Hippocamelus bisulcus

Jiménez, J., Guineo, G., Corti, P, Smith, J.A., Flueck, W., Vila, A., Gizejewski, Z., Gill, R.,McShea, B. & Geist, V. 2008. Hippocamelus bisulcus. In: IUCN 2008. 2008 IUCN Red List of Threatened Species

Taxonomy [top]

Kingdom	Phylum	Class	Order	Family
ANIMALIA	CHORDATA	MAMMALIA	CETARTIODACTYLA	CERVIDAE

Scientific Name: Hippocamelus bisulcus
Species Authority Molina, 1782
Common Name/s:

English – Patagonian Huemul, Chilean Guemal, Chilean Huemul, South Andean Deer, South Andean Huemul
French – Cerf Des Andes Méridionales, Huémul Des Andes Méridionales
Spanish – Ciervo Andino Meridional, Huemul, Huemul Patagónico

Assessment Information [top]

Red List Category & Criteria:	Endangered B2ab(i,ii,iii,iv,v); C2a(i) ver 3.1
Year Assessed:	2008
Assessor/s	Jiménez, J., Guineo, G., Corti, P, Smith, J.A., Flueck, W., Vila, A., Gizejewski, Z., Gill, R., McShea, B. & Geist, V.

Evaluator/s: Black, P. & Gonzalez, S. (Deer Red List Authority)

Justification:

This species is considered to be Endangered due to an ongoing decline due to habitat loss and hunting, reduction in range (area of occupancy) and because remaining populations are small and fragmented.

Criterion B (Geographic range):
The area of occupancy reflects the fact that the huemul will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. Population estimates for this species are a minimum of 1048 and a maximum of 1500 (Lopez *et al*. 1998; Polilitis 1983, 2006; Diaz and Smith-Fluenck 2000). Densities of 5-8.6 huemul/km² have been reported in well-studied groups (Diaz and Smith-Fluenck 2000, Frid 1999, Grosse 1949, Wensing, 2005), and based on body size, huemul are expected to occur at densities of about 5 deer/km² (Damuth 1987). Therefore we estimate the area of occupancy is likely much less than 500 km². The population is severely fragmented (Vila *et al*. 2006, Lopez *et al*. 1998, Diaz and Smith-Fluenck 2000). There are 101 groups (subpopulations) recognized for the 1048-1500 huemul, 60% of groups are found within one grid of max. 64 km² (often 10-20 individuals), 15% of groups are found within 2 grids of max. 128 km² (often 10-30 animals), and 8% of populations are found within an areas of only 192 km² (often 10-30 animals); (i) extent of occurrence: decline observed and projected (Polilitis 1998, 2003; Smith-Flueck *et al*. 2004); (ii) area of occupancy: decline observed and projected (Polilitis 1998 2003; Smith-Flueck *et al*. 2004); (iii) area, extent and/or quality of habitat: decline observed and projected (13); (iv) number of locations or subpopulations: decline observed and projected (Polilitis 1998, 2003; Smith-Flueck *et al*. 2004); (v) number of mature individuals: decline observed and projected (Polilitis 1998, 2003; Smith-Flueck *et al*. 2004)

Criterion C (small population and decline):
There are fewer than 2,500 mature individuals; there is a continuing and projected decline in numbers of mature individuals; and no subpopulation estimated to contain more than 250 mature individuals (Vila *et al*. 2006, Lopez *et al*. 1998; Polilitis 1983, 2006; Diaz and Smith-Fluenck 2000).

History:

1996 – Endangered (Baillie and Groombridge 1996)
1994 – Endangered (Groombridge 1994)
1990 – Endangered (IUCN 1990)
1988 – Endangered (IUCN Conservation Monitoring Centre 1988)
1986 – Endangered (IUCN Conservation Monitoring Centre 1986)
1982 – Endangered (Thornback and Jenkins 1982)

Geographic Range [top]

Range Description: The huemul is endemic to Chile and Argentina and currently only inhabits the Andes of Southern Chile and Argentina (Vila *et al.* 2006). The subpopulation in the Nevados de Chillán area (VIII Region of Chile) has the greatest degree of spatial isolation, with a distance of about 425 km from the nearest subpopulation to the south in Nahuel Huapi national park (Argentina, 40º30'S, Dirección Nacional de Fauna Silvestre). The southern part of Lanin national park (Argentina) may still have a subpopulation, but this needs to be confirmed (Roberto Nogara pers. comm.). The remainder of the current distribution also has a high degree of fragmentation apparently mainly due to past human activity, with the coastal populations in Chilean Patagonia presenting the lowest fragmentation, with the most continuous stretch of populations in areas that are nearly void of human presence due to the remoteness of a rugged terrain and the extreme weather conditions (Corti *et al*. 2005).. The degree of isolation of subpopulations within much of the region, or its effects, are, however, unclear.

The historical distribution range of huemul covered a latitudinal range of 20 degrees along about 2,000 km. In southern Patagonia huemul reached the Atlantic, and whereas they occurred in the Patagonian steppe to the north, it is presently uncertain how far east they might have reached (Diaz and Smith-Flueck 2000).

