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Abstract. Habitat use by water buffaloes (*Bubalus bubalis*) in the wet grasslands around the Kerkini Lake was investigated during the wintering period 2014-2015. Three different grasslands were identified as available habitats for water buffaloes according to the dominant grass species (*Paspalum paspalodes*, *Cynodon dactylon* and *Poa trivialis*). The use of these grasslands by buffaloes, as well as of the riparian *Salix* forest, was evaluated using the dung – counting method. Grassland patches dominated by the species *Cynodon dactylon* and *Poa trivialis* were used more intensively by water buffaloes compared to the *Salix* forest ($P = 0.001$ and $P < 0.001$ respectively). On the contrary, grasslands dominated by the *Paspalum paspalodes* were used less significantly ($P < 0.001$) by these herbivores in relation to all the other available habitats. Feeding activities of water buffaloes are concentrated in *Cynodon dactylon* and *Poa trivialis* patches while *Paspalum paspalodes* patches are currently an underutilized natural resource.

Keywords. Dung counting method – Grassland –Herbivores – Wet meadows.

Utilisation de l'habitat par des buffles d'eau pâturant en liberté au lac Kerkini

Résumé. *L'utilisation de l'habitat par des buffles d'eau (*Bubalus bubalis*) dans les prairies humides autour du lac Kerkini a été investiguée durant la période d'hivernage 2014-2015. Trois prairies différentes ont été identifiées comme habitats disponibles pour les buffles d'eau selon l'espèce herbacée dominante (*Paspalum paspalodes*,* Cynodon dactylon *et* Poa trivialis*). L'utilisation par les buffles de ces prairies et de la forêt riveraine de Salix, a été évaluée en utilisant la méthode de comptage des excréments. Les zones de prairies dominées par l'espèce* Cynodon dactylon *et* Poa trivialis *étaient utilisées plus intensément par les buffles d'eau comparées à la forêt de* Salix *(P = 0,001 et P < 0,001 respectivement). Au contraire, les prairies dominées par* Paspalum paspalodes *étaient utilisées moins significativement (P < 0,001) par ces herbivores par rapport à tous les autres habitats disponibles. Les activités alimentaires des buffles d'eau se concentraient sur les zones à* Cynodon dactylon *et* Poa trivialis *tandis que les zones à* Paspalum paspalodes *étaient présentement une ressource naturelle sous-utilisée.*

Mots-clés. *Méthode de comptage des excréments – Prairies – Herbivores – Prairies humides.*

I – Introduction

Understanding the principles shaping spatial distribution patterns of herbivores is a prerequisite for the sustainable rangeland management. Abiotic (e.g. slope, distance to water, physical barriers etc.) and biotic (e.g. vegetation composition, productivity and quality of forage, etc.) components of habitats have been well documented as critical factors influencing the use of space by large-herbivores (Owen-Smith, 1988). In most cases however, the availability of forage resources plays crucial role as herbivores usually spend more time in areas where the resource levels are high (Senft *et al.*, 1987). Water buffaloes (*Bubalus bubalis*) may exert major influences on plant communities through their grazing activities, which however, under appropriate management scheme, may be beneficial to both the primary producers and the consumers (Kazoglou *et al.*, 2004; Wiegleb and Krawczynski, 2010).

The aim of this study was to investigate the use of available habitats for free grazing water buffaloes at Kerkini Lake, northern Greece. Investigating the use of habitats by buffaloes,

indubitably, will contribute to a more sustainable and profitable use of the grazing wet grasslands at Kerkini Lake.

II – Materials and methods

The study area is defined as the grassland at the northern and eastern parts of the Kerkini Lake. Kerkini Lake is a National Park included in the list of the wetlands of international importance for waterbirds (according to Ramsar convention) and is a Special Protection Area (SPA). Due to the lake's operation as an irrigation reservoir, its water level fluctuates by 5 m and its surface usually decreases from 75km^2 to 50km^2 yearly (higher levels in May – June and lowest in August - September). As a consequence, the study area is available for grazing for about 4-8 months per year, usually from August to December-January, but in dry years grazing period may be prolonged till February-March. This depends mainly on the amount of precipitation and its annual fluctuations.

Habitat use of water buffaloes was evaluated in the non-marshy grassland (i.e. about 400-450m away from the shoreline), approximately 900 ha, located at the northern (from Mandraki eastwards) and eastern parts of the Kerkini Lake. About half of this area is dominated mainly by the grass species *Paspalum paspalodes*. Within the study area, there are also scattered grassland patches in a mosaic pattern, dominated either by *Cynodon dactylon* or *Poa trivialis*. In addition, a remnant riparian *Salix* spp. forest covers about 20% of the study area with an understorey dominated mainly by *Paspalum paspalodes*. This forest is a suitable habitat for many bird species and supports the largest colony of cormorants (*Phalacrocorax* spp.). However, this forest is under risk mainly due to the lack of regeneration. The study area is the main feeding place of about 2,000 free grazing water buffaloes (unherded), a rising farming industry which is a very important economic activity both at the local and the national level (Cazacu *et al.*, 2014). The relative use of the three grassland patches dominated by different grass species, as well as of the riparian *Salix* forest, was evaluated using the dung – counting method (Litvaitis *et al.*, 1996), in 50 randomly selected plots (50 x 50 m) per habitat (i.e. 200 plots in total). The number of faeces deposited in these plots was recorded at late November 2014. During the study (wintering period 2014-2015), flooding was occurred from early December 2014 onwards, thus buffaloes' grazing period was about four months (August to November 2014). The use of available habitats was estimated by excluding disturbed and water-covered sites, dense *Rubus* spp. stands, roads, etc., which are not available for grazing by buffaloes. Marshy habitat near the shoreline (less than 400-450m away) was also excluded, as the use of this habitat by buffaloes was negligible (Manly *et al.* 2002; Markkola *et al.* 2003).

