, 1995). Thermal stress can produce a cascade of secondary effects that may affect the survival of immobilised animals. Nevertheless, very few field studies have addressed this topic with carnivores.

As part of an ecological study of Pampas foxes it was decided to assess their immobilisation. For this process we used two anaesthetic combinations, ketamine–xylazine and tiletamine–zolazepam, to determine an appropriate dosage to immobilise individuals for adequate and safe field-handling, while minimizing recovery time. Additionally, a detailed analysis of thermoregulatory problems associated with these two drug combinations is provided and radio-tracking was used to assess immobilised animals following release.

2. Materials and methods

2.1. Study area

The Ernesto Tornquist Provincial Park is located in Sierra de la Ventana (38°03′S–62°00′W), an isolated ancient mountain that reaches 1240 m above sea level in the otherwise flat Pampas of the Buenos Aires Province, Argentina. The park is surrounded by cattle ranches with predominantly non-native grasses and agriculture. The grassland within the park is dominated by short prairie-grasses of the genera *Stipa*, *Piptochaetium*, *Briza*, and *Festuca*, and is intensively grazed by a dense population of free-ranging horses (Scorolli and Lopez Cazorla, 2010); in areas with thin soils shrubs predominate (*Eupatorium* and *Discaria*). The landscape is dotted with groves of exotic species of trees (*Pinus* spp., *Cupressus* spp., and *Quercus* spp.) (Frangi and Bottino, 1995). The climate is temperate; rainfall is concentrated in spring and to a lesser extent in summer. Mean annual rainfall is 646 mm and ranges from 21 mm in July to 68 mm in March. Monthly mean temperatures range from 8.2 °C in July to 23.2 °C in March.

2.2. Animals

Pampas foxes were captured from December 1998 to June 2006, using three capture devices: iron mesh-wire box traps (40 × 40 × 120 cm, custom built), soft-padded leg-hold traps (Victor Soft Catch® 1½ Oneida Victor, Euclid, Ohio, USA), and stop-integrated locking neck snares (custom built) (Luengos Vidal et al., 2003). The traps were monitored four times daily to reduce the risk of thermoregulatory stress and injures related with the traps (Luengos Vidal, 2003).

2.3. Capture and drugs

Captured foxes were physically restrained with a Y pole or with a restraining box depending on the trap model used and immediately chemically immobilised by intramuscular injection in the lateral thigh. Drug dosages were based on visual weight estimation based on personal experience with foxes. We used two drug combinations: Ketamine hydrochloride (K) 50 mg/ml (Ketalar®, Parke-Davis, Morris Plains, New Jersey, USA) and Xylazine hydrochloride (X) 20 mg/ml (Rompun®, Mobay Corp., Animal Health Division, Shawnee, USA); T–Z: Tiletamine hydrochloride (T) 50 mg/ml) and zolazepam hydrochloride (Z) 50 mg/ml) (Telazol®, Fort Dodge Anival Health, Fort Dodge, Iowa, USA). If the initial dose of K–X, or T–Z was inadequate for immobilisation, an additional injection with 50% of the dose of K, evaluated by the visually assessed weight of the animal, was administered (Kreeger et al., 2002).

2.4. Collection of data

After immobilisation, estimated weight, gender, and morphometric measures were recorded (see Luengos Vidal et al., 2009); the animal's age was estimated from observations of tooth wear, body size and reproductive condition (Crespo, 1971). Foxes were classified as infants when they only had milk teeth; juveniles until they had all the permanent teeth (up to 11 months age approximately); and then adults (Luengos Vidal et al., 2009). All animals were ear-tagged and 26 individuals were fitted with radio-collars for spatial ecology analysis. Capture, handling, and marking of foxes followed the guidelines of the American Society of Mammalogists (Sikes and Gannon, 2011) and SAREM, the Argentina Society of Mammalogy (Giannoni et al., 2005). The Buenos Aires provincial government through the Ministerio de Asuntos Agrarios authorised all field activities.

Respiration rate (breaths/min) was determined visually by observing chest movements, heart rate (beats/min) was monitored with a stethoscope, and rectal temperature was measured using a digital thermometer. These parameters were taken at 10 min intervals as soon as practical after immobilisation and until handling procedures were completed. Additionally, capillary refill time was visually assessed as an aid in assessing blood volume and peripheral perfusion. An ophthalmic ointment (Lacryvisc gel, Alcon Laboratorios S.A., D.F., Mexico) was applied to the eyes to lubricate the cornea and conjunctiva and prevent desiccation. A cloth blindfold was placed over the corneas to minimize the risk of eye injuries from light, minimize visual stress, and prevent dissecation.

