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Spatial behaviour of adult male Alpine ibex (*Capra ibex ibex*) in the Gran Paradiso National Park

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Abstract. During a two year preliminary study, the spatial organization of a group of males of Alpine ibex (*Capra ibex ibex*) was examined in the Gran Paradiso National Park, Western Italian Alps. Annual, seasonal, and rut home ranges were determined as well as altitudinal migration of a group of radio-collared adult Alpine ibexes from December 1995 to January 1998. The small annual home range size showed a traditional use of space, confirmed also by the high overlapping values between home ranges of consecutive years: the ibexes returned to the same places from year to year.

For the rut period home ranges we obtained lower overlapping values. Rut home ranges size changed from winter to winter, depending on the snow cover which limited the movements of the ibex.

Winter and spring home ranges were smaller than summer and autumn ones. Mean vertical movement patterns were similar in the two years, the highest altitudes were reached in summer and the lowest in spring.

Key words: Alpine Ibex, Western Italian Alps, dispersion, telemetry

Introduction

Mammals have a spatial behaviour influenced by environmental factors, population density, resource availability and distribution (Staines 1974, Larter and Gates 1994). In relation to the seasonal variations of these factors, animals modify their home ranges in order to maximize access to resources and reproductive success. For these reasons, Alpine and Spanish ibex modify their spatial behaviour from one season to another (Nievergelt 1966, Escos and Alados 1991, Gonzales 1994).

Snow cover seems to play a primary role in limiting the movements of mountain ungulates, because of their difficulty in walking and lesser food availability (Georgii and Schroeder 1983, Schmidt 1993, Cederlund and Sand 1994). To reduce energetic expenditure, they move as little as possible when snow cover is high (Georgii and Schroeder 1983, Thor 1990, Schmidt 1993).

The spatial behaviour of the Alpine ibex (*Capra ibex ibex*) is little known and the only data available were obtained using radio-tracking techniques in reintroduced populations. Most of these data were collected monitoring the displacements of released Alpine ibexes (Terrier and Polaert 1987, Michallet 1994, Terrier *et al*. 1991, Terrier *et al*. 1994, Terrier and Rossi 1994, Tron *et al*. 1994, Pedrotti *et al*. 1995). These animals have a different spatial behaviour compared with autochthonous ones (Pedrotti *et al*. 1995) because of important exploratory requirements, and their home ranges are larger because they probably include not used areas.

In many mountain ungulates, altitudinal migration is considered an adaptation to the exploitation of the best trophic resources (Georgii and Schroeder 1983, Hamr 1985, Festa-Bianchet 1986, Terrier and Rossi 1994). In autumn, this migration seems to be due more to adverse weather conditions rather than to forage quality (Georgii and Schroeder 1983, Koubek and Hrabě 1996).

The aim of the present study was to analyze preliminarily the spatial behaviour of a group of adult male Alpine ibexes in the Gran Paradiso National Park, which belongs to the native population from which all the populations in the Alps derive.

Study area

This study was carried out in the Western Italian Alps, in the northern part of the Gran Paradiso National Park.

The study area is roughly 13,000 ha wide. The altitude ranges from 1,450 m to 3,969 m a.s.l.

Secondary pastures are present in the bottom of the valley. The slopes are covered by sparse stands of larch trees (*Larix decidua*) interspersed with rocks. Above 2,200 m a.s.l. the area is characterized by alpine meadows, rock cliffs, and stone ravines. The limit of perpetual snow is 3,200 m.

During the study period the temperature ranged from -23 °C in winter 1996 to 25 °C in summer 1997.

Methods

In November 1995, ten adult males were captured by tele-sedation techniques.

