BioOne COMPLETE

Dairy Cattle Husbandry and Red Deer Utilization of a Summer Range in the Central Italian Alps

Authors: Mattiello, Silvana, Redaelli, Walter, Crimella, Miro C., and Carenzi, Corrado

Source: Mountain Research and Development, 23(2) : 161-168

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2003)023[0161:DCHARD]2.0.CO;2

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use

Mountain Research and Development Vol 23 No 2 May 2003: 161–168

Silvana Mattiello, Walter Redaelli, Miro C. Crimella, and Corrado Carenzi

Dairy Cattle Husbandry and Red Deer Utilization of a Summer Range in the Central Italian Alps

In the Italian Alps dairy cattle are taken to mountain ranges during the summer, which can lead to overlap of areas used by cattle with areas traditionally used by wild ungulates. The aim of the present study was to evaluate the effect of dairy cattle husbandry on the utilization by red deer (Cervus elaphus) *of a summer range at an altitude of 1500–1700 m in the Central Italian Alps. Spatial overlap between the 2 species occurred, suggesting that the presence of cattle themselves has a limited impact on red deer. The area where milking took place was among the areas most preferred by deer, probably because of the remains of supplementary feed delivered to cattle during milking operations as well as the presence of high concentrations of cattle urine (salt concentration). Milking operations in the field had the highest impact on red deer in our study, as shown by the dramatic reduction of deer in the area (index of presence: IP = 0.03 ± 0.02 during milking versus 0.35 ± 0.07 without milking; P < 0.001) and by the complete absence of spatial overlap during milking. This indicates that human activities related to dairy cattle husbandry had a higher impact on red deer than did the presence of cattle themselves. Deer seemed to adapt to the rhythm of milking operations, which were carried out routinely every day at fixed times, thus representing a predictable disturbance.*

Keywords: *Grazing; red deer; fecal pellet count; cattle husbandry; Alps; Italy.*

Peer reviewed: *February 2002.* ***Accepted:*** *November 2002.*

Introduction

In the Italian Alps dairy cattle, which are usually kept in small or medium farms on valley floors, are taken to mountain ranges during the summer to let them benefit from free ranging, fresh forage, and cool weather. This common practice can lead to an overlapping of areas used by cattle with areas traditionally used by wild ungulates. When this occurs, the 2 species may either compete or enjoy mutual benefits. Different assumptions can be formulated in response to this hypothesis: for example, wild ungulates may (1) leave a cattle range, (2) avoid the vicinity of cattle, (3) use the same area as cattle at alternate times, or (4) share the same places at the same time with cattle.

Several aspects of the spatial interactions between wild and domestic stock have been investigated widely. For example, it was found that mule deer (*Odocoileus hemionus*) have a tendency to reduce their use of areas grazed by cattle (Loft et al 1993; Yeo et al 1993) and to shift to different habitats when pasture availability is reduced by cattle grazing (Loft et al 1991). Competition between mule deer and cattle was particularly evident at high cattle-stocking densities and in years with unfavorable weather conditions (Kie et al 1991), whereas low densities had no remarkable effect on mule deer distribution (Willms et al 1979). Most of the interactions reported between deer and cattle refer to beef cattle, and none of the above studies was conducted in an alpine environment. In the Alps, cattle taken to summer ranges are usually dairy breeds used for milk production. This means that a constant presence of men is required in the area for milking operations, something which, like other human activities, can have an additional impact on red deer. This has been observed, for example, in white-tailed deer (*Odocoileus virginianus*) in response to ranching operations (Hood and Inglis 1974) and hunting (VerCauteren and Hygnstrom 1998), in mule deer in response to military activities (Bernatas et al 1998), and in red and fallow deer (*Cervus elaphus* and *Dama dama*) in response to recreational disturbances (Humphries et al 1989; Langbein and Putman 1992; Bullock et al 1993). Short-term behavioral responses may produce long-lasting effects, eventually leading to mortality or reduced reproductive capability if the disturbance persists (Stephenson et al 1996).

The aim of the present study was to evaluate the effect of cattle and human activities related to animal husbandry on the utilization of a mountain summer range by red deer. We also compared the results obtained by direct observation with fecal pellet counts to estimate the presence of deer.

Methodology

The study area

Research was carried out on the Pian dei Cavalli summer range (Figure 1), located in Val Fontana (Central Italian Alps), at an altitude of 1500–1700 m (46°13'N, 12°27'E; Figure 2). The valley is characterized by a humid, cold continental climate. The botanical composition of the pasture area is mainly Gramineae, followed by varying proportions of composite, labiate, leguminous, and *Ranunculus* vegetation (Leggeri 1997). The study area was approximately 100 hectares, of which an area of 63 hectares was used by cattle. The average red deer density in the hunting domain of Sondrio, where Val Fontana is located, is 2 deer per 100 hectares (data from the Hunting Management Com-

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use

FIGURE 1 The Pian dei Cavalli summer range study area. The hut from which observations were carried out can be seen on the left. (Photo by Silvana Mattiello)

mittee of Sondrio). At the time of our research, the red deer population in the valley ranged from 220 to 270 animals, so that the local red deer density ranged from 2.7 to 3.4 deer per 100 hectares. Chamois (*Rupicapra rupicapra*) and roe deer (*Capreolus capreolus*) are also present in the valley. Preliminary observations showed that, of the 3 species, red deer was the only one that interacted with cattle and used the same area (Bergami 1995).

