



## OBSERVATIONS ON HABITAT USE AND SOCIAL ORGANIZATION OF A HUEMUL *Hippocamelus bisulcus* COASTAL POPULATION IN CHILE

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### Abstract

*Habitat use and social organization of a huemul Hippocamelus bisulcus coastal population was studied in a periglacial fjord of Chile during spring. Only interior populations of this endangered deer had been previously studied. Typical group size was 2.2, and adult males and females were observed associating only twice. All age-sex classes (except fawns) fed mostly on the perennial herb Gunnera magellanica. Adult males and juveniles primarily used periglacial grassland, and adult females mainly bluff habitat. Newborn fawns were seen only on bluffs. Adult females may be using bluffs during spring to minimize predation on their newborn offspring. Old-growth forest was not used during spring, but fecal pellet-group transects suggested that this habitat had been used during winter. Coastal populations have suffered less human impact than interior populations, but some coastal areas are likely to be affected by logging, and there is a demand for transplanting coastal deer to interior reserves. To ensure the species' long-term survival, a better understanding of the behavioural ecology of coastal populations is necessary before resource extraction and transplants occur.*

**Keywords:** southern Chile, huemul deer, coastal populations, habitat use, social organization, behavioural ecology.

### INTRODUCTION

The huemul *Hippocamelus bisulcus* is a medium-sized deer endemic to southern Chile and Argentina and currently classed as endangered (IUCN, 1990). Prior to European colonization, the species was abundant between latitudes 34° and 53° S, mainly along the spine of the Andes, but also on steppes east of the mountains (Cabrera & Yepes, 1960; Povilitis, 1978; Diaz, 1990). The majority of animals are now concentrated along the mountainous Patagonian Coast of Chile (Frid, 1991; Povilitis, 1986; local fishermen, pers. comm.), and

populations surviving in the interior are small and few (Povilitis, 1983a; Aldridge, 1988).

In the interior, huemul populations have been either threatened or eliminated by poaching, ranching, and logging (Povilitis, 1978, 1979, 1983a). These regions have a more benign climate than the Patagonian Coast, are often suitable for agriculture, and are relatively accessible from roads and human settlements. By contrast, gigantic ice-caps, poor soils and a stormier climate have minimized human presence and impacts in Chile's Patagonian Coast, where an unknown number of huemul still occupy pristine habitats on the central mainland (Frid, 1991; Povilitis, 1986), Wellington Island, the Brunswick Peninsula (local fishermen, pers. comm.), and adjacent areas. These subantarctic locations, however, are the southwest extreme of the huemul's original distribution. Suitable habitats are fragmented by glaciers and, though primary succession forage may be abundant during spring, forests are well-developed in only a few locations (Pisano, 1977, 1987; Veblen & Schlegel, 1982; Alaback, 1991). Outside the growing season—when huemul are likely to require browse, thermal cover and snow interception—fragmentation and poor development of forests probably make much of the Patagonian Coast a marginal habitat. The opportunity for detailed huemul studies in more optimal environments seems to be lost to the past.

The international logging industry has recently shown a strong interest in Chile. Large-scale logging has started in the coastal—interior ecotone of southern Patagonia, including areas occupied by huemul. Chipping plants have been established, allowing profitable logging of poorly developed forests (Frid, 1990b; Frid & Nikiforuk, 1990). Following the depletion of road-accessible old-growth timber, large-scale logging and other human impacts will likely spread further into Chile's Patagonian Coast. If we are to ensure the huemul's long-term survival, a detailed understanding of the habitat requirements and behavioural ecology of coastal populations will be necessary *before* resource extraction becomes more extensive.

Previously published studies of the behavioural ecology of huemul are scarce and deal exclusively with

interior populations (Povilitis, 1978, 1983b, 1985). Coastal populations are virtually unknown. In this paper I present observations on habitat use and social organization of a huemul coastal population. In spite of data limitations, this study represents most of our current knowledge of coastal populations and allows us to formulate refined, testable hypotheses. Perhaps it will also stimulate *in situ* conservation efforts for huemul living along the Patagonian Coast, the last stronghold of this endangered species.