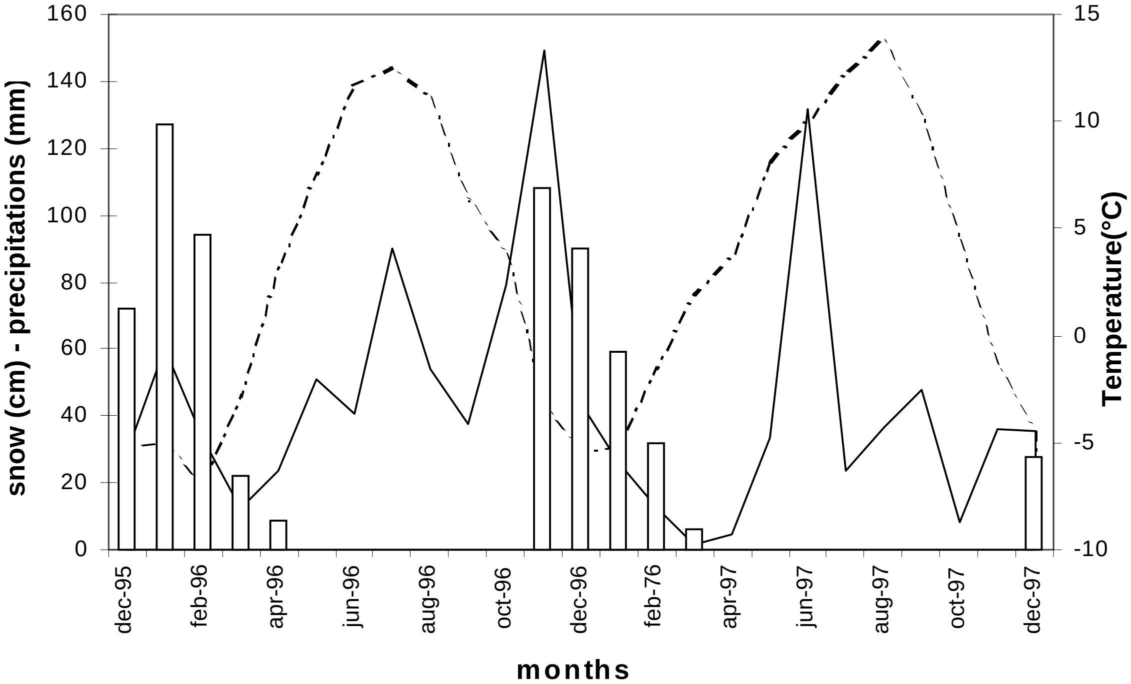

Fig. 1. Mean monthly temperature (broken line), total monthly precipitation (full line) and total monthly snowfall (column) during the two years of study. Cogne valley (Italy) 1996-1997

We weighted the animals, we estimated age by horn growth, we took morphometric measures and we fitted the males with radio-collars.

Ibex were followed from December 1995 to January 1998. They were located with a directional antenna and a portable receiver.

In summer, localizations were collected mainly by direct observations with binoculars and spotting scopes. In winter, most of the fixes were made by triangulation from at least three known points, because of the risk of avalanches.

The position of each radio-tagged male was plotted onto a 1:10,000 map.

For each animal at least 12 fixes/month were collected, evenly distributed in the daylight hours. From December to January 1 fix/day/male was collected to better define male spatial behaviour during the rutting period.

We calculated home range size using two methods: Kernel analysis (Worton 1989, Harris *et al.* 1990, Kernohan *et al.* 1998) and Minimum convex polygon (Hayne 1949, Harris *et al.* 1990), both including 95% of the fixes.

Ranges V software (Kenward and Hodder 1996) was used for home range analysis and annual (12-95/11-96; 12-96/11-97), seasonal (winter:Dec-Feb; spring: Mar-May; summer: Jun-Aug; autumn: Sep-Nov) and rut (01-12/10-01) home ranges were calculated. Rut definition was based on observations of the ibex behaviour in this period.

Non-parametric tests were used to analyze the data, with a=0.05 as confidence level.

The Wilcoxon matched-pairs signed-ranks test for dependent data (Siegel and Castellan 1992) was used for comparing the home ranges calculated with MCP and those calculated with Kernel, and for comparing home ranges of different seasons.

Also altitudinal migration of adult males was studied, dividing the study area into three ranges: the bottom of the valley (1,500 m), the upper limit of the trees (2,000 m), the alpine meadows (2,500 m), the areas with perpetual snow being excluded.

The climatic station situated near the Botanical Garden of Paradisia (Valnontey) provided temperature and precipitation values for the two years of the study (Fig. 1).

