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CENSUS AND SUMMER-AUTUMN DISTRIBUTION OF PYRENEAN CHAMOIS IN "LOS VALLES" NATIONAL HUNTING RESERVE (SPAIN)*

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SUMMARY

Chamois numbers, distribution and habitat features were assessed during July and November 1986 in "Los Valles" National Hunting Reserve (Spanish Pyrenees). Two census systems were tested: consecutive daily surveys and simultaneous drives. Although the latter method was considered more accurate, consecutive surveys contributed to improve it substantially.

Minimum Reserve population numbers were appraised in 970 individuals. Although sex-ratio was ~~low~~ quite biassed (1 male for 3.3 females), fertility ratio was found moderately high (75%). Density distribution of chamois varied according to an increasing West-East gradient. Rockiness and human disturbances (e.g. tourism, sheep stock and poaching) were found as main factors determining such distribution pattern. Principal differences between Summer and Autumn habitat characteristics were altitude descent, reduction of slope gradient, North to South exposure change, and rock to pasture shift.

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INTRODUCTION

The difficulty and even the impossibility of determining the exact number of chamois which inhabit relatively large areas, has often been commented upon (García-González et al., 1985). One of the papers of this Symposium (Meile) deals specifically with this subject. This situation can be extended to other mountain ungulates. The efforts of the census probably do not correspond to the results; but from the wildlife management's point of view, reasonably accurate figures and trends in the increase or decrease of the population will be enough (Nievergelt, 1981).

Chamois hunting in Spain usually takes place in the National Hunting Reserves, managed by the local autonomous Government. Hunting is also allowed on the periphery of these Reserves, although the density is very low. For inside the Reserves, a number of licences (6% of the official census) are issued but only for hunting the male. The females are hunted only occasionally (selective hunting).

This particular study was commisioned by the Hunting Management Service of the autonomous Government of Aragón, who had , in recent years, noticed a decrease in chamois numbers in one of the Reserves called "Los Valles". Part of the results obtained will be shown in this paper. The aims of the study were to assess the chamois population in the Reserve with reference to number and structure, and to establish the principal factors which determine its distribution, particularly during the summer-autumn period.

STUDY AREA

"Los Valles" National Hunting Reserve has a planimetrical surface of 280 km^2 and is to be found in the western extreme of the Spanish Pyrenees (fig. 1). Its northern boundary coincides with the frontier between Spain and France, and its western boundary with that of the Comunidad Autónoma de Navarra. This is almost the

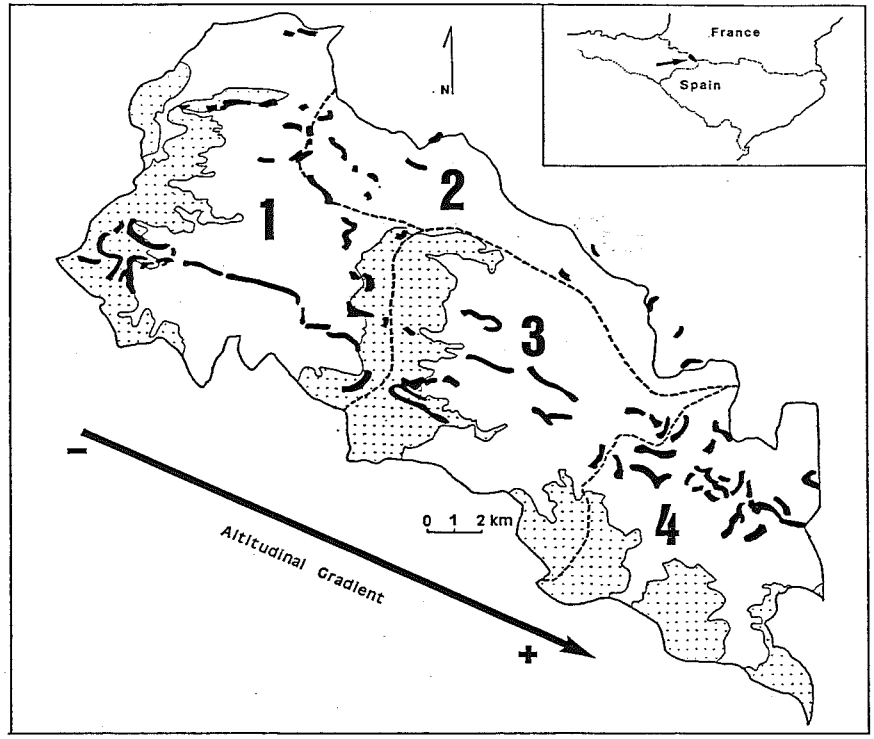

Fig. 1.- Limits and situation of "Los Valles" National Hunting Reserve. Numbers and discontinuous lines show the sectors in which Reserve where divided for census purposes. Dotted patches correspond to the forest and black thick lines correspond to the cliffs.

western limit of the distribution of the Pyrenean chamois. Only a few small herds are found in more western parts, with a tendency towards diminishing (Berducou, 1985).

