ABSTRACT - This study was conducted in order to identify the relationships between stocking rate, management system, topographic conditions and weed encroachment of summer pastures in “Lessinia”, a pre-Alpine area in the Veneto region (North-Eastern Italy). Using the data from a field survey on 46 summer pastures (30 with dairy cows and 16 with other bovine categories), various ANOVA/ANCOVA models were used to test the effects on stocking rate of livestock category, supplementary concentrate feeding, and pasture weed encroachment, slope and elevation. Stocking rate was higher in summer pastures with dairy cows than in those with other bovine categories, and in pastures with moderate slopes than in those with higher ones, but was unaffected by supplementary concentrate feeding, altitude and weed encroachment. This indicates that in the considered areas stocking rate is not constrained by pasture productivity and is kept at sub-optimal levels. Future research is needed to make more clear the effects that the present management status may have on the evolution of pastures productivity and biodiversity value.

Key words: Livestock systems, Alpine summer pasture, Stocking rate, Grazing management.

Introduction – In the mountain areas of the Veneto region, as in many other European areas, livestock production systems have recently experienced important changes that resulted in the abandoning or sub-optimal management of grasslands (Giupponi et al., 2006). In addition, management of grasslands is strongly influenced by topographic conditions, with elevation and topography being major constraints that may force to extensive utilisation (Marini et al., 2008). This study was conducted in the grazing system of the summer pastures of the pre-Alpine area of “Lessinia”, in the western part of the Veneto region, in order to identify the relationships between stocking rate, which is a well known key management variable in determining long-term productivity of grazing systems (Ohlenbush et al., 1994; Ziliotto et al., 2004), category of livestock summered, topographic conditions and weed encroachment of pastures.
**Material and methods** – The study area is located in the “Lessinia” mountain community, which comprises 18 municipalities in the western pre-Alpine area of the Veneto region. Summer pasture is defined here as a holding where livestock is moved over summertime from the lowland permanent farms. Forty-six summer pastures, all with bovine, were visited and the following information was collected by means of a standard interview: category and number of livestock (dairy cows or other bovine), supplementary feeding (yes, no) and length of grazing season (days). Pasture area was digitized over aerial photographs (1:10000) and classes of pasture weed encroachment were determined: <5%, from 5 to 20% and >20%. Stocking rate was calculated as livestock units (LU)/pasture surface (ha), where cattle >2 years=1 LU and cattle from 6 months to 2 years=0.6 LU. Mean altitude (m a.s.l.) and slope (%) of pastures were calculated from a Digital Elevation Model (DEM), with a cell size of 25x25m², in ArcGIS 9.2®. Prior to statistical analysis, stocking rate was log-transformed to obtain a normal distribution. Stocking rate was subjected to ANOVA/ANCOVA analyses with the effects of livestock category (lactating cows or other bovine livestock), supplementary concentrate feeding (yes/no), weed encroachment, and elevation and/or slope, which were tested both as covariates or as fixed effects after grouping them into classes (from 1253 m to 1388 m, from 1388 m to 1517 m and >1517 m for elevation, and from 14 to 22%, from 22 to 27% and >27% for slope) based on variability distribution. There was no significant correlation between slope and elevation (n=46; r=0.06; P=0.68). The best model was chosen on the basis of R² and RMSE.

**Results and discussion** – A description of the surveyed summer pastures is given in Table 1. Thirty pastures (herein called “Dairy”) were exploited by dairy cows, and 16 (herein called “Other”) by dry cows or other bovine categories. Season length, average elevation and slope of pastures were very similar for the two groups. This was surprising, since dairy cows are expected to need more productive and accessible pastures than other categories. However, this particular feature might be explained by the use of supplementary feeding, that was common in Dairy but infrequent in Other, thus compensating for the differences in forage productivity.

| Livestock categories | N  | Season (d) | Elevation (m a.s.l.) | Slope (%) | Suppl. feeding | Pasture surface (ha) | LU¹ |
|----------------------|----|------------|----------------------|-----------|-----------------|-----------------------|-----|
|                      |    |            |                      |           | Yes | No |                      |      |
| Dairy                | 30 | 124 (6)    | 1489 (131)           | 12.9 (7.3)| 28  | 2  | 66 (24)               | 71 (28) |
| Other                | 16 | 126 (14)   | 1513 (134)           | 13.7 (6.8)| 7   | 9  | 40 (26)               | 41 (25) |
| Total                | 46 | 125 (10)   | 1495 (132)           | 13.1 (7.2)| 35  | 11 | 56 (28)               | 60 (30) |

¹LU=livestock unit

Average surface of pasture was only slightly larger for Dairy, but variability within groups was remarkable. However, Dairy summered on average more LU than Other.

The various ANOVA and ANCOVA models used to analyse stocking rate always showed a significant effect of livestock category (F=6.01; P<0.01 for the best model), with Dairy ha-
ning a higher stocking rate than Other (Table 2). The best model showed a significant effect of slope classes with the lowest slope having higher stocking rates than the other classes (F=3.97; P<0.05). Slope tested as covariate and elevation, either when used as covariate or when used as fixed effect, never showed a statistical significance. In addition, supplementary feeding did not influence stocking rate (F=1.16; P>0.05). Finally, weed encroachment was highly variable between pastures (ranging from 5 to 50% of the total surface) but did not influence stocking rate (F=1.18; P>0.05).

### Table 2. Effects of livestock category and pasture slope class on stocking rate (LS means ±SE).

| Livestock category | Slope class (%) |
|--------------------|-----------------|
|                    | 14-22 | 22-27 | >27 |
| Dairy              | 30    | 16    | 22  |
| Other              | 16    |       | 16  |
| N                  | 8     |       | 8   |
| Stocking rate (LU/ha) | 1.00 ±0.72 | 0.73 ±0.44 | 1.02 ±0.75 | 0.80 ±0.52 | 0.76 ±0.49 |

Different superscripts within column differ significantly P<0.05.

**Conclusions** – Based on the general knowledge of grazing management optimisation (Ohlenbush *et al.*, 1994; Ziliotto *et al.*, 2004), stocking rate should be positively related to pasture productivity, which is in turn inversely related to elevation, slope and weed encroachment. In this survey, only slope showed the expected effect. The lack of effects of elevation and weed encroachment, in spite of their remarkable variability, suggests that in this area stocking rates are managed at sub-optimal levels and therefore are only partially constrained by pasture productivity.

Further research is needed to elucidate the tendency of pastures that, under the present management situation, seems to be destined to an increasing weed encroachment and shrubs-woodland colonization (Ziliotto *et al.*, 2004). This is important not only in view of the forage productivity, but also for the strong impact that management conditions may have on the biodiversity value of Alpine grasslands.

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**REFERENCES** – Giupponi, C., Ramanzin, M., Sturaro, E., Fuser, S., 2006. Climate and land use changes, biodiversity and agri-environmental measures in the Belluno Province, Italy. Environ. Sci. Policy., 9 (2): 163-173. Marini, L., Fontana, P., Klimek, S., Battisti, A., Gaston, K. J., 2008. Impact of farm size and topography on plant and insect diversity of managed grasslands in the Alps. Biol. Conserv., 142 (2): 394-403. Ohlenbusch, P. D., Watson, S. L., 1994. Stocking rate and grazing management. Kansas State University, MF-1118. Ziliotto, U., Andrich, O., Lasen, C., Ramanzin, M., 2004. Tratti essenziali della tipologia veneta dei pascoli di monte e dintorni. Regione del Veneto- Accademia Italiana di Scienze Forestali, Venezia.