

**Chemical immobilization of the endangered huemul (*Hippocamelus bisulcus*): adaptive veterinarian management strategies**

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Chemical immobilization is a key tool in conservation medicine yet effective protocol for chemical immobilization of the endangered huemul (*Hippocamelus bisulcus*) is lacking. The Argentine government protocol follows Chilean capture protocols for this species even though results have not been ideal. This prompted us to test alternative combinations. One aim was to reduce the medetomidine levels to determine if this reduced the unwanted side effects. We thus tested and compared five anesthetic drug combinations on the endangered huemul in Argentina to identify the most effective protocol for capturing free-ranging and captive animals.

We selected five drug combinations as used in other cervid species (Table 1). The government protocol used for group 1 ( $n = 4$ ; all free-ranging) was medetomidine 0.12 mg/Kg and ketamine 1.98 mg/Kg. In Groups 2 and 3 ( $n = 4$  and  $n = 2$ ; half were free-ranging), medetomidine levels were reduced to minimize hypoxemia and tachypnea commonly reported in Chilean captures.<sup>1</sup> For Groups 4 and 5 ( $n = 2$  and  $n = 2$ ; all captive deer) ketamine was excluded with the goal to achieve neuroleptoanalgesis.

**Table 1.** Five drug combinations used for chemical immobilization and reversal of huemul (*Hippocamelus bisulcus*) at Shoonem Protected Park, Chubut, Argentina.

PROTOCOL 1		PROTOCOL 2		PROTOCOL 3		PROTOCOL 4		PROTOCOL 5	
Anesthesia	Reversal	Anesthesia	Reversal	Sedation	Reversal	Sedation	Reversal	Sedation	Reversal
Ketamine 1.98 mg/kg		Ketamine 1.5 mg/kg		Midazolam 0.2 mg/kg	Flumazonil 0.01 mg/kg	Midazolam 0.05 mg/kg	Flumazonil 0.01 mg/kg	Ketamine 1.5 mg/kg	
Medetomidine 0.12 mg/kg	Antipamizole 5:1	Medetomidine 0.08 mg/kg	Antipamizole 5:1	Medetomidine 0.08 mg/kg	Antipamizole 5:1	Medetomidine 0.06 mg/kg	Antipamizole 5:1	Medetomidine 0.05 mg/kg	Antipamizole 5:1
		Butorphanol 0.1 mg/kg	Naloxone 0.05 mg/kg	Butorphanol 0.3 mg/kg	Naloxone 0.05 mg/kg	Butorphanol 0.3 mg/kg	Naloxone 0.05 mg/kg	Butorphanol 0.15 mg/kg	Naloxone 0.05 mg/kg

Captures ( $n = 14$ ) were conducted during the winters of 2022–2025: seven involved free-ranging adults<sup>2</sup> transported up to 35 km to the Shoonem Breeding and Rehabilitation Center (directed by WTF), while the remaining captures took place within the Center (Table 2).

**Table 2.** Details of the clinically managed huemul individuals and the monitoring parameters recorded during the application of the different anesthesia protocols along with body condition scores (BCS) at Shoonem Protected Park, Chubut, Argentina. NR: no value registered.

Animal ID	Sex	Date	Protocol	Wild or captive	Time to recovery (min)	Cardiac frequency (L/min)	Respiratory Frequency (bpm)	Estimated weight (kg)	Body condition score
1	♂	8/21/22	1	Wild	NR	32	100	80	2.5
2	♀	8/22/22	1	Wild	00:07	32	100	75	3
3	♀	8/23/22	2	Wild	0:10	44	96	75	2
4	♀	8/24/22	1	Wild	0:10	52–60	60–88	65	2
5	♂	8/27/22	1	Wild	0:11	NR	112	75	3
6	♂	8/27/23	2	Wild	0:02	44	80–112	75	3
6	♂	8/28/24	4	Captive	0:07	44	80	75	3
3	♀	8/28/24	4	Captive	0:15	40	40	65	3
7	♀	8/29/24	2	Wild	0:08	60	88–96	65	3
8	♂	7/31/24	2	Captive	0:00	NR	76–80	65	3
9	♀	9/27/25	5	Captive	0:00	48–54	56–80	65	3
10	♀	9/27/25	5	Captive	0:03	48–54	56–80	65	3
6	♂	9/27/25	3	Captive	NR	46–54	76–100	75	2
11	♂	9/27/25	3	Captive	0:17	46–54	76–100	75	3

Assessing the body condition of huemul accurately by eye is difficult given their thick fur, which thermoregulates to  $-50^{\circ}\text{C}$ .<sup>3</sup> The only way to accurately assess body condition, therefore, is by hands-on palpation, then scoring them against a Body Condition Score (BCS) chart.<sup>4</sup> We used a score system similar to that of Purinamills.com for deer, which is on a five-point scale, with 5 representing obese fat conditions, and 1 an emaciated animal. An ideal BCS lies between 3 and 4 and can be as high as 4.5 just prior to the rut, especially in bucks. We used half-scores (effectively making it a 10-point scale).