Geographically consists of the head of four valleys pointing N-S, which can be distinguished in fig. 1 by the forest patches. The principal mountain masses form a range of limestone, from E-W (Sierras Interiores) visible in fig. 1 by the lines of crags. All along this mountain range the altitude increases towards the East. Other existing geological material is as follows: from South to North there are almost parallel strips of Flysch (marls and sandstone), limestone masses, red-slate and clays of Permo-Trias. Supraforestal pastures occupy most of the surface and the forest itself is made up principally of Pinus sylvestris, Fagus sylvatica and Abies alba. A more complete physiographic description can be found in Balcells (1984).

The Hunting Reserve was created in 1967. From that time the population of chamois increased until 1975-76, when the official numbers slowly began to fall. An epidemic of keratoconjunctivitis in 1982-83 sharpened the decline. In the two years previous to this present study the official population stood at 600 individuals.

MATERIAL AND METHODS

The field work was carried out by specialised personnel during the months of July and November 1986. Twelve and seven consecutive days were used in each period, with a total of 792 and 612 man-hours. The teams consisted of 2-3 wildlife specialists and the area of study was divided into 4 sections (fig. 1). In each period two census systems were tried out: surveys and simultaneous drives. During the survey phase, one or sometimes two teams covered each sector, during several consecutive days. This phase lasted one week in the Summer census so that the personnel could become familiar with the terrain and three days in the Autumn census. The reconnaissance hikes lasted all day apart from time taken for food.

It was endeavoured that the reconnaissance hikes would not overlap in time. The aim of each team was to locate and make an inventary of the maximum number of chamois groups. Each encounter was marked on a map (1:25000) and on standardised cards the number of individuals was recorded, structured according to 4 sex-age classes and several environmental variables (García-González, 1985). No quantitative evaluation of actual habitat characteristics of study area has been done because the study aims were to compare inter-seasonal habitat use. At the end of each day, the ground covered was marked on the map. The direction in which the animals fled was also recorded when this, in fact, happened.

In the simultaneous drives phase (similar to "pointage-flash", Berducou et al., 1982), the record types where the same, but in this case all the teams concentrated in the same sector, at the same time, comprehensively covering the different sectors on successive days.

The material used was the usual for this sort of survey: binoculars 10x40, telescope 20-50x, compass, altimeter and maps (1:25000).

RESULTS

Taking into account all the recorded sightings, a total of 1614 individuals in July and 1195 in November were recorded, distributed among 180 and 175 groups respectively. These figures represent the total number of contacts made by the observers during the consecutive survey and simultaneous drives phases in each period. To estimate the size of the population a careful selection of possible duplicated groups was carried out.

The criteria for selection were as follows:

a) Place, time and direction of escape of similar groups observed by different teams (drive method).

b) Structure of the group (particularly number of kids) and

proximity ($\leq$ 500 m) of sightings obtained on different days (survey method).

c) Restrictive criterion: in case of any doubt the procedure was to eliminate the group presumed duplicated.

The simultaneous drive method is considered to be the most accurate system of census. During the summer period the results were obtained by this method, except in sector 3 where they were obtained by the survey method, as several important herds seen on previous days were not to be seen in the usual place during the simultaneous drive. During the Autumn, bad weather reduced general visibility, especially on the days of the simultaneous drive, and the survey censuses were considered more reliable.

After this selection process some final results were obtained - these can be seen in Table 1 by sectors, sex-age classes and seasons. In Autumn, visibility was at its worst. However, in Summer the concentration of female groups at high altitude made their sightings easier (García-González et al., 1985). For this reason, the summer census is considered more genuine, not forgetting that it deals with minimum numbers.

As it can be seen in Table 1, the most populated sectors were the most eastern, and the least populated those of the north-western extreme and the range on the French frontier.