Results and discussion

Mean annual MCP home ranges ranged from 536.9

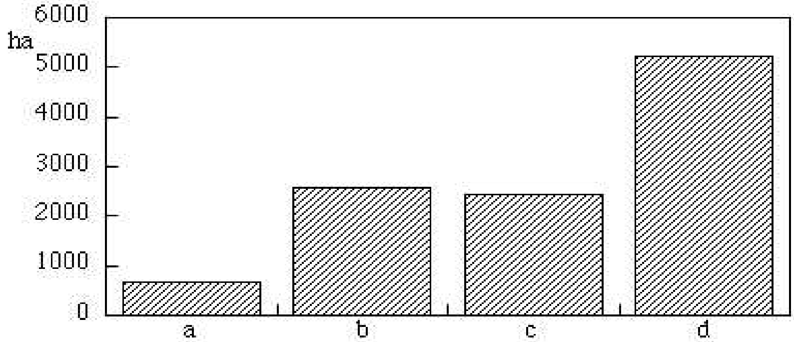

Fig. 2. Comparison among annual home ranges of: a) ibex of the Gran Paradiso National Park (this study); b) reintroduced ibex in Italian Alps (Pedrotti *et al.* 1995); c) reintroduced ibex in French Alps (Michallet 1994); d) Spanish ibex (Escos and Alados 1992).

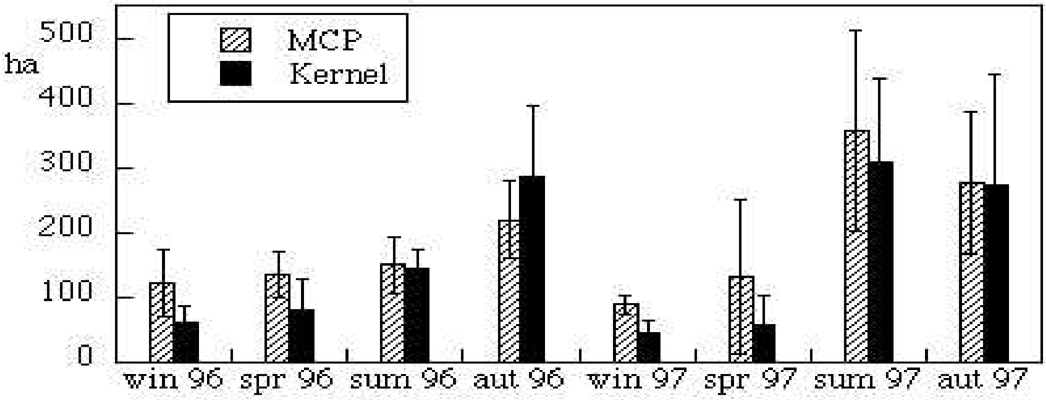

Fig. 3. Seasonal home ranges dimensions in the two years of study.

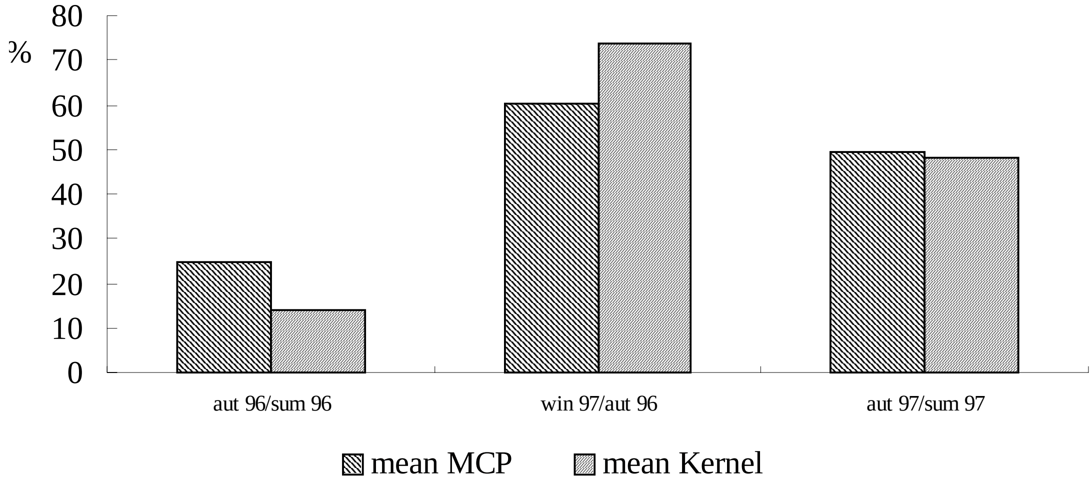

Fig. 4. Overlap values between the home ranges of following season and the proceeding one.

± 182 ha in the second year (Dec. 1996 - Nov. 1997) to 547.5 ± 108.2 ha in the first year. With the Kernel method, the values ranged from 430 ± 52.4 ha in the first year to 467 ± 130.1 ha in 1996-97.