Countries: Native:
Argentina; Chile

Range Map: (click map to view full version)

Population [top]

Population: The species occurs in fragmented subpopulations with reported densities ranging from 0.02 - 5.66 deer/km² and averaging 1.25 (n=17) (reviewed in Diaz and Smith-Flueck 2000), however, some estimates included unoccupied areas. Wensing (2005) measured 8.64 huemul/km² in coastal Chile. It has been estimated that no more than 1,000 animals survive in Chile (Drouilly 1983) and 500 in Argentina (Flueck and Smith-Flueck 2006a), resulting from reductions of over 99% in population size and of over 50% in distribution (Redford and Eisenberg 1992). In Argentina, the remaining huemul reside along 1,850 km of Andes in about 50 subpopulations, which are mostly fragmented (Flueck and Smith-Flueck 2006a). There are an estimated 101 subpopulations of huemul, but 50 of these only live within 8x8 km squares whereas another 15 live within 8x16 km squares. Of these 65 subpopulations, 67% are outside of protected areas (Vila *et al.* 2006). In Chile, most huemul populations are concentrated in coastal Patagonian where extensive habitat is present in almost a continuous form. However, fragmentation increases northwards on the mainland.

Population Trend: Decreasing

Habitat and Ecology [top]

Habitat and Ecology: Habitat:
At present, the huemul occurs mainly in the Andes mountains, from close to sea-level up to 3,000 m elevation, and is found mainly at the forest edge and forests of southern beech (*Nothofagus*

spp.). Locally, huemul are still found in a variety of habitats: from valley flats to steep mountain slopes; from open grasslands to closed shrubby or forested habitats, inclusive of post-fire or mixed habitats. The pattern of using different habitat components has been found to vary and depends on availability, season, presences of other herbivores and predators, or disturbances, and is reflected in the broad dietary spectrum (see below). In the past, however, huemul occurred also in completely treeless areas of the Patagonian grasslands (Diaz 1993, also see Frid 1994). Annual home range size in some currently used habitat has been estimated to be about 350-650 ha with daily travel distances of up to 8 km, but rarely more than 5 km (reviewed in Diaz and Smith-Flueck 2000, Gill *et al*. 2007).

Group size:
Recent reports show group sizes of huemul ranging from single males to mixed groups of 11, whereas, group sizes in the past have exceeded 100 huemul in open grassland areas, likely as winter congregations (reviewed in Diaz and Smith-Flueck 2000). The large group sizes mentioned in the past, and the characteristics of current areas still containing medium-sized groups indicate that past densities were likely higher in most places. Pefaur *et al*. (1968) stated that densities had diminished. Steffen (1900) reported that after his crew ran out of food, they continued living off huemul for weeks.

Predators:
Predators of the huemul include man, puma (*Puma concolor*), culpeo fox (*Pseudalopex culpaeus*) and domestic dogs. A fawn was observed being killed by a fox, then chased off by the huemul mother (Wensing 2005, Paulo Corti unpubl.). Saucedo and Gill (2004) reported several fawns being killed by foxes. Hershkovitz (1972) described the several species of foxes, like culpeo fox, as dog-like or coyote-like in general appearance and habits. Puma have been shown to be an important ultimate mortality factor in one subpopulation (Smith-Flueck and Flueck 2001). Huemul will escape persistent pursuers by trying to out run them, by seeking refuge on cliffs or by using lakes, being very efficient swimmers. When threatened by predators, huemul may attempt avoidance by first remaining motionless or hiding, a strategy that is not optimal when fire arms are present. However, when discovered at close range they will flee, and rapidly. Huemul are known to snort, stomp the ground, or run effortlessly uphill or downhill; they also bound like mule deer and take to water. During captures conducted near Tortel in Chile, if the threat came from below, the huemul ran rapidly uphill, however, individuals were also observed to run quickly downhill, distancing themselves such that the capture team, using dogs, often lost the animals (O. Guineo pers. comm.). Huemul have the capacity to learn and have been observed to increase their flight distance in relation to disturbance activity, for instance, becoming flighty at 300 m when approached by people and/or their dogs (pers. comm. from M.L. Thomas and O. Guineo, Frid 2001). Krieg found in the 1920's that huemul in north-eastern areas was were considered very shy, whereas those in the southwest were extremely trusting (Krieg 1925:593).

There are no studies showing a negative impact from dogs on huemul populations, although in very reduced populations a loss from any factor is very significant. In fact, dogs have been shown to kill 36% of marked fawns and also adults (Corti 2006), which would place great pressure on mid-sized subpopulations and could result in local extinctions of reduced or declining subpopulations as an stochastic event rather than as a constant factor (P. Corti, unpubl.). It has been assumed that huemul are easy prey to dogs based on anecdotal accounts mentioning that they can become paralyzed after reaching a state of panic. This reaction has been explained by the absence of native cursorial predators. However, the evolutionary history of huemul included cursorial predators in North and South America, including Canis, which became extinct in South America only in the Holocene.