Considering the planimetric surface, the density in summer for the sectors 1 to 4 was 2.1, 1.4, 4.3 and 5.9 animals/km^2 respectively. In fig. 2 the current density for each period of observation is shown, together with some factors which appear to affect the distribution, such as crags, travellers routes, poaching pressure and livestock pressure. The total of summering sheep calculated by sectors, according to the municipal records and personal sightings, were 13000, 100, 4600 and 5000 for sectors 1 to 4 respectively.

For each km^2 the total number of chamois sightings was recorded, discounting the duplicated ones. Solitary individuals or

Table 1.- Results of censusses carried out in Los Valles Hunting Reserve (1986) specified by sector, season and age class. Y, yearling; K, kid; Ind., indetermined; %*, without indetermined

SUMMER

SECTOR	♂	♀	Y	K	Ind.	TOTAL	(%)
1	12	76	32	69	24	213	(22)
2	10	23	5	12	1	51	(5)
3	9	164	28	113	18	332	(34)
4	14	124	67	97	72	374	(39)
TOTAL	45	387	132	291	115	970	
%	(5)	(40)	(14)	(30)	(12)		
%*	(5)	(45)	(15)	(34)			

AUTUMN

SECTOR	♂	♀	Y	K	Ind.	TOTAL	(%)
1	8	39	25	30	44	146	(25)
2	4	9	2	4	5	24	(4)
3	26	95	30	42	73	266	(45)
4	19	46	16	38	40	159	(27)
TOTAL	57	189	73	114	162	595	
%	(10)	(32)	(12)	(19)	(27)		
%*	(13)	(44)	(17)	(26)			