In the present study, Alpine ibex showed smaller home range sizes than those recorded in other mountain ungulates (Escos and Alados 1992, Georgii and Schroeder 1983) and in reintroduced Alpine ibex populations (Terrier and Polaert 1987, Michallet 1994, Terrier *et al.* 1994, Pedrotti *et al.* 1995, Tron *et al.* 1994) (Fig. 2). Our sample was part of an autochthonous population, which showed a traditional use of space, in contrast to the newly introduced alpine colonies that exhibited a relevant exploratory behaviour.

Seasonal home ranges

The average size of home ranges differed among seasons: larger home range sizes in summer and autumn, smaller in winter and spring (Fig. 3).

Home range size significantly differed between summer and spring, and autumn and winter: summer and autumn home ranges were greater than winter and spring ones ($z = 2.38$, $p = 0.009$ and $z = 2.20$, $p = 0.014$, respectively, for summer/spring and autumn/winter). Significant differences in different years were observed only between the summer home range size ($z = 2.52$, $p = 0.006$), and this difference was probably due to a different sampling. In June 1996, the fixes were collected only in the second half of the month when the males had already reached the alpine meadows, while the migration from the spring to the summer sites was lost.

The size of the autumn ranges was the largest as a consequence of the movements of males from the alpine meadows to the winter ranges. They left their summer due to environmental conditions, as happens in other mountain ungulates (Koubek and Hrabě 1996)

Different overlap values between autumn and summer home ranges in our two study years (Fig. 4) reflected the different climatic conditions and confirmed the primary role of the unfavorable winter climate in determining the move to the winter range. In September 1996, the temperature values were lower than the summer ones, and at high altitude it was already snowing. The males moved towards the wintering areas and this fact explains the high overlap between winter and autumn home ranges. On the contrary, in September 1997 the mean temperature was similar to the summer one and there were no snowfalls, so the males stayed on the alpine meadows. This spatial behaviour confirms that Alpine ibexes like many other mountain ungulates (Georgii and Schroeder 1983, Schmidt 1993, Koubek and Hrabě 1996) avoid snow, and that snowfalls are the main factor in determining the autumnal migration in this species. Moreover snowfalls influenced the rut home range size of male Alpine ibex: in the first two years the rut home ranges were similar in size, while in 1998 home range sizes increased (z = 2.20, p = 0.014; U = 30, p = 0.032) (Fig. 5). The scarce and late snowfalls of the tirth winter had a great influence in the use of space. We observed that the snow cover was the decisive factor which limited the extension of the ibex winter range; the snow cover reduces the ibex displacements, so the less it snows the larger the ranges used by the animals.

The high overlap between the same seasons in different years (Fig. 6) points to the traditional space use of this population. Male ibexes returned to the same areas from year to year. This was particularly evident in the spring when the males were looking for forage of good quality, which was available at the bottom of the valley. These areas are very limited because of human presence, so the ibexes were forced to go to the same areas from a year to year.

The low value of overlap between the rutting home ranges of consecutive years, always lower than 50% (Fig. 6) militate against a traditional use of space during the rutting period. The change in spatial behaviour of male Alpine ibex during the rutting season might be due to the variation in female distribution. In winter 1997-1998, females, given the limited snow cover, were free to move to areas otherwise inaccessible.

Altitudinal distribution

Mean vertical movements did not differ in the two years, showing the highest values in summer and the lowest in spring (Fig. 7).

Temperature and forage seem to be the main factors influencing annual vertical movements in moun-