## STUDY SITE, DEER, AND METHODS

### Study site and habitats

Field work took place during spring, from 26 October to 20 December 1990. The 9.8 km<sup>2</sup> study site was located in a 13.3-km<sup>2</sup> watershed on the mainland of Chile's Patagonian Coast south of 48°. The watershed is at the head of a fjord, adjacent to the southern continental ice-cap, one of the largest ice masses outside the poles (Mercer, 1970). Precipitation is evenly distributed throughout the year and has an annual mean of 3585 mm at the nearest weather station (Zamora & Santana, 1979). This station, however, is located in a weather shadow, and precipitation is probably greater at the study site. Biogeoclimatic conditions resemble those of periglacial areas in Southeast Alaska and Prince William Sound, except that at the study site winters are milder and summers cooler (Alaback, 1991). Detailed phytogeographic descriptions of Chile's Patagonian Coast can be found in Pisano (1977, 1987), Veblen and Schlegel (1982), and Dollenz (1982).

Surface areas of habitats and the study site were estimated by using an electronic digitizer on a 1 : 60 000 aerial photograph. Elevations were estimated in the field using map and altimeter. Basal areas of forest on the west side of the study site were estimated by taking a cruising gauge reading every 20 m on one contiguous, end-to-end, transect ( $n = 109$ ) plots. Basal areas of forest on the east side of the study site were not estimated. For the purposes of this study, habitats were classified as follows:

- (1) *Periglacial grassland*: This relatively flat valley bottom covers 27.5% of the study site, and has an altitudinal range of 0–110 m above sea level (asl). It is recently deglaciated, and has various ponds and lakes. Soils are moderately well-drained. Vegetation is dominated by graminoids. Shrubs are sparse and the herb *Gunnera magellanica* is abundant.
- (2) *Low-elevation bluffs* (referred to as 'bluffs' throughout this paper): This habitat covers 4.5% of the study area, and has an altitudinal range of 10–200 m asl. The terrain is generally steep and exposed, except for ridge-tops and benches. Vertical bluffs, up to 20 m high, are interspersed with vegetated ledges and slopes. Soils are moderately well-drained. The vegetation is similar to that of periglacial grassland, including abundant *G. magellanica*, but patchier.
- (3) *Grassland-forest edge*: This ecotone is sharply defined by moraines, covers 0.9% of the study site, and has an altitudinal range of 100–115 m asl. Slopes are generally of low incline, and the soil is well-drained. The vegetation is a combination of periglacial grassland and forest species. Shrubs and *G. magellanica* are abundant.
- (4) *Old-growth forest* (referred to as 'forest' throughout this paper): This habitat covers 20.7% of the study site, and has an altitudinal range of 110–400 m asl. It is found only on valley sides and above the moraine. The semi-continuous canopy is dominated by *Nothofagus* spp. Trees reach heights of 25–30 m, and dbh measured up to 1.3 m. Mean basal area on the west side of the study site measured 211.2 m<sup>2</sup>/ha ( $n = 109$  plots, SD = 89.3 m<sup>2</sup>/ha). Understorey shrubs are abundant and *G. magellanica* is scarce.
- (5) *Moorland*: This broad habitat classification includes Magellanic moorland (*sensu*: Godley, 1960, cited in Pisano, 1987) and the alpine zone. Moorland covers 46.2% of the study site, and extends from 110 to about 1000 m asl. Slopes are variable and soils very poorly drained. During spring, elevations above 600 m were still mostly under snow cover. Shrubs are scarce except inside clumps of scrub forest. *G. magellanica* is scarce, below 150 m asl, and is rare above this elevation. Mosses are abundant.
- (6) *Beach*: Flat and pebbly beach is found at sea level and covers 0.2% of the study area. Macroalgae are absent.

### The deer

Twenty-two deer (eight adult males, six adult females, two subadult males, two yearling males, two yearling females and two newborn fawns) were individually distinguished by antler shape or coat markings. Four adult males were, however, observed for <20 min each, and are included in the group size data only. An additional eight huemul were sighted in valleys adjacent to the study area; no data were collected on them.

Age-sex criteria followed those described by Povilitis (1983b) except for black facial markings which, unlike those observed by him, were equally distinct in males and females. In addition, individuals with spike antlers were classified as subadult males, and individuals without antlers buds and with body size approximately 10% smaller than that of adult females were classified as yearling females. Yearlings of both sexes and subadult males were classed together as 'juveniles'. Both fawns were first observed in mid-November, when 2–4 days old, one of them until it was 4–6 days old. Most deer readily habituated to the observers, and could be approached to distances of 5 m or less.