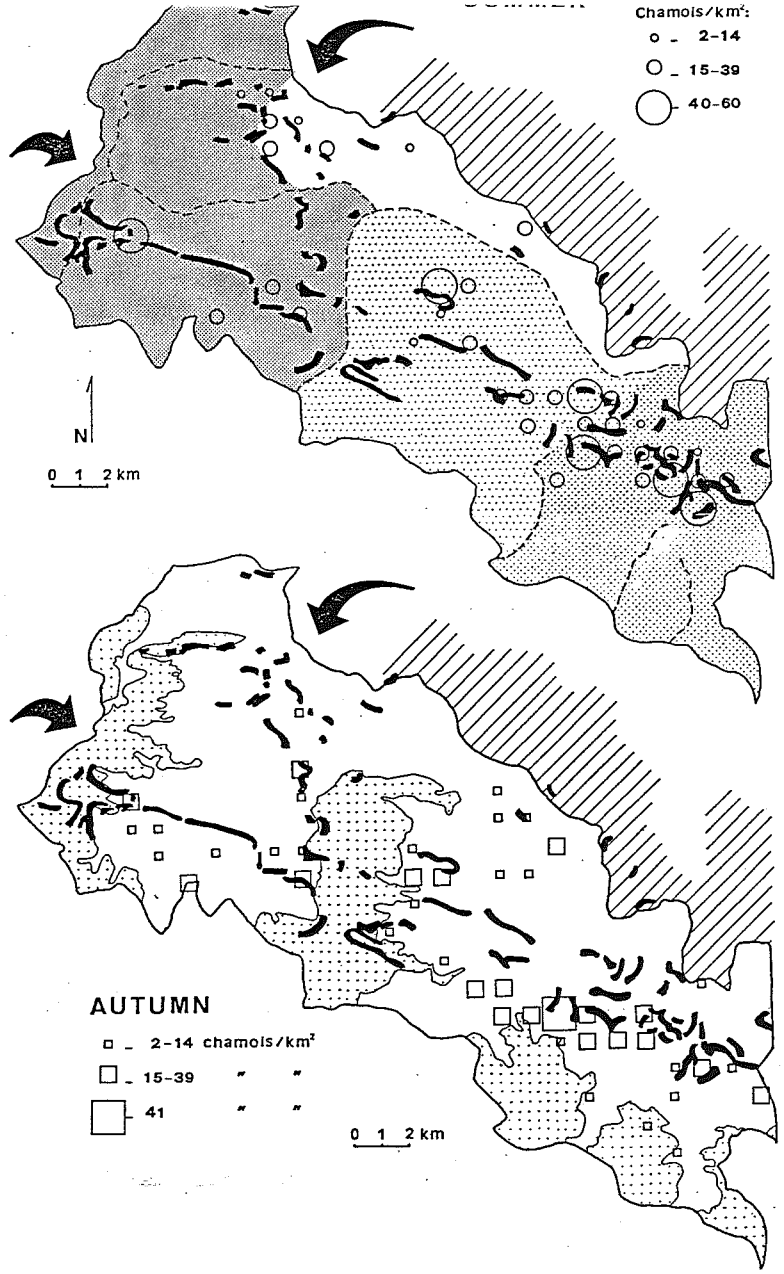

Fig. 2.- Density distribution of chamois in "Los Valles" National Hunting Reserve when surveys were carried out. Discontinuous lines: main ways of human transit; inclined stripes: French National Park (P.N.P.O.); black thick lines: cliffs and crags; arrows: main fronts of poaching pressure; dotted in Summer: intensity of summering sheep stocks by sectors; dotted in Autumn: forest.

lone females with their kids were not recorded in fig. 2. In Summer the great concentration of groups on rocky terrain maybe highlighted, avoiding the areas most used by man. In Autumn, there is a drop in altitude, they abandon the steeper areas and are to be found most frequently between the edge of the forest and the crags. In Autumn, the occupied surface grows bigger, probably because of the reduction in the average size of the groups (9.0 and 6.8 chamois per group in Summer and Autumn respectively). The overlapping of territory between Summer and Autumn is estimated at 12.3%.

Several population ratios have been calculated from the data in Table 1. The fertility ratio (i.e. number of kids/adult females x 100) for the whole Reserve is 75%. An indirect ratio of first year mortality can be estimated, dividing the number of kids by the number of yearlings. Expressed as a percentage that is 55%. The proportion of males to females is 1:3.3. The first two ratios have been calculated from the Summer data and the sex-ratio with the data from the mating season.

Apart from the spatial distribution, several environmental variables have been considered to distinguish the habitat of the chamois in Summer and Autumn. In Table 2 and in fig.3 the results of the whole Reserve have been summarized. The sum total of all the recorded sightings have been taken.

The altitudinal range in which the chamois were seen in Summer varies between 1400 and 2500 metres, the most frequent elevation being between 1900 and 2100 metres. In Autumn there is a drop in altitude. There were no sightings of chamois above 2300 m, the most frequent heights being between 1700 m and 2000 m.

In Summer the predominant exposure was towards the North, although quite a few individuals were to be found facing the South. In Autumn the numbers exposed towards the South were clearly greater.

The gradient of the slope was divided into 4 categories. In Summer the chamois were to be found on steeper and steeper slopes, while in Autumn on slopes of a lesser gradient. These differences

Table 2.- Chamois frecuency distribution (number of individuals) according to four spacial variables in the two prospected seasons: summer (S) and autumn (A). In brackets number of chamois groups.

ALTITUDE	Summer		Autumn	
2401-2500	30	(1)	0	
2301-2400	128	(8)	0	
2201-2300	157	(19)	27	(2)
2101-2200	215	(33)	66	(8)
2001-2100	350	(30)	99	(14)
1901-2000	331	(27)	269	(36)
1801-1900	158	(24)	265	(36)
1701-1800	100	(14)	316	(44)
1601-1700	58	(12)	46	(19)
1501-1600	67	(9)	87	(11)
1401-1500	20	(3)	20	(5)

COMPASS DIRECTION	Summer		Autumn	
N	618	(66)	133	(21)
NE	128	(13)	29	(5)
E	194	(24)	118	(27)
SE	30	(5)	126	(15)
S	423	(45)	446	(63)
SO	38	(2)	65	(14)
O	136	(18)	192	(21)
NO	31	(4)	8	(4)

PHYTOGEOMORPHOLOGIC SUBSTRATUM	Summer		Autumn	
Crest	19	(3)*	41	(12)
Cave	3	(2)	0	
Crag	234	(42)	129	(24)
Crag foot	164	(40)	74	(6)
Snow patch	187	(26)	74	(15)
Scree	419	(51)	44	(14)
Stony pasture	444	(49)	575	(81)
Compact pasture	125	(13)	220	(32)
Sheep salt site	17	(1)	0	
Forest	0		0	
Forest opening	0		0	
Livestock resting site	0		0	
Stream/Spring	0		0	

GRADIENT OF SLOPE	Summer		Autumn	
0°- 5°	117	(9)	170	(29)
5°- 30°	182	(13)	311	(45)
30°- 60°	560	(59)	517	(80)
60°- 90°	755	(100)	157	(21)

*Sum of groups is greater than total groups seen due to some groups were assigned to more than one phytogeomorphologic substratum.