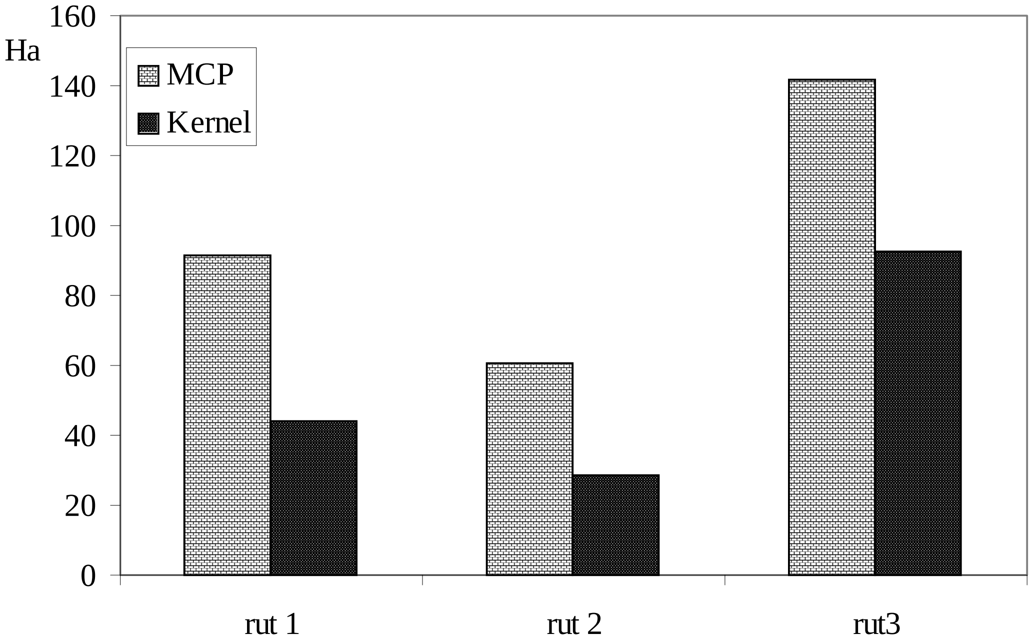

Fig. 5. Rut home ranges sizes.

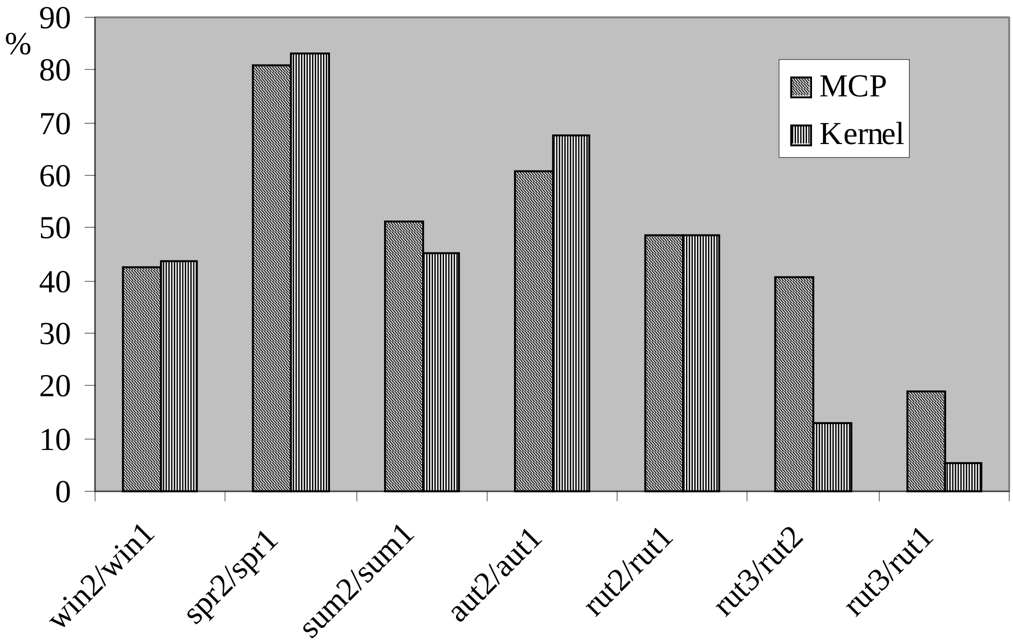

Fig. 6. Overlap values between the home ranges of the same season in the two years.

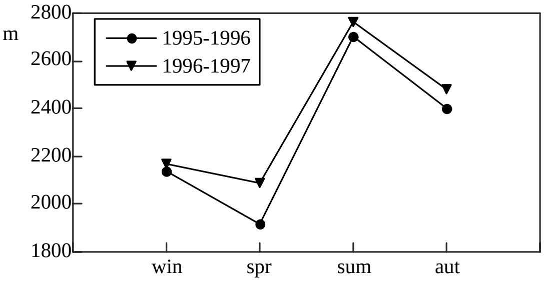

Fig. 7. Mean altitude variation in the course of the year by our ibex adult males sample.

tain ungulates (Nievergelt 1966, Staines 1974, Wiersema 1984, Festa-Bianchet 1986).

The lowest altitudes are reached in spring. In summer, male ibex reach the alpine pastures at higher altitudes. In autumn, when the snow covers the upper meadows, they move towards lower altitudes, and in winter they stay at intermediate altitudes, on those sites where the snow first melts and where the risk of avalanches is lowest. They then go down in spring to find forage of good quality for satisfying energetic requirements, which will have increased after the winter fasting.

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