Management of domestic animals

Cattle were of the Italian "Bruna" dairy breed, numbering between 60 animals (lactating cows and occasionally some heifers and calves) at the beginning of summer and 20 (only cows) at the end of September because of the progressive return of cattle to their indoor stables in the lower part of the valley. The study was conducted for 3 consecutive summers (1996–1998), from June to September. Cattle were not always present on the summer range when data collection began in June. In July of all 3 years, cattle were taken to a higher summer range for a fortnight to allow the pasture to recover from intensive grazing, but they were always present in the study area in August and September. Therefore, the observations took place partly when cattle were present and partly in their absence. Milking operations took place in the field twice a day, in the morning and in the evening, partly by hand and partly by a milking machine placed in the middle of the summer range. During milking operations, pellet feed was delivered to the cows.

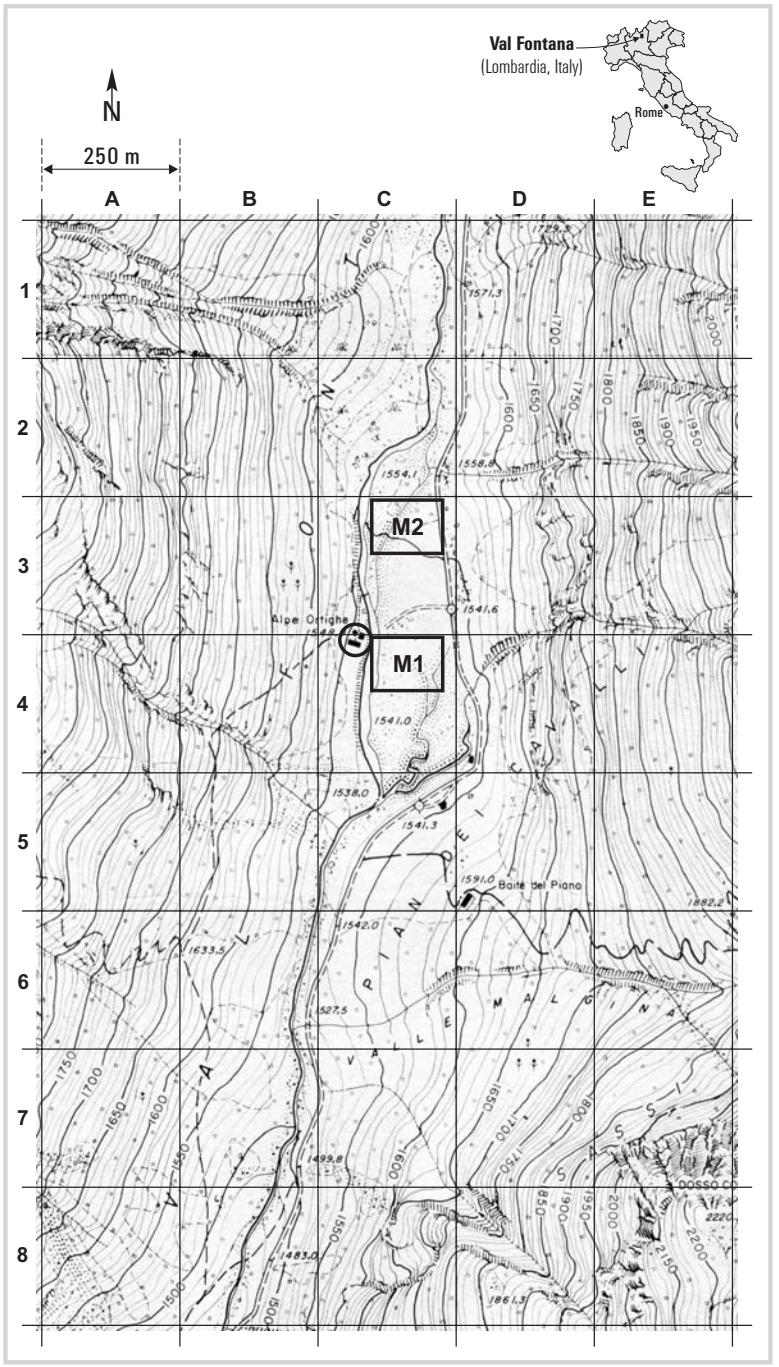
Data collection

Direct observations, with the aid of binoculars (7×35) and a telescope (70×77), were made from a hut located on the summer range (Figures 1, 2) and were concentrated at dawn and dusk (when there was enough sunlight to observe the animals), during hours when deer are more active (Clutton-Brock et al 1982). Deer were observed by 2 observers for a total of 264 hours; the observation effort amounted to 528 man-hours, equally distributed during 4 months of the 3 years. The positions of both deer (specified by sex and age class) and cattle were recorded on a Military Geographic Institute map (1:10,000) divided into grid units (GU) of 6.25 hectares each (250 m × 250 m) (Figure 2). In cases of poor visibility, observations were suspended. For cattle the collected data sets describe the entire area of activity, whereas for red deer the data sets represent only the space used during the observation hours; during the rest of the day deer ranged in a much wider area than that under observation.

In 1996, on the occasion of the collection of fecal samples for diet determination in deer and cattle, we observed the presence of deer pellets on the summer range even when no deer were recorded by direct observations at dawn and at dusk (Mattiello et al 1997b). We, therefore, formulated the hypothesis that deer might visit the area outside the observation hours, possibly during the night. To test this hypothesis and verify whether the results from direct observa-

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use

FIGURE 2 Study area (portion of the Carta Tecnica Regionale, Section N. C2e5, Alta Val Fontana, Regione Lombardia) and location of Val Fontana in Italy. The circle indicates the hut from which behavioral observations were carried out. M1 shows the milking place in 1995, 1997, and 1998, whereas M2 shows the milking place in 1996. Letters and numbers designate the coordinates of the grid units. (Map by authors)



