



Article

Loss of Migratory Traditions Makes the Endangered Patagonian Huemul Deer a Year-Round Refugee in Its Summer Habitat

Werner T. Flueck ^{1,2,3,*}, Jo Anne M. Smith-Flueck ^{4,5,7} , Miguel E. Escobar ⁵, Melina Zuliani ^{1,6} , Beat Fuchs ⁷, Valerius Geist ^{8,†}, James R. Heffelfinger ⁹ , Patricia Black-Decima ¹⁰, Zygmunt Gizejewski ¹¹, Fernando Vidal ^{12,13}, Javier Barrio ¹⁴ , Silvina M. Molinuevo ¹⁵, Adrian J. Monjeau ^{1,6} , Stefan Hoby ¹⁶ and Jaime E. Jiménez ¹⁷

- ¹ National Council of Scientific and Technological Research (CONICET), Buenos Aires 1425, Argentina; melinazuliani@gmail.com (M.Z.); amonjeau@gmail.com (A.J.M.)
 - ² Swiss Tropical and Public Health Institute, University of Basel, 4001 Basel, Switzerland
 - ³ Argentine National Parks, Bariloche 8400, Argentina
 - ⁴ Laboratorio de Teriogenología 'Dr Héctor H. Morello', Facultad de Ciencias Agrarias, Universidad Nacional del Comahue, Cinco Saltos 8303, Argentina; j.smith@deerlab.org
 - ⁵ Fundación Shoonem, Parque Protegido Shoonem, Alto Río Senguer 9033, Argentina; shoonem@hotmail.com
 - ⁶ Departamento de Análisis de Sistemas Complejos, Fundación Bariloche, Bariloche 8400, Argentina
 - ⁷ DeerLab, Bariloche 8400, Argentina; beat.fuchs63@gmail.com
 - ⁸ Faculty of Environmental Design, University of Calgary, Calgary, AB T1N 1N4, Canada
 - ⁹ Arizona Game and Fish Department, Phoenix, AZ 85006, USA; jheffelfinger@azgfd.gov
 - ¹⁰ Facultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán, San Miguel de Tucumán 4000, Argentina; black.patricia@gmail.com
 - ¹¹ Institute of Animal Reproduction and Food Research, Polish Academy of Sciences, PI-10-747 Olsztyn, Poland; zygmunt.gizejewski@wp.pl
 - ¹² Departamento de Ciencias Basicas, Facultad de Ciencias, Universidad Santo Tomas, Villarrica 8370003, Chile; fauna.andina@gmail.com
 - ¹³ Fauna Andina, Centro de Conservación y Manejo de Vida Silvestre, Villarrica 102, Chile
 - ¹⁴ Centro de Ornitología y Biodiversidad, Lima 33, Peru; javbar@gmail.com
 - ¹⁵ Laboratorio de Investigación en Osteopatías y Metabolismo Mineral, Departamento de Ciencias Biológicas, Facultad de Ciencias Exactas, Universidad Nacional de La Plata, La Plata 1900, Argentina; silvinamolinuevo@yahoo.com.ar
 - ¹⁶ Berne Animal Park, 3006 Bern, Switzerland; stefan.hoby@bern.ch
 - ¹⁷ Department of Biological Sciences, Advanced Environmental Research Institute, University of North Texas, Denton, TX 76203, USA; jaime.jimenez@unt.edu
- * Correspondence: wtf@deerlab.org
† Deceased.



Citation: Flueck, W.T.; Smith-Flueck, J.A.M.; Escobar, M.E.; Zuliani, M.; Fuchs, B.; Geist, V.; Heffelfinger, J.R.; Black-Decima, P.; Gizejewski, Z.; Vidal, F.; et al. Loss of Migratory Traditions Makes the Endangered Patagonian Huemul Deer a Year-Round Refugee in Its Summer Habitat. *Conservation* **2022**, *2*, 322–348. <https://doi.org/10.3390/conservation2020023>

Academic Editors: Antoni Margalida and Guillermo Blanco

Received: 8 March 2022

Accepted: 29 April 2022

Published: 31 May 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract: The huemul (*Hippocamelus bisulcus*) is endangered, with 1500 deer split into >100 subpopulations along 2000 km of the Andes. Currently occupied areas are claimed—erroneously—to be critical prime habitats. We analyzed historical spatiotemporal behavior since current patterns represent only a fraction of pre-Columbian ones. Given the limited knowledge, the first group (n = 6) in Argentina was radio-marked to examine spatial behavior. Historically, huemul resided year-round in winter ranges, while some migrated seasonally, some using grasslands >200 km east of their current presence, reaching the Atlantic. Moreover, huemul anatomy is adapted to open unforested habitats, also corroborated by spotless fawns. Extreme naivety towards humans resulted in early extirpation on many winter ranges—preferentially occupied by humans, resulting in refugee huemul on surrounding mountain summer ranges. Radio-marked huemul remained in small ranges with minimal altitudinal movements, as known from other subpopulations. However, these resident areas documented here are typical summer ranges as evidenced by past migrations, and current usage for livestock. The huemul is the only cervid known to use mountain summer ranges year-round in reaction to anthropogenic activities. Losing migratory traditions is a major threat, and may explain their presently prevalent skeletal diseases, reduced longevity, and lacking recolonizations for most remaining huemul subpopulations.

Keywords: *Hippocamelus bisulcus*; conservation policy; historical distribution; human impact; migration; nutritional ecology; refugee species

1. Introduction

The Patagonian huemul (*Hippocamelus bisulcus*) is considered an endangered Odocoileine deer by the International Union for the Conservation of Nature [1], with Argentina having only an estimated 350–500 individuals left and split into 60 or more groups, and Chile having around 1000 remaining that are split into approximately 40 groups. Moreover, these groups are fragmented along some 2000 km of Andean mountains [2] and represent a numerical reduction of over 99% of the original population size [3]. Their social organization including social and sexual segregation, is very plastic as in other cervids, and likely highly influenced by population density [4]. The huemul have been negatively affected mainly by past overhunting, but also loss and fragmentation of habitat, malnutrition, diseases, dogs, and possibly by the introduction of alien wild and domestic ungulate species [1]. Unrestricted killing in the past to acquire valued products was one of the main factors that resulted in widespread population declines and the endangered status of this species (reviewed in Supplementary File S1). Extremely naive and tolerant of human presence [5], huemul can be easily killed at a close distance by the simple use of rocks, clubs or knives (Figure 1). This unique docile behavior towards humans has resulted in their local extirpation, especially in those areas used by indigenous people and early colonists (Supplementary File S1). However, past over-harvesting has not only resulted in local extirpation, but we hypothesize that it also eliminated their migratory traditions.

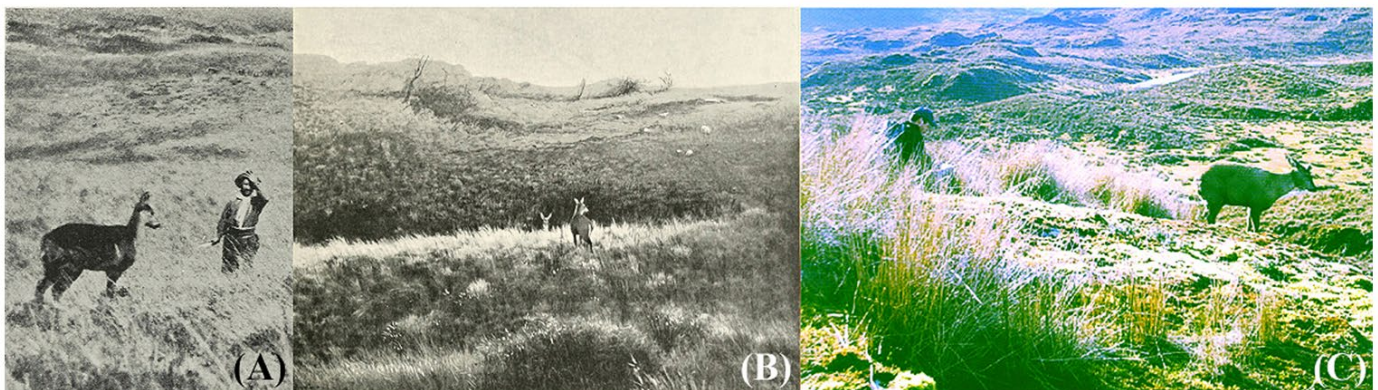


Figure 1. Huemul are well-known for their use of steppe grassland and lack of fear of humans. (A) Gaucho with knife hunting a huemul, photographed by Onelli in 1904, see Supplementary File S1, (B) huemul walking away after having sniffed the leg of Prichard in 1902, see Supplementary File S1, (C) a more recent close encounter near Cochrane, Chile.

Although extant groups of huemul persist along the seasonal Andean Mountain range, none have been shown to still exhibit migratory behavior [6]. Seasonal migration allows a species to capitalize on spatiotemporal variation in resources and being a plastic behavior, also results in colonization of new areas. Among cervids, year-round resident populations on winter ranges in seasonal mountain environments are the norm, as well as the eventual development of a portion of that population that migrates altitudinally [7,8]. Migratory cultural behavior is transmitted vertically from mother to young, whereas dispersal is innate and by random diffusion that is predetermined genetically, but may also occur secondarily in response to environmental conditions [9]: thus, preserving cultural traits like migrating are considered important, especially for endangered species [10–13] (Supplementary File S2).

Most extant huemul subpopulations thus tend to exist today in remote mountain areas that have been unattractive for human settlement because of climatic conditions, topography, remoteness or having otherwise little value for agriculture or forestry [14,15]. Modern mainstream interpretations commonly consider areas of extant subpopulations as

representing prime habitat in which the huemul evolved [2,16]. There is a common misconception that these areas represent their natural ecological niche, rather than recognizing that the huemul may have been isolated by anthropogenic activities to persist only in such suboptimal habitat that was less accessible to humans, and effectively has become a refugee species by being forced to contract its range and lose its migratory behavior [17–20]. The huemul continue to be described as “mountain deer adapted to Andes mountains”, “found only in the Andes”, “high-altitude species”, “mountain deer with unmistakable mountaineer anatomy”, “at 2000–3000 m asl of Andes”, “commonly in high-altitude regions that are also rocky and steep”, and “a forest deer” [6,21–24]. This unfounded assumption has led to the characterization of the huemul as predominately a browser and a non-migratory species. This has influenced the course of huemul conservation and the approaches taken over the past four decades [25]. Historical evidence of past huemul distribution is commonly depreciated by calling these “anecdotal accounts”, thus disregarding all such data, including those from reputable scientific explorers of the Patagonian region during the last two centuries (reviewed in Supplementary File S1).

Securing adequate sample sizes of field data is difficult with rare and endangered species that live in remote refuge areas as occurs with huemul [6]. The current pattern of habitat use by many isolated huemul subpopulations, including the few remaining huemul reported here from Shoonem Park, and the revealed differences with the documented historical patterns, highlights the central urgency to achieve a valid diagnosis of the causes and consequences of becoming a year-round refugee in areas which qualify as seasonal summer ranges [20].

For the present study, we (1) provide a summary of an extensive literature review of historical records of this species that we conducted in order to examine the evidence of huemul occurrences in the treeless landscape of Patagonia and their seasonal movement patterns; then (2), we provide new information on seasonal habitat use by the first group of huemul ever radio-collared in Argentina as a means to then compare current patterns with historical ones; (3) we evaluate the process of migration and occupation of new habitat areas by wild cervids to put into perspective our findings regarding the behavioral change between past and current movement patterns and habitat use by huemul; and finally, (4) we discuss the implications of huemul having lost migratory traditions and the consequences of being forced to live year-round in a refugia which formerly represented only a seasonal summer habitat, and the secondary problems that have arisen as a result.

2. Materials and Methods

2.1. Systematic Literature Review

To better understand the flexibility and phenotypic plasticity of huemul through the lens of their overall usage of habitats in Argentina, we gleaned the literature on historical habitat use by this species, and then evaluated processes involved in the migration, dispersal, and occupation of new habitat areas among other wild cervids. A comprehensive review (2021–2022) was based on the broad literature access provided by Swisscovery (<https://slsp.ch>, accessed on 4 April 2022), including the ISI Web-of-Knowledge and their 17 external databases, by searching for huemul and other related deer species to assemble actual and historical data on huemul occurrences, and compare this to distribution patterns of other cervids. The systematic search about huemul included *Hippocamelus bisulcus* and its synonymy [26,27], that is the various historic taxonomic terms used for this species, like *Equus bisulcus* (Molina, 1788), *Equo bisulco* (Leuckart, 1816), *Cervequus andicus* (Lesson, 1842), *Camelus equinus* (Treviranus, 1803), *Lama bisulca* (Fisher, 1829), *Auchenia huemul* (Smith, 1827), *Auchenia huamel* (Hamilton, 1842), *Cervus andicus* (Lesson, 1842), *Cervus antisensis* (Burmeister, 1879), *Cervus chilensis* (Gay and Gervais, 1846), *Cervus leucotis* (Giebel, 1855), *Capreolus leucotis* (Gray, 1849), *Capreolus huamel* (Gray, 1850), *Furcifer huamel* (Gray, 1850), *Furcifer chilensis* (Sclater, 1883), *Furcifer andicus* (Lesson, 1850), *Furcifer antisensis* (Wagner, 1855), *Xenelaphus leucotis* (Gray, 1872), *Xenelaphus bisulcus* (Prichard, 1902), *Huamela leucotis* (Gray, 1872), *Creagroceros chilensis* (Fitzinger, 1873), *Cariacus chilensis* (Brooke, 1879), *Mazama*

bisulca (Lydekker, 1898), *Odocoileus bisulcus* (Trouessart, 1898), and *Hippocamelus dubius* (Leuckart, 1816). Additional older literature cited in historical accounts was accessed by visiting key libraries containing such old original documents. Given the absence of other cervids in Patagonia, except the extremely small pudu (*Pudu puda*), and clear physical differences to guanaco (*Lama guanicoe*), the past documentation of a cervid identified with any of the taxonomic synonyms for huemul were taken as valid data.

Moreover, assessing the validity of a given data point for representing evidence was based on the physical description of the observed animal, their drawings or their photographs, which basically prevented any biased data point. The key sources about historical habitat use-including spatiotemporal, are reviewed in Table 1, Supplementary File S1, and displayed in Section 4.

Table 1. Selection of historical reports about huemul: distribution between the Andean Mountains and the Atlantic Ocean, coexistence with guanaco, group sizes, migratory-resident behavior, and hunting.

Date	Author(s)	Observations of Presence
1521 and 1598 after	Eastman 1915	By Atlantic ports of San Julian and Desire, Atlantic
1793	Pennant	By Port Desire, Atlantic Coast
1833	MacDouall	By Gregory Bay, open area, 100 km from the nearest forest
1835	Roulin	By Port San Julian, Atlantic Coast
1863	Cox	Year-round resident populations on winter ranges, coexisting with guanaco
1864	Claraz	Many guanacos coexisting with equally as many huemul in lowlands
1871	Musters	Harvested huemul in open, treeless areas
1875	Günther	Between Andean Mountain foothills and Patagonian mesas, reaching the Atlantic Coast
1880	Behm	Seen in open area far from forests while hunting 45 km east of Chilean border
1892	Philippi	Large groups during seasonal migration to lower areas
1898	Lydekker	Migration down to the open grassland plains where they remain during winter
1900	Steffen	His team ate huemul for weeks, working in open grasslands of foothills: coexistence with guanaco further east
1901	Burmeister	Eighteen huemul (2 groups) in open grasslands, 220 km from nearest forest
1902	Prichard	Groups with more than 100 huemul coexisting with guanaco during winter in valleys
1903	Church	Grassland plains were the home of guanaco, huemul and ostriches
1903	Hatcher	Harvesting huemul in the open 100 km from the nearest forest
1904	Anonymous	The governor hunted huemul far east of continental divide 270 km from forests (includes photo)
1905	Onelli	Near Choiquenilahue and between Senguier and Chubut rivers, 120 km from forests
1911	Neveu-Lemaire	Reported winter migration down to valleys
1923	Osgood	Harvesting huemul in steppe grasslands far from forest, coexisting with guanaco
1925	von Colditz	Harvesting several huemul in steppe grasslands far from forest
1929	Gigoux	Reported seasonal migration and formation of large herds in winter
1936	Giai	Reported seasonal migration and formation of 50 or more huemul in winter
1940	Krieg	Year-round resident huemul in low valleys
1945	Agostini	Many guanacos and equally as many huemul in open grasslands
1949	Grosse	Seasonal migrations and large herds in low valleys
1962	Liebermann	Seasonal migrations in winter down to protected valleys and foothill areas
1969	Kolliker Frers	Reported huemul still occurred in Patagonian open grasslands until 1850s

2.2. Radiotelemetry

We studied the huemul in the Protected Park Shoonem (44°51' S, 71°48' W; 167 km² with elevations ranging from 850–2060 m asl), located on the eastern slopes of the southern Andes. The studied watershed contains Fontana and La Plata lakes, which are surrounded by tall mountains (Figure 2). Within the sub-Antarctic zone, the site containing huemul around lake La Plata is covered by old-growth, dense forests predominately of deciduous lenga beech trees (*Nothofagus pumilio*), which occur from the lake level (930 m) up to about 1300 m, with the uppermost lenga forming chaparral [28]. The seasons are defined as winter from June to August, and summer from December to February. The mean winter temperature is −3 °C with winter precipitation between 300–400 mm, principally as snow (Figure 2), while the total annual mean precipitation is 2000 mm [29]. Most Andean environments are characterized by harsh climatic conditions, extensive deep snow cover in winter, and contrasting altitudinal levels such that it results in guanaco migrating toward low altitudes when the snow cover is too deep to survive [30,31].