### Pellet-group transects as a winter habitat use index

Forest provides a snow-intercepting canopy and thermal cover. By contrast, periglacial grassland does not provide shelter against winter condition. Indices of

**Table 1. Approximate proportion of survey effort undertaken for each habitat ( $n = 116$  surveys of individual habitats)**

Habitat	% survey effort
Beach	23.9
Low-elevation bluffs	16.8
Grassland-forest edge	19.8
Forest	3.0
Moorland	10.8
Periglacial grassland	25.7

huemul winter use were obtained for both habitats by counting pellet-groups on two stratified transects (forest,  $n = 107$  plots; periglacial grassland,  $n = 142$  plots). The transects were sampled during late October, and consisted of contiguous, end-to-end,  $1 \text{ m} \times 20 \text{ m}$  plots. In Southeast Alaska, pellet-group densities counted in the early spring have served as an index of winter habitat use by Sitka black-tailed deer *Odocoileus hemionus sitkensis* (e.g. Kirchoff *et al.*, 1983; Rose, 1984). Since climate is similar, I assumed that the same pellet deterioration rates and interpretation of pellet-group densities were applicable to my study site. The mean densities and degree of aggregation (negative binomial exponent  $k$ ) of pellet-groups in forest and periglacial grassland were compared with frequency distributions using chi-square tests (White & Eberhardt, 1980).

#### Spring habitat use and behavioural data

Huemul were observed during foot surveys. About 30% of the total survey effort took place from a standard route covering bluffs, periglacial grassland, grassland-forest edge, and beach on the southwest portion of the study area. The remaining survey effort consisted of haphazard reconnaissance of bluffs, beach, periglacial grassland and grassland-forest edge inside and/or outside the standard route, and of moorland and forest (Table 1). Both survey types were undertaken throughout the spring.

Group size, identification, and age-sex class of group members were recorded. A group was defined as a set of deer in which individuals travelled synchronously, interacted with each other at least once during the observation period, and were separated from each other by no more than 30 m. Groups were considered independent only if they contained a completely different set of individuals, or if they were sighted on different days. Typical group size (*sensu* Jarman, 1974) was estimated for each individual deer using the frequency of different-sized groups in which the individual was seen. If on a given day an individual was seen in groups of different sizes, only the group in which it was first seen was included in this estimate. Typical group size for the population was calculated from the typical group sizes of individuals.

Habitat use, activity budgets, and food use were measured through continuous recording of focal individuals (Martin & Bateson, 1986). Recording session onset was determined by when huemul were encountered, regardless of their activity at the time. Recording

session termination was *ad lib*, varying with the severity of the weather and the observer's willingness to endure storm conditions. According to Altmann (1974), '*ad lib* termination produces a sample with unknown and perhaps variable dependence on the behaviour being sampled'. Therefore, except for food-use data, only broad categories of states are reported.

Measures obtained were the proportions of observation time individuals spent on each variable. Thus, data obtained for each individual are weighted equally, regardless of differences in observation time accumulated for each deer. Measurement reliability (*sensu* Martin & Bateson, 1986), however, drops below a certain length of cumulative observation time, and minimum record requirements were used to exclude under-sampled deer from statistics (see captions and footnotes of tables and figures).

Focal individuals were observed between 0730 and 2200 h for sessions ranging from 5 min to 10.5 h ( $n = 118$  sessions, mean = 1.6 h, SD = 2.0 h). Because huemul allowed observers to be at a very close range and group sizes were small, it was sometimes possible to record some variables (e.g. habitat and activity) for more than one focal individual at a time. Observations totalled 172.2 huemul-hours (number of huemul in group  $\times$  number of hours group was observed).

To determine whether the variability in length of recording sessions introduced any gross biases into the habitat-use estimate, a second estimate was obtained from the proportion of days individuals were first sighted on each habitat ( $n = 100$  huemul days: summation of daily huemul sightings). Both methods gave the same results for fawns. For the remaining age-sex classes, the results of both methods were compared with log-likelihood ratios (Zar, 1984) and were found not to be significantly different (all uncorrected  $G < 2.4$ ,  $p > 0.05$ , d.f. = 3,4).

Use of bluffs relative to periglacial grassland was compared between adult males and adult females with a Mann-Whitney  $U$  test (Zar, 1984). Proportions of observation time spent feeding, and of feeding time spent eating *Gunnera magellanica*, were compared between adult males on periglacial grassland and adult females on bluffs using the same test.