tions could give a reliable estimation of the presence of deer on the summer range, we also estimated the presence of deer in 1997 and 1998 during 24-hour periods, using the fecal pellet group counts method (Mayle and Staines 1998). The summer range was cleared of all fresh deer pellets in the morning (all deer left the area after this time), and 24 hours later, all fresh pellets were counted. This operation was repeated 10 times in different months in 1997 and 1998, on days with no rain and on which direct observations were also carried out. According to Mitchell and McCowan (1984), the ability to detect fecal deposits in short vegetation is around 100%. Vegetation height in our study area was always below 20 cm (Leggeri 1997); therefore, an accurate pellet count could be achieved.

Data analysis

For each observation session, a coefficient of spatial overlap (CSO) between deer and cattle was calculated as follows: CSO = number of GU used by both deer and cattle/the number of GU used by cattle. This coefficient is derived from a modification made by Bassano (1994) to the "coefficient of apparent affinity" used by Berducou and Bousses (1985).

For red deer, the time spent in the area used by cattle was also recorded, and data were used for the calculation of an index of presence (IP) of deer (calculated as the amount of time each deer spent on the summer range in each observation session divided by the duration of the observation session). This index was used to take into account not only the number of deer that used the cattle area but also the amount of time they spent in it. In some cases, IPs were calculated as cumulative values for different observation sessions (eg, IP in June, July, August, and September) by cumulating the time spent by deer in the summer range in all the sessions considered divided by the cumulative duration of these sessions.

CSO and IP were submitted to a nonparametric analysis of variance (Kruskal–Wallis test; Siegel and Castellan 1992) to detect differences due to the year (1996, 1997, or 1998), the month (June, July, August, or September), the time period (dawn or dusk), the presence of milking operations (yes or no), and the presence of cattle on the summer range (yes or no). Because CSO in the absence of cattle was always 0, the effect of the last factor could be considered only for IP. Standard error was used as a measure of dispersion of data.

The relation between the number of pellets and the IP obtained from direct observations on the day between cleaning and pellet count was investigated by calculation of Spearman correlation rank (Siegel and Castellan 1992).

Results

Presence of deer

The cumulative number of deer sightings during the 3 years was 485, most of which were recorded in June (57.1%) and July (26.4%), with only 14.2% and 2.3% recorded in August and September, respectively. A

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use

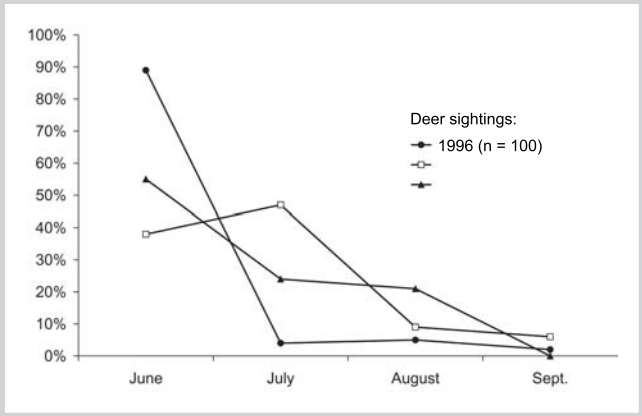


FIGURE 3 Percentage of deer observed each month in the 3 years of the study.