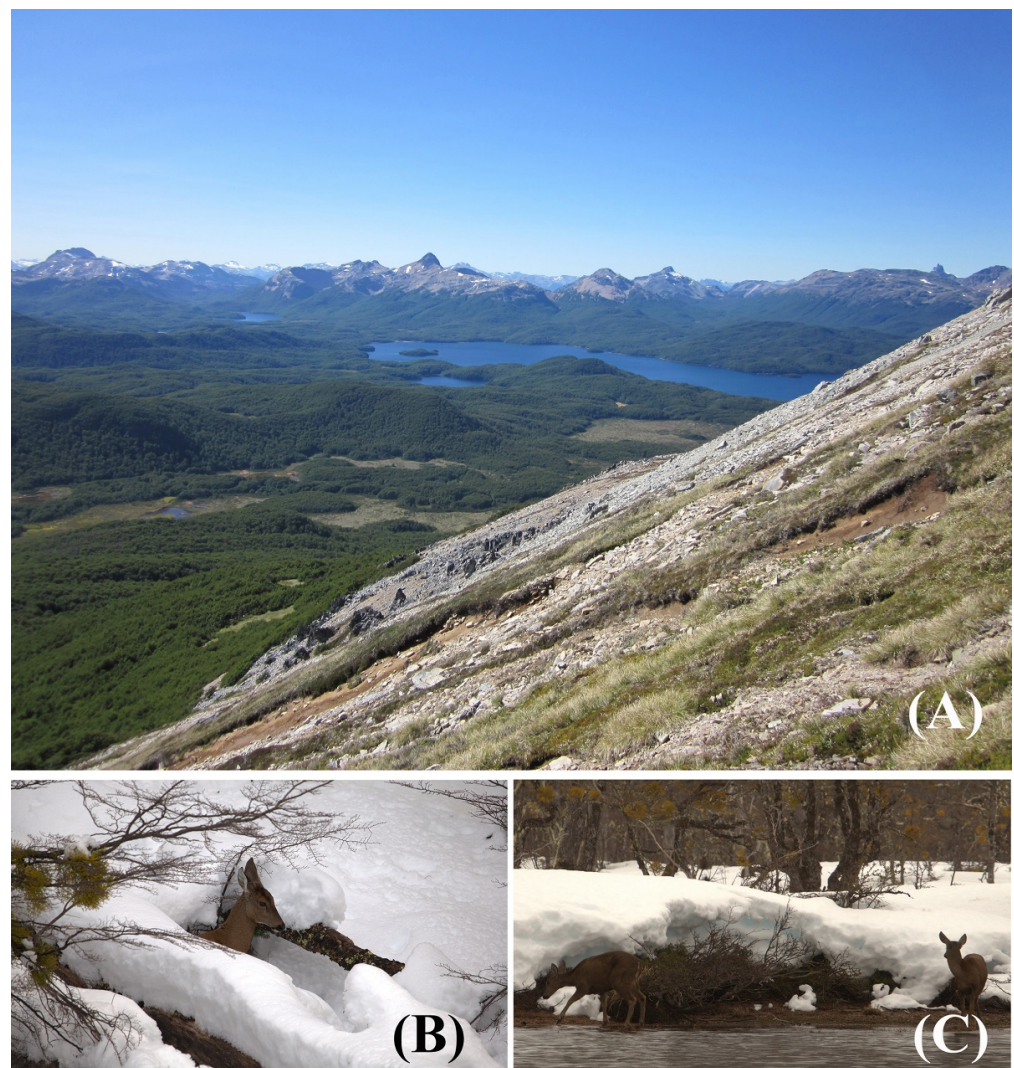


Figure 2. (A) Protected Park Shoonem (only its western part: $44^{\circ}51' S$, $71^{\circ}48' W$), owned by the village of Alto Rio Senguer, province of Chubut. The view is of the western portion of Lake La Plata, with the surrounding mountains physically defining the watershed of the river Senguer and serving as a refuge area for huemul. The edge of the lake provides the lowest elevation accessed by huemul during winter, (B) snow conditions frequently result in huemul using open water for their displacements, (C) photos taken in September 2017.

During the winter of 2017, adult huemul (3 females, 3 males) were immobilized by darting (permit Disp. Nr. 22/2017-DFyFS-MP, Province of Chubut). To minimize risks, a DanInject JM SP25 rifle allowing continuous pressure adjustment, and a mounted scope containing a laser range finder, were used to dart the animals. Medetomidine and ketamine, reversed by atipamezole are considered very safe for cervids [32] induction and reversal are fast (2 min or less), there is generally an ample tolerance for various concentrations, and highly concentrated drugs allowed the use of small darts, thus minimizing trauma. Moreover, changes in pulse and respiratory rates are minimal [33]. The time of induction was noted, the animal was kept in lateral recumbency, eyes were covered, the pulse, respiratory rates, and temperature were monitored, the general health condition was examined, and after blood collection and placing the radio collar, the reversal was applied.

Individuals were fitted with VHF radio transmitters (Sirtrack Ltd., Havelock North, NZ, USA; Telonics Inc., Mesa, AZ, USA) with several capable of transmitting signals for up to 10 years, a time window exceeding the average life span of deer in this area [34]. During the winter of 2021, the VHF radio collar was replaced with a satellite unit (Lotek, Newmar-

ket, ON, Canada) on one male. We monitored the radio-collared individuals regularly to determine if they were alive or dead, and then located them using the telemetry equipment to allow us to make observations regarding their physical state, group composition and other biological data, and to record their general locations, or their precise GPS locations based on visual observations or triangulations [35]. The altitude above sea level (asl) of each location was determined via Google Earth. Given the behavioral responses of the animals and the reduced frequency of visual encounters, the method was considered to be acceptable regarding animal welfare. Confirmations via radio signals as to whether an individual was dead or alive were determined repeatedly (2 times per week usually), and covered every month of the study period (August 2017 to April 2022), and were accomplished more frequently than location determinations. Non-statistical techniques for range analysis were used to calculate home range sizes based on the determined locations, using a minimum concave polygon (MCP) approach. This choice was made in order to specifically exclude the lake surfaces, and thus to ensure that such areas not used by collared individuals were not included in home range calculations [35–39]. However, the present analysis emphasized only the documented maximal space use, independent of the frequency of usage as an indication of probability density surface [40]. Although a small number of precise locations may result in a reduced estimate of the home range size, the sampling over a large time period, as in this study, compensates by repeatedly covering all seasons [41]. Moreover, even crudely estimated home range sizes have led to insights into animal behavior and ecology [41], and this information is fundamentally important for managing and maintaining viable populations [6]. The home range sizes determined here may not allow comparisons to other studies, but among the present cases. The coverage of precise and general locations during all seasons of several years was considered sufficient to evaluate potential migratory movements. These were defined as follows: resident, the distance between centroids of seasonally used areas is less than 3 km; migrant, the distance between centroids of seasonally used areas is more than 3 km with repeated seasonal return [38,42], or the elevational separation is >500 m [43]. The perimeter lengths of the home ranges, the largest linear distance of displacements, and patterns of winter and summer locations—particularly elevational shifts (asl), were also calculated and compared regarding sex and seasons. Although the quantity of locations is limited and covers several years, inter-annual site fidelity is common among cervids and thus permits a description of seasonal habitat use patterns [44]. Descriptive statistics were used to summarize the data and to describe the samples [45]. Hence, means and standard errors were computed, and compared by sex and season using independent *t*-test. Lastly, the VHF data from a male collected over 48 months was compared to satellite data from his new collar, covering 8 months. Additionally, opportunistic observations of unmarked deer were recorded by date and location and used to document spatiotemporal habitat use patterns in this population.

3. Results

3.1. Historical Distribution

Based on the broad literature review, a total of 130 historical records were found covering the years 1521 until 1915, and a further 190 records covering the years up to 1990. Publications since 1990 about huemul numbered 129, which is about 3.7% compared to the quantity of publications about red deer (*Cervus elaphus*), indicating the scant modern research activity concerning huemul.

Considering historical observations and records in the Protected Park Shoonem, huemul formerly occurred also much farther east of this watershed, following the water course and diminishing elevations. For example, numerous specimens were collected in a scientific expedition near the shore of Lake Fontana [46] some 35 km further east of currently extant huemul, and huemul were sighted in mountains some 180 km east of the present study population [47] (Section 4). The literature review resulted in numerous additional localities with historical evidence of huemul presence based on hunting collections,

shed antlers, and archeological samples, as well as observations of residency and seasonal migratory behavior ($n = 54$, Table 1, Supplementary File S1). The historical distribution reached some 680 km further north of the currently northern-most and isolated population [48–50]. The historical distribution depicted in Section 4 is an approximation based on historical sites and at a scale that does not indicate potentially inhabitable areas [51]. However, most of this area contains guanaco [52] and allows livestock production [53], which thus serves to indicate that these areas also would sustain huemul. Historically used sites further east drop some 265 m in elevation for every 100 km towards the Atlantic coast, whereas annual precipitation drops from a maximum of 2000 mm at the continental divide to 400 mm at 100 km east, and down to 180 mm at another 150 km further east [5,54].

3.2. Extent of Altitudinal Movements

The six VHF radios of collared huemul resulted in 89 precise locations (mean = 14.83, SE = 2.6, range 6–24, Figure 3, Appendix A), whereas general surveys allowed additional confirmations of their seasonal presence ($n = 935$). The satellite unit placed on the male provided over 1675 additional location points over an 8-month period, corroborating the prior data based on his VHF radio. The coastline along the lake turned out to be the lowest elevation (930 m) used in the study area and thus represents the lower extent of the altitudinal gradient upon which movements were recorded, as none of the huemul moved further east and down the watershed during winter.

The elevations used during summer did not differ between males and females ($t = 2.03$, $p = 0.056$), and ranged between 930–1153 m asl ($n = 37$, mean = 1013.86 m, SE = 8.97). During winter, the elevations used also did not differ between males and females ($t = -1.52$, $p = 0.101$), and ranged between 930–1164 m asl ($n = 29$, mean = 969.03 m, SE = 10.27). The minimal elevational difference between the lowest summer and highest winter location for five huemul averaged a mere 36.2 m (SE = 21.06, range 11–119 m), with the highest elevations recorded in summer. One female though had a difference of 223 m, but with the highest elevation recorded during a mild winter, rather than during previous summers. However, these elevational usages are minimal and indicate residential behavior, as corroborated by general telemetry surveys every month, which numbered 37 to 239 observations per animal with a mean (\pm SE) of 150.17 (\pm 40.06; $n = 935$). Year-round average elevations for males (mean = 979.53 m, SE = 7.36, range 966–992 m asl) were similar to those of females (mean = 1001.59 m, SE = 5.8, range 991–1011 m asl).

When comparing mean elevations in summer versus winter, these did not differ ($t = -2.042$, $p = 0.055$) for females (summer: 1050 m, SE = 31.82; winter: 976.42 m, SE = 16.87), whereas for males (summer: 1006.76 m, SE = 8.85; winter: 948.02 m, SE = 5.26) they differed slightly ($t = -6.87$, $p = 0.02$), although their absolute maximal altitudinal difference was only 159 m. Overall, the maximal annual elevational displacements by these six huemul across all months of the study period averaged only 149.5 m (range 74–229 m). Moreover, marked, and also many unmarked individuals, were located at the shore of the Lake La Plata (930 m asl) in every month of the year (Figure 3). Additional huemul signs (tracks, feces, bones) were recorded up to 1250 m asl, even though surveys were conducted up to 100 m above the treeline which is at 1300 m asl, corroborating earlier observations that there is little use above the treeline [3,28].

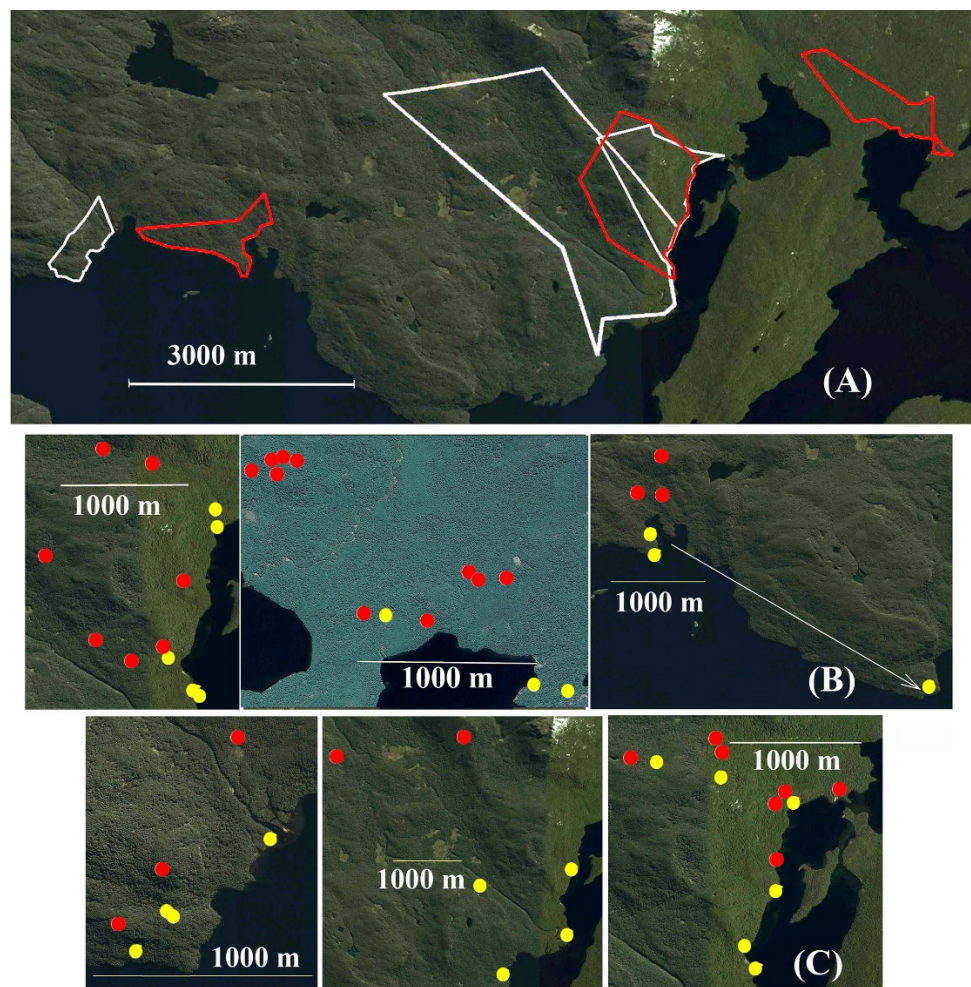


Figure 3. (A) Annual home ranges of 3 male (red) and 3 female (white) huemul in the Protected Park Shoonem. Precise locations in winter (yellow) and summer (red) of 3 male (B), and of 3 female huemul (C). Arrow indicates one unusual displacement in late winter, which ended in death by starvation.

3.3. Extent of Horizontal Movements and Size of Annual Home Ranges (MCP)

Because individuals were marked in separate capture events in different areas, they all were considered to belong to different social groups. However, subsequent observations revealed that the home ranges of two females slightly overlapped, the home range of a male overlapped those of these two females (Figure 3a), and they were also sighted together. The longest horizontal displacement recorded within the habitually used yearly home ranges averaged 2133 m (SE = 448) among the six huemul. Two exceptional movement distances were not included in these data: a male with a home range not exceeding 1.6 km in dimension based on 14 months of data, suddenly left it in early spring, to move along the edge of the lake to a new site 4.7 km away (Figure 3b). There he died shortly after from starvation/malnutrition, and with severe bone pathology having negatively affected his foraging behavior [55]. One female (2–3 years old) moved 2.13 km after the capture event, but then returned shortly afterward to remain in a defined home range not exceeding 1.1 km in dimension. The perimeter length of yearly home ranges among 5 huemul averaged 5032 m (SE = 738), with an additional home range of a female having 11 km of perimeter. Since horizontal movements were recorded every month between August 2017 and April 2022, their magnitudes indicate the absence of migratory movements. This is in agreement with the absence of sightings of huemul (live, dead, shed antlers) further down the watershed for many decades.