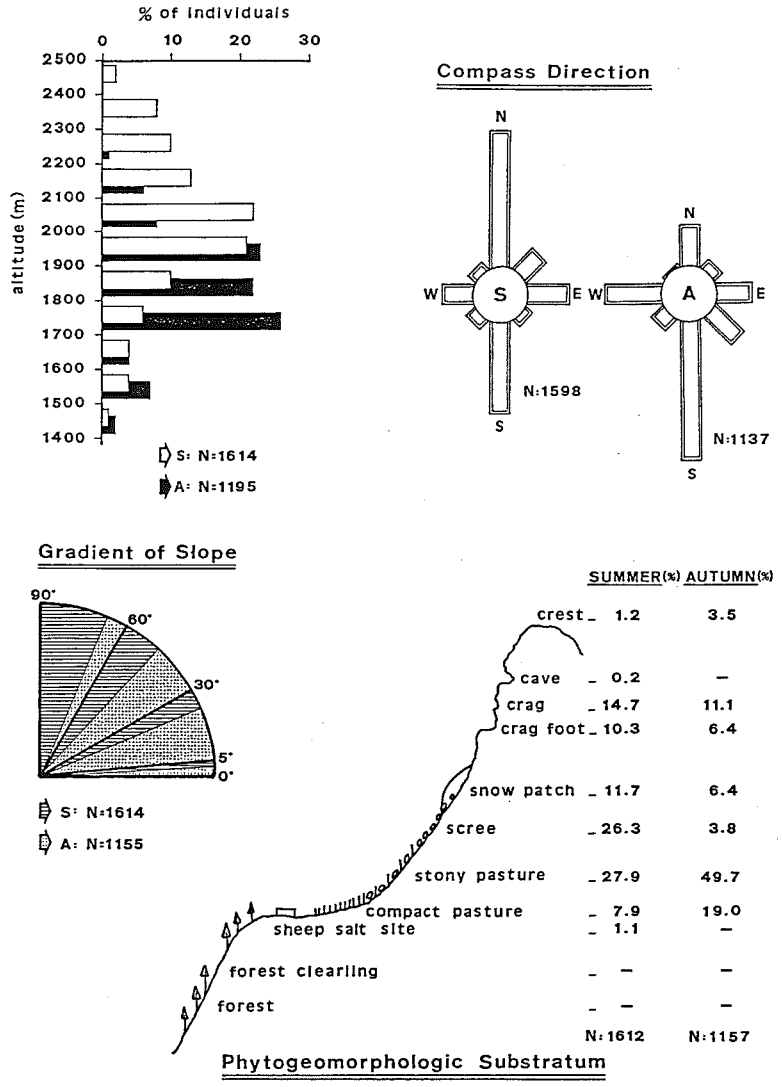

Fig. 3.- Chamois distribution in function of some spatial variables, in percentage of total sightings. S: Summer; A: Autumn; N: total number of individuals. Phytogeomorphologic substratum has been arranged in figure according to an altitudinal sequence, but both variables are obviously independent.

are compatible with the drop in altitude and the rarer frequentation of rocky substrata in Autumn. The flat areas (0°- 5°) were frequented very rarely in both seasons.

With regard to the physical substratum on which the sightings were carried out, it should be noted that not one individual was seen in the forest or its clearings, in neither season.

In the area of the study the edge of the forest fluctuates between 1500 and 1600 m. The sightings carried out in lower altitudes were on other kinds of substrata such as rocks or caves. In Summer the most frequent substrata were stony pastures, screes and crags, corresponding to higher altitudes. In Autumn half the individuals were sighted on stony pastures, and the frequency on compact pasture increased to double, corresponding to flatter slopes. Obviously sightings on snow dwindled considerably in Autumn.

The distribution of frequencies for Summer and Autumn are significantly different ($p < 0.001$) from each other in all the spatial variables chosen according to a G-test of independence (Sokal & Rohlf, 1969). The values of χ^2 were 645.5; 444.7; 371.1 and 471.7 for the altitude, exposure, gradient and substratum respectively.

DISCUSSION

The two census systems used differ above all in the duration of the actual inspection time. In the simultaneous drives the aim is to make an inventory of the whole population as quickly as possible to avoid duplication (Berducou et al. 1992). When only a few personnel are used there is a risk that some groups will go unnoticed. The fewer personnel, the greater the risk. Using the survey method, in which one or two groups thouroughly oversee a sector for several days, the risk of leaving out groups uncounted is smaller. If the number of inspection days is not very high, the risk of duplication diminishes due to the sedentary nature of the species (Gonzalez, 1985; Pachlatko & Nievergelt, 1985). The number of people needed is also lower.