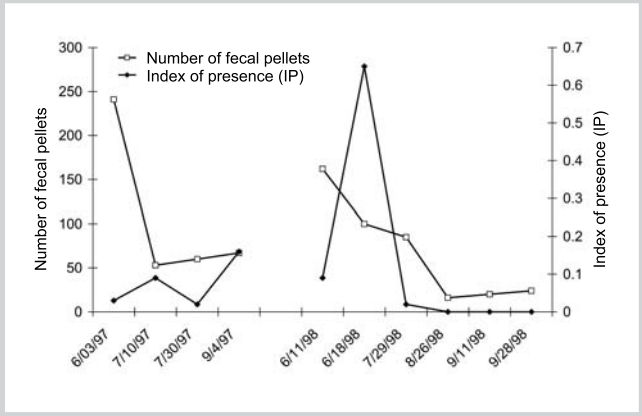


FIGURE 4 Relationship between the number of fecal pellets and the IP obtained from direct observations in the 24 hours between cleaning and pellet count.

decreasing trend in the number of deer sightings throughout the summer was clear during all the 3 observation years (Figure 3). For this reason, although June may not represent a typical summer situation, in this study it appeared to be the most appropriate month to be taken as an example of analysis of the utilization of the summer range by red deer in response to human activities and for comparing the space used by the 2 sexes in the study area. This is the reason why data collected in this month are shown in the following examples. The presence of hinds (48.2% of all sightings for adults, 12.6% for yearlings, and 10.5% for an unknown age class) was more frequent than that of stags (16.5% of all sightings for adults and 3.5% for yearlings); 8.7% of sightings were calves.

In the area used by cattle the IP did not differ between years, whereas a seasonal effect was observed, as shown by the statistical differences between months ($P < 0.001$). The IP was higher in June, and it decreased progressively to minimum values until the end of the grazing season (June, 0.44 ± 0.09; July, 0.21 ± 0.11; August, 0.10 ± 0.05; September, 0.02 ± 0.02).

This trend was consistent with the fecal pellet count, which correlated significantly with the IP calculated for the same days ($r = 0.67$, $P < 0.05$; Figure 4). Nevertheless, it should be noted that toward the end of the grazing season the fecal pellet count detected some deer presence even on days when no deer had been spotted during direct observations.

No differences in the IP were found as a function of the time period or the presence or absence of cattle on the summer range, although the IP was higher with cattle (IP = 0.24 ± 0.05) than without cattle (IP = 0.04 ± 0.01).

Milking operations significantly affected the IP, which was lower during milking (0.03 ± 0.02 during milking versus 0.35 ± 0.07 without milking; $P < 0.001$).

Space use by the 2 sexes

A clear preference for different areas was evident for hinds and stags. In general, hinds tended to use the northwestern and central parts of the study area, whereas stags were more often seen in the southeastern portion. Hinds with yearlings and calves could be frequently observed in the flatter area grazed by cattle, mainly represented by GU C2, C3, C4, and C5, often in close proximity to cows (sometimes within 3–4 m!), and also on the upper northwestern slopes (GU B1, B2, and C1), from where they approached the area used by cattle at the end of milking operations. Their presence was particularly concentrated in and around the milking area, which was usually in C3 or C4. They were occasionally observed also in D5, D6, and E6, when these areas were not being used by males.

Red deer stags could be frequently spotted in areas above 1600 m, such as the upper southeastern meadows (GU D4 and D5), areas not reachable by cattle, or on eastern and southeastern slopes (GU D6, D7, E3, E4, E6, and E7). The few red deer stags observed in female groups were subadult males. An example of sexual segregation, from June 1998, is given in Figure 5.

Space use by deer and cattle

Although cattle grazed throughout the day in a higher number of GU on the summer range, during the observation hours they used only 10 GU during the whole research period, and they were usually seen in or around the milking area. By contrast, deer extended over a wider area (21 GU) during the same hours of observation, which included steeper sites. Each species used the same areas throughout the 3 years.

Spatial overlap between deer and cattle was observed: during the whole observation period, 80% of the GU used by cattle was used also by deer.

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use

No significant differences in spatial overlap were found between years or between time periods, although significant variations were recorded between months (CSO: 25.00% ± 4.05 in June, 7.53% ± 2.89 in July, 5.47% ± 2.75 in August, 1.32% ± 1.32 in September; $P < 0.001$).

No spatial overlap was ever observed during milking operations, whereas during the milking hours, the average CSO was 18.06% ± 2.79 ($P < 0.001$). An example of spatial overlap depending on the presence or absence of milking operations is given by cumulative data relative to June 1996, reported in Figure 6.