The home range sizes reported here are a reflection of the sampling frequency of VHF radios allowing precise fixes, but covering all seasons and several years. The mean size of annual home ranges (MCP, representing minimal values) did not differ between males and females ($t = -0.56674$, $p = 0.300589$), averaging 159.33 ha (SE = 64.52). The home range size of one female was estimated at 464 ha and resulted from moving several kilometers to also use another flat area. In the one case, where the VHF collar was replaced with a satellite radio, the former technique determined a home range of 68 ha with a maximal displacement of 2147 m ($n = 24$), while the latter resulted in 190 ha with a maximal displacement of 2500 m ($n = 1675$). However, the 190 ha consisted of areas used at the end of winter and the beginning of summer, amounting to 163 ha and 147 ha, respectively, with an 80.5% overlap (Appendix A).

3.4. Processes of Migration and Geographic Expansion to New Habitat by Wild Cervids

Past over-harvesting not only resulted in the extirpation of local huemul subpopulations, but we hypothesize that it also eliminated their migratory traditions. Considering this loss, recognizing the processes involved in migratory traditions among cervids plays a key role in better understanding the consequence of losing such behavior [10].

Among cervids living in seasonal environments, including *Odocoelines*, a newly (re)colonized area initially has deer behaving as residents, whereby migratory behavior is non-existing. It also occurs even if the translocated animals stemmed from populations being migratory in their original site [12]. Only after multiple decades (up to 90 years for *Alces*) and increasing local population density, have translocated populations increase their propensity to start migrating again [12]. While deer movements are shaped by the distribution of resources for fine-scale foraging, this will eventually also include broad-scale migrations [56].

Regarding migration behavior, the multi-generational process to encounter and adopt movement corridors that allow green-wave surfing [56] plays an important role in the foraging strategy of *Odocoelines*, and the access to plant green-up along the migratory route is an additional key foraging benefit of migration [57]. Migration behavior thus not only refers to using fixed seasonal ranges, but also provides important foraging value while deer move along these corridors following the green wave (spring green-up), thereby enabling a prolonged exposure to high-quality forage and hence more energy [57].

Fundamental and primary mechanisms for ungulate migration involvement are non-genetic processes of social learning and cultural transmission [12]. Moreover, spatial memory of the migration route had an extraordinary influence on migration, affecting movements manifold stronger than tracking spring green-up or autumn snow depth [56], and was characterized by strong fidelity [13,44,58]. Such spatial memory along with resource tracking allowed deer to repeatedly use the same migratory routes of 820 km round-trip [56,59]. Consequentially, the loss of migratory traditions will thus expunge generations of knowledge about the locations of high-quality forage and likely suppress population abundance [10,12], and leave pockets of potential habitat unoccupied because of the lost memory of viable migratory routes [13]. For instance, *Odocoelines* were shown to have little to no plasticity in terms of whether or where they migrated: resident deer remained residents, and migrant deer remained migrants, regardless of age, reproductive status or number of years monitored ([13,60]; Supplementary File S2). Certainly, some individual plasticity does occur and explains the development of new movement patterns including recolonizations [8,61].

For seasonal environments, Fretwell theorized in 1972 [17] how species would select habitats. Accordingly, under natural conditions, wild cervids tend to occupy all available habitats by doing best in source areas, so named for allowing positive population growth. Animals dispersing from source areas will also start to occupy suboptimal areas, including sink areas, so named because the local recruitment rate achieved there does not compensate for the local losses. There, populations are only maintained by replacement with newly arriving dispersers from source areas. Similarly, initial populations establishing themselves

in source areas are year-round residents. Some dispersers, particularly in mountains at seasonal latitudes, will eventually move altitudinally to establish new summer ranges, and then return to their original winter area, thereby rejoining that resident population [62]. Thus, over several generations, basic plasticity becomes apparent, resulting in partial migration (coexisting resident and migratory individuals), changes in timing and routes, and also changes at the individual level [8]. Moreover, established migratory traditions can override signals of habitat quality and predation risks, such that deer can pass the best summer habitats to remain in the worst habitat at much further distance [13,58], or cross several mountain ranges to get to traditional winter-summer areas (Supplementary File S1). Similarly, when the culturally transmitted migratory behavior is interrupted after offspring lose their migratory mother, for instance, they will adopt resident behavior (Supplementary File S1). These well-documented processes of migratory behavior of cervids thus support the same hypothesized behavior among huemul, and the fact that it can be eradicated by over-killing, for instance.

Various observations show that the dispersal of adult or juvenile animals naturally connects source and sink areas [63]. Yet, source-sink population dynamics may change if dispersal is somehow constrained, e.g., by rapid anthropogenic changes in landscapes resulting in animals no longer making optimal habitat selection decisions as acquired by cultural transmission [64,65].

A comprehensive review by Xu et al., (2021) [8] revealed that many wild ungulates exhibit substantial migratory plasticity resulting in partial migration, and changes in migratory paths or localities. Their study revealed 127 migration change events in direct response to natural and human-induced environmental changes across 27 ungulate species. In addition to the suite of ecological processes playing a role which they described, we report here for the first time that the huemul is the only example of an ungulate in seasonal habitat having changed its behavior to become year-round residents in typical seasonal summer range habitat.

4. Discussion

4.1. Historical Spatial Habitat Use

The weight of evidence indicates that local extirpations of huemul resulted from overhunting by early humans and their dogs, which was exacerbated by huemul's lack of anti-human behavior [66,67] (Supplementary File S1; Figure 1). Nonetheless, several historical accounts between the years 1521–1925 still mentioned huemul subpopulations — with some even considered numerous, extending from the Andean ecotonal foothills to the Patagonian mesas, and even reaching as far east as the Atlantic coast (Figure 4, Table 1). A huemul was harvested in 1904 at a site 270 km east of the continental divide, which is 225 km east of the eastern-most currently living huemul [25]. This hunt by the governor of Chubut was documented photographically [68]. Additionally, huemul were described to co-occur with guanaco in areas even reaching the Atlantic coast (Supplementary File S1).

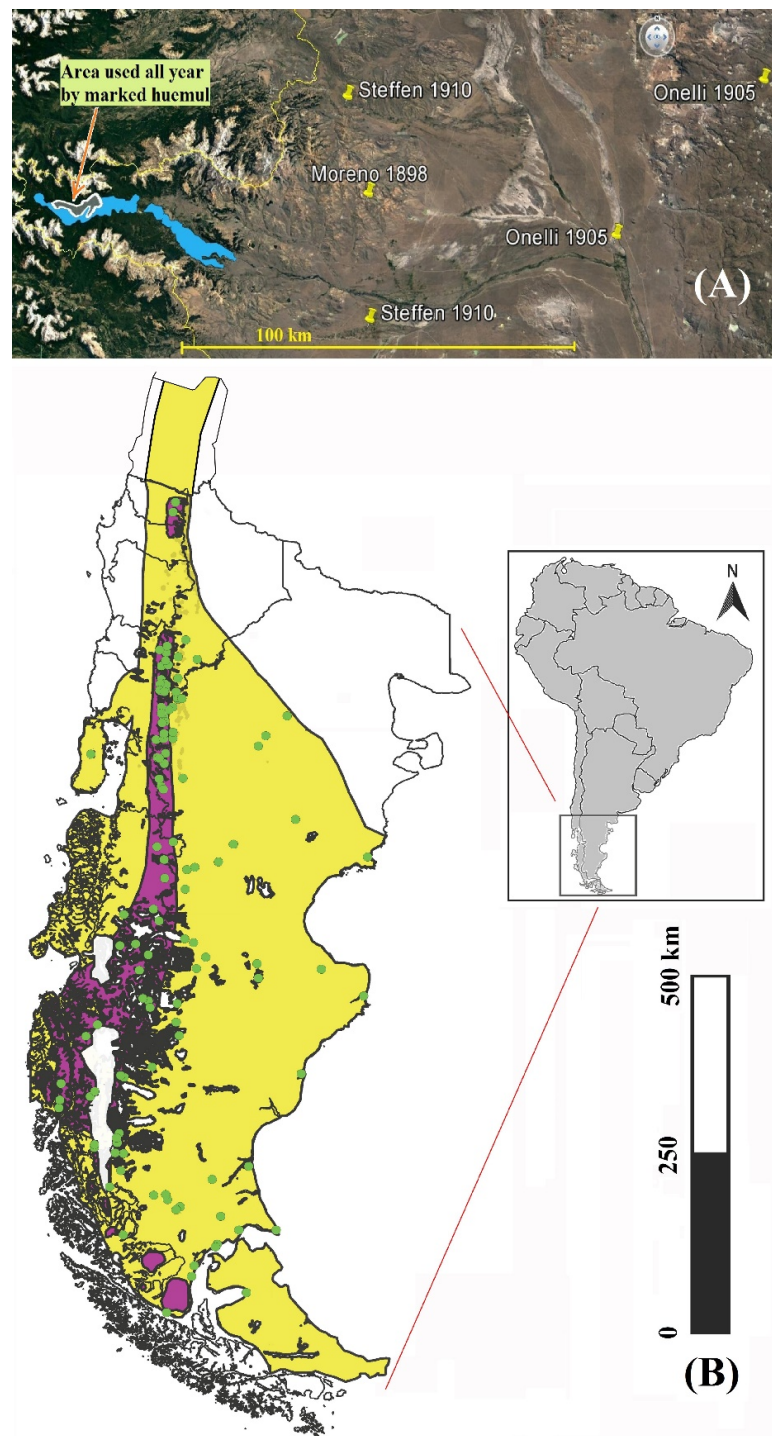


Figure 4. (A) Historical and current spatial distribution of huemul in the Protected Park Shoonem. The blue polygons show lakes Fontana and La Plata. The current year-round range (grey polygon outlined in white) is at the upper elevational margin of summer ranges and near the Andean continental divide, compared to historically used areas (indicated by yellow ticks) [47,69,70]. Distances traveled to summer ranges in the past are well within common seasonal movement distances for similar cervids like *Odocoileus*. (B) Historical distribution (yellow); current distribution (purple: Jimenez et al. [71]), unsuitable areas (internal white zones indicating bare ice fields, rocky slopes without vegetation, or lakes), and historical locations (green dots), based on reports by naturalists, shed antlers, and archeological samples (Supplementary File S1).

The historical accounts of huemul also occurring far from forests are further corroborated by their osteology: analyses of rear limb ecomorphology indicate huemul are adapted to open habitat (unforested) areas [72,73]. The perceived short stature thus was not due to short limbs but to a thick coat of long hair (up to 19.5 cm long, Source: Shoonem Foundation collection) that concealed the leg length, thus creating a misperception [74]. Moreover, huemul limb morphology does not overlap with species considered mountain specialists, but falls within the range of other cervids, with some populations of *Rangifer* spp. and even *Odocoileus virginianus* having much shorter legs than huemul: these findings contradict the long-standing assertion that attributed the apparent short stature of huemul to be an adaptation to mountainous terrain [74,75]. Moreover, stable isotope analyses of archeological samples reveal that huemul's diet from open environments cannot be differentiated from that of steppe guanaco [76]. Lastly, the cryptic pattern of fawns does not coincide with huemul having evolved in forested habitats. Camouflage appears to be the single most important evolutionary force in explaining why most cervids have spotted fawns: this crypsis provides the strongest protection in forests as a likely mechanism by which fawns could escape detection by predators [77]. Yet very few cervid species, including huemul, have non-spotted fawns, which is to be expected if natural selection acted on the species principally in open habitat areas [77]. Consequently, Webb (2000) proposed the cervid tribe Rangiferini, which includes the northern *Rangifer* and the southern *Hippocamelus*, the former using extensive open tundra and steppe [78]. Hence whereas historic data confirms a reduction in distributional range of huemul, together with anatomic data it also indicates the loss of migratory traditions (see below).

4.2. Historical Seasonal Habitat Use

The hypothesis that the huemul was once migratory like other cervids in seasonal environments, is corroborated by historical observations. Thus, in the past, huemul frequently were year-round residents in valleys and other low elevation winter ranges, while some migrated between summer and winter ranges, and formed large winter groups of more than 100 individuals [66,69,79–81]. Current habitat use by huemul in the Protected Park Shoonem certainly represents only a small fraction of the watershed reported to have been used historically [46,47] (Figure 4). Additionally, old shed antlers, which are not related to a harvested animal, have been collected in historically used temperate grasslands, including a few sites near the Atlantic Ocean some 300 km east of Andean summer ranges. Analyses of aboriginal use of huemul showed that hunting occurred in grassland summer ranges, together with guanaco [82,83]. Moreover, it should be noted that even very early on (e.g., 1847, 1873, etc.) it was recognized that huemul already had regionally disappeared and remained mainly in high and inaccessible areas [31], which already were interpreted as being refugee areas (Supplementary File S1), though this perspective was lost in recent decades.

Similarly, bighorn sheep (*Ovis canadensis*) were overhunted, and lost their traditional seasonal migrations resulting in many sedentary herds and associated seasonal deficiencies due to low forage quality, which was considered the ultimate cause of declining herds, and one of the largest problems challenging their long-term persistence [84]. Sika deer (*Cervus nippon*) in Japan also respond strongly to hunting and disturbances, and their seasonal migrations aim toward safer areas to avoid hunting and culling, besides being warmer and less snowy in winter. Sika deer are avoiding hunting areas representing the most suitable foraging sites (e.g., pastures), to move to safer sites even with poor forage, like forested areas with hunting prohibited [85].

4.3. Contemporary Spatiotemporal Habitat Use in the Protected Park Shoonem

The pattern of seasonal habitat use was very similar among both sexes. Areas used during harsh winters occurred at the lowest possible local elevation (lake shores), but these are also regularly used during the remainder of the year. Conversely, during the mild winter of 2021, one female used an elevation even higher than in any summer since 2017. This explains the very reduced minimal yearly elevational displacement

(mean = 36.2 m). Moreover, given that unmarked and some marked huemul were observed year-round at lake level, it appears most or all marked huemul used the shoreline during the summer as well. In comparison, huemul further north (Los Alerces National Park) [86] had a similar elevational displacement between average summer and winter locations of merely 200 m, which were classified as seasonal shifts. Moreover, these small seasonal elevational differences and distances, plus their presence at all elevations during the whole year, hence indicate that these huemul are non-migratory [6]. Huemul studied in Chile over several years in three different areas showed that winter and summer range usage largely overlapped, with an insignificant mean elevational displacement of about 200 m, and thus were considered non-migratory [87]. After reintroducing huemul around 1980 to Torres del Paine National Park, some family groups remained in low-elevation areas year-round, while other individuals eventually adopted a pattern of using areas somewhat elevated (up to 150 m higher) in summer, and descending to those lower areas mainly during winter, which was also considered as non-migratory [88,89,91]. Lastly, huemul in periglacial refuge areas by the Pacific coast also had limited elevational displacement as the treeline there is only at about 400 m asl. These huemul were non-migratory; they favored the flat and open grassland habitat, where twice as many fecal pellet groups were found as compared to those in forested hillsides [14].

Maximal horizontal movements were also very limited within the year-round habitually used home ranges of huemul in our study population at Shoonem Park. The longest movement (4.7 km) was made by a male in early spring, maybe induced by advanced disease, which terminated in his death from starvation shortly after (Figure 3b). In the study by Gill et al. [87], individuals considered non-migratory rarely moved more than 5 km, and the mean distance moved between summer and winter areas was 552 m (range 44–1219 m). In contrast, the reintroduction of seven huemul in the years since 2016 in the Los Rios region (Chile) revealed that exploratory movements of one male during the first month following his liberation included two excursions that reached 10 and 18 km in length, occurring in opposite directions, and that extended beyond his eventual home range (F. Vidal unpubl. data). The other animals moved less before establishing a home range. All released animals were born in the breeding center Huilo Huilo, they were radio-collared and released next to the center, and were permanently surveyed thereafter. It revealed that these adults and their fawns remained in the valley bottoms shared with the guanaco, and they never climbed the mountains that surround the center and their final home ranges (F. Vidal unpubl. data). The dispersal events and subsequent habitat use by these huemul so far are the first-ever documented cases, and they illustrate the movement potential of huemul, their all-year resident behavior in valley bottoms near riparian habitat with the best grass availability, which thus helps explain their historical distributions and movements, in concordance with the behavioral capacity of other *Odocoileus*.

The short movements displayed by huemul studied here explain the small year-round home ranges, averaging 167 ha (SE = 64.6), albeit possibly an underestimation. Year-round mean home range sizes in Tamango (Chile) were 318 ha, and similar between non-migratory females and males [87]. For huemul reintroduced to Torres del Paine National Park, year-round home range sizes as determined during a 10-year study varied between 269–336 ha [89]. In comparison, although similar-sized mule deer (*Odocoileus hemionus*) are typically migratory in the Rocky Mountains, resident deer on winter ranges utilized a continuous year-long home range, displacing only some 1300 m between seasons, and shifting to just slightly higher elevations in summer [60,90].

The huemul studied here clearly were year-round residents within a single and well-defined area, which was also corroborated by numerous antlers shed in that area. These resident huemul used an area that would be typical summer range habitat within this seasonal mountainous region, but is unsuitable for year-round inhabitancy due to nutritional limitations as evidenced by prevalent pathology [5,34,92] and lack of recovery of this population (Supplementary File S2). Moreover, solely between the early 1900s till the 1960s

the snow line rose by about 100–200 m in many parts of the Andes [93], which likely plays a role in this study area and the concomitant performance of this study population.