Documented interactions of huemul with dogs are rare, and thus the following accounts recorded by M.L. Thomas are instructive (Flueck and Smith-Flueck 2006b). Case 1: an adult huemul male ran down a logging trail, bounding side to side to navigate tree logs while trying to outrun 3 dogs. Case 2: a female and her fawn calf were chased by 2 dogs; they did not run to water but contoured a hill for about 1.5 km and then climbed to the higher ground, outrunning the dogs. Case 3: a radio-collared female huemul and her week-old fawn were observed. The doe suddenly went in front of several approaching dogs and away from the bedded fawn. The barking dogs circled away from the area to about 500 m and continued barking for 20 minutes. About 4 hours later, just at dusk the female approached the fawn from the other direction, nursed it and then headed back the same way she had come, taking the fawn about 500 m out of the area. Adult huemul have been observed to apparently become exhausted after relatively short chases (P. Corti, unpubl.), reasons for which should be studied. All 8 dead males described by M.L. Thomas (pers. comm.) in that area (which area?) died in winter just before antler shedding, which often indicates males that died from low physical condition and thus were susceptible to predation.

Feeding behavior:
Studies so far of individual wild subpopulations showed the number of plant species in the diet as low as 11 and as high as 120 in Torres del Paine (Guineo and Garay 2008, in press), which is dependent on the vegetation community, pressure from other herbivores, predators and disturbances. On the other hand, females spent 93 % of foraging time on only two plant species during the summer-fall season at Fiord Tempano in O'Higgins National Park (van Winden 2006). Graminae in the summer diet for instance was as low as 0.1% (Smith-Flueck 2003) or as high as 16% (D. Sierralta, unpubl.). The results of these and other studies shows that the diet of huemul can vary substantially from one subpopulation to another (also see Smith-Flueck 2003, Galende *et al*. 2005).

The Zoo in Buenos Aires kept huemul from 1936 to at least 1942, and, being 1500 km from natural huemul habitat, likely maintained huemul on an artificial diet (Flueck and Smith-Flueck 2006a). Huemul utilizing the Patagonian steppe in the past (Diaz 1993, Diaz and Smith-Flueck 2000) certainly had a different diet, maybe more like taruca (H. antisensis) given that the puna vegetation is very closely related to that of the Patagonian steppe, and many of the dominant genera are frequent in both regions and few of the Puna's genera are absent in Patagonia (Fernández and Busso 1997). It is interesting to note that two species, Maytenus sp. and Alstroemeria sp., were highly preferred in several fecal diet studies, yet were only accepted at a medium and low level, respectively, by captive-fed huemul. Instead these huemul preferred a native willow (Salix humboldtiana) above all other species (Drouilly 1983), which suggests that this plant species might have been a main staple of their winter diet, back when huemul were able to migrate to the river valleys before the arrival of settlers. Considering the consumption of at least 120 plant species in Torres del Paine, the completely different environments elsewhere used currently and historically, and the successful rearing in the Buenos Aires zoo indicate that the huemul is using an even larger number of plant species, is flexible in its diet which is to be expected of a ruminant, and is a mixed feeder overall.

Seasonal movements:
In other migrating cervids, several factors are known to affect migratory behavior, such as snow depth and consistency and availability of food as stimuli to seek lower elevations, population density, age and sex structure, and behavior of the predator. A consistent pattern among temperate cervids in mountains is that after the initial arrival of a population (through dispersal, re-introduction, invasion) it begins with a resident population, occupying winter ranges (McCullough 1985, Haller 2002). Huemul in some areas moved to 1,000 m elevation in winter and to 3,000 m in summer in the past (Housse 1953)

Past descriptions of huemul reveal that both resident and migratory behaviors existed. Krieg (1940) indicated the existence of all-year resident huemul in quiet valley bottoms, comparing them to the phenomena of the ‘forest chamois' (Rupicapra rupicapra) as opposed to chamois moving to high elevation Alps during the summer. On the eastern side of the Andes, seasonal migrations of medium distances are still remembered by older people living in intermountain valleys, usually from many decades earlier, but longer migrations are only known from a few reports by early explorers (Flueck and Smith-Flueck 2006b) and would be a movement pattern similar to cervids inhabiting the Rocky mountains and adjoining prairies of North America.

The distance of migration depends on the steepness of an area. As the animals take advantage of phenological changes (Atzler 1984), steep terrain requires little lateral displacement to gain altitude. Thus, huemul in steep terrain in Chile had short migration distances, ‘migrations’ were mainly reflected as an altitudinal shift; in the study areas of Gill *et al*. (2007), huemul undertook either a modest seasonal migration or none at all as summer and winter areas overlapped. Winter severity is important in determining actual migratory behavior; other cervids, for instance, commonly remain at higher altitudes during winters with less snow (Brown 1992, Sabine *et al*. 2002). On the other hand the reverse situation represents a trap for several huemul populations, when during harsher winters they do go to lower areas that have been settled, and where they could die from hunting or dogs.