Discussion

As observed in similar studies (Loft et al 1991, 1993), deer did not completely quit the area in response to the presence of cattle. Although some authors pointed out a reduction in the use by deer of habitats frequented by cattle (Loft et al 1991; Yeo et al 1993), this did not happen in our study. On the contrary, although this difference was not statistically significant, deer were seen more often on the summer range in the periods when cattle were present. This may be due to the good pasture quality in this area, which was probably improved by cattle grazing; this can help make pasture more palatable for deer (Wallace and Krausman 1987) by reducing the incidence of ligneous forage (Willms et al 1979) and supplying nutrients to the surrounding vegetation as a result of defecation and urination (Williams and Haynes 1995). Human intervention may also help to improve pasture quantity and quality for cattle grazing, simultaneously producing a general improvement of feeding resources for wild ungulates (Leslie et al 1996).

The area where milking took place was one of the most preferred by deer when humans were absent. This was probably due to the remains of supplementary feed, which was delivered to cattle during milking operations and which was very tempting to deer. The presence of high concentrations of cattle urine was also attractive, probably because of its salt concentration: in fact, deer were frequently observed licking the ground in this area. This behavior has been reported for other deer species, such as the reindeer, and is considered to have played a role in the domestication of this species (Zeuner 1963).

The greater presence of female deer on the summer range and the greater presence of males in the surrounding upper areas support the results of a previous study carried out in Val Fontana (Mattiello et al 1997a). The presence of hinds in lower areas and stags in upper areas may be explained by the different food requirements of the 2 sexes. Large-bodied animals, such as red deer stags, can better tolerate poor-quality foods found at higher altitudes (Demment and van Soest 1985). Furthermore, the attraction of high-quality pasture and

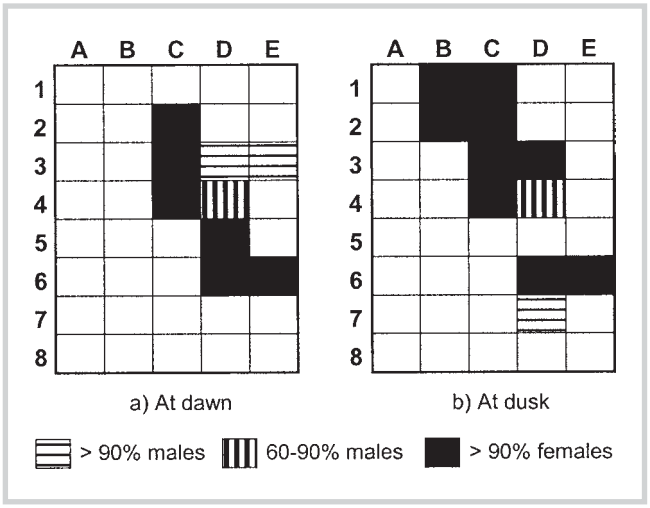


FIGURE 5 Space use by the 2 sexes in June 1998, at dawn and at dusk. No deer were observed in white grid units.

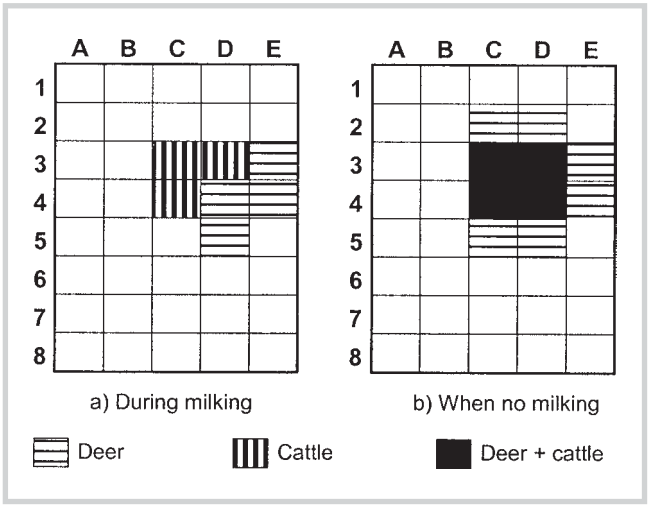


FIGURE 6 Spatial overlap between deer and cattle, with and without milking operations (cumulative data from morning observations in June 1996).

concentrated feed is probably stronger for females at this time of the year, when the energetic and high-protein demand for milk production is particularly high. In the Italian Alps the birth season is concentrated in May–June; therefore, the peak of lactation is right at the beginning of the grazing season. Among fallow deer, females were also observed more frequently in areas visited by tourists, probably searching for supplementary feed provided by these visitors (Mendolia et al 1990). In another red deer population on the Island of Rum, it was observed that lactating hinds often visited pastures with high levels of available protein but with short green feed. By contrast, stags stayed in areas with lower-quality vegetation but higher-standing crops to

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use

satisfy their greater energy requirements due to their greater body size (Clutton-Brock et al 1982). This observation was consistent with the data collected by Osborne (1980; reported by Clutton-Brock et al 1982), who observed that sheep grazing reduced the number of stags using pasture more than the number of hinds. Patches where cattle grazed before are probably selected by hinds because the remaining grasses develop compensatory growth, thus providing fresh and growing grasses with high protein content. This hypothesis seems to be confirmed by the results of a companion study carried out in the same summer range in Val Fontana, which showed that pasture samples from the areas subjected to higher grazing pressure by cattle were of better quality, especially in protein content, than samples from areas subjected to lower grazing pressure (Mattiello et al 2002). The need for high protein is possibly the reason why, in our study, hinds responded less than stags to dairy cattle husbandry, whereas in other studies female deer seemed to be more disturbed by human activities than males (Langbein and Putman 1992).