For this study, apart from economic reasons, it was considered preferable the use of a small but specialised number of personnel (able to distinquish sex-age classes, with experience of mountains, etc) rather than the opposite. This situation suited the survey method better, but, as the simultaneous drive method is considered more accurate, the two systems were used in conjunction, both methods complimenting each other relatively well. Previous knowledge of the location of the main herds allowed a more effective planning of the simultaneous drives. After carrying out a painstaking selection of the sightings, it was established that the minimum number of chamois inhabiting the Reserve, stood at about as conservative estimate, a thousand individuals, which in any case is quite a lot higher than the official estimate.

The calculated population ratios show a sex-ratio quite different from its theoretical value, in favour of the females. One could expand this situation to other Hunting Reserves in the Spanish Pyrenees (García-González et al., 1985), and it would seem to be a logical consequence of a greater hunting pressure on the males. Nevertheless, the fertility ratio obtained (75%) could be considered moderately high. Caughley (1970) points to 80% for a population to be considered stable. These results contradict the hypothesis, that there is a direct relationship between reduction in fertility and imbalance in the sex-ratio in favour of females (Chabaud, 1976; Berducou et al., 1982). The authors of this paper propose the hypothesis, that this particular relationship could be the reverse. However, at the moment these aren't enough published data to verify it. The first-year mortality ratio is higher than that obtained in other studies (García-González et al., 1985), perhaps as a consequence of the milder winter (1985-86).

The analysis of the chamois group distribution in the Reserve (fig. 2) reveals two relevant facts. The summer distribution seems to be strongly linked to the presence of crags and cliffs. The chamois' preference for this type of habitat is a fact already known (Elsner-Schack, 1985) and is in contrast to the worse adaptation to this environment shown by Couturier (1958). The high mountain crags offer the chamois greater safety and the possibility of avoiding disturbances caused by summering livestock and tourism. The quality

of the food and thermic comfort are also factors contributory to their altitudinal ascent (García-González, in prep.). Some authors point to a preference in the summer period, for flat habitats with few rocks and plentiful pastures (Hamr, 1985; Lovari & Cosentino, 1986). These results do not contradict the present paper, as they are probably due to differences in the relief and the generally lower altitude in the area. In the mating season there is an altitudinal descent tending towards flatter slopes facing South. Sightings on rocky substratum decrease in number and those on open pasture area increase. The upkeep of their harems is probably easier for the males in open spaces.

The other relevant fact is the observed density gradient, rising towards the East. The difference in density between the surveyed sectors seem to be the result of a combination of several factors. In the westernmost sector, the general altitude is lower (fig. 1) and the relief is milder. This diminishes the frequency of steep areas where the chamois can find shelter from man-made disturbances (the tourist pressure is greater in sectors 1 and 2). The presence of domestic animals has been pointed out as a possible cause of repulsion for the chamois (Dubost, 1985). In fig. 2, the density of summering sheep stock has been estimated by sectors with regard to the Summer. Cattle have not been taken into account as a certain compatibility with the chamois has been observed (personal observations). Cattle graze freely in the summer rangelands, whereas sheep are always guided by dogs and shepherds. As it can be seen, sheep pressure is greater in the western sector; not only during the survey period, but also during the last few decades (Balcells, 1984).

Another incidental factor in the density gradient is the poaching pressure. It is difficult to quantify its importance, but information obtained makes it relevant. This pressure is applied to a higher degree in the north-western sector, due to, on the one hand, the scarcity of bailiffs in this sector. On the other hand, the greater difficulty met by the poachers in crossing the French National Park with weapons or dead animals, where there is much more surveillance than on the Spanish side. The pressure applied in

the West corresponds to the poachers from the neighbouring region (Navarra), who cannot find specimens to hunt in their own area (which is the boundary of the distribution area of the Pyrenean chamois).

To conclude, the difficulties involved in chamois counts in relatively large Reserves and the necessity of revising some ideas about the structure and dynamics of the population (such as relationships between sex-ratio and fertility) should be pointed out. And lastly to highlight the concordance between the observed chamois distribution in this paper, the known habitat preferences of the chamois and the stress factors caused directly or indirectly by man.

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