Induction time (IT) was defined as the time from injection until complete immobilisation (i.e., no response to mechanical stimuli); manipulation time (MT) as the time from injection until the first non-stimulated head movement (which determined the termination of sampling activities). Recovery time (RT) was the interval between injection and the animal's ability to maintain an upright posture. Liberation time (LT) was the interval between injection and complete recovery (normal gait, unimpaired locomotion). Criteria for an "effective dose" combination were as follows: (1) mean induction time <11 min (McKenzie, 1993; Kreeger et al., 2002; Castillo et al., 2012), (2) sedation of sufficient depth to allow safe and comfortable handling during at least 15 min, and (3) normal cardiac (90–120 bpm) and respiratory rhythm (20–50 bpm) (Kreeger et al., 1989).

In the cases of thermoregulatory problems, hypothermia was considered to occur when the rectal temperature was below 36 °C (moderate <36 °C, severe <35 °C) and hyperthermia above 39 °C (moderate >39 °C, severe >40 °C) (West et al., 2007). As soon as the immobilised fox showed thermoregulatory problems measures were initiated to warm or cool the body in the cases of hypo or hyperthermia, respectively, and return the animal to normothermia.

After sample collection (feaces, hairs and external parasites) and individual identification by ear-tag or radio-collar, each animal was placed in a recovery cage and monitored until it showed normal gait, when it was released at the capture site. For a sample of 26 foxes post-anesthesic survival was assessed by radio-tracking continuously during 24–48 h after their release.

2.5. Statistical analysis

Doses were expressed as mean dose ± SD. Because the data were not normally distributed Wilcoxon–Mann–Whitney tests (W) for independent samples were used to determine whether statistical differences existed in the doses of drugs used in the effective and ineffective cases with both combinations and to compare across genders and age classes for both protocols. The Wilcoxon test for paired data was used to determine statistical

variations in the physiological parameters (temperature, respiratory and cardiac rhythm) between the first 15 min and the subsequent measurements. The proportion of effective doses for both protocols between the trap models were compared with a χ^2 (considering the different level of stress causes by each type of trap). Kruskal–Wallis tests (H) were also applied to compare IT, MT, RT, and LT between drug protocols.

3. Results

One hundred and twenty-nine foxes were captured during 164 capture events. Thirty-three of the foxes (20.1%) were released without chemical restraint because they had been trapped recently (<1 month before), or in case of extreme weather conditions. Additionally, three (1.8%) of the animals died: two showed evidence of capture myopathy at necropsy (one before drug administration and one immediately after chemical restraint; Luengos Vidal unpubl. data); the last one was bitten by a venomous snake (*Bothrops alternatus*) while in a leg-hold trap.

The K–X protocol was used to immobilise 115 foxes. For eighty-seven foxes (74.8%) the protocol was effective with a mean ± SD dose of 10.7 ± 3.3 and 1.0 ± 1.0 mg/kg (ketamine and xylazine respectively; Table 1). In the remaining 29 cases it was necessary to administer supplementary ketamine (mean ± SD dose of 6.8 ± 4.6 mg/kg). No statistical differences in drug doses between effective and ineffective doses were found for K (W: 1598.5, p: 0.59) but X doses were lower for ineffective cases (W: 1323.5, p: 0.02). We delivered one supplementary 22 times, three times in six cases, and four times in one case (Table 1).

The T–Z combination was assessed 13 times: 12 cases were successful with a dose of 7.2 ± 2.1 mg/kg; supplementary dosing with ketamine was only required in one case (1.9 mg/kg). The dose of T–Z in this case was almost 50% lower than the effective mean dose for this protocol (3.8 mg/kg; Table 1).

There was no significant effect of trap type on the effectiveness of the K–X protocol (χ^2: 1.31, d.f.: 2, p: 0.5194). The K–X protocol was effective in 72.2% of the leg-hold traps, 82.7% of the snare traps, and 71.4% of the box traps. This analysis was not possible with T–Z because of the small sample size.

3.1. Immobilisation

Whereas recovery time (W: 569.0, $p < 0.0001$) differed between effective and ineffective doses for the K–X combination, we found no variations in induction time (W: 257.5, p: 0.95), manipulation time (W: 1336.5, p: 0.20), or release time (W: 781.0, p: 0.24). When the effective cases were compared between drug protocols, differences were found in the release time (W: 260.5, p: 0.0105) and liberation time (Table 1). The other time parameters were very similar (IT W: 170, p: 0.9482; MT W: 208.5 p: 0.6069; RT W: 388, p: 0.1999; Table 1).