Dung-count data were subjected to one-way analysis of variance (ANOVA). The four available feeding habitats for buffaloes (three grasslands and the *Salix* forest) were treated as different levels of a fixed factor. Levene's test was performed prior the analysis in order to check the homogeneity of variances. Tukey's test was used to evaluate differences between the average number of buffaloes' dung per habitat. Differences were considered significant at $P \leq 0.05$ (Petrie and Watson, 1999).

III – Results and discussion

Patches dominated by the species *Cynodon dactylon* and *Poa trivialis* were used by water buffaloes significantly more ($P = 0.001$ and $P < 0.001$ respectively) than the remnant riparian *Salix* forest (Fig. 1), which however, was used significantly more than the grassland patches dominated by the species *Paspalum paspalodes* ($P < 0.001$). No significant differences were evaluated between the grassland patches dominated by the species *Cynodon dactylon* and *Poa trivialis* ($P = 0.413$).

Water buffaloes tend to concentrate their grazing efforts in the grassland sites dominated by the

grass species *Cynodon dactylon* and *Poa trivialis*. This behaviour of buffaloes is probably a consequence of their tendency to reduce the consumption of *Paspalum paspalodes* biomass, which is the most available food resource in the study area. However, in order to improve this valuable for domestic and avian herbivores grassland, distribution of buffaloes should be regulated in a more evenly way, using mild management practices to minimize possible adverse effects on bird populations. Under this aspect, management practices such as placement of salt and supplement and favouring preferred plant species could be implemented, in order to attract buffaloes to the patches dominated by *Paspalum paspalodes* and to lightening the use of the other two identified grassland habitats and of the *Salix* forest. Such practices have been implemented successfully to modify and control grazing distribution of large herbivores (Bailey *et al*., 1996).

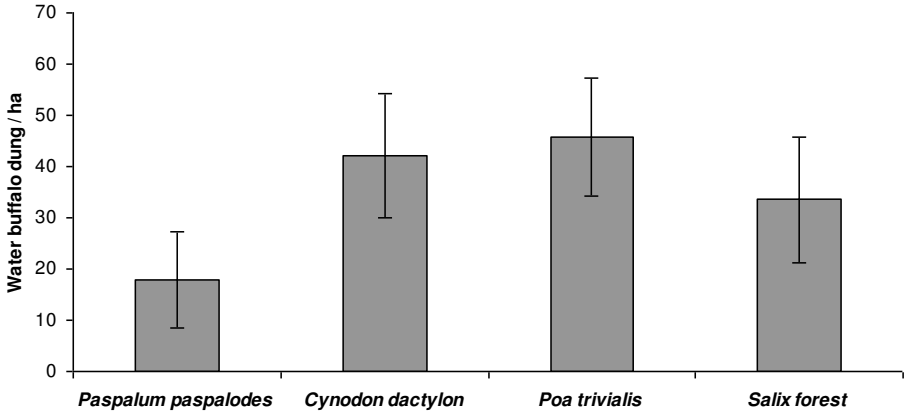

Fig. 1. Average number of water buffalo dung (± SD) deposited in the grassland sites dominated by the grass species *Paspalum paspalodes*, *Cynodon dactylon*, *Poa trivialis*, and in the riparian *Salix* forest in the non-marshy area at Kerkini Lake, during the four month grazing period (August to November) of 2014. Different letters between columns indicate significant differences (a = 0.05).

Grazing has direct and indirect impact on plants influencing their growth, survival and reproduction, therefore it is considered as a powerful tool influencing plant population dynamics as well as the abundance, spacing and the feeding strategies of wild herbivores (Holechek *et al*., 2004). It is well documented that the slow passage of food from the digestive system of buffaloes makes them capable to consume low quality forage, high in fiber (Laca *et al*., 1994; Perrin and Brereton-Stiles, 1999). Buffalo grazing may cause massive changes in vegetation composition and structure (Letts *et al*., 1979; Braithwaite *et al*., 1994; Skeat *et al*., 1996) and they tend to select high quality forage if this is available (Winnie *et al*., 2008). Future research should address the issue of possible effects of buffaloes on the plant and bird communities in the wet meadows and especially of the riparian *Salix* forest at Kerkini Lake. This forest supports the greatest colony of wintering cormorants in Greece, its ecological significance is high and is under threat from lack of regeneration, grazing pressure of buffaloes and other degrading influences (Kazantzidis and Naziridis, 1999). This knowledge is valuable in developing an appropriate grazing management scheme incorporating the needs both of free grazing buffaloes and bird fauna in the wet meadows at Kerkini Lake.

IV – Conclusions

Grassland patches dominated by the species *Cynodon dactylon* and *Poa trivialis* were used by water buffaloes significantly more than the riparian *Salix* forest, while those dominated by the

species *Paspalum paspalodes* were used less than any other available habitat. The implementation of mild management practices, e.g. placement of salt and supplement and favouring preferred plant species in the latter patches may attract buffaloes and is expected to improve their distribution throughout the study area. This approach is also expected to lower the grazing intensity of buffaloes in the riparian *Salix* forest.

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