Systems: Terrestrial

List of Habitats:

1	Forest
1.3	Forest - Subantarctic
1.4	Forest - Temperate
3	Shrubland
3.2	Shrubland - Subantarctic
3.4	Shrubland - Temperate
3.8	Shrubland - Mediterranean-type Shrubby Vegetation
4	Grassland
4.3	Grassland - Subantarctic
4.4	Grassland - Temperate
5	Wetlands (inland)
5.4	Wetlands (inland) - Bogs, Marshes, Swamps, Fens, Peatlands
5.11	Wetlands (inland) - Alpine Wetlands (includes temporary waters from snowmelt)
6	Rocky areas (eg. inland cliffs, mountain peaks)
8	Desert
8.2	Desert - Temperate
14	Artificial/Terrestrial
14.3	Artificial/Terrestrial - Plantations

Threats [top]

Major Threat(s): The widespread reduction in numbers and distributional range across the full extent of the historic range (Redford and Eisenberg 1992) was likely due to a combination from overkill, overstocking with domestic livestock (feral and controlled animals), and land conversion for agricultural purposes. This process started before the arrival of Spaniards and peaked before the first systematic accounts were made (Miller 1980), and details remain to be elucidated. Based on the chronology of human settlement, the impact was earlier in the northern than in the southern portion of the distribution, and earliest possibly in the northwestern portion, which is the central valley of Chile. Krieg (1925: 593) having surveyed the area of huemul distribution, noted that few people on the west side of the Andes had seen huemul as they only remained in the highest and remotest areas.

The major reduction in numbers and distribution resulted in an increased fragmentation of the population. The resulting subpopulations continue to experience a variety of factors, which keep their numbers low or decreasing. When an isolated subpopulation becomes very small (10-30 huemul, a common feature of the present situation), then ANY loss of individuals is important (Caughley 1994), including from natural predators. It is under these very local circumstances that many different biophysical factors can become crucial: logging, mining, construction of roads, water reservoirs and other infrastructure, livestock grazing, farming, poaching, new diseases, uncontrolled and/or feral dogs, or unregulated tourism. Huemul subpopulations from such a large variety of habitats and circumstances can be expected to be of different average physical condition, and thus might respond differently to a given factor.

One important omnipresent threat is that both Chile and Argentina have weak mechanisms to protect huemul in non-protected areas, and even inside protected areas, from inadequate responses by authorities due to financial and other constraints. Thus, other national interests may override the presence of a huemul subpopulation, and major public constructions are realized instead (e.g. related to hydroelectric power, pipelines, freeways, new towns, development of tourism, etc). The many economic activities tolerated are mainly related to livestock production, forest products, and tourism of all types including hunting.

Another omnipresent and continuous threat is the virtual elimination of suitable winter range. Whereas some subpopulations have access to a sufficient altitudinal range within a small area (due to steepness of terrain), others would need to migrate over much longer distances, particularly on the eastern slopes of the Andes. In all cases, if the winter range is basically occupied by settlers, farmers or livestock producers, uncontrolled hunting and uncontrolled dog populations might prevent a subpopulation from recovering. Most if not all historical winter ranges on the eastern slopes are private and are used intensely for livestock production and/or hunting. This includes many protected areas including the national reserves of national parks. Besides the loss of winter ranges, the migratory behavioural patterns have also been eliminated, because huemul reaching those winter ranges were regularly killed. Migration behaviour in other cervids has been shown to be an acquired trait which can be eliminated through hunting or barriers (Baker 1978, Hjeljord 2001, Berger 2004, Bolger *et al.* 2008). Thus, habitat loss, deterioration of winter habitat and loss of traditional migratory behaviour may be some of the more common factors in many of the subpopulations.

An omnipresent continuous threat is the vulnerability towards humans, due to an initial lack of wariness which provides easy killing opportunities as has been reported consistently since the 1800's. Thus there are few opportunities for a huemul to learn to increase the flight distance. Losses from illegal hunting continue and might have an important effect on the viability of very reduced subpopulations. Populated areas result in losses of huemul from hunting and from dogs, and thus they contribute to undermining the reformation of original migratory behavioural patterns.

There are several threats which might take importance at a local situation, but cannot be considered to represent an omnipresent problem. The local circumstances of a given subpopulation would determine the need for specific research to address the problems and to find adequate counter measures (Corti *et al*. 2005).

Food competition from other herbivores: currently, but certainly in the past, huemul formed part of a natural multi-herbivore system. As in any such system, it is the combined herbivore pressure on forage which is of interest. Like other ruminants, huemul have a plastic feeding behaviour (see under Habitat and Ecology). Diets in other cervids have been shown to change according to intraspecific changes in density or changes in the combined density or mixture of a herbivore community. For instance, it was shown that huemul and red deer diets in a lenga forest habitat overlapped between 42 and 62% (Smith-Flueck 2003). Whereas several studies like this one show that different herbivores (native and exotic) eat the same plant species as huemul, there are no studies to show that this foraging by other herbivores affects huemul performance, such as a decrease in reproduction or increase in mortality, thus reducing the population growth rate lamda. In fact, huemul still have remained, even in the presence of cattle production lasting over 110 years (Flueck and Smith-Flueck 2006b). Meanwhile huemul have disappeared in areas with no cattle, sheep, nor exotic red deer (Smith-Flueck 2003). Krieg, already in 1940, observed that forage in winter range areas produced a large quantity of domestic and wild exotic herbivores with superb body development. Thus he considered that a lack of forage could not explain the absence of native herbivores like huemul. Overgrazing, by definition, through excessive livestock or uncontrolled wild exotic herbivore density in huemul areas would be expected to affect all herbivores present in that area.