For the K–X effective cases, induction, manipulation, and recovery times did not vary with trap model (IT, H: 0.30, p: 0.835; MT, H: 0.64, p: 0.7242, RT, H: 0.87, p: 0.6462), whereas the liberation time was shorter for animals captured in box traps (95.67 ± 34.07 min) when compared to neck snares (146.16 ± 64.77 min) and leg-hold traps (155.87 ± 86.35 min; H: 6.45, p: 0.0396). There was no effect on protocol effectiveness of gender (Table 2).

3.2. Physiological variables

Both initial and subsequent respiratory rates (Fig. 1a) were higher with T–Z (mean ± SD, initial: 45.77 ± 11.91 breaths/min; subsequent: 41.50 ± 10.89 breaths/min) than with K–X (initial: 31.64 ± 11.62 breaths/min; subsequent: 30.59 ± 10.65; W: 736.5, p: 0.0005 and W: 588.0, p: 0.0004 for initial and subsequent records, respectively). With K–X, respiratory rates were the highest at the beginning of the procedure in 83.6% of the cases, whereas this value was lower with T–Z (33.3%), although these differences were not significant (K–X, Z: 0.91, p: 0.3647; T–Z p: >0.9999 value estimated from bootstrapping).

With K–X, mean heart rate was 130.0 ± 41.1 beats/min initially (the first measurement recorded within 10 min of immobilisation) and averaged 125.9 ± 38.7 beats/min during the rest of the handling. With T–Z mean heart rate was 191.2 ± 32.5 beats/min initially, and 177.3 ± 35.8 beats/min subsequently. Heart rate was higher with T–Z than K–X both initially (W: 756, p: 0.0001) and for the rest of the handling (W: 1110, p: 0.0001) (Fig. 1b). However, no differences for K–X, Z: 0.86 p: 0.3871 and for T–Z p: 0.1833 (*p*-value estimated from bootstrapping) when comparing between initial and pre-liberation heart rates, were found.

3.3. Thermoregulatory issues

In the cases when doses were effective, the trends in temperature variation across time were similar between protocols (Fig. 1c) for normothermic animal. Also the proportions of foxes with thermoregulatory issues (hypothermia or hyperthermia) were similar between protocols (Table 1, χ^2: 0.24, d.f: 2, p: 0.889).

Table 1
Comparison between drug effectiveness in Pampas foxes live trapped in Argentina (K: ketamine, X: xylazine, T–Z: tiletamine–zolazepam, IT: induction time, MT: manipulation time, RT: recovery time, LT: liberation time).

	K–X		T–Z	
	Effective	Ineffective	Effective	Ineffective
N	86	29	12	1
Mean weight ± SD	4.9 ± 1.5	5.2 ± 1.3	5.0 ± 0.9	3.8
Male/female	42/44	18/11	9/3	1 male
Mean dose K (mg/kg) ± SD	10.7 ± 3.3	10.5 ± 3.3	–	–
Mean dose X (mg/kg)±SD	1.1 ± 1.1	0.9 ± 1.0	–	–
Mean dose T–Z (mg/kg) ± SD	–	–	7.2 ± 2.1	3.7
IT (min) ± SD	9.8 ± 7.2	8.6 ± 2.4	8.7 ± 3.2	8
MT (min) ± SD	40.1 ± 29.3	19.4 ± 8.2	37 ± 5.7	15
RT (min) ± SD	50.8 ± 30.1	53.0 ± 19.3	68.7 ± 47.7	35
LT (min) ± SD	141.7 ± 70.2	125.4 ± 61.2	280 ± 116	53
Hypothermic (%)	17.4	3.4	16.7	
Normothermic (%)	48.8	58.6	41.7	100
Hyperthermic (%)	32.6	37.9	41.7	

Table 2
Variations in handling time parameters (in min) between male and female Pampas foxes effectively and ineffectively immobilised with two drug protocols (K–X: ketamine–xylazine, T–Z: tiletamine–zolazepam). For references see Table 1.