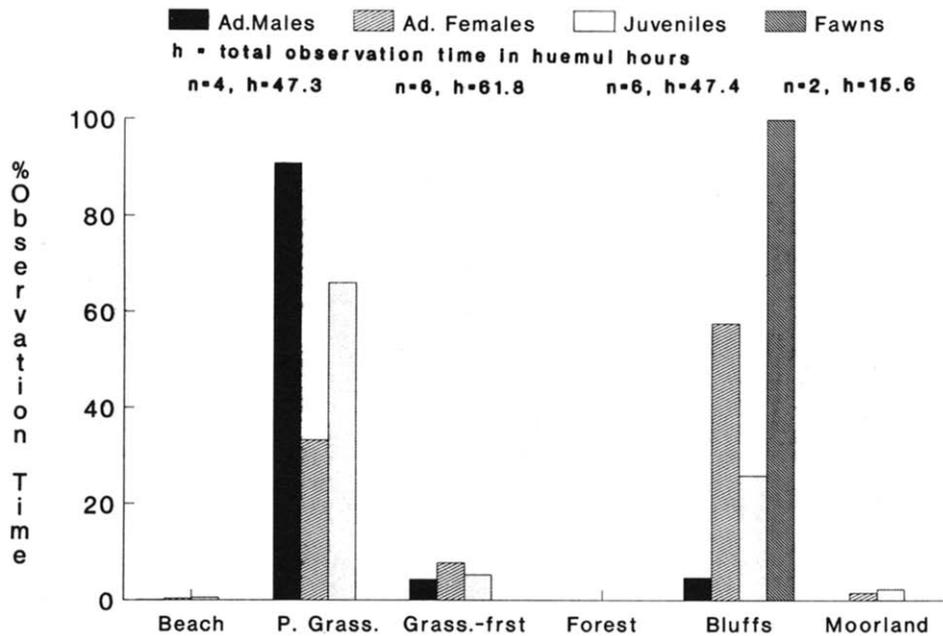
## RESULTS

#### Winter habitat use

Mean pellet-group (pg) density was twice as large in the forest (mean =  $0.02 \text{ pg/m}^2$ , SD =  $0.005 \text{ pg/m}^2$ ,  $n = 107$ ) than on the periglacial grassland (mean =  $0.01 \text{ pg/m}^2$ , SD =  $0.003 \text{ pg/m}^2$ ,  $n = 142$ ), but the difference was not significant. The degree of aggregation did not differ between habitats (all chi-square values  $< 3.39$ ; d.f. = 1,2;  $p > 0.05$ ).

#### Spring habitat use

The deer used elevations between sea level and 150 m asl for 96% of the observation time. They spent only small proportions of observation time on beach (0.2%),



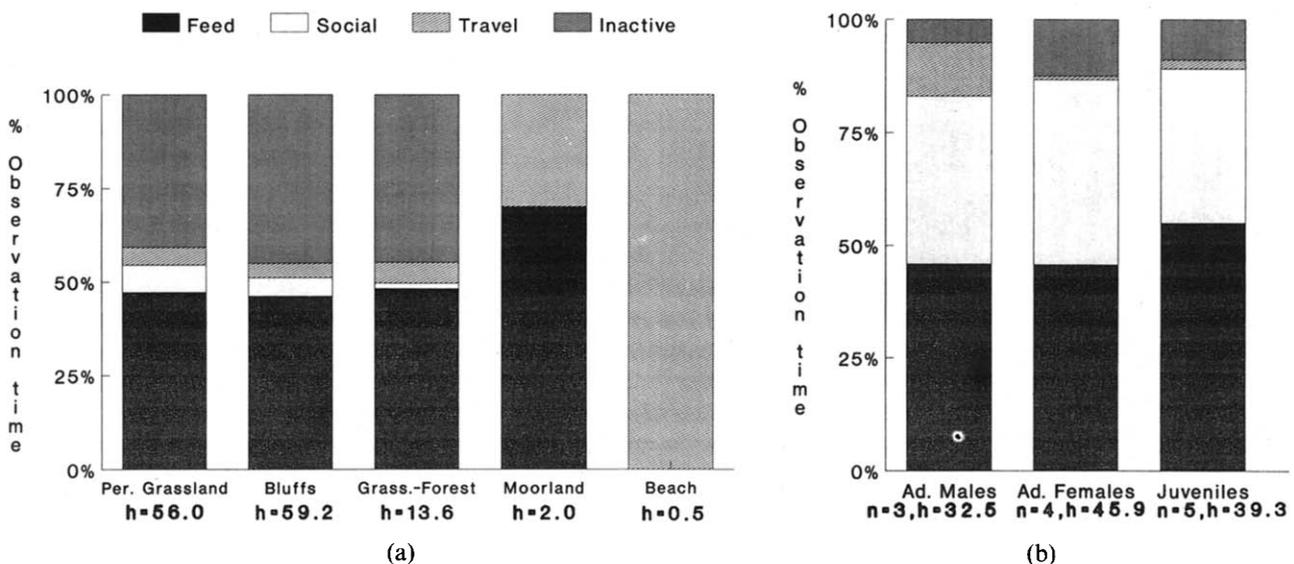
**Fig. 1.** Huemul habitat use by age-sex class, as estimated by proportions of observation time (huemul-h), October–December 1990, mainland of Chile's Patagonian Coast. The mean records per individual were (in observation hours and days): adult males, mean = 11.8 h hours (h), 9.3 days (d); SD = 9.1 h, 5.1 d; adult females mean = 10.3 h, 4.5 d; SD = 12.7 h, 5.2 d; juveniles, mean = 8.0 h, 5.0 d; SD = 6.7, 4.0 d; fawns, one fawn was observed for 0.4 h, 2.0 d; the second for 15.2 h, 3.0 d.