Diseases: When other herbivores (native, exotic wild or domestic) use the same range as huemul, diseases can be transmitted. In Argentina, records from local government agricultural research institutions (INTA), animal health authorities (SENASA) and livestock veterinarians are available to indicate the presence of dangerous diseases near huemul populations, as the raising of livestock is the major economy for the region. Brucellosis could be a concern for reduced huemul populations. In Chile, ongoing research is showing new findings of diseases transmitted from cattle (P. Corti, unpubl.).

Anecdotal accounts by settlers are cited who claimed that foot and mouth disease (FMD) was responsible for decimating huemul over huge areas 60-70 years ago, and that they are very susceptible (König 1952, Simonetti 1995). FMD outbreaks in the UK resulted in experimental studies of 5 cervid species which were all susceptible to FMD to some degree. Based on natural behaviour of these free-living deer in the UK, they are considered unlikely to be an important factor in the maintenance and transmission of the virus during an epidemic of FMD in domestic livestock (Thrusfield and Fletcher 2002, Fletcher 2004). At normal densities of cervids, FMD is considered a self-limiting disease (Morgan *et al*. 2003). The low densities of huemul and reactions of other cervids to FMD render those early anecdotal accounts by settlers doubtful. Additionally, at the possible rate of increase in deer with one young per year, a population would have recovered by 300% in only a few years. Some, citing Texera of 1974, believe diseases like Cysticercus tenuicollis to be fatal to huemul when transmitted by livestock (Flueck and Smith-Flueck 2006b). However, Texera stated that he did not consider the presence of C. t. to be the cause of death, rather that the condition of the female deteriorated after a premature parturition, aggravated by very little space and little variety of food provided. Furthermore, in other cervids and ungulates the presence of C. t. is considered of little significance and usually does not result in any clinical signs (Leiby and Dyer 1971, Prestwood *et al*. 1976, Mason 1994, Letkova and Lazar 2006). The adult stage is cosmopolitan in distribution and occurs in the small intestine of dogs, foxes, and other wild carnivores including puma (Rausch *et al*. 1983).

A recent study (Flueck and Smith-Flueck 2008) reports on bone disease based on dead huemul. Osteopathology was found in 52% of adults, 63% showed mandibular, 100% maxillary and 78% appendicular lesions. These skeletal lesions would affect the capacity for predator avoidance, suggested as an explanation for the low average adult age (3.1 years) and lack of population recovery. Compared to other ungulate studies, huemul were affected at young ages and with more compounded and severe pathologies. It was hypothesized that the generalized chronic alveolar osteomyelitis and osteoarthritis in huemul was secondary and related to nutritional ecology.

Invasive species: no studies are available showing any direct effects on huemul, neither through competition, predation nor diseases. Invasive species potentially threatening huemul include Cervus elaphus, Dama dama, Sus scrofa, Lepus europaeus, and Oryctolagus cuniculus, but it is unclear if they contributed to the present situation as huemul subpopulations disappeared frequently before the arrival of these species. Feral livestock with the same potential impacts include cattle, sheep, horses, and goats. Similar effects result from extensively run livestock and dog use, which is a widespread land use throughout the huemul distribution. Additional wild species with a potential to affect huemul are currently held in fenced areas, thus representing potential sources of future escapees: Capreolus capreolus, Capra ibex, and Hemitragus jemlahicus (Flueck and Smith-Flueck 2006a).

Predation: this poses an important threat to reduced subpopulations of huemul as each loss is the more important as the size of the subpopulation diminishes: a demographic stochasticity problem. If it is suspected as a mayor mortality cause, it should be confirmed through studies and eliminated with all means possible. One study based on tagged animals showed that 36% of fawns and also adult huemul were killed by dogs (Corti 2006). Depending on other factors affecting mortality and recruitment, dog predation can be enough to prevent recovery or even precipitate a decline. Other subpopulations though have declined in the absence of dogs, and the nature of local threats has to be determined for each subpopulation. It is also possible that reduced huemul subpopulations cannot recover, and thus are threatened with extinction from predation by native species. In such cases it might be necessary to temporarily reduced the pressure from native predators.

Logging and silviculture: extraction of wood should not by itself create a problem, as huemul do well in post-fire landscapes. Negative impacts would be expected from secondary issues, like hunting, presences of dogs, new roads providing access, and likelihood of new settlers and livestock. Marked huemul have been shown to leave areas disturbed by logging (Gill *et al*. 2007). Pure plantations, especially of exotic conifers, would likely make habitat unsuitable. The subpopulation at Cerro Castillo (Chile) appears to be expanding to areas which had been reforested with exotic pine trees to stop erosion (J. Jimenez pers. comm.).