		IT		MT		RT		LT	
Male mean ± SD	K–X ineffective	8	±2.74	23.75	±8.29	54.38	±20.48	127.69	±74.16
	K–X effective	8.44	±2.68	38.09	±19.35	52.72	±21.58	147.75	±57.57
	T–Z effective	9	±3.61	38.75	±4.79	48.33	±16.93	226	±126.76
Female mean ± SD	K–X ineffective	9.2	±2.28	16.2	±6.41	48.33	±13.92	122.22	±39.7
	K–X effective	8.8	±2.71	43.09	±36.76	48.32	±36.41	139.43	±79.64
	T–Z effective	8	±2.83	30	±0	127.5	±74.25	362.5	±3.54
Test H (p)	K–X ineffective	1.84	(0.52)	4.45	(0.03)	0.67	(0.40)	0.03	(0.86)
	K–X effective	0.07	(0.76)	0.15	(0.69)	4.04	(0.04)	1.4	(0.23)
	T–Z effective	2.4	(0.95)	2	(0.4)	1.36	(0.03)	0.33	(0.3)

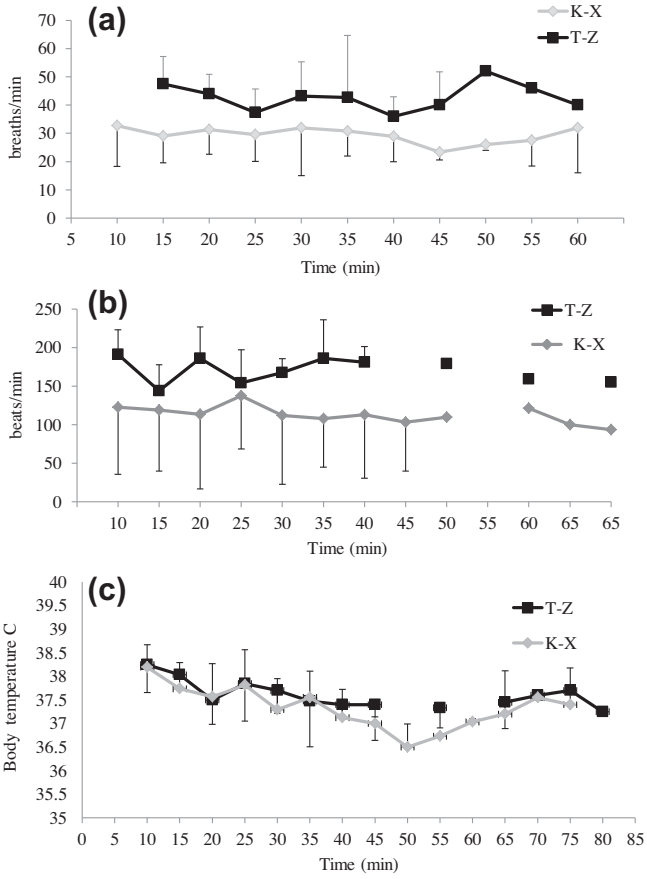

Fig. 1. Comparison between MEAN (±SD) values for (a) heart rate and (b) respiratory rate at 5-min intervals for Pampas foxes anaesthetised with a combination of K–X (ketamine–xylazine) and T–Z (tiletamine–zolazepam).

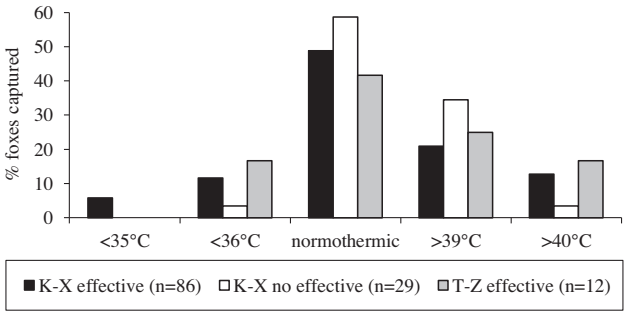

Fig. 2. Percentages of immobilised Pampas foxes showing severe hyperthermia (>40 °C), mild hyperthermia (>39 °C), normothermia (36–39 °C), severe hypothermia (<35 °C), mild hypothermia (<36 °C) for two drug protocols (K–X: ketamine–xylazine, T–Z: tiletamine–zolazepam) and effectiveness.