One of the very few huemul subpopulations known to be recovering, that resulted from the reintroduction to Torres del Paine National Park, where valley bottoms function as source areas, has resulted in huemul spatially expanding to eastern grassland areas [88,91]. This suggests that the absence of recolonizations of additional areas by most other extant huemul groups is because their current habitats do not qualify as source areas. Thus, the absent population growth with simultaneous low densities, results in very few or no dispersers, and thus explains the recorded lack of recolonization. For instance, whereas initial colonists of low valleys reported unearthing old, shed antlers when first plowing [94], the very rare contemporary huemul disperser entering that valley usually ends up dying [95]. Additionally, the continuing extinction of numerous such groups localized in remote refuge areas have been documented [96]. This coincides with observations that whereas dispersing adults or juveniles naturally connect source and sink areas, this has not been registered among the remaining extant huemul groups.

4.4. Implications of Having Lost Migratory Traditions

Areas used by extant resident huemul at high elevations are considered to represent summer ranges, thus constituting an ecological trap. This is substantiated by red deer introduced to former huemul winter ranges: initially, they behaved exclusively as resident deer, remaining on the winter range year-round. However, after several decades of population growth, a segment of the herd became migratory [5]. Importantly, guanaco are also known to use high mountains and forests, with corresponding seasonal migrations to low elevation winter ranges [30,97], with displacement distances reaching 70 km [98,99]. Moreover, guanaco were also drastically overhunted like huemul, but in contrast, have largely been eliminated from their prior mountainous distribution [31,52,100–102]. Notably, since colonial times, past and current livestock producers practice transhumance by herding their animals out of the Shoonem Protected Park before winter, as is the practice in other similar watersheds both in Argentina and Chile, in order to move them to areas considered appropriate winter ranges [103]. *Odocoileus* of similar body size were shown to avoid areas with >40 cm of snow [104], which may explain the use by huemul of the lake shores in the Protected Park Shoonem during peak winter, where snowpacks are considerably reduced along the beaches (Figure 2). However, this year-round residency in a seasonal area classified as a summer range can result in health problems due to dietary deficiencies.

Historical remarks already considered the use of summer and winter ranges as a determinant of huemul health. Given the low density of herbivores in most areas of extant huemul, protein and energy supplies are considered adequate and cannot explain the prevalent disease pattern or the lacking population recovery (Supplementary File S2). Health issues have now been corroborated by the high prevalence of skeletal pathologies in huemul spread over a large geographical region [95], including nearly 90% of individuals reported in this study, which qualifies these huemul as refugees (Supplementary File S2). Nutritional deficiencies were hypothesized to account for the high incidence of bone disease [106]. For one, valley bottoms tend to have soils enriched in minerals due to the topographic effect and accordingly, huemul reported here as residents in a summer range suffer from acute geochemical stress [105]. Moreover, huemul were shown to be deficient in essential micronutrients (Se, Cu, Mn) which coincides with their skeletal problems [55,107,108], and low average life span [34]. This is similar to situations in bighorn sheep [84] (Supplementary File S2), and likely explains the unusual reactions of huemul to other diseases due to their compromised metabolic and immune systems [55]. In contrast, migratory mammalian herbivores partially living in resource-poor environments travel farthest to fulfill their resource needs [109,110].

By eliminating sedentary subpopulations on winter ranges and consistently removing the last dispersing huemul, the remaining animals exhibit the aberrant behavior of becoming tied year-round to refuge areas that qualify as seasonal summer ranges. This artificial

anthropogenic elimination of migratory traditions has resulted in most extant huemul remaining in suboptimal Anthropocene refugia [19,111]. Clearly, the resident behavior reported here for huemul taking place on a seasonal summer range is not the norm for cervids that use winter ranges either as residents or seasonal migrators.

4.5. Implications for Conservation

To base conservation strategies for huemul on its modern distribution is erroneous due to being an artifact, as has been recognized for other ungulates [18,84,108] (Supplementary File S2). Remarkably, Grzimek in 1973 [81] already recognized that huemul have been exterminated in most historical areas, such that they only survive in a few small mountain refuge areas (“bis auf wenige winzige Rückzugsgebiete ausgerottet”). Moreover, it is essential that the “shifting baseline syndrome” be overcome [112], that is repeating old, unfounded and outdated interpretations, like huemul being a “mountain deer”, being short-legged, non-migratory, etc., which qualify as stereotyping and compromising conservation efficacy [20]. As shown with published fake information, these are cited many times, over long periods, and have even caused an impact on human health [113]. The largest risk for refugee species occurs when the currently occupied suboptimal habitats are identified as the conservation priority areas for the species in question, as has been modeled for huemul based on the extant distribution (e.g., Riquelme et al.) [2]. This risk is especially large when the species has been limited to suboptimal habitat for numerous decades [17], even centuries, as has occurred with resilient huemul. Acknowledging historical species ranges is thus important for recovering endangered species [17,19,20,114–117] (Supplementary File S2). Most important for non-recovering subpopulations is the need to differentiate if extant subpopulations live in a marginal or natural sink area, or in an artificial ecological trap, since the latter two will drive a local subpopulation to become extirpated. Moreover, sedentariness on seasonal summer ranges by loss of migratory culture may be one of the largest problems challenging the long-term persistence of most huemul subpopulations, as has been determined for bighorn sheep populations (Supplementary File S2). Illustratively, the rare case of a growing huemul subpopulation after its reintroduction in Torres del Paine National Park, with resident groups in valley bottoms, is expanding into grassland areas where they overlap with guanaco [88,91]. Similarly, huemul reintroduced in the Los Rios region (Chile) became residents in valley bottoms together with guanaco (F. Vidal unpubl. data). To recover endangered huemul, Kauffman et al. [117] recently pointed out the importance to consider their historical distribution and migratory tradition. Moreover, it is critically important to recognize the length of time required to reestablish migratory behavior as shown in different cervids, which needed 12 or more generations to reinitiate migratory behavior, once a critical density among residents was attained (Supplementary File S2). A key requirement will be the conservation of “migratory routes”, a target essentially already projected in Argentina, by huemul being declared a Natural Monuments by federal and provincial laws [118]. An additional tool is declaring new areas containing migratory routes as a Natural Monument according to Category III of the IUCN. Importantly, the preservation of migratory routes also allows fundamental ecological processes to continue (food webs, nutrient cycling) [119], besides their function to assure the survival of species dependent on seasonal migration [10,117].

Differentiating between the proximate and ultimate causes of mortality is necessary to understand the population dynamics of ungulate populations. Particularly the interaction between predation and malnutrition as a cause of mortality is difficult to disentangle without manipulative experiments or other means of assessment [120]. Therefore, to experimentally test the refugee interpretation, it is highly recommended that huemul be reintroduced into habitats proposed to be critical source areas and with minimal modern anthropogenic threats, to monitor their habitat-specific fitness, while using animals in the currently inhabited refuge areas as controls [10,17,20,118]. Reverting the artificial situation would require creating resident subpopulations of huemul in formerly used winter ranges (Figure 4). Furthermore, instead of waiting until reaching densities that

promote the natural emigration and re-establishment of migratory traditions, this process could be accelerated by training young animals via imprinting to acquire a migratory pattern, as has been done successfully with other ungulates [121,122]. Once winter ranges are repopulated, along with positive recruitment rates, the expansion to unoccupied ranges, i.e., neighboring winter and summer ranges, can occur. Available evidence supports the hypothesis that a major factor behind the current failure of many huemul subpopulations to recover numerically and spatially is the current absence of their members in suitable winter ranges. Repopulating such areas would in time also allow reconnections between the currently isolated subpopulations, concordant with the common pattern among other cervids in seasonal regions, which consists of mixed group compositions on both summer and winter ranges. In this way, a winter range frequently receives migratory members from several distinct summer ranges, while a summer range will receive members from distinct winter ranges [58,60,123–125], and thus contributes to gene pool diversity.

A lesson learned from this study, of general application to conservation biology, is that it can be a fatal mistake to define the “area of habitat” (AOH according to Brooks et al.) [126] for an endangered species on the basis of its current distribution. This distributional range is often not the same environmental space that was once occupied by the species under natural conditions (from source to sink habitats) but is instead a refuge where it was displaced by the human footprint, and frequently is nutritionally insufficient to sustain its populations. Unfortunately, the ‘protected area paradox’ [15,19,127], which is widespread and applies to huemul, has facilitated the provision of protection in less productive habitats and has resulted in ineffectual attempts to conserve huemul in suboptimal habitats (i.e., as refugee species) where the subpopulation barely persists at extremely low densities and with compromised health issues.

5. Conclusions

Making a leap towards conceptualizing what constitutes the fundamental factors preventing recovery of most subpopulations could release the huemul from its current imperilment. Many winter ranges historically used by all-year residents and also by migratory huemul apparently have turned from source to sink areas, mainly because of human predation in the past, and currently due to a lack of dispersers, due to the abundance of humans, dogs, automobile traffic, and agricultural land conversion. Among cervids in seasonal mountain areas, the huemul appears to be the only one that has mostly year-round resident subpopulations in what would be considered a typical summer range, and thus can be classified as an unfortunate refugee species, stuck in an ecological trap. To our knowledge, this is the first published account of a cervid species afflicted by these circumstances. Several huemul refugee subpopulations are known to be severely afflicted with disease resulting from concomitant micronutrient deficiencies, which explains their short life spans, and absence of both population growth and spatial expansion. Major steps towards reverting the prevailing absence of recovery over the past decades will be their reintroduction to historic winter source areas and the subsequent encouragement and fostering of reestablishing the migratory tradition. Additionally, a numerical and spatial recovery will also result in reconnecting the currently isolated subpopulations. The distributional retraction of the huemul and the extirpation of numerous local and isolated populations, including islands such as Tierra del Fuego and Chiloé, clearly show that without strong assistance from novel conservation technologies it will be difficult to prevent the extinction of this endemic deer in Patagonia.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/conservation2020023/s1>. File S1: Compendium of the Review about the Huemul Distribution in Patagonia: Past and Present; File S2: Compendium: Review of Consequences for Ungulates when losing Migratory Traditions. References [129–304] are cited in Supplementary Materials File.

Author Contributions: Conceptualization, W.T.F., J.A.M.S.-F., Z.G. and F.V.; Data curation, W.T.F. and J.A.M.S.-F.; Formal analysis, W.T.F., J.A.M.S.-F., M.Z., V.G., J.R.H., P.B.-D., Z.G., A.J.M. and J.E.J.; Funding acquisition, W.T.F. and J.A.M.S.-F.; Investigation, W.T.F., J.A.M.S.-F., M.E.E., M.Z., B.F., F.V., J.B., S.M.M. and S.H.; Methodology, W.T.F.; Supervision, W.T.F.; Writing—original draft, W.T.F., J.A.M.S.-F., M.Z., B.F., V.G., J.R.H., P.B.-D., Z.G., F.V., J.B., S.M.M., A.J.M., S.H. and J.E.J.; Writing—review & editing, W.T.F., J.A.M.S.-F., M.E.E., M.Z., B.F., V.G., J.R.H., P.B.-D., Z.G., F.V., J.B., S.M.M., A.J.M., S.H. and J.E.J. All authors have read and agreed to the published version of the manuscript.

Funding: We would like to extend our gratitude to the Foundation Erlenmeyer, Basel, Switzerland who provided the main funding for this work, the Projekt Gabelhirsch.

Institutional Review Board Statement: All animals used in this study were managed in accordance with strict animal ethics protocols and according to the Ministry of Production, Province of Chubut in Argentina (permit Disp. Nr. 22/2017-DfyFS-M.P.).

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We recognize that this work has been supported mainly from a grant by the Erlenmeyer Stiftung, Switzerland. We thank Rudolf Roth, Martin Hug, and Kurt Aeschbacher for accompanying the huemul work during several years with a great understanding of all the challenges. We thank Enrique Verde and Renzo Mottino for outstanding field assistance, and the Dirección de Fauna y Flora Silvestre of the Province of Chubut for supporting, encouraging, and permitting the research and conservation management projects with huemul (permit Disp. Nr. 47/2019-DFyFS-M.P.). Much appreciated are the various assistants who helped with field- and other valuable work and input, and the Rewilding Argentina Foundation for the placement of a first satellite radio collar. We also thank Rory Putman and William Fagan for the detailed analyses and improvements made to the manuscript, as well as several reviewers for all their constructive comments. Finally, we dedicate this article in memory of our co-author Valerius Geist (1934–2021), a highly respected evolutionary and behavioral ecologist who was a pioneer in his field. He spent years towards understanding why the huemul fails to recover despite the millions of hectares available of so-called “prime habitat”, and he actively participated on the IUCN Huemul Task Force and in the last two assessments of this species for the IUCN Red list. Thank you, Val, for your invaluable input in making this paper a reality.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Spatial behavior of huemul during summer and winter (precise locations based on VHF radio collars), in the Protected Park Shoonem, Chubut, Argentina, between August 2017 and April 2022.

Cases	Total Data Points (N)			Minimal Separation (m)		Vital Status	
	Summer	Winter	Spring/Fall	Horizontal	Altitudinal	Capture	Dead
female 1	3	6	4	122	68	2017	unknown
female 2	2	3	1	2140	143	2017	2018
female 3	8	7	5	0	0	2017	alive
male 1	3	3	5	423	38	2017	2018
male 2	7	7	1	89	71	2017	2020
male 3	14	4	6	0	0	2017	2022

Table A2. Scale of the spatial behavior of Male 3 (satellite radio collar) at the end of winter, and the autumn of 2022.

	GPS Fix * (n)	Area (ha)	Perimeter (m)	Overlap	Seasonal Displacement
(a) Aug 13–Sept 30	437	163	5760	76 %	490 m more south than (b)
(b) Oct 1–Dec 10	405	147	4810	85%	235 m more north than (a)
(c) Dec 11–Mar 7 2022	833	158	5440		no changes
Total survey	1675	190	6610		

* these are precise points with DOP of 2 or less.

References

- Black-Decima, P.A.; Corti, P.; Díaz, N.; Fernandez, R.; Geist, V.; Gill, R.; Gizejewski, Z.; Jiménez, J.; Pastore, H.; Saucedo, C.; et al. *Hippocamelus bisulcus*. In *The IUCN Red List of Threatened Species*; International Union for Conservation of Nature and Natural Resources: Gland, Switzerland, 2016.
- Riquelme, C.; Estay, S.A.; López, R.; Pastore, H.; Soto-Gamboa, M.; Corti, P. Protected areas' effectiveness under climate change: A latitudinal distribution projection of an endangered mountain ungulate along the Andes Range. *PeerJ* **2018**, *6*, e5222. [[CrossRef](#)] [[PubMed](#)]
- Smith-Flueck, J.M.; Flueck, W.T. Natural mortality patterns in a population of southern Argentina huemul (*Hippocamelus bisulcus*), an endangered Andean cervid. *Zeits. Jagdwiss.* **2001**, *47*, 178–188. [[CrossRef](#)]
- Putman, R.; Flueck, W.T. Intraspecific variation in biology and ecology of deer: Magnitude and causation. *Anim. Prod. Sci.* **2011**, *51*, 277–291. [[CrossRef](#)]
- Flueck, W.T.; Smith-Flueck, J.M. Recent advances in the nutritional ecology of the Patagonian huemul: Implications for recovery. *Anim. Prod. Sci.* **2011**, *51*, 311–326. [[CrossRef](#)]
- Grotta-Neto, F.; Duarte, J.M.B. Movements of Neotropical Forest Deer: What Do We Know? In *Movement Ecology of Neotropical Forest Mammals: Focus on Social Animals*; Reyna-Hurtado, R., Chapman, C., Eds.; Springer Nature: Cham, Switzerland, 2019; pp. 95–109.
- Peters, W.; Hebblewhite, M.; Mysterud, A.; Spitz, D.; Focardi, S.; Urbano, F.; Morellet, N.; Heurich, M.; Kjellander, P.; Linnell, J.D.C.; et al. Migration in geographic and ecological space by a large herbivore. *Ecol. Monogr.* **2017**, *87*, 297–320. [[CrossRef](#)]
- Xu, W.; Barker, K.; Shawler, A.; Van Scoyoc, A.; Smith, J.A.; Mueller, T.; Sawyer, H.; Andreozzi, C.; Bidder, O.R.; Karandikar, H.; et al. The plasticity of ungulate migration in a changing world. *Ecology* **2021**, *102*, e03293. [[CrossRef](#)]
- Howard, W.E. Innate and environmental dispersal of individual vertebrates. *Am. Midl. Nat.* **1960**, *63*, 152–161. [[CrossRef](#)]
- Bolger, D.T.; Newmark, W.D.; Morrison, T.A.; Doak, D.F. The need for integrative approaches to understand and conserve migratory ungulates. *Ecol. Lett.* **2008**, *11*, 63–77. [[CrossRef](#)]
- Festa-Bianchet, M. Learning to migrate. *Science* **2018**, *361*, 972–973. [[CrossRef](#)]
- Jesmer, B.R.; Merkle, J.A.; Goheen, J.R.; Aikens, E.O.; Beck, J.L.; Courtemanch, A.B.; Hurley, M.A.; McWhirter, D.E.; Miyasaki, H.M.; Monteith, K.L.; et al. Is ungulate migration culturally transmitted? Evidence of social learning from translocated animals. *Science* **2018**, *361*, 1023–1025. [[CrossRef](#)]
- Sawyer, H.; Merkle, J.A.; Middleton, A.D.; Dwinnell, S.P.H.; Monteith, K.L. Migratory plasticity is not ubiquitous among large herbivores. *J. Anim. Ecol.* **2019**, *88*, 450–460. [[CrossRef](#)]
- Frid, A. Habitat use by the endangered huemul (*Hippocamelus bisulcus*): Cattle, snow, and the problem of multiple causes. *Biol. Conserv.* **2001**, *100*, 261–267. [[CrossRef](#)]
- Joppa, L.N.; Pfaff, A. High and Far: Biases in the Location of Protected Areas. *PLoS ONE* **2009**, *4*, e8273. [[CrossRef](#)]
- Quevedo, P.; Von Hardenberg, A.; Pastore, H.; Álvarez, J.; Corti, P. Predicting the potential distribution of the endangered huemul deer *Hippocamelus bisulcus* in North Patagonia. *Oryx* **2017**, *51*, 315–323. [[CrossRef](#)]
- Kerley, G.I.H.; Kowalczyk, R.; Croomsigt, J.P.G.M. Conservation implications of the refugee species concept and the European bison: King of the forest or refugee in a marginal habitat? *Ecography* **2012**, *35*, 519–529. [[CrossRef](#)]
- Faurby, S.; Araujo, M.B. Anthropogenic range contractions bias species climate change forecasts. *Nat. Clim. Change* **2018**, *8*, 252–256. [[CrossRef](#)]
- Nüchel, J.; Bocher, P.K.; Xiao, W.; Zhu, A.X.; Svenning, J.C. Snub-nosed monkeys (*Rhinopithecus*): Potential distribution and its implication for conservation. *Biodiv. Cons.* **2018**, *27*, 1517–1538. [[CrossRef](#)]
- Britnell, J.A.; Lewis, R.N.; Elsner-Gearing, F.; Harvey, N.; Stanbrook, E.; Shultz, S. Species stereotypes as a result of unconscious research biases compromise conservation efficacy. *Biol. Cons.* **2021**, *261*, 109275. [[CrossRef](#)]
- Redford, K.H.; Eisenberg, J.F. *Mammals of the Neotropics: The Southern Cone, Volume 2, Chile, Argentina, Uruguay, Paraguay*; The University of Chicago Press: Chicago, IL, USA; London, UK, 1992.
- Aldridge, D.; Lopez, R.; Saucedo, C.; Vila, A.R. *Los Ultimos Senderos del Huemul*; Fundacion Hiunay: Santiago, Chile, 2007; ISBN 9789567667062.