Genetic problems: inbreeding may affect various components of fitness, but it is poorly understood in natural populations (Coulson *et al*. 1998). They looked at 2 measures, birth weight and neonatal survival in red deer, and neither inbreeding coefficient nor individual heterozygosity was consistently related to these fitness components. China's population of Pere David's deer, once extinct in its native habitat in China, has grown to over 2,000 from 12 founders, with few signs of genetic retrogression after generations of inbreeding. To measure occurrence of inbreeding on a genetic basis might be difficult in general (Pemperton 2004), and very impractical for most remaining huemul subpopulations. Detection of a reduced fitness component with or without specific underlying causes might still be an indication of a problem related to inbreeding. On the other hand some species have been show to be apparently resistant to inbreeding possibly from purging of deleterious alleles (Windig *et al*. 2004). As there is no apt information on huemul, the precautionary principle indicates that increasing the size of subpopulations by all means should be a mayor major objective.

Small population size: this is the most important aspect in terms of extinction risk due to demographic and environmental stochasticity, and emphasis should be on determining the population size and monitoring the trend (O'Grady *et al*. 2004). Only a few subpopulations in Chile seem to be stable (Tamango and Castillo National Reserves, Torres del Paine National Park, some southern coastal subpopulations). One subpopulation in central Chile has been declining (Povilitis

1998), but trends for most subpopulations are unknown, or became only clear when local extinctions were evident. Although sightings in both countries have increased in recent times for some localities, it has not been shown to be due to a numeric response. Any factor known or suspected to prevent the numeric recovery should be eliminated. In the case that this is impossible, another valid option is a possible total capture of the group and to use it to reinforce other subpopulations, to re-introduce the animals to a site where negative factors are judged sufficiently reduced, or to stock a semi-captive centre.

Infrastructure development: both countries are experiencing rapid economic growth and are promoting its continuation. Several important huemul subpopulations face construction of the largest ever energy project of Chile, major dams and reservoirs and 1600 km of transmission lines, whereas smaller scaled hydro electric projects in Argentina will also affect several populations. Inundations of fertile valley bottoms will be a major loss of important habitat, whereas construction and later maintenance will increase the human contact with these huemul and thus result in losses from poaching, dogs and illegal releases of domestic livestock. The current environmental approach in Chile leans towards “the one who does the damage pays”, resulting principally in trying to mitigate by reducing damage, repair or compensation (pay if damage is irreversible).

Other
Some factors are not commonly listed as threats, yet they contribute substantially to the probability of achieving a recovery, or not. Some countries are obligated by law to spend the money necessary to address issues determined important for an endangered species. This appears not to apply to Chile nor Argentina. The National priorities regarding an endangered species or other National interests, like building dams, pipelines, roads etc differ, thus the adequacy of laws pertaining to huemul need to be confirmed. For instance, as of 1995, Chilean laws contained flaws, were inconsistent, and the mining code in Art. 17 permits mining exploration and exploitation within the Protected Wilderness Areas (Diaz and Smith-Flueck 2000). Also, the adequacy of enforcing the existing laws has direct implication on the potential to achieve a recovery, and should be explicitly analyzed.

Socioeconomic and political interests often override what conservation biology would recommend, and thus might limit the potential for recovery. Settlers within National parks raise livestock (Martin and Chehebar 2001), utilizing up to 56% of park areas (Simberloff *et al*. 2003), but commonly run several fold more livestock than permitted (Serret *et al*. 1994). Although areas of Reserves in National Parks were de

List of Threats:

1 Residential & commercial development
1.1 Housing & urban areas
1.3 Tourism & recreation areas
2 Agriculture & aquaculture
2.1 Annual & perennial non-timber crops
2.1.2 Small-holder farming
2.1.3 Agro-industry farming
2.2 Wood & pulp plantations
2.2.1 Small-holder plantations
2.2.3 Scale Unknown/Unrecorded
2.3 Livestock farming & ranching
2.3.1 Nomadic grazing
2.3.2 Small-holder grazing, ranching or farming
2.3.3 Agro-industry grazing, ranching or farming
3 Energy production & mining

3.2 Mining & quarrying
5 Biological resource use
5.3 Logging & wood harvesting
5.3.5 Motivation Unknown/Unrecorded
6 Human intrusions & disturbance
6.1 Recreational activities
6.3 Work & other activities
7 Natural system modifications
7.1 Fire & fire suppression
7.1.3 Trend Unknown/Unrecorded
7.2 Dams & water management/use
7.2.11Dams (size unknown)
8 Invasive & other problematic species & genes
8.1 Invasive non-native/alien species
8.1.1 Unspecified species
8.2 Problematic native species

Conservation Actions [top]

Conservation Actions:

As 63% of all subpopulations are outside of protected areas (and another 9% are partially outside), there is an urgent need to establish management plans for most of the remaining huemul subpopulations. The huemul is classified as endangered in the Chilean and Argentinean Red Data Books of Vertebrates (Glade 1988, Díaz and Ojeda 2000) and is also listed in the Appendix I of CITES and UNEP/CMS Conventions. This species has been protected by law since 1929 in Chile and 1989 in parts of Argentina (Diaz and Smith-Flueck 2000). In order to promote huemul conservation, five Binational Workshops have been conducted since 1992. In 2001, both countries developed their national huemul conservation plans (Chile began with an update in 2007), but funding constraints have thus far impeded their implementation. The species occurs in 13 Chilean national parks and reserves (Corti *et al.* 2005), and populations occurring outside of protected areas are either barely known or unknown. In Argentina, huemul occur in 5 national parks plus several provincial reserves. Both countries also have some private reserves with huemul populations. Nevertheless, only 28% of the 101 identified subpopulations in both countries were found within existing protected areas, 63% were located outside of protected areas, while 9% were found partially within protected areas (Vila *et al*. 2006). Moreover, most protected areas in both countries are ‘paper parks': financial constraints result in insufficient personnel and infrastructure and prevent adequate inventorying, monitoring and protective measures. For instance, problems are such that field-based national park wardens in Argentina often do not receive fuel for transportation, for 2 month periods (2007/2008). A man on horseback with 5 dogs, another roaming dog, and a group of 3 horseback riders were seen in the course of one day, on visiting an area classified as Critical due to huemul presence in an Argentina national park reserve. (C. Chehebar 2007, report to national park administration). Furthermore, management plans, if prepared, are based on limited data, and are hardly, if at all, implemented (Martin and Chehebar 2001, Rusch 2002). In remote national parks of Chile, cattle introductions and poaching of huemul are common due to lack of infrastructure for enforcement (Frid 2001, Corti 2006). Other important limitations result from socioeconomic and political interests which prevent the implementation of conservation measures, such as removal of cattle from national parks, which utilize up to 56% of park areas (Simberloff *et al*. 2003). On the other hand, the public system of protected areas contains extensive habitat formerly and currently still used by huemul, making it a prime candidate for contributing significantly to huemul recovery (Flueck and Smith-Flueck 2006a).

An urgent task is thus to find ways to extend the implementation and control of existing policies established for protected areas (Martin and Chehebar 2001, Rusch 2002).

Some conservation measures currently prioritized by government agencies of both countries include: increase efforts to obtain more information on huemul subpopulations such as the current distribution, abundance, and threats; encourage more effective protection of the identified subpopulations (emphasizing an increase of protection in the VIII and XI regions of Chile and in the Province of Chubut of Argentina); promote the creation of private protected areas with presence of huemul (or suitable habitat) to facilitate connectivity and dispersal; promote training to improve local skills in wildlife management and monitoring techniques; and encourage educational activities and media campaigns to raise awareness about the huemul´s status. Achieving these measures would be more likely through coordination (also binationally) between the several administrative jurisdictions, private owners, and local communities.

The present state of huemul with its high degree of fragmentation, small subpopulation sizes, and low total number (Vila *et al*. 2006) indicates that the situation is not viable, and may be less so in Argentina with only a few hundred remaining huemul. The trend follows a continued loss of subpopulations, i.e. a reduction in numbers and area of occupancy, even within national parks (Franke 1949, Povilitis 1998, Serret 2001). In 1936, the Argentine National Parks created a captive breeding station in order to repopulate park areas already devoid of huemul, and in 1971 the 'Operativo Nacional Huemul' was launched to prevent huemul from extinction, although the program never crystallized. The goal today is the species' recovery (e.g. Argentina National Huemul Conservation and Recovery Plan), which implies an increase in numbers and distribution to a viable level. For recovery to succeed, threats to individual remaining huemul subpopulations need to be understood (Corti *et al*. 2005). Making decisions about corrective measures should be based on understanding these threats, and would take conservation beyond the creation of protected areas. Basic information on the species and on most subpopulations is very scarce, which complicates interpretations of some observations. If sufficient data are lacking to make informed management decisions, they likely are insufficient to build a realistic PVA model which would be premature or even misleading; urgent management needs and research priorities can be identified without constructing a quantitative model (Ralls *et al*. 2002). Thus, a fundamental need is to increase well-founded knowledge about the ecology and biology of the species and factors preventing the recovery of individual subpopulations. It is important to study detrimental factors with a holistic approach since the factors acting on a given subpopulation are multi-factorial, and the importance of factors may change over time. In-situ studies are recommended; however, a recovery strategy for huemul must also include ex-situ tools, as for many of the questions, the most efficient, and sometimes only, approach would be controlled studies of semi-captive animals (captive center in Chile since 2005). It would also provide opportunities to study re-introduced groups (stemming from the captive breeding center), taking an adaptive management approach (Flueck and Smith-Flueck 2006a, Armstrong and Seddon 2007). In consequence, several additional conservation measures surfaced that need to be incorporated:

1. Scientific research, as performed in similar situations worldwide, should be facilitated by all agencies involved and for any existing huemul subpopulation
2. Management decisions for any subpopulation should be made acknowledging the limitations imposed by socioeconomic and political constraints and the gaps of information, and should take the approach of the Precautionary Principle until better information is available
3. Centres with semi-captive huemul for studies and re-introductions function as a valuable recovery tool and should be facilitated, particularly if non-competing funds are available. Efforts should be directed to gain a maximum of information through research under controlled

conditions and through reintroductions
4. Once subpopulations are known to be recovering numerically and spatially, they should become a research focus in order to determine the reasons for the recovery success.