Although alpine pastures were found to be a suitable winter habitat for the red deer in the Austrian Alps (Schmidt 1993), the pasture under observation was very seldom used throughout the winter (Mattiello, personal communication), probably because of the abundant snow cover at this time of the year, which represents an important limiting factor for deer. The peak of deer presence in the alpine pasture under observation was recorded in June, and then a progressive reduction was observed until September, which presumably continued until winter. The decrease of deer was probably also related to the decrease in the CSO and may be explained by several factors. First of all, we should take into account the effect of cattle grazing on forage available on the summer range. Mattiello et al (2002) observed a significant reduction in pasture biomass in the study area as a direct response to cattle grazing and a temporal decrease of protein content accompanied by an increase of fiber content (neutral detergent fiber, acid detergent fiber, and lignin) throughout the summer. Quantitative and qualitative worsening of pasture might be one of the reasons that induced red deer to leave this area to find better feeding areas. According to Loft et al (1991), the presence of cattle, especially at high stocking densities, may result in significant habitat selection by deer, which might be induced to temporarily leave their traditional home ranges. Another reason for the reduction of the IP may be migration toward breeding areas, which takes place in early September.

A further motivation, in addition to the previous two, is probably connected to the hours during which observations were carried out. Because the days were longer in June and became progressively shorter until September, observations at dawn took place earlier in June (from 5 to 7 AM) and later in September (from 7 to 9 AM), whereas at dusk they took place later in June (from 7 to 9 PM) and earlier in September (from 5:30 to 7:30 PM), with intermediate situations in July and August. We can hypothesize that despite the changes in the duration of daylight, deer continued to move to and from the summer range at the same hours throughout the whole grazing period. Therefore, they might have been present on the summer range in September too, although they could not be seen in the dark. This hypothesis is supported by the presence of deer feces observed during fecal pellet counts even on days when no deer had been spotted by direct observations (eg, August and September 1998; Figure 4). The significant correlation found between IP and number of fecal pellets suggests that both methods are suitable for the estimation of deer presence. Although both methods revealed a decrease in the use of the summer range by red deer, direct observations probably underestimate the presence of deer in August and September, when the amount of daylight decreases. Therefore, the presence of fecal pellets in these months suggests that the presence of deer may be linked to activity patterns related to the milking time and the availability of supplementary feed. At the end of the grazing period, milking operations in the evening took place at twilight, after which it was too late for direct observations. In June and July, by contrast, most of the deer were seen in the evening, after the milking operations. Therefore, it is likely that in August and September deer arrived at the summer range when the observation session was already over. Analogously, deer moved away in the morning in response to the start of milking operations. Thus, they could be seen only when direct observations were made during earlier hours, that is, in June and July. From our results it appears that, independent of the photoperiod, deer can adapt to specific rhythms related to human activities, as confirmed in the literature reviewed by Putman (1988).

Methodological implications arise from comparison of the results obtained by direct observations with those of fecal pellet counts. Although a significant correlation between the 2 methods was found, researchers must take into account that direct observations can provide additional information about animal classes that would not be obtained by fecal pellet count. On the other hand, when deer presence needs to be evaluated during a 24-hour period, in the absence of night vision instruments, fecal pellet count can give a more reliable estimation. In our study, combining the 2 methods was very useful for obtaining more complete information.

Although the presence of cattle may not be a sufficient reason for deer to leave the summer range, the presence of milking operations in the field had a high

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use

impact on red deer in our study, and it induced a dramatic reduction in the presence of deer in the area, as shown by the significantly lower IP recorded and by the complete absence of spatial overlap during milking. Similar results were obtained in a preliminary study carried out in 1995 by Mattiello et al (1997c) in the same area. This suggests that human activities related to dairy cattle husbandry had a greater impact on deer than the presence of cattle. Nevertheless, although the number of deer was reduced on the summer range, deer did not quit this area. It is known that predictable disturbances produce less marked effects on wild ungulates than totally unpredictable events (Bullock et al 1993; Stephenson et al 1996; Bernatas et al 1998). This is probably the reason why deer did not react by fleeing over great distances and did not quit the study area in response to the presence of cattle, as happened with white-tailed deer in response to intensive ranching operations (Hood and Inglis 1974).