23. Vila, A.R.; Saucedo, C.; Aldridge, D.; Ramilo, E.; Corti, P. South Andean Huemul *Hippocamelus bisulcus* (Molina 1782). In *Neotropical Cervidology*; Duarte, J.M., González, S., Eds.; FUNEP: Jaboticabal, Brazil, 2010; pp. 89–100.
24. Gonzalez, S.; Barbanti Duarte, J.M. Speciation, evolutionary history and conservation trends of neotropical deer. *Mastozool. Neotrop.* **2020**, *27*, 37–47. [[CrossRef](#)]
25. Escobar Ruiz, E.M.; Smith, J.M.; Flueck, W.T. *El Huemul—Shoonem: Madera que se Mueve/re*, 2nd ed.; Biblioteca Popular “Dr. Enrique Perea”: Alto Río Senguier, Argentina, 2020.
26. Díaz, N.I.; Smith-Flueck, J. *The Patagonian Huemul. A Mysterious Deer on the Brink of Extinction*; Literature of Latin America: Buenos Aires, Argentina, 2000.
27. Donoso, D.; Iriarte, A.; Segura, B.; Tirado, M. Antecedentes de Huemul (Capítulo 1). In *El Huemul de Aysén y Otros Rincones*; Iriarte, A., Donoso, D.S., Segura, B., Tirado, M., Eds.; Ediciones Secretaría Regional Ministerial de Agricultura de la Región de Aysén y Flora & Fauna Chile Ltd.: Aysen, Chile, 2017; pp. 13–61.
28. Smith-Flueck, J.M. La Ecología del Huemul (*Hippocamelus bisulcus*) en la Patagonia Andina de Argentina y Consideraciones sobre su Conservación. Ph.D Thesis, Universidad Nacional del Comahue, Bariloche, Argentina, 2003; pp. 1–361.
29. Sauter, T. Revisiting extreme precipitation amounts over southern South America and implications for the Patagonian Icefields. *Hydrol. Earth Syst. Sci.* **2020**, *24*, 2003–2020. [[CrossRef](#)]
30. Puig, S.; Rosi, M.I.; Videla, F.; Mendez, E. Summer and winter diet of the guanaco and food availability for a High Andean migratory population (Mendoza, Argentina). *Mammal. Biol.* **2011**, *76*, 727–734. [[CrossRef](#)]
31. Kölliker, A.; Kühn, F.; Reichert, F.; Tomsen, A.; Witte, L. *Patagonia. Resultado de las expediciones en 1910 a 1916*; Sociedad Científica Alemana: Buenos Aires, Argentina, 1917; Volumes 1 and 2.
32. Citino, S.B.; Bush, M.; Grobler, D.; Lance, W. Anesthesia of boma-captured Lichtenstein’s hartebeest (*Sigmocerus lichtensteini*) with a combination of thiafentanil, medetomidine and ketamine. *J. Wildl. Dis.* **2002**, *38*, 457–462. [[CrossRef](#)] [[PubMed](#)]
33. Muller, L.I.; Osborn, D.A.; Doherty, T.; Keel, M.K.; Miller, B.F.; Warren, R.J.; Mille, K.V. Optimal Medetomidine Dose When Combined with Ketamine and Tiletamine-zolazepam to Immobilize White-tailed Deer. *J. Wildl. Dis.* **2012**, *48*, 477–482. [[CrossRef](#)] [[PubMed](#)]
34. Flueck, W.T.; Smith-Flueck, J.M. Age-independent osteopathology in skeletons of a south American cervid, the Patagonian huemul (*Hippocamelus bisulcus*). *J. Wildl. Dis.* **2008**, *44*, 636–648. [[CrossRef](#)] [[PubMed](#)]
35. White, G.C.; Garrott, R.A. *Analysis of Wildlife Radio-Tracking Data*; Academic Press: San Diego, CA, USA, 1990.
36. Harris, S.; Cresswell, W.J.; Forde, P.G.; Trehwella, W.J.; Woollard, T.; Wray, S. Home-range analysis using radio tracking data: A review of problems and techniques particularly as applied to the study of mammals. *Mammal. Rev.* **1990**, *20*, 97–123. [[CrossRef](#)]
37. Börger, L.; Franconi, N.; de Michele, G.; Gantz, A.; Meschi, F.; Manica, A.; Lovari, S.; Coulson, T. Effects of sampling regime on the mean and variance of home range size estimates. *J. Anim. Ecol.* **2006**, *75*, 1393–1405. [[CrossRef](#)]
38. Zweifel-Schielly, B.; Kreuzer, M.; Ewald, K.C.; Suter, W. Habitat selection by an Alpine ungulate: The significance of forage characteristics varies with scale and season. *Ecography* **2009**, *32*, 103–113. [[CrossRef](#)]
39. Kropil, R.; Smolko, P.; Garaj, P. Home range and migration patterns of male red deer *Cervus elaphus* in Western Carpathians. *Eur. J. Wildl. Res.* **2015**, *61*, 63–72. [[CrossRef](#)]
40. Kie, J.G.; Matthiopoulos, J.; Fieberg, J.; Powell, R.A.; Cagnacci, F.; Mitchell, M.S.; Gaillard, J.M.; Moorcroft, P.R. The home-range concept: Are traditional estimators still relevant with modern telemetry technology? *Philos. Trans. R. Soc. B* **2010**, *365*, 2221–2231. [[CrossRef](#)]
41. Powell, R.A. Animal home ranges and territories and home range estimators. In *Research Techniques in Animal Ecology: Controversies and Consequences*; Boitani, L., Fuller, T., Eds.; Columbia University Press: New York, NY, USA, 2000.
42. Bunnefeld, N.; Börger, L.; van Moorter, B.; Rolandsen, C.M.; Dettki, H.; Solberg, E.J.; Ericsson, G. A model-driven approach to quantify migration patterns: Individual, regional and yearly differences. *J. Anim. Ecol.* **2011**, *80*, 466–476. [[CrossRef](#)]
43. Spitz, D.B.; Hebblewhite, M.; Stephenson, T.R.; German, D.W. How plastic is migratory behavior? Quantifying elevational movement in a partially migratory alpine ungulate, the Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*). *Can. J. Zool.* **2018**, *96*, 1385–1394. [[CrossRef](#)]
44. Morrison, T.A.; Merkle, J.A.; Hopcraft, J.G.C.; Aikens, E.O.; Beck, J.L.; Boone, R.B.; Courtemanch, A.B.; Dwinnell, S.P.; Fairbanks, W.S.; Griffith, B.; et al. Drivers of site fidelity in ungulates. *J. Anim. Ecol.* **2021**, *90*, 955–966. [[CrossRef](#)]
45. Marshall, G.; Jonker, L. An introduction to descriptive statistics: A review and practical guide. *Radiography* **2010**, *16*, e1–e7. [[CrossRef](#)]
46. Anchorena, A. *Descripción Gráfica de la Patagonia y Valles Andinos*; Compañía Sudamericana de Billetes de Banco: Buenos Aires, Argentina, 1902.
47. Onelli, C. El huemul. Su patria: Su vida. *Rev. Jardín Zool. Buenos Aires* **1905**, *1*, 370–374.
48. Bahre, C.J. *Destruction of the Natural Vegetation of North-Central Chile*; University of California Publications in Geography: Berkeley, CA, USA, 1979; Volume 23, pp. 1–117. ISBN 0-520-09594-4.
49. Saavedra, B.; Simonetti, J.A. Archaeological evidence of Pudu pudu (Cervidae) in central Chile. *Z. Säugetierkunde* **1991**, *56*, 252–253.
50. Ale, A. A social economic formation of hunter-gatherers in the semiarid northern Chile: A revaluation of San Pedro Viejo of Pichasca site. *Zaranda Ideas* **2014**, *11*, 67–88.

51. Merow, C.; Wilson, A.M.; Jetz, W. Integrating occurrence data and expert maps for improved species range predictions. *Glob. Ecol. Biogeogr.* **2017**, *26*, 243–258. [[CrossRef](#)]
52. Travaini, A.; Zapata, S.C.; Bustamante, J.; Pedrana, J.; Zanón, J.I.; Rodríguez, A. Guanaco abundance and monitoring in Southern Patagonia: Distance sampling reveals substantially greater numbers than previously reported. *Zool. Stud.* **2015**, *54*, 23. [[CrossRef](#)]
53. De Gea, G. *El Ganado Lanar en la Argentina*, 2nd ed.; Universidad Nacional de Río Cuarto: Río Cuarto, Argentina, 2007; ISBN 978-950-665-448-1.
54. Uboldi, J.A.; Angeles, G.R.; Gentili, J.O.; Gernaldi, A.M.; Melo, W.D.; Carbone, M.E. *Geotecnologías del sur Argentino. Casos de Estudio*; Departamento de Geografía y Turismo (TIG), Universidad Nacional del Sur: Bahía Blanca, Argentina, 2014.
55. Flueck, W.T. Nutrition as an etiological factor causing diseases in endangered huemul deer. *BMC Res. Notes* **2020**, *13*, 276. [[CrossRef](#)]
56. Merkle, J.A.; Sawyer, H.; Monteith, K.L.; Dwinnell, S.P.; Fralick, G.L.; Kauffman, M.J. Spatial memory shapes migration and its benefits: Evidence from a large herbivore. *Ecol. Lett.* **2019**, *22*, 1797–1805. [[CrossRef](#)]
57. Aikens, E.O.; Kauffman, M.J.; Merkle, J.A.; Dwinnell, S.P.H.; Fralick, G.L.; Monteith, K.L. The greenscape shapes surfing of resource waves in a large migratory herbivore. *Ecol. Lett.* **2017**, *20*, 741–750. [[CrossRef](#)]
58. Flueck, W.T. The effect of selenium on reproduction of black-tailed deer (*Odocoileus hemionus columbianus*) in Shasta County, California. Ph.D Thesis, University of California, Davis, CA, USA, 1989.
59. Kauffman, M.J.; Copeland, H.E.; Berg, J.; Bergen, S.; Cole, E.; Cuzzocreo, M.; Dewey, S.; Fattebert, J.; Gagnon, J.; Gelzer, E.; et al. *Ungulate Migrations of the Western United States*; Report 2020–5101; U.S. Geological Survey Scientific Investigations: Reston, VA, USA, 2020; Volume 1.
60. Gogan, P.J.P.; Klaver, R.W.; Olexa, E.M. Northern Yellowstone Mule Deer Seasonal Movement, Habitat Selection, and Survival Patterns. *West. North Am. Nat.* **2019**, *79*, 403–427. [[CrossRef](#)]
61. Van de Kerk, M.; Larsen, R.T.; Olson, D.D.; Hersey, K.R.; McMillan, B.R. Variation in movement patterns of mule deer: Have we oversimplified migration? *Mov. Ecol.* **2021**, *9*, 44. [[CrossRef](#)] [[PubMed](#)]
62. Haller, H. Der Rothirsch im Schweizerischen Nationalpark und dessen Umgebung. Eine alpine Population von *Cervus elaphus* zeitlich und räumlich dokumentiert. *Natl. Forsch. Schweiz* **2002**, *91*, 1–144.
63. Howe, R.W.; Davis, G.J.; Mosca, V. The demographic significance of ‘sink’ populations. *Biol. Conserv.* **1990**, *57*, 239–255. [[CrossRef](#)]
64. Remes, V. How can maladaptive habitat choice generate source-sink population dynamics? *Oikos* **2000**, *91*, 579–582. [[CrossRef](#)]
65. Braunisch, V.; Bollmann, K.; Graf, R.F.; Hirzel, A.H. Living on the edge. Modelling habitat suitability for species at the edge of their fundamental niche. *Ecol. Model.* **2008**, *214*, 153–167. [[CrossRef](#)]
66. Goss, R.J. *Deer Antlers: Regeneration, Function and Evolution*; Academic Press: New York, NY, USA, 1983.
67. Tonko, J. Kawesqar travel narratives. *Onomazein* **2008**, *18*, 11–47.
68. Anonymous. Excursión del gobernador del Chubut. *Caras Caretas* **1904**, *7*, 58.
69. Moreno, F.P. Apuntes preliminares sobre una excursión a los territorios del Neuquén, Río Negro, Chubut y Santa Cruz. *Rev. Mus. La Plata* **1898**, *8*, 200–459.
70. Steffen, H. Viajes de exploración: Estudio en la Patagonia occidental 1892–1902. *Anal. Univ. Chile* **1910**, *2*, 1–419.
71. Jiménez, J.; Guineo, G.; Corti, P.; Smith, J.A.; Flueck, W.T.; Vila, A.; Gizejewski, Z.; Gill, R.; McShea, B.; Geist, V. *Hippocamelus bisulcus*. In *IUCN Red List of Threatened Species*; IUCN: Gland, Switzerland, 2008.
72. Curran, S.C. Expanding ecomorphological methods: Geometric morphometric analysis of Cervidae post-crania. *J. Archaeol. Sci.* **2012**, *39*, 1172–1182. [[CrossRef](#)]
73. Curran, S.C. Exploring Eucladoceros ecomorphology using geometric morphometrics. *Anat. Rec.* **2015**, *298*, 291–313. [[CrossRef](#)]
74. Flueck, W.T.; Smith-Flueck, J.M. Osteological comparisons of appendicular skeletons: A case study on Patagonian huemul deer and its implications for conservation. *Anim. Prod. Sci.* **2011**, *51*, 327–339. [[CrossRef](#)]
75. Flueck, W.T. Functional limb anatomy in a refugee species: The endangered Patagonian huemul deer (*Hippocamelus bisulcus*). *Anat. Histol. Embryol.* **2021**, *50*, 411–416. [[CrossRef](#)]
76. Barberena, R.; Méndez, C.; Mena, F.; Reyes, O. Endangered species, archaeology, and stable isotopes: Huemul (*Hippocamelus bisulcus*) isotopic ecology in central-western Patagonia (South America). *J. Archaeol. Sci.* **2011**, *38*, 2313–2323. [[CrossRef](#)]
77. Caro, T. The adaptive significance of coloration in mammals. *BioScience* **2005**, *55*, 125–136. [[CrossRef](#)]
78. Webb, S.D. Evolutionary history of New World Cervidae. In *Antelopes, Deer, and Relatives*; Vrba, E.S., Schaller, G.B., Eds.; Yale University Press: New York, NY, USA, 2000; pp. 38–64.
79. Prichard, H.H. Field notes upon some of the larger mammals of Patagonia made between September 1900 and June 1901. *Proc. Zool. Soc. Lond.* **1902**, *1*, 272–277.
80. Gai, A.G. Huemul, inofensivo venado de las soledades cordilleranas de la Patagonia. *Chacra* **1936**, *6*, 99–101.
81. Grzimek, B. *Grzimeks Tierleben: Enzyklopädie des Tierreichs—Säugetiere 3*; Neue Schweizer Bibliothek: Zurich, Switzerland, 1973.
82. Bürger, O. *Aus der Wildnis des Huemul. Erlebnisse und Abenteuer unter den Kolonisten und Indianern Chiles*; Verlag Deutsche Buchwerkstätten: Dresden, Germany, 1924.
83. Goni, R.A.; Belardi, J.B.; Re, A.; Nuevo Delaunay, A.; Molinari, R.L.; Ferraro, L. Los grabados de la meseta del lago Strobel (Patagonia argentina) desde una perspectiva regional. In *Actas del Primer Simposio Nacional de Arte Rupestre*; Cusco Nov. 2004; Institut Francais d’Etudes Andines: Lima, Peru, 2007; pp. 427–438.