List of Conservation Actions:

1 Land/water protection
1.1 Site/area protection
1.2 Resource & habitat protection
2 Land/water management
2.1 Site/area management
2.3 Habitat & natural process restoration
3 Species management
3.2 Species recovery
3.3 Species re-introduction
3.3.1 Reintroduction
3.4 Ex-situ conservation
3.4.1 Captive breeding/artificial propagation
4 Education & awareness
4.1 Formal education
4.2 Training
4.3 Awareness & communications
5 Law & policy
5.4 Compliance and enforcement
5.4.2 National level
5.4.3 Sub-national level

Citation: Jiménez, J., Guineo, G., Corti, P, Smith, J.A., Flueck, W., Vila, A., Gizejewski, Z., Gill, R., McShea, B. & Geist, V. 2008. *Hippocamelus bisulcus*. In: IUCN 2008. 2008 IUCN Red List of Threatened Species. <www.iucnredlist.org>. Downloaded on **06 November 2008**.

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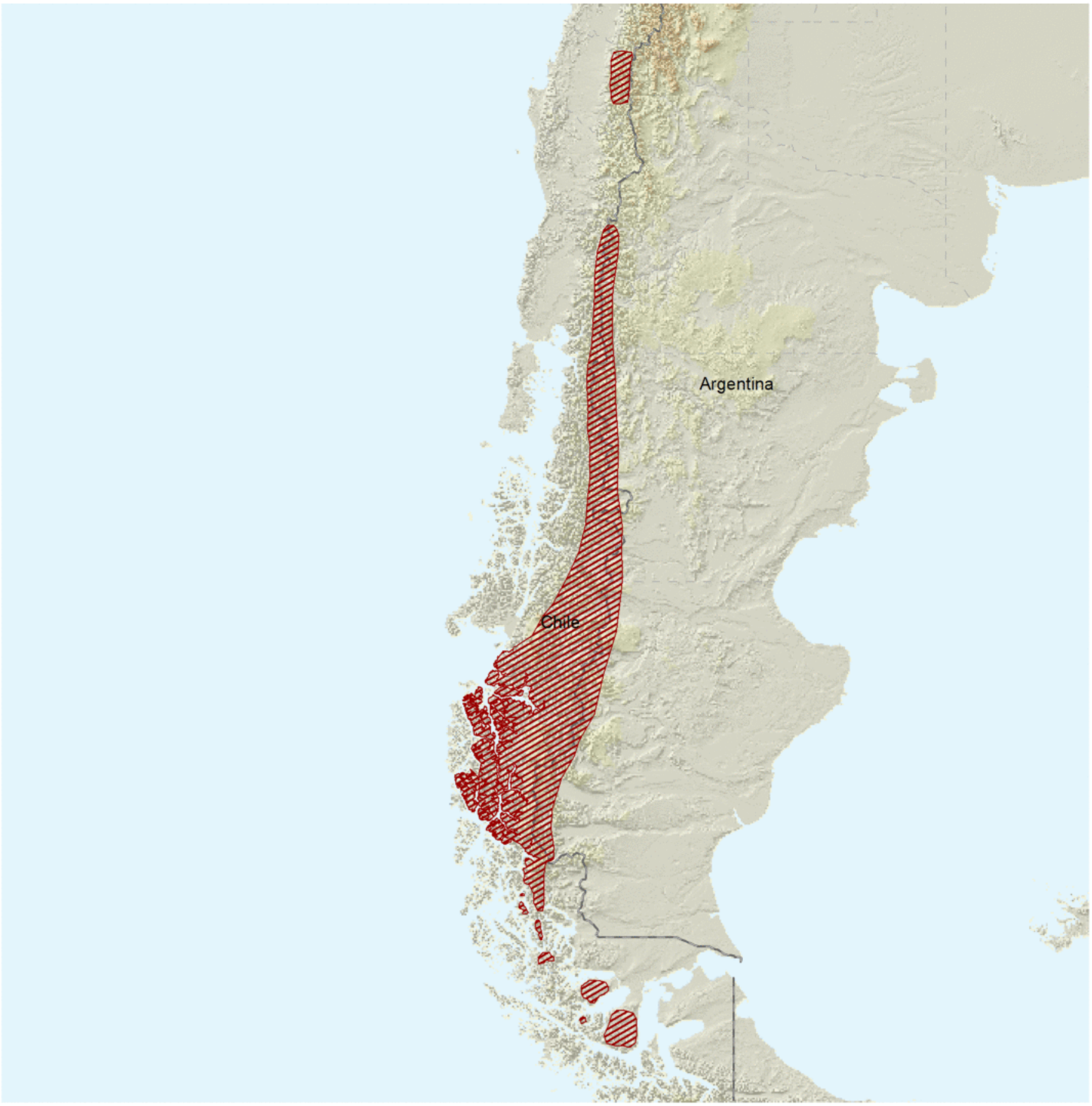

Hippocamelus bisulcus

NE DD LC NT VU EN ENDANGERED CR EW EX

range type

- native (resident)
- native (breeding)
- native (non breeding)
- reintroduced
- introduced
- origin uncertain
- possibly extinct
- extinct

- national boundaries
- subnational boundaries
- lakes, rivers, canals
- salt pans, intermittent rivers

azimuthal equal area central point: 0°, 0°

map created 10/01/2008

data source:
IUCN (International Union for Conservation of Nature)