moorland (0.1%), and grassland–forest edge (4.3%), and were not seen using the forest. During observations, they used primarily either periglacial grassland (47.5%) or bluffs (47.0%). The proportion of time spent on bluffs relative to periglacial grassland depended on age–sex class, and differed significantly ( $U = 21$ , 1-tailed  $p = 0.05$ ) between adult males ( $n = 4$ , mean = 4.5%, SD = 5.4%) and females ( $n = 6$ , mean = 63.4%, SD = 34.7%). Adult males were observed almost exclusively on periglacial grassland, and adult females primarily on bluffs (Fig. 1). One adult female was lactating for part of the observations, and a second

throughout. Both lactating females and their associated newborn fawns were seen only on bluffs. Juveniles ( $n = 6$ ) were observed mainly on periglacial grassland but used bluffs in a proportion intermediate to that of adult males and females (Fig. 1).

#### Feeding behaviour and other activities during spring

Huemul fed on 11 different plants, but while on bluffs, grassland or grassland–forest edge they fed mainly on *Gunnera magellanica* (Table 2). Use of this perennial herb and the proportion of observation time spent feeding did not differ significantly between adult



**Fig. 2.** Huemul activity budgets by (a) habitat and (b) age–sex class as estimated by proportions of observation time (huemul-h) during October–December 1990, on the mainland of Chile's Patagonian Coast. Social behaviour included mother–young interactions, courting, chasing, allogrooming, flail fights, horning and sparring matches. These data include only individuals with a minimum record of 1.8 h. The mean recorded per individual was (in observation hours): adult males ( $n = 3$ ), mean = 10.9 h, SD = 4.3 h; adult females ( $n = 4$ ), mean = 9.3 h, SD = 9.3 h; juveniles ( $n = 5$ ), mean = 7.9 h, SD = 5.6 h.

**Table 2. Food use by habitat (all age-sex classes:  $n = 14 = 3$  adult males, 5 adult females, 6 juveniles), October–December 1990 mainland of Chile's Patagonian Coast**

Numbers indicate mean % of observed feeding time (huemul-h) that huemul fed on a given plant type. These data include only individuals with a minimum observation record of 0.3 h. The mean record per individual was 3.4 h (SD = 3.0 h).

Observation h	Habitat			
	Periglacial grassland 22.0	Bluffs 18.2	Grassland– forest edge 5.0	Moorland 1.2
Ericaceous species	0.1	0.1	0.6	0
<i>Desfontainea spinosa</i>	0	0.1	1.2	0
<i>Embothrium coccineum</i>	Not available in these habitats			15.3
<i>Escallonia serrata</i>	0	0.2	16.3	0
<i>Fuchsia magellanica</i>	9.0	8.5	1.7	0
<i>Gunnera magellanica</i>	87.3	83.4	66.6	0
<i>Lebetanthus</i> spp.	0	0	0.6	0
<i>Nothofagus antarctica</i>	0	0	3.2	84.7
<i>Nothofagus betuloides</i>	1.3	6.1	1.9	0
<i>Ribes magellanicum</i>	0.1	1.6	7.9	0
Unidentified herb	2.3	0	0	0
Total observation record (h)	22.0	18.2	5.0	1.2

females on bluffs ( $n = 3$ ) and adult males on periglacial grassland ( $n = 3$ ) (respectively: Table 3,  $U = 6$ , 2-tailed  $p > 0.05$ ; Table 4,  $U = 7$ , 2-tailed  $p > 0.05$ ).