84. Risenhoover, K.L.; Bailey, J.A.; Wakelyn, L.A. Assessing the Rocky Mountain Bighorn Sheep Management Problem. *Wildl. Soc. Bull.* **1988**, *16*, 346–352.
85. Nagaike, T. Bark Stripping by Deer Was More Intensive on New Recruits than on Advanced Regenerants in a Subalpine Forest. *Forests* **2020**, *11*, 490. [CrossRef]
86. Diaz, P.; Marqués, B.I.; Vila, A.R. Seasonal habitat use and selection of the endangered huemul deer (*Hippocamelus bisulcus*) in Patagonian Andes. *Mammalia* **2013**, *77*, 371–380. [CrossRef]
87. Gill, R.; Saucedo, C.; Aldridge, D.; Morgan, G. Ranging behavior of huemul in relation to habitat and landscape. *J. Zool.* **2008**, *274*, 254–260. [CrossRef]
88. Guineo, O.; Guineo Garay, R.; Garay, G. *Conociendo al Huemul de Torres del Paine*; La Prensa Austral: Punta Arenas, Chile, 2008.
89. Garay, G.; Ortega, I.M.; Guineo, O. Social ecology of the huemul at Torres Del Paine National Park, Chile. *Anal. Inst. Patagon.* **2016**, *44*, 25–38. [CrossRef]
90. Webb, S.L.; Dzialak, M.R.; Houchen, D.; Kosciuch, K.L.; Winstead, J.B. Spatial ecology of female Mule deer in an area proposed for wind energy development. *West. N. Am. Nat.* **2013**, *73*, 347–356. [CrossRef]
91. Rau, J.A. Crecimiento poblacional de huemules del sur nativos y reintroducidos en la zona austral de Chile. In *4ta Reunión Chileno-Argentina sobre Estrategias de Conservación del Huemul*; Acosta-Jamett, G., Ed.; CONAF and CODEFF: Santiago, Chile, 2003; pp. 43–45.
92. Flueck, W.T.; Smith-Flueck, J.M. Troubling disease syndrome in endangered live Patagonian huemul deer (*Hippocamelus bisulcus*) from the Protected Park Shoonem: Unusually high prevalence of osteopathology. *BMC Res. Notes* **2017**, *10*, 739. [CrossRef] [PubMed]
93. Clapperton, C.M. The glaciation of the Andes. *Quat. Sci. Rev.* **1983**, *2*, 83–155. [CrossRef]
94. Flueck, W.T.; Smith-Flueck, J.M. Huemul heresies: Beliefs in search of supporting data. 2. Biological and ecological considerations. *Anim. Prod. Sci.* **2012**, *52*, 694–706. [CrossRef]
95. Flueck, W.T. Elusive cranial lesions severely afflicting young endangered Patagonian huemul deer. *BMC Res. Notes* **2018**, *11*, 638. [CrossRef]
96. Smith-Flueck, J.M.; Barrio, J.; Ferreyra, N.; Nuñez, A.; Tomas, N.; Guzman, J.; Flueck, W.T.; Hinojosa, A.; Vidal, F.; Garay, G.; et al. Advances in ecology and conservation of *Hippocamelus* species in South America. *Anim. Prod. Sci.* **2011**, *51*, 378–383. [CrossRef]
97. Franklin, W.L. Biology, ecology, and relationship to man of the South American camelids. In *Mammalian Biology in South America*; Mares, M.A., Genoways, H.H., Eds.; Pymatuning Laboratory of Ecology, University Pittsburgh: Linesville, PA, USA, 1982; Volume 6, pp. 457–489.
98. Mueller, T.; Olson, K.A.; Dressler, G.; Leimgruber, P.; Fuller, T.K.; Nicolson, C.; Novaro, A.J.; Bolgeri, M.J.; Wattles, D.; DeStefano, S.; et al. How landscape dynamics link individual- to population-level movement patterns: A multispecies comparison of ungulate relocation data. *Glob. Ecol. Biogeogr.* **2011**, *20*, 683–694. [CrossRef]
99. Gelin, M.L.; Branch, L.C.; Thornton, D.H.; Novaro, A.J.; Gould, M.J.; Caragiulo, A. Response of pumas (*Puma concolor*) to migration of their primary prey in Patagonia. *PLoS ONE* **2017**, *12*, e0188877. [CrossRef]
100. Franklin, W.L.; Bass, F.; Bonacic, C.F.; Cunazza, C.; Soto, N. Management of Patagonian guanaco in the grazing agroecosystem of southern Chile. *Wildl. Soc. Bull.* **1997**, *25*, 65–73.
101. Bonavia, D. *The South American Camelids: An Expanded and Corrected Edition*; Monograph 64; Cotsen Institute of Archaeology Press, UCLA: Los Angeles, CA, USA, 2009; Available online: <https://escholarship.org/uc/item/7xs9j2zs> (accessed on 4 April 2022).
102. Schroeder, N.M.; Matteucci, S.D.; Moreno, P.G.; Gregorio, P.; Ovejero, R.; Taraborelli, P.; Carmanchahi, P.D. Spatial and Seasonal Dynamic of Abundance and Distribution of Guanaco and Livestock: Insights from Using Density Surface and Null Models. *PLoS ONE* **2014**, *9*, e85960.
103. Ladio, A.H.; Lozada, M. Summer cattle transhumance and wild edible plant gathering in a Mapuche community of northwestern Patagonia. *Hum. Ecol.* **2004**, *32*, 225–240. [CrossRef]
104. Poole, K.G.; Mowat, G. Winter habitat relationships of deer and elk in the temperate interior mountains of British Columbia. *Wildl. Soc. Bull.* **2005**, *33*, 1288–1302. [CrossRef]
105. Myburgh, J.; McGowan, K.; Davis, A. Veterinary Geology. In *Practical Applications of Medical Geology*; Siegel, M., Selinus, O., Finkelman, R., Eds.; Springer: Cham, Switzerland, 2021.
106. Flueck, W.T. Consideraciones acerca de la calidad nutritiva de hábitat, hábitat óptimo, y evaluación de hábitat para huemul. In *4ta Reunión Chileno-Argentina Sobre Estrategias de Conservación del Huemul*; Acosta-Jamett, G., Ed.; CONAF and CODEFF: Santiago, Chile, 2003; pp. 30–34.
107. Landete-Castillejos, T.; Molina-Quilez, I.; Estevez, J.A.; Ceacero, F.; Garcia, A.J.; Gallego, L. Alternative hypothesis for the origin of osteoporosis: The role of Mn. *Front. Biosci. Elite Ed.* **2012**, *4*, 1385–1390. [CrossRef]
108. Gambín, P.; Serrano, M.P.; Gallego, L.; García, A.; Cappelli, J.; Ceacero, F.; Landete-Castillejos, T. Does Cu supplementation affect the mechanical and structural properties and mineral content of red deer antler bone tissue? *Animal* **2017**, *11*, 1312–1320. [CrossRef]
109. Bartlam-Brooks, H.L.; Beck, P.S.; Bohrer, G.; Harris, S. In search of greener pastures: Using satellite images to predict the effects of environmental change on zebra migration. *J. Geophys. Res. Biogeosci.* **2013**, *118*, 1427–1437. [CrossRef]
110. Teitelbaum, C.S.; Fagan, W.F.; Fleming, C.H.; Dressler, G.; Calabrese, J.M.; Leimgruber, P.; Mueller, T. How far to go? Determinants of migration distance in land mammals. *Ecol. Lett.* **2015**, *18*, 545–552. [CrossRef]

111. Monsarrat, S.; Jarvie, S.; Svenning, J.C. Anthropocene refugia: Integrating history and predictive modelling to assess the space available for biodiversity in a human-dominated world. *Philos. Trans. R. Soc. B* **2019**, *374*, 20190219. [[CrossRef](#)] [[PubMed](#)]
112. Soga, M.; Gaston, K.J. Shifting baseline syndrome: Causes, consequences and implications. *Front. Ecol. Environ.* **2018**, *16*, 222–230. [[CrossRef](#)]
113. Bar-Ilan, J.; Halevi, G. Retracted articles—The scientific version of fake news. In *The Psychology of Fake News: Accepting, Sharing, and Correcting Misinformation*; Greifeneder, R., Jaffé, M.E., Newman, E.J., Schwarz, N., Eds.; Taylor & Francis Group: New York, NY, USA, 2021.
114. Novillo, A.; Ovejero, A.J.A.; Cristobal, L.; Ojeda, R.A. Alpine Mammals of South America. In *Encyclopedia of the World's Biomes*; Goldstein, M.I., DellaSala, D.A., Eds.; Elsevier: Amsterdam, The Netherlands, 2020; pp. 441–460.
115. Cromsigt, J.P.G.M.; Kerley, G.I.H.; Kowalczyk, R. The difficulty of using species distribution modelling for the conservation of refugee species—The example of European bison. *Div. Distrib.* **2012**, *18*, 1253–1257. [[CrossRef](#)]
116. Lea, J.M.D.; Kerley, G.I.H.; Hrabar, H.; Barry, T.J.; Shultz, S. Recognition and management of ecological refugees: A case study of the Cape mountain zebra. *Biol. Conserv.* **2016**, *203*, 207–215. [[CrossRef](#)]
117. Kauffman, M.J.; Cagnacci, F.; Chamaillé-Jammes, S.; Hebblewhite, M.; Hopcraft, J.G.C.; Merkle, J.A.; Mueller, T.; Mysterud, A.; Peters, W.; Roettger, C.; et al. Mapping out a future for ungulate migrations. Limited mapping of migrations hampers conservation. *Science* **2021**, *372*, 566–569. [[CrossRef](#)]
118. Lopez Alfonsin, M.A.; Bucetto, M.S. Endangered species and mechanisms for the recovery and conservation of biodiversity: A study on the viability of mechanisms and bureaucratic obstacles. *LEX* **2019**, *17*, 297–324.
119. Doughty, C.E.; Roman, J.; Faurby, S.; Wolf, A.; Haque, A.; Bakker, E.S.; Malhi, Y.; Dunning, J.B.; Svenning, J.C. Global nutrient transport in a world of giants. *Proc. Nat. Acad. Sci. USA* **2018**, *113*, 868–873. [[CrossRef](#)]
120. Monteith, K.L.; Bleich, V.C.; Stephenson, T.R.; Pierce, B.M.; Conner, M.M.; Kie, J.G.; Bowyer, R.T. Life-history characteristics of mule deer: Effects of nutrition in a variable environment. *Wildl. Monogr.* **2014**, *186*, 1–62. [[CrossRef](#)]
121. Allred, W.J. Re-establishment of seasonal elk migration through transplanting. *N. Am. Wildl. Conf.* **1950**, *15*, 597–611.
122. Stüwe, M.; Nievergelt, B. Recovery of Alpine ibex from near extinction: The result of effective protection, captive breeding, and reintroductions. *Appl. Anim. Behav. Sci.* **1991**, *29*, 379–387. [[CrossRef](#)]
123. Gruell, G.E.; Papez, N.J. Movements of mule deer in northeastern Nevada. *J. Wildl. Manag.* **1963**, *27*, 414–427. [[CrossRef](#)]
124. Haywood, D.D.; Brown, R.L.; Smith, R.H.; McCulloch, C.Y. *Migration Patterns and Habitat Utilization by Kaibab Mule Deer*; Arizona Game & Fish Department Research Branch: Phoenix, AZ, USA, 1987; pp. 1–44.
125. Brown, C.G. Movement and migration patterns of mule deer in southeastern Idaho. *J. Wildl. Manag.* **1992**, *56*, 246–253. [[CrossRef](#)]
126. Brooks, T.M.; Pimm, S.L.; Akçakaya, H.R.; Buchanan, G.M.; Buthchart, S.H.M.; Foden, W.; Hilton-Taylor, C.; Hoffmann, M.; Jenkins, C.N.; Joppa, L.; et al. Measuring terrestrial area of habitat (AOH) and its utility for the IUCN Red List. *Trends Ecol. Evol.* **2019**, *24*, 977–986. [[CrossRef](#)]
127. Kerley, G.I.H.; te Beest, M.; Cromsigt, J.P.G.M.; Pauly, D.; Shultz, S. The Protected Area Paradox and refugee species: The giant panda and baselines shifted towards conserving species in marginal habitats. *Conserv. Sci. Pract.* **2020**, *2*, e203. [[CrossRef](#)]
128. Adams, A.W. Migration. In *Elk of North America. Ecology and Management*; Thomas, J.W., Toweill, D.E., Eds.; Stackpole Books: Harrisburg, PA, USA, 1982; pp. 301–321.
129. Agassiz, L. The 1871-1872 Hassler expedition. In *Museum of Comparative Zoology; Occurrence Dataset, Version 162.229*; Morris, P.J., Ed.; Harvard University: Cambridge, MA, USA, 1872.
130. Aldenderfer, M.S. *Montane Foragers: Asana and the South-Central Andean Archaic*; University of Iowa Press: Iowa, IA, USA, 1998.
131. Andersen, R. Habitat deterioration and the migratory behavior of moose (*Alces alces* L.) in Norway. *J. Appl. Ecol.* **1991**, *28*, 102–108. [[CrossRef](#)]
132. Agencia CTyS-UNLaM/DICYT. Descubren los Restos Fósiles de Seis Ciervos Prehistóricos. 2021. Available online: www.dicyt.com (accessed on 7 October 2021).
133. Armesto, J.J.; Manushevich, D.; Mora, A.; Smith-Ramireza, C.; Rozzi, R.; Abarzúa, A.M.; Marquet, P.A. From the Holocene to the Anthropocene: A historical framework for land cover change in southwestern South America in the past 15,000 years. *Land Use Policy* **2010**, *27*, 148–160. [[CrossRef](#)]
134. Aschero, C.A. Las escenas de caza en Cueva de las Manos: Una perspectiva regional (Santa Cruz, Argentina). In *IFRAO Congress—Symposium: Pleistocene Art of the Americas (Pre-Acts) Austral*; Talleres Gráficos Guillermo Kraft Ltda: Buenos Aires, Argentina, 2010.
135. Avital, E.; Jablonka, E. *Animal Traditions*; Cambridge University Press: Cambridge, UK, 2000.
136. Battin, J. When good animals love bad habitats: Ecological traps and the conservation of animal populations. *Cons. Biol.* **2004**, *18*, 1482–1491. [[CrossRef](#)]
137. Baumann, M.; Babota, C.; Schibler, J. Native or naturalized? Validating alpine chamois habitat models with archaeozoological data. *Ecol. Appl.* **2005**, *15*, 1096–1110. [[CrossRef](#)]
138. Behm, E. Reise im südwestlichen Patagonien von J.T. Rogers und E. Ibar, 1877, nebst den Tagebüchern von A. de Viedma 1782 und J.H. Gardiner 1867. *Petermanns Geogr. Mitteilungen* **1880**, *26*, 47–64.
139. Berger, J.; Wangchuk, T.; Briceno, C.; Vila, A.; Lambert, J.E. Disassembled Food Webs and Messy Projections: Modern Ungulate Communities in the Face of Unabating Human Population Growth. *Front. Ecol. Evol.* **2020**, *8*, 128. [[CrossRef](#)]