Inclusion of ketamine produced faster inductions and made heartbeat and blood pressure more evident for sampling. Other physiological parameters were similar across all combinations. When comparing the two dart-delivery systems (DANiNJECT rifle versus blowpipe), we found the blowpipe worked well in all four attempted chemical immobilization cases (2025), all carried out in the center on docile individuals acclimated to humans.

Developing and refining chemical immobilization protocols for *Hippocamelus bisulcus* is essential to ensure the welfare of huemul individuals during captures and translocations in conservation projects. Anesthesia and sedation of huemul pose a challenge due to the limited species-specific information available and the inherent difficulties of working with wild ungulates in mountainous environments. The results of this study reinforce the need to interpret the huemul's anesthetic response with caution, as most of the protocols currently used are extrapolated from other cervid species.

The reference protocol presented physiological limitations, whereas the alternative combinations improved cardiorespiratory stability and allowed for safer and more predictable recoveries—especially valuable during long transports or in animals under professional care. This experience highlights the value of adaptive management as a tool to reduce risks and strengthen conservation actions for an endangered species. Environmental conditions in the huemul's habitat represent another key factor. Capture in steep, hard-to-access terrain not only affects the logistics of the procedure, but also impacts the animal's physiology, particularly thermoregulation and oxygenation. These circumstances may explain part of the variability detected in induction and recovery times, as well as in the monitored physiological parameters. In this regard, access to portable monitoring equipment and strategies to mitigate thermal stress becomes essential to reduce associated complications.

It is crucial to prioritize techniques that minimize physiological impact, reduce handling time, and allow for safe recovery. Protocols that ensure rapid, stable, and predictable immobilization are especially important. We conclude that, given how little the huemul has been studied from this perspective, it is feasible to use different drug combinations that are applied in other cervid species to perform procedures in this species. Considering the huemul's docile temperament compared with more reactive cervids, it is plausible that lower dosage ranges may be sufficient to achieve safe and effective immobilization, although additional research is required to confirm this tendency.

From these results, we recommend including ketamin for darting free-ranging animals as it produced faster inductions, and parameters of heartbeat and blood pressure were more evident during sampling.

Furthermore, we recommend the use of the DANiNJECT blowpipe when working with huemul in a captive center, when an individual can be approached within 10 meters without difficulty. This technique will reduce the impact of the dart, resulting in less injuries. In comparison, for captures of wild huemul, the DANiNJECT rifle is the darting tool of choice, taking into account the further distances encountered in the wild between the targeted huemul individual and the shooter, with variable and difficult mountainous terrain.

We conclude that in-situ versus ex-situ conditions should guide both drug choice and delivery method.

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# 11TH INTERNATIONAL DEER BIOLOGY CONGRESS

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This Collection of full papers and short communications records the plenary presentations and oral and poster presentations submitted at the 11th International Deer Biology Congress, held in Dunedin, New Zealand in February, 2026. The Congress was attended by more than 190 scientists from Asia, North and South America, Europe and Oceania and covered a wide range of topics in deer biology. These included deer products and farming systems, deer health and welfare, physiology, nutrition, genetics, ecology, deer conservation, and the management of wild deer populations. Field trips during the Congress demonstrated New Zealand deer farming and the role of science in supporting this industry, and also the significance of native animal and plant conservation in Aotearoa-New Zealand.

There were nine plenary papers, presented by Cam Speedy and Kaylyn Pinney (The value and consequence of your deer here – a cultural paradox), Iain Gordon (Forty-five years of studying deer: a personal; reflection of the past, present and future of deer research), Kurt VerCauteren (Managing agricultural damage and disease of deer through applied research: one team's contribution), Suzanne Rowe (Development of genomic tools for genetic improvement in New Zealand deer), Jim Heffelfinger (Cervid conservation in North America: managing across a mosaic of jurisdictions), David Hazlerigg (What can chronobiology tell us about cervids? What can cervids tell us about chronobiology? And why should we care?), Kevin Monteith (Nutritional legacies across space and time: evidence for a nutritional ecotype), Chunyi Li (Antler stem cells: discovery, attributes and potential clinical applications) and Hayato Iijima (A history of deer management and abundance estimation in Japan: past lessons and future challenges).

The tradition of awarding the Tony and George Bubenik Memorial Award was continued at this Congress. This prize is awarded to the early researcher who is judged by a panel to have presented the best oral paper at the Congress. There were nine candidates. The prize was awarded to Amanda Van Buskirk for her oral presentation 'Estimating deer density with

camera and unmarked models to guide population management’.

The Collection editors are Assoc. Prof Gordon Dryden (The University of Queensland, Gatton, Australia) and Assoc. Prof Francisco Ceacero (Czech University of Life Sciences, Prague, Czechia).

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