Feeding took place in all habitats used except beach (Fig. 2). Sparring matches (even when antlers were in velvet), and horning (*sensu* Geist, 1981), were often observed in adult males, making them the age-sex class with the most observed social interactions (Fig. 2).

#### Group size and composition during spring

Huemul groups ( $n = 104$ ) ranged in size from one to four individuals and typical group size was 2.2. Adult males and adult females were observed associating only

**Table 3. Use of *Gunnera magellanica* by adult males on periglacial grassland and adult females on bluffs, October–December 1990, mainland of Chile's Patagonian Coast**

These data include only individuals with a minimum observation record of 1.0 h.

Age-Sex class and habitat	Total observation time (huemul h)	Mean % time spent by individuals feeding on	
		<i>Gunnera magellanica</i>	Other plants
Adult males ( $n = 3$ ) on periglacial grassland	13.1 <sup>a</sup>	75.9	24.1
Adult females ( $n = 3$ ) on bluffs	11.3 <sup>b</sup>	82.3	17.7

<sup>a</sup> Observation record per individual: mean = 4.4 h, SD = 2.8 h.

<sup>b</sup> Observation record per individual: mean = 3.8 h, SD = 4.3 h.

**Table 4. Feeding budgets of adult males on periglacial grassland and of adult females on bluffs, October–December 1990, mainland of Chile's Patagonian Coast**

These data include only individuals with a minimum record of 2.4 h

Age-sex class and habitat	Total observation time (huemul-h)	Mean % time spent by individuals	
		Feeding	Non-feeding activities <sup>a</sup>
Adult males ( $n = 3$ ) on periglacial grassland	29.7 <sup>b</sup>	48.8	51.2
Adult females ( $n = 3$ ) on bluffs	27.9 <sup>c</sup>	66.3	33.7

<sup>a</sup> Includes travel, inactive, and social behaviour.

<sup>b</sup> Record per individual: mean = 10.0 h, SD = 4.4 h.

<sup>c</sup> Record per individual: mean = 9.3 h, SD = 11.2.

twice. Juveniles often associated with both adult sex classes.

## DISCUSSION

### The forest as winter habitat

Direct observations suggested that, during spring, the forest was not used. Pellet-group densities, although larger in forest, were not significantly different from those on periglacial grassland, perhaps due to small sample sizes. The latter habitat received much use during spring and the lack of difference in pellet-group densities suggests that during winter the forest received at least equal use as the periglacial grassland.

High-volume, old-growth temperate rainforest is a mosaic of treefall gaps with larger understorey biomass, and of canopy cover (Alaback, 1982, 1991). In South-east Alaska (e.g. Rose, 1984; Schoen & Kirchoff, 1990), and British Columbia (e.g. Harestad, 1984), the combination of snow-intercepting canopy, thermal cover and food abundance makes this forest type important winter habitat for black-tailed deer *O. h. s.* and *O. h. columbianus*; huemul may be similarly forest-dependent.

Local fishermen claim that huemul are less abundant in recently deglaciated, poorly forested areas than on Wellington Island. This 220 km-long island is separated from the mainland by less than 1 km, is not recently deglaciated, and has the most developed coastal forests south of 49° S (Dollenz, 1982). It may be an appropriate site for comparison with periglacial areas, and for testing the hypothesis that population productivity is a function of the availability of high-volume, old-growth forest.

### Secondary spring habitats

Huemul were seen using the beach only for travelling, which may be explained by this habitat's low availability and absence of food. Macro-algae, which are consumed by black-tailed deer (Schoen & Kirchoff, 1988), were scarce on the beach, probably due to the

low salinity of the fjord and to scouring by icebergs along the shore.