Conclusions

Although deer did not abandon the summer range when cattle were present, human activities related to dairy cattle husbandry (ie, milking) can induce them to leave this area or at least to reduce the time they spend on it, thus decreasing the use of areas with good pasture quality in a season when hinds require extra energy and protein for lactation. The Val Fontana is a particularly important area for red deer in the Central Italian Alps because it represented one of the main paths for the return of this species from the border with Switzerland at the beginning of the 20th century, after a long absence from this area (Redaelli and Nera 1985). Red deer is therefore an important species in Val Fontana, from where they spread to the adjacent alpine valleys. Many traditional activities are related to the presence of this ungulate species, such as hunting and the preparation of local recipes. At the same time, we should not neglect the importance of animal husbandry activities in mountain areas. In recent years, many of these areas have been progressively abandoned because of difficult living conditions and low yields from husbandry. The reduction of animal husbandry activities in hilly and mountainous areas contributes to an increase in the surface area of "marginal lands," with all the related problems of environmental degradation. In response to this phenomenon, the European Community is now encouraging and promoting extensive animal husbandry to preserve the land and produce healthy animal products while respecting animal welfare. In this regard, it seems important to encourage animal husbandry activities in mountain areas. At the same time, it is vital to consider the impact these activities may have on the environment as a whole, including wildlife, and try to minimize them in order to maintain local red deer populations in good condition. To this end, because deer appear to adapt to the rhythm of human activities, we suggest that cattle breeders try as much as possible (1) to maintain a regular time schedule for husbandry; (2) to limit the number of persons involved in such operations, possibly avoiding sudden and frequent changes of personnel; and (3) to minimize the noise produced by milking operations.

AUTHORS

Silvana Mattiello, Miro C. Crimella, and Corrado Carenzi
Faculty of Veterinary Medicine, Istituto di Zootecnica, Via Celoria 10, 20133 Milan, Italy.
silvana.mattiello@unimi.it (S.M.), miro.crimella@unimi.it (M.C.C.), and corrado.carenzi@unimi.it (C.C.)

Walter Redaelli
Hunting Management Committee, Via Colonnel Alessi 16, 23100 Sondrio, Italy.

ACKNOWLEDGMENTS

We are grateful to the village of Chiuro (Sondrio, Italy) for allowing the use of the hut from which the observations were carried out, and to the cattle owners for their valuable help during the observations. We also sincerely thank all the students at the University of Milan (Italy) and the Van Hall Instituut of Leeuwarden (Netherlands) who helped with the collection of field data. The Hunting Management Committee of Sondrio also made a significant contribution, and the help and advice of hunters were very useful throughout the study. We are grateful to Lillian Gorbea for correcting the English text. We also wish to thank the Sistema Informativo Territoriale–Divisione Generale Territorio e Urbanistica, Regione Lombardia, for providing the regional map that we used for data collection and for allowing its reproduction in this article. The research was partially funded by the Ministry of the University and Scientific and Technological Research (MURST 40%).

REFERENCES

Bassano B. 1994. *Competizione territoriale e trofica tra ungulati domestici e selvatici nel Parco Nazionale del Gran Paradiso* [PhD thesis]. Turin, Italy: Faculty of Veterinary Medicine, University of Turin.

Berducou C, Bousses P. 1985. Social grouping patterns of a dense population of chamois in the Western Pyrenees National Park, France. *In:* Lovari S, editor. *The Biology and Management of Mountain Ungulates.* London: Croom Helm, pp 167–175.

Bergami G. 1995. *Aspetti eco-etologici del cervo nobile (Cervus elaphus) in una valle alpina* [degree thesis]. Milan, Italy: Faculty of Veterinary Medicine, University of Milan.

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use

Bernatas S, Krausman PR, Peek JM, Mock P. 1998. Military overflight effects on free-roaming California bighorn sheep. *Gibier Faune Sauvage* 15:879–888.

Bullock DJ, Kerridge FJ, Hanlon A, Arnold RW. 1993. Short-term responses of deer to recreational disturbances in two deer parks. *Journal of Zoology* 230:327–332.

Clutton-Brock TH, Guinness FE, Albon SD. 1982. *Red Deer: Behaviour and Ecology of Two Sexes.* Chicago, IL: Edinburgh University Press.

Demment MW, van Soest PJ. 1985. A nutritional explanation for body size patterns of ruminant and non-ruminant herbivores. *American Naturalist* 125:641–672.

Hood RE, Inglis JM. 1974. Behavioral responses of white-tailed deer to intensive ranching operations. *Journal of Wildlife Management* 38:488–498.

Humphries RE, Smith RH, Sibly RM. 1989. Effects of human disturbance on the welfare of park fallow deer. *Deer* 7:458–463.

Kie JG, Evans CJ, Loft ER, Menke JW. 1991. Foraging behavior by mule deer: The influence of cattle grazing. *Journal of Wildlife Management* 55:665–674.