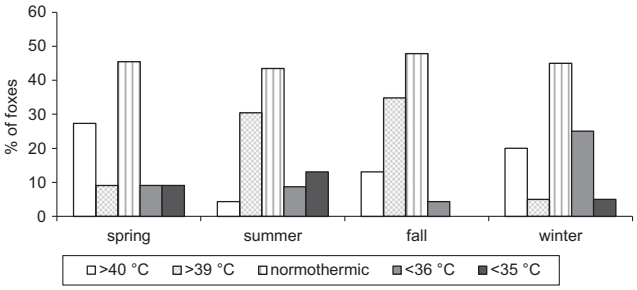

Fig. 3. Seasonal variations in proportion of thermoregulatory issues for Pampas foxes immobilised with K–X (ketamine–xylazine).

Severe hyperthermia (>40 °C) was only observed in foxes (n = 5) that received the K–X protocol. Moderate hyperthermia (>39 °C) was the most frequently observed (n = 11) issue with both protocols including ineffective K–X cases (Fig. 2). Initial mean temperature was 39.4 °C (range 9.1–39.9 °C, for the animals treated with the effective K–X protocol that demonstrated moderate hyperthermia while the initial mean temperature was 40.5 °C (range 40–40.8 °C) for the cohort that suffered severe hyperthermia. Foxes with moderate hyperthermia required a mean of 27 min (range 10–27 min) to return to levels below 38 °C and foxes with severe hyperthermia required 38.2 min (range 20–80 min) to reach a normal rectal temperature.

In normothermic foxes (n = 59) treated with K–X, mean ± SD rectal temperature was 38.8 ± 0.52 °C (range 36.9–38.9 °C) during the first 15 min and then decreased slightly to 36.9 ± 0.56 °C (36.6 to 37.8 °C).

Foxes with moderate hypothermia showed an average initial rectal temperature of 37.9 °C (range 37.2–38.6 °C) whereas temperature was 36.9 °C (range 35.1–38.6 °C) for foxes with severe hypothermia. Typically foxes with moderate hypothermia required 66.1 min (range 40–100 min) to recover normothermia and animals affected by severe hypothermia required 106 min (range 90–120 min).

The relation between thermoregulatory stress and season is shown in Fig 3. Most of the cases of severe hyperthermia (n = 3) were recorded in summer and all occurred during the night. Moderate hypothermia was strongly related with winter (55.5%). Moderate hyperthermia occurred mainly in winter with 55% of these cases occurring at night time. Predictably, severe hyperthermia cases were particularly frequent in summer and autumn, but showed no relationship with time of the day.

3.4. Post immobilisation survival

Twenty-six foxes were radio-tracked following capture. Following release the foxes vacated the immediate area running to a secure site, where they then spent several hours (21.4 ± 5.8 h) with typical small movements. After this period the foxes became active especially after sunset. Eighteen (70%) foxes were tracked for a minimum of 245 days (mean ± SD: 401.3 ± 325.6 days; expected battery life of collars: 360 days) until battery exhaustion. None showed any evidence of abnormal behaviour or activity patterns following the capture process. Two females had successful litters. Of the remaining 30% (n = 8), four had technical problems with collars that prevented post-capture follow up. Of the remaining foxes one was killed by hunters, one by a car, one by a dog, and one died from undetermined causes.

4. Discussion and conclusion

For both the T–Z and K–X protocols, the doses used in this study were typically sufficient for the immobilisation and initial handling of all free-ranging Pampas foxes. However, in 30 cases a supplemental ketamine administration was required to complete the procedure. Even knowing the optimal initial dosage for either protocol, the difficulty in assessing an accurate weight in a free-ranging species means that some individuals will be either under- or over-dosed. This is further confounded by individual variation in responses to the protocols that hinders the detection of differences between effective and ineffective K–X doses. Although statistical differences were found for the doses of X, it is difficult to separate the individual effect of each drug in this combination. The small sample of individuals with ineffective doses did not allow any strong conclusions for T–Z.

The variation in release time found among trap devices suggests that drug efficiency may have been affected by the model of trap used. The release time is a very important consideration in field conditions because it may increase social risk (pups may be rejected by their mothers and adults may not be accepted back into the group in the case of social species) and the risk for thermoregulation problems (Fowler, 1995; West et al., 2007). It has been reported that in the Pampas fox the differences between types of traps can precipitate marked individual variations in responses which can lead to physical injuries, thermoregulatory issues or metabolic disturbances such as capture myopathy (Luengos Vidal et al., 2003). Additionally, it is likely that the large individual variations in responses to drugs are related to capture stress (Kreeger and Seal, 1986) and its interactions with individual dissimilarities in nutritional and health conditions (Travaini et al., 1992).