The low use made of moorland by huemul may have been due to this habitat's scarcity of *G. magellanica*. Even though huemul were briefly observed feeding on moorland, at the study site this habitat is located mainly at elevations greater than 150 m asl and its plant phenology is later than that of lower elevations. Similar to black-tailed deer in southeast Alaska and British Columbia (Harestad, 1984; Schoen & Kirchoff, 1990), huemul may increase their use of moorland as plant phenology advances during summer. However, fecal pellet-groups seemed uncommon on moorland, and even though this habitat received less survey effort than bluffs, periglacial grassland and grassland-forest edge, huemul using adjacent habitats were observed moving into moorland only once.

Forest habitat has the lowest visibility and received the least survey effort. Huemul using the grassland-forest edge, however, were not seen moving into the forest, and these observations may indicate an actual lack of forest use during spring. The forest could potentially provide cover from predators, but perhaps in spring this potential is overridden by the forest's scarcity of *G. magellanica*.

Huemul were observed making moderate use of the grassland-forest edge. This ecotone has a combination of abundant *G. magellanica* and browse, as well as a dense cover of shrubs. At least during spring, it could offer more forage and equal security cover as the forest. The moderate use of grassland-forest edge may be partially explained by this habitat's low availability.

#### Foraging, fawn security, primary spring habitats

The high use huemul made of periglacial grassland and bluffs could be related to these habitats' abundance of *G. magellanica*. Because of greater steepness and exposed bedrock, however, bluffs have a higher energy cost during locomotion (Parker *et al.*, 1984) and patchier food than periglacial grassland. So why would adult females, in spite of the physiological demands of lactation, spend most of their time and do most of their feeding on bluffs? Similar to bighorn sheep *Ovis canadensis* (Festa-Bianchet, 1988; Berger, 1991) and other ungulates (Main & Coblentz, 1990), adult female huemul may be selecting for a habitat that provides the greatest neonatal security but which also compromises some aspects of foraging efficiency. On bluffs, neonate exposure to colpeo foxes *Dusicyon culpeus*, which were seen at the study site, and cougars *Felis concolor* may be minimized. Bluffs, however, may be ineffective against condors *Vultur gryphus*, which I once observed circling above a huemul fawn and its guarding mother. Condor predation on fawns would not be surprising, for golden eagles *Aquila chrysaetos* are known to prey on young mountain goats *Oreamnos americanus* (Chadwick, 1983) and bighorn sheep (Geist, 1971).

Taruca *H. antisensis*—the only other member of the genus *Hippocamelus* and a species endemic to the Andes of Peru, Bolivia, northern Chile and northern

Argentina—also uses steep, rocky terrain for neonatal security (Merkt, 1985). Habitat use during the fawning season has not been quantified for huemul in the interior, but these populations are also known to use steep, rocky terrain (Povilitis, 1978, 1979). This choice of security cover resembles that of some Caprinae (e.g. Chadwick, 1983; Geist, 1971) and makes the genus *Hippocamelus* unusual among the Cervidae.

#### Group size during spring

The small group sizes (typical group size 2.2) observed are similar to those of interior huemul (typical group size 1.9, computed from data of Povilitis, 1983b). Taruca were reported to live in much larger groups, ranging from one to 31 individuals and with a mean size of 6.4 (SE 0.36) (Merkt, 1985, 1987). Aggregation is primarily an antipredator strategy, and large groups can only be formed where there is an even food distribution (Geist, 1974; Jarman, 1974). The differences in typical group size between huemul and taruca may be reflecting differences in ecological conditions.

#### Coastal and interior populations: A conservation perspective

There are large gaps in our knowledge of the behavioural ecology of huemul in general. Previously published studies are few, and have focused only on interior huemul populations (Povilitis, 1978, 1979, 1983b, 1985).

Because of the remoteness and harshness of their environment, coastal populations have largely escaped human impacts, but have also received little conservation attention. It may be only a matter of time before they are threatened by resource extraction, and there is a demand for transplanting deer from the coast to protected areas of the interior (Chilean Forest Service, pers. comm.). I suggest that a huemul conservation strategy will require an in-depth understanding of how population productivity relates to different forest types, and of how neonatal survival relates to bluff habitat.

Both interior and coastal populations need to be conserved to maintain genetic diversity, but only coastal populations may have the potential for ensuring the species' long-term survival. Further studies of coastal huemul populations may be able to provide the foundation for a conservation strategy, and could also be compared with studies of black-tailed deer in Southeast Alaska and British Columbia. This ecological comparison would broaden our understanding of odcoileid deer inhabiting biogeoclimatically analogous areas in opposing hemispheres.

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