Langbein J, Putman RJ. 1992. Behavioural responses of park red and fallow deer to disturbance and effects on population performance. *Animal Welfare* 1:19–38.

Leggeri P. 1997. *Effetti del pascolamento bovino in un'area di monticazione della Val Fontana* [degree thesis]. Milan, Italy: Faculty of Veterinary Medicine, University of Milan.

Leslie DM Jr, Soper RB, Lochmiller RL, Engle DM. 1996. Habitat use by white-tailed deer on cross timbers rangeland following brush management. *Journal of Range Management* 49:401–406.

Loft ER, Kie JG, Menke JW. 1993. Grazing in the Sierra Nevada: Home range and space use patterns of mule deer as influenced by cattle. *California Fish and Game* 79:145–166.

Loft ER, Menke JW, Kie JG. 1991. Habitat shifts by mule deer: The influence of cattle grazing. *Journal of Wildlife Management* 55:16–26.

Mattiello S, Bergami G, Redaelli W, Verga M, Crimella MC. 1997a. Ecology and behaviour of red deer (*Cervus elaphus*) in an alpine valley. *Zeitschrift für Säugetierkunde (International Journal of Mammalian Biology)* 62(Suppl. II):129–133.

Mattiello S, Leggeri P, Pozzi A, Trabalza-Marinucci M, Fantuz F, Zanatta G, Redaelli W, Crimella M. 2002. Impatto del pascolamento bovino sulla vegetazione di un alpeggio frequentato da cervi. *In:* Enne G, Greppi GF, editors. *Zootecnia di Montagna Valorizzazione della Agricoltura Biologica e del Territorio.* Milan, Italy: MG Editori, pp 225–233.

Mattiello S, Perri M, Peracino V, Bassano B, Redaelli W. 1997b. *Dietary Overlap Between Red Deer and Cattle in the Italian Alps.* Abstracts of the XXIII Congress of the International Union of Game Biologists; Lyon, France. Paris, France: Office National de la Chasse, pp 136–137. [Available from Silvan Mattiello].

Mattiello S, Pozzi A, Leggeri P, Trabalza-Marinucci M, Redaelli W, Carenzi C. 1997c. Social and spatial interactions between red deer and cattle in the Italian Alps. *Zeitschrift für Säugetierkunde (International Journal of Mammalian Biology)* 62(Suppl. II):134–138.

Mayle BA, Staines BW. 1998. An overview of methods used for estimating the size of deer population in Great Britain. *In:* Goldspink CR, King S, Putman RJ, editors. *Population Ecology, Management and Welfare of Deer.* Manchester, UK: Manchester Metropolitan University and Universities Federation for Animal Welfare, pp 19–31.

Mendolia C, Magistrelli S, Mattiello S, Ferrante V, Olivieri O, Ferrari G. 1990. Behaviour of park fallow deer. *Publication of the Veterinary Deer Society* 4:43–55.

Mitchell B, McCowan D. 1984. The defecation frequencies of red deer in different habitats. *Annual Report of the Institute of Terrestrial Ecology* 1983:15–17.

Putman R. 1988. *The Natural History of Deer.* Worcester, UK: Billing and Sons.

Redaelli W, Nera G. 1985. La Valtellina e il cervo. Cenni storici. *Sondrio Caccia* 1:3–4.

Schmidt K. 1993. Winter ecology of nonmigratory Alpine red deer. *Oecologia* 95:226–233.

Siegel S, Castellan NJ Jr. 1992. *Statistica non parametrica*. 2nd ed. Milan, Italy: McGraw-Hill Libri Italia S.r.l.

Stephenson TR, Vaughan MR, Andersen DE. 1996. Mule deer movements in response to military activity in Southeast Colorado. *Journal of Wildlife Management* 60:777–787.

VerCauteren KC, Hygnstrom SE. 1998. Effects of agricultural activities and hunting on home ranges of female white-tailed deer. *Journal of Wildlife Management* 62:280–285.

Wallace MC, Krausman PR. 1987. Elk, mule deer, and cattle habitats in Central Arizona. *Journal of Range Management* 40:80–83.

Williams PH, Haynes RJ. 1995. Effect of sheep, deer and cattle dung on herbage production and soil nutrient content. *Grass and Forage Science* 50:263–271.

Willms W, McLean A, Tucker R, Ritcey R. 1979. Interactions between mule deer and cattle on big sagebrush range in British Columbia. *Journal of Range Management* 32:299–304.

Yeo JJ, Peek JM, Wittinger WT, Kvale CT. 1993. Influence of rest-rotation cattle grazing on mule deer and elk habitat use in east-central Idaho. *Journal of Range Management* 46:245–250.

Zeuner FE. 1963. *A History of Domesticated Animals.* London: Hutchinson.

Downloaded From: https://bioone.org/journals/Mountain-Research-and-Development on 20 Oct 2021
Terms of Use: https://bioone.org/terms-of-use