140. Berger, J.; Steven, L.; Cain, S.L.; Berger, K.M. Connecting the dots: An invariant migration corridor links the Holocene to the present. *Biol. Lett.* **2006**, *2*, 528–531. [[CrossRef](#)]
141. Brandborg, S.M. *Life History and Management of the Mountain Goat in Idaho*; Wildlife Bulletin No. 2; Department of Fish and Game: Boise, ID, USA, 1955; 142p.
142. Bubenik, G.A.; Bubenik, A.B. *Horns, Pronghorns, and Antlers*; Springer: New York, NY, USA, 1990.
143. Burmeister, C.V. *Memoria Sobre el Territorio de Santa Cruz*; Imprenta La Nación, Ministerio de Agricultura de la Republica Argentina: Buenos Aires, Argentina, 1901.
144. Burmeister, H. The huemul. *Nature* **1873**, *9*, 82. [[CrossRef](#)]
145. Burmeister, C.V. Nuevos datos sobre el territorio Patagonico de Santa Cruz. *Rev. Museo Plata* **1893**, *4*, 227–256, 338–352.
146. Cabrera, A.; Yepes, J. *Mamíferos Sudamericanos*, 1st ed.; Compañía Argentina de Editores: Buenos Aires, Argentina, 1940; 370p.
147. Carballo Marina, F.; Manzi, L.M.; Campan, P.A.; Belardi, J.B.; Tiberi, P.; Manero, A.; Saenz, J.L. Distribución del registro arqueológico en la cuenca del río Gallegos (Santa Cruz): Línea de base y aporte a la preservación del patrimonio. In *Arqueología del Extremo sur del Continente Americano*; Borrero, L.A., Franco, N., Eds.; Editorial Dunker: Buenos Aires, Argentina, 2008; pp. 175–225.
148. Cardich, A.; Miotti, L. Recursos Faunísticos en la Economía de los Cazadores-Recolectores de Los Toldos (Provincia de Santa Cruz). *Relaciones Soc. Argent. Antropol.* **1983**, *16*, 269–273.
149. Castellanos, A. Paleontología estratigráfica de los sedimentos neógenos de la Provincia de Córdoba. *Publ Inst. Fisiogr. Geol.* **1944**, *23*, 1–47.
150. Church, G.E. A traveller in Patagonia. *Nature* **1903**, *67*, 321–322. [[CrossRef](#)]
151. Clapperton, C.M. Nature of environmental changes in South America at the Last Glacial Maximum. *Palaeogeogr. Paleoclimatol. Palaeoecol.* **1993**, *101*, 189–208. [[CrossRef](#)]
152. Claraz, M.G. Sur l'Equus bisulcus, de Molina. *Revue et Magasin de Zoologie Pure et Appliquee* **1864**, 241–248.
153. Coltorti, M.; Abbazzi, L.; Ferretti, M.P.; Iacumin, P.; Paredes Rios, F.; Pellegrini, M.; Pieruccini, P.; Rustioni, M.; Tito, G.; Rook, L. Last Glacial mammals in South America: A new scenario from the Tarija Basin (Bolivia). *Naturwissenschaften* **2007**, *94*, 288–299. [[CrossRef](#)]
154. Conway, W. *Act III in Patagonia: People and Wildlife*; Island Press: Washington, DC, USA, 2005.
155. Cox, G.E. *Viaje a las Regiones Septentrionales de la Patagonia: 1862–1863*; Imprenta Nacional: Santiago, Chile, 1863; 266p.
156. Cruz, I.; Muñoz, A.S.; Caracotche, M. A huemul (*Hippocamelus bisulcus*) antler artefact in archaeological deposits of the Atlantic coast. Implications for human mobility and species distribution. *Magallania* **2010**, *38*, 287–294. [[CrossRef](#)]
157. da Silva, F.M.; da Silva Alves, R.; Franca Barreto, A.M.; Bezerra de Sá, F.; Borges Lins e Silva, A.C. A megafauna pleistocénica do estado de Pernambuco. *Estudos Geológicos* **2006**, *16*, 55–66.
158. Dabbene, R. Sobre la existencia del huemul de Bolivia y Perú, *Odocoileus* (*Hippocamelus*) *antisensis* (Orb.) y del avestruz petiso, *Rhea darwini* Gould en el N.W. de la República Argentina. *Anales del Museo Nacional Buenos Aires* **1911**, *14*, 293–307.
159. Dawilov. *Coihue*; Gmo. van Woerden & Cia: Buenos Aires, Argentina, 1926; 103p.
160. de la Cruz, L. Descripción de la naturaleza de los terrenos que se comprenden en los Andes, poseídos por los Peguanches; y los demás espacios hasta el río de Chadileubu. In *Colección de Obras y Documentos Relativos a la Historia Antigua y Moderna de las Provincias del Río de la Plata*; de Angelis, P., Ed.; Imprenta del Estado: Buenos Aires, Argentina, 1836; pp. 1–67.
161. De Agostini, A.M. *Andes Patagónicos: Viajes de Exploración a la Cordillera Patagónica, 1era Versión*; Imprenta Gotelli: Buenos Aires, Argentina, 1941.
162. De Agostini, A.M. *Andes Patagónicos: Viajes de Exploración a la Cordillera Patagónica Austral*; Talleres Gráficos Guillermo Kraft Ltda: Buenos Aires, Argentina, 1945; Volume 1, pp. 1–409.
163. Díaz, N.I. Antecedentes sobre la historia natural de la taruca (*Hippocamelus antisensis*) y su rol en la economía Andina. *Chungara* **1995**, *27*, 45–55.
164. Díaz, N.I. Changes in the range distribution of *Hippocamelus bisulcus* in Patagonia. *Z. Säugetierkunde* **1993**, *58*, 344–351.
165. Díaz, N.I. The huemul (*Hippocamelus bisulcus* Molina, 1782): A historical perspective. In *The Patagonian Huemul, a Mysterious Deer on the Brink of Extinction*; Díaz, N.I., Smith-Flueck, J., Eds.; L.O.L.A.: Buenos Aires, Argentina, 2000; pp. 1–31.
166. Díaz, N.I.; Prieto, A.; Bahamonde, G. Guanacos tímidos, huemules confiados: El límite occidental de los cazadores terrestres australes. *Magallania* **2007**, *35*, 133–138. [[CrossRef](#)]
167. Eastman, C.R. Beginnings of American natural history. *Amer. Museum J.* **1915**, *15*, 349–355.
168. Eisenberg, J.F. The contemporary Cervidae of Central and South America. In *Antelopes, Deer, and Relatives*; Vrba, E.S., Schaller, G.B., Eds.; Yale University Press: New York, NY, USA, 2000; pp. 189–202.
169. Falkner, T. *A Description of Patagonia and the Adjoining Parts of South America: Containing an Account of the Soil, Produce, the Religion, Government, and Some Particulars Relating to Falkland Islands*; Hereford: London, UK, 1774; 144p.
170. Fernandez, P.M.; Cruz, I.; Bautista Belardi, J.; de Nigris, M.; Muñoz, S. La explotación del huemul (*Hippocamelus bisulcus*, Molina 1782) en la Patagonia a lo largo del holoceno. *Magallania* **2016**, *44*, 187–209. [[CrossRef](#)]
171. Fernández, O.A.; Busso, C.A. Arid and semi-arid rangelands: Two thirds of Argentina. In *Proceedings from an International Workshop in Iceland*; Arnalds, O., Archer, S., Eds.; Rala Report no. 200; Agricultural Research Institute: Reykjavik, Iceland, 1997; pp. 41–60.

172. Fielder, P.C. Implications of selenium levels in Washington mountain goats, mule deer, and Rocky Mountain elk. *Northwest Sci.* **1986**, *60*, 15–20.
173. Flint, R.F.; Fidalgo, F. Glacial Drift in the Eastern Argentine Andes between Latitude 41°10' S. and Latitude 43°10' S. *Bull. Geol. Soc. America* **1969**, *80*, 1043–1052. [[CrossRef](#)]
174. Flueck, W.T. Spatio-temporal movements among red deer males, *Cervus elaphus*, introduced to Patagonia. In *XXVIIth Congress of the International Union of Game Biologists*; Pohlmeier, K., Ed.; Hannover DSV-Verlag: Hamburg, Germany, 2005; pp. 330–332.
175. Flueck, W.T. Exotic deer in southern Latin America: What do we know about impacts on native deer and on ecosystems? *Biol. Invasions* **2010**, *12*, 1909–1922. [[CrossRef](#)]
176. Flueck, W.T. Osteopathology and selenium deficiency co-occurring in a population of endangered Patagonian huemul (*Hippocamelus bisulcus*). *BMC Res. Notes* **2015**, *8*, 330. [[CrossRef](#)] [[PubMed](#)]
177. Flueck, W.T.; Smith-Flueck, J.M. Über das in Argentinien angesiedelte Rotwild (*Cervus elaphus* L., 1758): Verbreitung und Tendenzen. *Zeits. Jagdwiss.* **1993**, *39*, 153–160. [[CrossRef](#)]
178. Flueck, W.T.; Smith-Flueck, J.M. Predicaments of endangered huemul deer, *Hippocamelus bisulcus*, in Argentina: A review. *Europ. J. Wildl. Res.* **2006**, *52*, 69–80. [[CrossRef](#)]
179. Flueck, W.T.; Smith-Flueck, J.M. Huemul heresies: Beliefs in search of supporting data. 1. Historical and zooarcheological considerations. *Anim. Prod. Sci.* **2012**, *52*, 685–693. [[CrossRef](#)]
180. Flueck, W.T.; Smith-Flueck, J.M. Radio marking the first group of endangered Patagonian huemul deer in Argentina. *J. Neotrop. Mammal.* **2018**, *25*, 461–465. [[CrossRef](#)]
181. Flueck, W.T.; Smith-Flueck, J.M.; Mincher, B.J.; Winkel, L.H.E. Soil selenium levels corroborate direct evidence of selenium deficiency in endangered Patagonian huemul deer (*Hippocamelus bisulcus*). In *Proceedings of the 8th International Deer Biology Congress*; Ma, J., Zhang, M., Halbrook, R., Liu, B., Zhang, W., Eds.; Northeast Forestry University: Harbin, China, 2014; pp. 52–53.
182. Frailey, D.; Campbell, K.E.; Wolff, R.G. Additions to the knowledge of *Hippocamelus*, *Ctenomys*, and *Myocastor* from the middle Pleistocene of the Tarija basin, Bolivia. *Occas. Papers Museum Nat. Hist. Univ. Kansas* **1980**, *85*, 1–14.
183. Gay, C. *Historia Fisica y Politica de Chile: Zoologia*; Museo de Historia Natural de Santiago: Santiago, Chile, 1847; 495p.
184. Gazzolo, C. Botanical composition of taruka (*Hippocamelus antisensis*) diet during rainy season in Huascarán national park, Peru. In *Advances in Deer Biology*; Bartos, L., Dusek, A., Kotrba, R., Bartosova, J., Eds.; Research Institute of Animal Production: Praha, Czech Republic, 2006; p. 216.
185. Geist, V. *Deer of the World*; Stackpole Books: Pennsylvania, PA, USA, 1998; 421p.
186. Gigoux, E.E. El huemul. *Rev. Chilena Hist. Nat.* **1929**, *23*, 573–582.
187. Goni, R.A. Arqueología de momentos tardíos en el Parque Nacional Perito Moreno (Santa Cruz, Argentina). In *Precirculados del IX Congreso Nacional de Arqueología Argentina*; Universidad de Buenos Aires: Buenos Aires, Argentina, 1988; pp. 140–151.
188. Gonzalez, V.; Tapia, V. Manual bovino de carne. *Boletín INIA* **2017**, *4*, 1–173.
189. Grosse, A. El huemul—Ciervo de los Andes y emblema del escudo Chileno. *Condor* **1949**, *12*, 10–12.
190. Guérin, C.; Faure, M. The Cervidae (Mammalia, Artiodactyla) of the Upper Pleistocene/Lower Holocene deposits of the Serra da Capivara National Park Region (Piauí, Brazil). *Geobios* **2009**, *42*, 169–195. [[CrossRef](#)]
191. Günther, A. Comments about Sclater and *Cervus chilensis*. In *Proceedings of the Scientific Meetings of the Zoological Society of London*; Messrs. Longmans, Green, Reader and Dyer: London, UK, 1875; pp. 44–46.
192. Hatcher, J.B. *Reports of the Princeton University Expeditions to Patagonia, 1896–1899. Vol. I: Narrative of the Expeditions. Geography of Southern Patagonia*; E. Schweizerbart'sche Verlagshandlung: Stuttgart, Germany, 1903; 314p.
193. Hauman, L. Étude phytogéographique de la Patagonie. *Bulletin de la Société Royale de Botanique de Belgique* **1926**, *58*, 105–179.
194. Hershkovitz, P. The recent mammals of the neotropical region: A zoogeographic and ecological review. In *Evolution, Mammals, and Southern Continents*; Keast, A., Erk, F.C., Glass, B., Eds.; State University New York Press: New York, NY, USA, 1972; pp. 311–431.
195. Hershkovitz, P. The recent mammals of the Neotropical region: A zoogeographic and ecological review. *Quart. Rev. Biol.* **1969**, *44*, 1–70. [[CrossRef](#)]
196. Hoffstetter, R. La faune pleistocene de Tarija (Bolivie). Note préliminaire. *Bulletin Muséum National d'Histoire Naturelle* **1963**, *35*, 194–203.
197. Honess, R.F.; Frost, N.M. A Wyoming bighorn sheep study. *Wyoming Game Fish Depart. Bull.* **1942**, *1*, 1–127.
198. Horkheimer, H. *Nahrung und Nahrungsgewinnung im Vorspanischen Peru*; Colloquim Verlag: Berlin, Germany, 1960.
199. Housse, P.R. *Animales Salvajes de Chile en su Clasificación Moderna: Su Vida y Sus Costumbres*; Ediciones de la Universidad de Chile: Santiago, Chile, 1953; 189p.
200. Ibar Bruce, J. *Aisen, Hombres y Naturaleza*; Imprenta de la Armada: Valparaíso, Chile, 1973; pp. 1–164.
201. Iglesias, R.E. El huemul. *Montaña* **1965**, *7*, 26–28.
202. Jakopak, R.P.; LaSharr, T.N.; Dwinnell, S.P.H.; Fralick, G.L.; Monteith, K.L. Rapid acquisition of memory in a complex landscape by a mule deer. *Ecology* **2019**, *100*, e02854. [[CrossRef](#)]
203. Johnson, L. Informe sobre una prospección arqueológica en magallanes. *Ans. Inst. Pat. Punta Arenas* **1976**, *7*, 87–94.
204. Kolliker Frers, A. Das Waidwerk und die autochthonen Cerviden in Argentinien. In *Parque Diana*; Vogel, C.A., Ed.; Stefan Schwarz Verlag: München, Germany, 1969; pp. 25–31.

