

EFFECTS OF INTERSPECIES INTERACTIONS: INCREASED HORMONAL STRESS
RESPONSE OF APENNINE CHAMOIS (*Rupicapra pyrenaica ornata*) INDUCED BY
LIVESTOCK AND RED DEER (*Cervus elaphus*)

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Interspecies interactions among ungulates may lead to competition because of an overlap of their habitat and food resources. Moreover interactions among potential competitors may cause a lower density or even the complete displacement of one competitor from its preferred habitats. This issue increases in case of overlap between wild and domestic ungulates: human presence related to livestock may indeed disturb and affect wildlife. Animals can face these adverse situations stimulating their endocrine system to produce glucocorticoids (stress responses). These hormones have an adaptive value and can provoke rapid physiological and behavioural adjustments that lead animals to react more efficiently to adverse circumstances. However, if stress persists may lead to a chronic stress state that can play a serious role in populations' decline. This concern has even major conservation importance when endangered species, such as Apennine chamois (*Rupicapra pyrenaica ornata*), are involved. Therefore, we used a non-invasive method to retrospectively evaluate the physiological stress response of Apennine chamois induced by the overlap between this species and red deer (*Cervus elaphus*) and livestock. In particular, we investigated (i) the effects of these interspecies interactions on chamois and (ii) if they could affect the health status of this endangered species.

Overall 318 chamois fresh faeces were sampled in three Italian National Parks: Abruzzo Lazio Molise (ALMNP), Majella (MNP) and Gran Sasso Monti della Laga (GSMLNP). In ALMNP and MNP three sampling macro-areas were identified (just chamois (C); overlap between chamois and red deer (CR); overlap between chamois and livestock, cattle and small ruminants (CL); in GSMLNP samples were gathered in areas C and CL. In the three parks sampling was conducted in September 2012 and July 2013; in ALMNP a further sampling was added in November 2012. Concentrations of faecal cortisol metabolites (FCM) were determined by an enzyme immunoassay (EIA) and data were analysed through Generalized Linear Models.

FCM concentrations of Apennine chamois were significantly influenced by the overlap between this species and livestock and red deer. FCM values registered in CL areas of ALMNP (both September 2012 and July 2013) and MNP (September 2012) were significantly higher than those recorded in C and CR areas. In MNP (July 2013), FCM concentrations of CR area were significantly higher than those of C and CL areas and FCM values of CL area were significantly higher than those of the C one. In GSMLNP (July 2013), FCM values registered in CL areas were significantly higher than those recorded in C area. Concerning the sampling months of ALMNP, in September and July FCM values of CL area were higher than those registered in November. In CR area FCM concentrations of July were higher than those of September and November. In both September and July, FCM values of CL area were higher than those of C and CR areas of the same sampling month.

Our results support that the overlap between Apennine chamois and both livestock and red deer may affect this endangered species. The higher FCM values of CL areas in ALMNP and MNP (September 2012) and in ALMNP and GSMLNP (July 2013) suggest a stressful condition of chamois induced by livestock. Moreover, human disturbance and the presence of shepherd dogs related to livestock grazing should be considered as further potential stressors for chamois. Conversely in MNP (July 2013), although FCM concentrations of CL area were higher than those of the C ones, the high FCM concentrations of CR area highlighted the negative effect of red deer on chamois. This fact could emerge in July since during summer red deer may extend its home range reaching chamois' habitat altitude. This finding could be supported by the increase of FCM of CR area in ALMNP during July 2013. Besides, these results are confirmed by FCM of ALMNP during November 2012: lower hormone concentrations were registered in these areas since during November livestock was not present and red deer lived at a lower altitude.

The presence of livestock and red deer appears to induce stress in Apennine chamois and these interspecies interactions could contribute to the populations' decline of this endangered species. However, the fact that the effect of red deer on chamois emerged only in July in MNP and, partly, in ALMNP leads to an in-depth analysis. Conversely the results highlighted in CL areas of the three parks should be considered in the management and regulation of livestock grazing and of the related anthropogenic factors within parks.