The K–X combination resulted in a smooth induction and a smooth recovery from immobilisation. No deaths or serious adverse effects attributable to K–X occurred, although they have been reported for artic foxes *Alopex lagopus* (Fuglei et al., 2002) and wolves *Canis lupus* (Sladky et al., 2000). Finally, although a more complete study would be necessary to confirm our results, our post-release monitoring detected no adverse long-term consequences on survival and fitness.

The usage of T–Z also resulted in a smooth induction and recovery. The major difference was the more extended recovery time of foxes with T–Z. We have a small sample for this drug (n = 13) but we observed that recovery was very slow with the effective doses. Similarly, Acosta-Jamett et al. (2010) found longer release times with T–Z than K-medetomidine for two species of the same genus (*P. griseus* and *P. culpaeus*).

Although the respiratory and heart rates can be considered within a normal range for carnivores (West et al., 2007), the lack of physiological baseline data on *P. gymnocercus* prevented a proper evaluation of the physiologic effects of the drugs used. The respiratory rates of immobilised foxes remained relatively stable for both drugs and the large individual variations did not enable us to confirm statistically the tendency to increase respiratory rates for the first few minutes with K–X. Respiratory rates were consistently higher in foxes with T–Z than K–X. This agrees with what has been reported by Acosta-Jamett et al. (2010) with the combination of K with medetomidine. Similarly, although the heart rates remained stable during immobilisation for both drugs, the rates for foxes treated with T–Z were higher than for those with K–X. Interestingly, the heart rates recorded with the K–X protocol were lower when compared to those reported for other *Pseudalopex* species by Acosta-Jamett et al. (2010) with K and medetomidine.

Although it has been reported that thermal problems are associated with capture procedures (Fowler, 1995; Kreeger et al., 2002; West et al., 2007) and some cases of hypothermia have been reported for carnivores (Spelman et al., 1997; Soto-Azat et al., 2006; Castillo et al., 2012), thermal stress does not appear to be as common in carnivores as in other species (namely ungulates), few detailed descriptions have been published on this topic.

Despite the fact that the sites where we captured Pampas foxes would not be considered climatically extreme, we observed thermoregulatory complications in approximately 50% of the captures, which appeared to be independent of season. We are conscious that our data are only suggestive of a lack of relation with the ambient temperature, because we carried out no specifically designed experiment and took actions to restore a normal body temperature as soon as thermal stress was detected. Nevertheless, it is suspected that the counterintuitive finding that there is no association between season and thermal stress was caused by the ample daily variations in temperatures that typically occur in our study area throughout the year. Meyer et al. (2012) showed that the magnitude of the rise in body temperature that occurred in impalas (*Aepyceros melampus*) was more correlated to the individual animal's response to capture than to the immobilisation drug. The stress of capture relates to excessive muscular activity that may produce hyperthermia whereas prolonged restraint, related with trap models, may cause hypothermia before the chemical immobilisation. This situation, associated with the potential effects of capture drugs depressing an animal's thermoregulation system, may produce situations difficult to treat in field conditions and it has been mentioned that some animals may develop mild or clinically unapparent signs of hyperthermia (Cattet et al., 2008). The complications related to thermic stress that were recorded when trapping and handling wild Pampas foxes deserve a cautionary note, especially because our experience suggests that thermoregulatory issues are common in field situations. Hyperthermia was most commonly encountered, but by keeping immobilised animals in the shade, placing cold water bags on the animal, and irrigating it with cold water it was possible to restore foxes to normothermia. Hypothermia was encountered less commonly in our field condition. It is potentially more dangerous because it may be difficult to restore normal body temperature in the field with low ambient temperature and high humidity. Under such conditions we worked inside a tent, applied hot packs to the body, and carefully used a small portable camp stove to heat the tent. It is imperative that, regardless of the season of the year, the rectal temperature be routinely monitored so efforts to restore the patient to normothermia are initiated promptly. Because both hypothermia and hyperthermia can lead to more severe consequences for immobilised animals (Fowler, 1995), it is suggested that they should not be underestimated when planning and implementing field immobilisation protocols.

A dosage of 11 mg/kg of ketamine and 1 mg/kg of xylazine for an average handling time of 45 min is recommended for free-rang-

ing Pampas foxes. This drug combination offers a safe option, is not very expensive, and is readily available in most of the countries where the species occurs. Although more research is necessary to obtain an effective and safe dose for T–Z, this drug combination appears to be a good alternative for immobilising Pampas foxes.

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