205. Koprowski, J.L.; Krausman, P.R. *International Wildlife Management: Conservation Challenges in a Changing World*; Johns Hopkins University Press: Baltimore, MD, USA, 2019; 248p.
206. Krieg, H. Biologische Reisestudien in Südamerika. V. Die chilenischen Hirsche. *Zeits. Morphol. Ökol. Tiere* **1925**, *4*, 585–597. [[CrossRef](#)]
207. Krieg, H. *Als Zoologe in Steppen und Wäldern Patagoniens*; Bayerischer Landwirtschaftsverlag: Muenchen, Germany, 1940; 197p.
208. Lacroix, F. *Historia de la Patagonia, Tierra de Fuego, e Islas Malvinas*; Imprenta del Liberal Barcelones: Barcelona, Spain, 1841.
209. Laliberte, A.S.; Ripple, W.J. Range contractions of North American carnivores and ungulates. *BioScience* **2004**, *54*, 123–138. [[CrossRef](#)]
210. Laming-Emperaire, A.; Lavallée, D.; Humbert, R. Le site de Marazzi en Terre de Feu. *Objets et Mondes* **1972**, *12*, 225–244.
211. Latcham, R.E. Expedición científica Macqueen al Aysen. *Boletín del Museo Nacional* **1935**, *14*, 7–31.
212. Leopold, A.S.; Cain, S.A.; Cottam, C.; Gabrielson, I.N.; Kimball, T.L. Wildlife Management in the National Parks. *Am. For.* **1963**, *4*, 32–35, 61–63.
213. Liebermann, J. Sobre la historia natural del huemul. *Anal. Acad. Argent. Geogr.* **1962**, *6*, 157–168.
214. Lingle, S.; Wilson, W.F. Detection and avoidance of predators in white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*). *Ethology* **2001**, *107*, 125–147. [[CrossRef](#)]
215. Lista, R. La Tierra del Fuego y sus habitantes. *Boletín del Instituto Geográfico Argentino* **1881**, *2*, 109–114.
216. Lydekker, R. *The Deer of all Lands: A History of the Family Cervidae, Living and Extinct*; R. Ward: London, UK, 1898; pp. 1–329.
217. Lyman, R.L. Paleozoology in the service of conservation biology. *Evol. Anthropol.* **2006**, *15*, 11–19. [[CrossRef](#)]
218. Lyras, G.A.; Giannakopoulou, A.; Lillis, T.; van der Geer, A.A.E. Paradise lost: Evidence for a devastating metabolic bone disease in an insular Pleistocene deer. *Intern. J. Paleopathol.* **2019**, *24*, 213–226. [[CrossRef](#)] [[PubMed](#)]
219. MacDouall, J. *Narratives of a Voyage to Patagonia and Terra del Fuego*; Renshaw and Rush: London, UK, 1833; 320p.
220. Machon, J.F.; Juarez, F.N. *Patagonia 1892: Diario del Explorador Suizo Dr. Francisco Machón*; Editorial Dunker: Buenos Aires, Argentina, 2013.
221. Magalhaes, R.M.; Mello, M.G.; Bergqvist, L.P. Os cervídeos pleistocénicos da região nordeste Brasileira. *Anais da Academia Brasileira de Ciências* **1992**, *64*, 149–154.
222. Magne de la Croix, P. El huemul. *Caras y Caretas* **1937**, *40*, 117.
223. Mansur, M.E.; Piqué, R. Between the Forest and the Sea: Hunter-Gatherer Occupations in the Subantarctic Forests in Tierra del Fuego, Argentina. *Arctic Anthropol.* **2009**, *46*, 144–157. [[CrossRef](#)]
224. Markgraf, V.; Kenny, R. Character of rapid vegetation and climate change during the late-Glacial in southernmost South America. In *Past and Future Rapid Environmental Changes: Spatial and Evolutionary Responses to terrestrial Biota*; Huntley, B., Ed.; Springer: Berlin, Germany, 1997; pp. 81–90.
225. Marshall, L.G. Land Mammals and the Great American Interchange. *Am. Sci.* **1988**, *76*, 380–388.
226. Massara Paletto, V.; Buono, G. *Métodos de Evaluación de Pastizales en Patagonia Sur*; Centro Regional Patagonia, Ediciones INTA: Buenos Aires, Argentina, 2020; 288p.
227. Massone, M. Los paraderos tehuelches y proto-tehuelches en la costa del Estrecho de Magallanes. *Anales del Instituto de la Patagonia* **1984**, *15*, 27–42.
228. McClure, M.F.; Bissonette, J.A.; Conover, M.R. Migratory strategies, fawn recruitment, and winter habitat use by urban and rural mule deer (*Odocoileus hemionus*). *Europ. J. Wildl. Res.* **2005**, *51*, 170–177. [[CrossRef](#)]
229. Miller, S.; Rottman, J.; Taber, R.D. Dwindling and endangered ungulates of Chile: Vicugna, lama, Hippocamelus, and Pudu. *Trans. N. Am. Wildl. Natural Res. Conf.* **1973**, *38*, 55–67.
230. Mincher, B.J.; Mionczynski, J.; Hnilicka, P.P.; Ball, R.D.; Houghton, T.X. Some aspects of geophagia in Wyoming big-horn sheep (*Ovis canadensis*). *Europ. J. Wildl. Res.* **2008**, *54*, 192–198. [[CrossRef](#)]
231. Molina, J.I. *The Geographical, Natural, and Civil History of Chili*; Longman, Hurst, Rees, and Orme: London, UK, 1809; Volume 1.
232. Moreira-Arce, D.; Pefiaranda, D.A.; Lopéz, R.; Stipicic, G.J.; Hidalgo-Hermoso, E.; Simonetti, J.A. Observations of a coastal population of huemul, *Hippocamelus bisulcus* (Artiodactyla: Cervidae) in Riesco Island, Magallanes Region, Chile: A conservation opportunity. *Mammalia* **2021**, *85*, 291–295. [[CrossRef](#)]
233. Morejohn, G.V.; Dailey, D.C. The identity and postcranial osteology of *Odocoileus lucasi* (Hay) 1927. *Sierra Coll. Nat. Hist. Museum Bull.* **2004**, *1*, 1–54.
234. Moreno, F.P. Explorations in Patagonia. *Geogr. J.* **1899**, *14*, 241–269. [[CrossRef](#)]
235. Moreno, P.I.; Villagran, C.; Marquet, P.A.; Marshall, L.G. Quaternary paleobiogeography of northern and central Chile. *Rev. Chilena Hist. Nat.* **1994**, *67*, 487–502.
236. Moser, C.A. *The Bighorn Sheep of Colorado: A Review of Colorado's Bighorn Sheep Studies*; Technical Publication No. 10; The Colorado Game and Fish Department: Denver, CO, USA, 1962; 49p.
237. Musters, R.N. A year in Patagonia. *J. Royal Geogr. Soc. London* **1871**, *41*, 59–77. [[CrossRef](#)]
238. Mysterud, A.; Loe, L.E.; Zimmermann, B.; Bischof, R.; Veiberg, V.; Meisingset, E. Partial migration in expanding red deer populations at northern latitudes—A role for density dependence? *Oikos* **2011**, *120*, 1817–1825. [[CrossRef](#)]
239. Nelson, M.E.; Mech, L.D. Twenty-year home-range dynamics of a white-tailed deer matriline. *Can. J. Zool.* **1999**, *77*, 1128–1135. [[CrossRef](#)]

240. Neveu-Lemaire, M.; Grandidier, G. *Notes sur les Mammifères des Hauts Plateaux de l'Amérique du Sud*; Imprimerie Nationale: Paris, France, 1911; 127p.
241. Onelli, C. *Trepando los Andes*; Compania Sud-Americana de Billetes de Banco: Buenos Aires, Argentina, 1904; 297p.
242. Osgood, W.H. The journal of Wilfred Osgood: The Marshall Field Chilean Expedition of 1922-23. In Patterson, B.D. *Field Museum of Natural History Bulletin* **1983**, *54*, 28–33.
243. Packard, F.M. An ecological study of the Bighorn sheep in Rocky Mountain National Park, Colorado. *J. Mammal.* **1946**, *27*, 3–28. [[CrossRef](#)]
244. Paillan, J.T.; Tello, G.E. Los recursos naturales y culturales, 28 de Noviembre, Guer Aaike. In *Santa Cruz: Su Importancia Turística y Patrimonial*; Informe Científico Técnico UNPA 4, ICT-UNPA-35-2012; Universidad Nacional de la Patagonia Austral: Rio Turbio, Argentina, 2012.
245. Paula Couto, C. *Paleontologia Brasileira (Mamíferos)*; Instituto Nacional do Livro: Rio de Janeiro, Brasil, 1953.
246. Paula Couto, C. *Tratado de Paleomastozoología*; Academia Brasileira de Ciencias: Rio de Janeiro, Brasil, 1979.
247. Pefaur, J.; Hermosilla, W.; DiCatri, F.; Gonzalez, R.; Salinas, F. Estudio preliminar de mamíferos silvestres chilenos: Su distribución, valor económico e importancia zoonótica. *Rev. Soc. Med. Vet.* **1968**, *18*, 3–15.
248. Pennant, T. *History of Quadrupeds*, 3rd ed.; B & J White: London, UK, 1793.
249. Perez, A.E.; Batres, D.A. Los otros cazadores. Explotación de cérvidos en la Localidad Arqueológica Meliquina, Parque Nacional Lanin, República Argentina. In *Zooarqueología hoy. Encuentros Hispano-Argentinos*; Díez, J.C., Ed.; Universidad de Burgos: Burgos, Spain, 2008; pp. 89–107.
250. Philippi, R.A. Über den Guemul von Molina. *Archiv für Naturgeschichte* **1857**, *23*, 135–136.
251. Philippi, R.A. Zoología: Sinonimia del huemul. *Anales de la Universidad de Chile* **1873**, 717–722.
252. Philippi, R.A. El guemul de Chile. *Anal. Museo Nac. Chile Primer Seccion Zool.* **1892**, *2*, 1–9.
253. Phoca-Cosmetatou, N. Site function and the 'ibex-site phenomenon': Myth or reality? *Oxford J. Archaeol.* **2004**, *23*, 217–242. [[CrossRef](#)]
254. Prichard, H.H. *Through the Heart of Patagonia*; D. Appleton and Co.: New York, NY, USA, 1902; 346p.
255. Prichard, H.H. *Hunting Camps in Wood and Wilderness*; William Heinemann: London, UK, 1910; 274p.
256. Prothero, D.R.; Foss, S.E. *The Evolution of Artiodactyls*; JHU Press: Baltimore, MD, USA, 2007.
257. Pulliam, H.R. Sources, sinks, and population regulation. *Am. Naturalist* **1988**, *132*, 652–661. [[CrossRef](#)]
258. Rabassa, J.; Coronato, A. Glaciations in Patagonia and Tierra del Fuego during the Ensenadan Stage/Age (Early Pleistocene-earliest Middle Pleistocene). *Quaternary Intern.* **2009**, *210*, 18–36. [[CrossRef](#)]
259. Rabassa, J.; Coronato, A.; Martínez, O. Late Cenozoic glaciations in Patagonia and Tierra del Fuego: An updated review. *Biol. J. Linnean Soc.* **2011**, *103*, 316–335. [[CrossRef](#)]
260. Ramirez Morales, F. Apuntes para una historia ecológica de Chile. *Cuadernos de Historia* **1991**, *11*, 149–196.
261. Rasmussen, P.C. Geographic variation in morphology and allozymes of south american imperial shags. *The Auk* **1994**, *111*, 143–161. [[CrossRef](#)]
262. Re, A.; Delaunay, A.N.; Ferraro, L. Grabados en la meseta del lago Strobel (provincia de Santa Cruz, Argentina), el sitio laguna del Faldeo Verde. *Relaciones Soc. Argentina Antropol.* **2005**, *30*, 245–256.
263. Reichlen, H. *Huemul in Fell's Cave, Chile: Specimen MNHN-2M-MO-1988-211*; Museum National d'Histoire Naturelle: Paris, France, 1959.
264. Ren, J.Z.; Zhou, Z.Y.; Pan, B.; Chen, W. Selenium distribution in four grassland classes of China. In *Selenium in Biology and Medicine*; Comb, G.F., Spall-holz, J.E., Levander, O.A., Oldfield, J.E., Eds.; AVI Books: New York, NY, USA, 1987; pp. 769–774.
265. Ringuelet, R.A. *Temas de Ciencia Naturales*; Museo de La Plata: La Plata, Argentina, 1946.
266. Rosas, Y.M.; Peri, P.L.; Herrera, A.H.; Pastore, H.; Pastur, G.M. Modeling of potential habitat suitability of *Hippocamelus bisulcus*: Effectiveness of a protected areas network in Southern Patagonia. *Ecol. Processes* **2017**, *6*. [[CrossRef](#)]
267. Roulin, M. Mémoire pour servir a l'histoire du tapir: Et description d'une espece nouvelle (le tapir pinchaque) appartenant aux hautes régions de la Cordillere des Andes. *Mémoires des Savans Étrangers* **1835**, *6*, 5–112.
268. Rusconi, C. *Animales Extinguidos de Mendoza y de la Argentina*; Imprenta Oficial: Mendoza, Argentina, 1967.
269. Ryan, S.J. The role of culture in conservation planning for small or endangered populations. *Conserv. Biol.* **2006**, *20*, 1321–1324. [[CrossRef](#)]
270. Santos Gollan, J. *Contribución al Conocimiento de los Mamíferos del Parque Nacional de Nahuel Huapi*; Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires: Buenos Aires, Argentina, 1946; 66p.
271. Sawyer, H.; Middleton, A.D.; Hayes, M.M.; Kauffman, M.J.; Monteith, K.L. The extra mile: Ungulate migration distance alters the use of seasonal range and exposure to anthropogenic risk. *Ecosphere* **2016**, *7*, e01534. [[CrossRef](#)]
272. Sclater, P.L. Remarks on *Cervus chilensis* and *Cervus antiensis*. *J. Nat. History Ser.* **1873**, *11*, 213–214. [[CrossRef](#)]
273. Sclater, P.L. On *Cervus chilensis*. *Proc. Zool. Soc. Lond.* **1875**, *2*, 44–47.
274. Serret, A. *Observaciones Preliminares de Huemul, Hippocamelus bisulcus, en el Lago Nansen del Parque Nacional Perito Moreno, Provincia Santa Cruz*; Fundacion Vida Silvestre: Buenos Aires, Argentina, 1990; 23p.
275. Sierralta, D. La microhistología de fecas para el estudio de dieta del huemul. In *Huemul Ecology Research for Conservation Planning*, Darwin Initiative ed.; Darwin Initiative: Cochrane, Chile, 2003.
276. Siewert, C. Un viaje a Patagonia. *Boletin Inst. Geogr. Argentino* **1896**, *17*, 363–391.

277. Silveira, M.J. Analisis e Interpretacion de los Restos Faunisticos de la Cueva Grande del Arroyo Feo. *Relaciones Soc. Argent. Antropol.* **1979**, *13*, 229–253.
278. Simmonds, P.L. *A Dictionary of Useful Animals and Their Products*; E. & F.N. Spon: London, UK, 1883; 136p.
279. Sinclair, C. Daily life among the fishermen of the fog. In *Fishermen of the fog: The Changos and Their Ancestors*; Museo Chileno de Arte Precolombino: Santiago, Chile, 2009; pp. 41–48.
280. Skottsberg, C. *The wilds of Patagonia*; Edward Arnold: London, UK, 1911; 336p.
281. Stankowich, T. Tail-Flicking, Tail-Flagging, and Tail Position in Ungulates with Special Reference to Black-Tailed Deer. *Ethology* **2008**, *114*, 875–885. [[CrossRef](#)]
282. Stankowich, T.; Coss, R.G. Effects of predator behavior and proximity on risk assessment by Columbian black-tailed deer. *Behav. Ecol.* **2006**, *17*, 246–254. [[CrossRef](#)]
283. Steffen, H. Die Erforschung de Rio Puelo. *Petermanns Geographischen Mitteilungen* **1895**, *41*, 190–193.
284. Steffen, H. Die chilensische Aisen Expedition. *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* **1897**, *24*, 461–474.
285. Steffen, H. Reisen in den Patagonischen Anden. *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* **1900**, *27*, 194–220.
286. Steward, J.H. *Handbook of South American Indians. Volume 1. The Marginal Tribes*; Smithsonian Institution: Washington, DC, USA, 1946.
287. Stringham, S.F.; Rogers, L.L. Fear of Humans by Bears and Other Animals (Anthropophobia): How Much is Natural? *J. Behav.* **2017**, *2*, 1009.
288. Tarifa, T.; Yensen, E. Mammals of Bolivian Polylepis woodlands. *Revista Boliviana de Ecología y Conservación Ambiental* **2001**, *9*, 29–44.
289. Tatura, A.; del Valle, R.; Bianchi, M.; Outes, V.; Villarosa, G.; Niegodzis, J.; Debaene, G. Late Pleistocene palaeolakes in the Andean and Extra-Andean Patagonia at mid-latitudes of South America. *Quaternary Intern.* **2002**, *89*, 135–150. [[CrossRef](#)]
290. Teta, P.; Rodríguez, D. *Mammalogy National Collection (MACNMa)*; Occurrence Dataset; Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia' (MACN): Caba, Argentina, 2020.
291. Thirgood, S.J. The effect of sex, season and habitat availability on patterns of habitat use in fallow deer. *J. Zool. Lond.* **1995**, *235*, 645–659. [[CrossRef](#)]
292. Torrejon, F. Variables geohistoricos en la evolucion del sistema economico Pehuenche durante el periodo colonial. *Revista Universum* **2001**, *16*, 219–236.
293. Van Soest, P.J. *Nutritional Ecology of the Ruminant*; O & B Books, Inc.: Corvallis, OR, USA, 1982; 373p.
294. Via, S.; Gomulkiewicz, R.; DeJong, G.; Scheiner, C.D.; Schlichting, S.M.; Van Tienderen, P.H. Adaptive phenotypic plasticity: Consensus and controversy. *TREE* **1995**, *10*, 212–217. [[CrossRef](#)]
295. Vidaurre, F.G. *Des Herrn Abts Vidaure Kurzgefasste, Geographische, Natürliche und Bürgerliche Geschichte des Königreichs Chile*; Carl Ernst Bohn: Hamburg, Germany, 1782; 208p.
296. von Colditz, R. *Im Reiche des Kondor*; Paul Parey: Berlin, Germany, 1925; 415p.
297. von Thüngen, J.; Lanari, M.R. Profitability of sheep farming and wildlife management in Patagonia. *Pastoralism* **2010**, *1*, 274–290.
298. Wagner, J.U. *Die Säugthiere in Abbildungen nach der Natur*; L.D. Weigel: Leipzig, Germany, 1855.
299. Waterhouse, G.R. Mammalia. In *The Zoology of the Voyage of H.M.S. Beagle, Under the Command of Captain Fitzroy, During the years 1832-1836*; Smith, Elder and Co.: London, UK, 1839.
300. Webb, S.D. A history of savanna vertebrates in the New World. Part II: South America and the Great Interchange. *Annual Rev. Ecol. Evol. System.* **1978**, *9*, 393–426. [[CrossRef](#)]
301. Weber, A. *Chiloe: Su Estado Actual, su Colonizacion, su Porvenir*; Imprenta Mejia: Santiago, Chile, 1903; 194p.
302. Wells, K.W.; Stangl, F.B. Superior size and antler development in populations of white-tailed deer (*Odocoileus virginianus*) from the North Texas rolling plains. *Texas J. Sci.* **2003**, *55*, 337–346.
303. Wolffsohn, J.W. Notas sobre el huemul. *Revista Chilena de Historia Natural* **1910**, *14*, 227–234.
304. Yockney, I.J.; Hickling, G.J. Distribution and diet of chamois (*Rupicapra rupicapra*) in Westland forests, South Island, New Zealand. *N. Z. J. Ecol.* **2000**, *24*, 31–38.