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AVIAN DIVERSITY AND ABUNDANCE IN RELATION TO SEASON, LIVESTOCK PRESENCE AND VEGETATION COVER IN A MEDITERRANEAN COASTAL WETLAND

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Abstract.
Coastal wetlands are considered as systems of high avian diversity and are usually used for livestock production throughout the world. In this study, the diversity and seasonal abundance of avian species were monitored for two years on a monthly basis in a coastal grazing land in Evros Delta (Greece). The effects of cattle presence and different classes of vegetation cover on the species richness and the number of bird species respectively were also investigated. A total of 96 bird species belonging to 29 families were recorded. The most commonly encountered species was the Eurasian skylark Alauda arvensis. No significant effects were found among species richness and presence/absence of cattle, seasons or their interaction (p>0.05 in all cases). On the contrary, patches with vegetation cover 25.1 - 50.0% and 50.1 - 75.0% were used by more bird species in relation to patches covered by ≤25.0% or >75.0%. We concluded that the use of livestock grazing is a promising management tool to preserve the desired vegetation cover (25 – 75%).

Key words: encounter rates; line transects; distance sampling; livestock - bird interactions; grazing

Introduction

Coastal wetlands are considered as systems of great value and of high biodiversity, supporting a wide variety of residential and migratory bird species throughout the year. These systems provide a feeding/resting habitat for wildfowl, passerines, waders and other ground-nesting species (Milsom et al. 2000). Besides their importance for birds, they are usually used for livestock grazing throughout the world (Bakker et al. 1997). However, livestock grazing may affect directly (physical presence of livestock) and indirectly (grazing influences on vegetation) the use of the coastal grazing lands by birds and may have severe consequences on bird diversity (Drouilly et al. 2018). It is well documented that, apart from livestock presence, grazing has a direct and indirect impact on plants influencing their growth, survival and reproduction (McNaughton 1984) therefore, it is considered as a powerful tool influencing plant population dynamics, as well as plant community succession (van der Meijden et al. 1988; Davidson 1993). Since habitat characteristics and vegetation structure greatly influence many bird species, grazing may influence their population dynamics as well (Bos et al. 2005; Wang et al. 2013). As a consequence, livestock grazing can influence the abundance and distribution of bird populations (van der Graaf et al. 2002).

However, varying levels of grazing intensity can influence plant communities in different ways and their concomitant effects on avifauna are inconsistent and species specific (Vold et al. 2019). Farming abandonment or very light grazing intensities usually create habitats with high vegetation cover and favours species that prefer habitats of more advanced stages of succession (Suárez-Seoane et al. 2002; Sirami et al. 2008). Moderate grazing intensities are usually more beneficial than no grazing at all by creating habitats with higher heterogeneity that attract a higher number of bird species (Sliwinski & Koper 2015). On the other hand, overgrazed areas are usually used by a smaller number of bird species in relation to moderately or light grazed areas (Johnson et al. 2011; Ims & Henden 2012).

In this study, the effects of livestock presence (cattle) as well as the various levels of vegetation cover on the richness and the number of birds were investigated in a coastal grazing wetland, the Evros Delta (eastern Mediterranean, Greece). Evros Delta is among the largest deltaic ecosystems in Eastern Mediterranean, supporting a great variety of residential and migratory avian species (Goutner & Kazantzidis 1989; Goutner 1997).

The aim of this study is to determine: (i) the seasonal abundance of the avian community, (ii) the effects of cattle presence, seasons and their interaction on species richness, and (iii) the effects of various levels of vegetation categories on the number of bird species. We predicted that the physical presence of livestock should have minor effects on species richness. We also expected that sites with high or low vegetation cover, which are often the result of low or high livestock grazing intensities, will be used by a smaller number of bird species. The present study is among the few that attempt to record avian fauna in a coastal grazing land, to investigate its responses, i.e., to use specific sites in relation to livestock presence and relative vegetation cover and to provide management recommendations.

Study Area

Evros Delta is located in the northeastern part of Greece, at the border with Turkey (Fig. 1). It has an area of 9.500 ha and is among the most important wintering sites for waterfowl in Greece (Handrinos et al. 2015). It is one of the 12 National Parks of Greece and a Special Protection Area (SPA) and its significance for avifauna, has been acknowledged by Birdlife International, identifying the area as an Important Bird Area (Portolou et al. 2009).

Dimitriadis grassland (coordinates: 40° 47’ 19’’ N, 26° 02’ 00’’ E, approximately 300 ha) is the most important grazing area of the Evros Delta. This area is dominated mainly by two vegetation communities, halophytic and grass-forb communities, forming a temporal dynamic mosaic due to many involved factors, such as the non-uniform cattle grazing, the presence and the quality of the water, salinity of the soil, etc. Halophytic species, such as *Atriplex portulacoides*, *Salicornia* spp. and *Limonium bellidifolium*, are the dominant species in this landscape. Grass-forb communities (mainly *Puccinellia festuciformis*, *Poa* spp., *Plantago coronopus, Potentila argentea*) are the most valuable plants in the Evros Delta, as they are used more intensively by the major herbivore assemblages in this area and their main dietary items are the grasses (Karmiris et al. 2008, 2011). As a result of this non-uniform grazing pressure throughout the Dimitriadis grassland, a mosaic of patches with different levels of vegetation cover has been created, ranging from very low cover (less than 25%) to very high (more than 75%). The vegetation height ranges from 10 to 50 cm, which provides a suitable nesting site for several passerine and waterbird species. Dimitriadis grassland is the most important site for the wintering Greater white-fronted goose *Anser albifrons* Scopoli, 1769 in Greece*,* as thousands of them are recorded every year while many passerine, wader and raptor species use this grassland as well (Goutner & Kazantzidis 1989; Portolou et al. 2009; Mills 2011; Handrinos et al. 2015). Additionally, it is one of the two wintering sites for almost the entire fennoscandian Lesser white-fronted goose *Anser erythropus* Linnaeus,1758 population (the other one is Kerkini Lake, northern Greece). They spend at least 62.0 days a year in this habitat, usually from the end of December to early March (Vasiliadis et al. 2015), and as such, Dimitriadis grassland is of international importance and of great conservation concern.

Material and Methods

Bird counts

A systematic survey based on the line transect method (Bibby et al. 1998) was designed to estimate and monitor seasonal changes of the abundance of avian species .We randomly selected four points on the map, which were assigned to four line transects respectively. Transects were placed in order to include the various topographic and vegetative differentiations within the study area. Three transects of 900m and one of 560m spaced out to avoid double-counting of birds (minimum 400m perpendicular distance between them), comprised the set of line transects from which the main censuses were carried out (Fig. 1). Starting points were loaded to a GPS unit for easy following and were walked at approximately 2km/h speed (Bibby et al. 1992, Aynalem & Bekele 2008). Data collection was carried out from 7:00 to 10:30 am.

Censuses were repeated 10 times from April 2012 to March 2013 and 9 times from November 2013 to October 2014. Heavy rainfall and high wind speed resulted in the cancelation of August and November surveys of the first research period. At least two surveys were carried out each season, with an average time of 35.27 days between surveys. We practiced distance estimation with inanimate objects to gain experience at estimating distance by eye. We recorded cluster size and its perpendicular distance from the transect line according to the distance sampling method (Bibby et al. 1992). We employed six fixed-width belts (0-5m, 5-10m, 10-20m, 20-40m, 40-60m and 60-100m) on either side of the transects, to which birds were attributed. Each bird was attributed to the belt where it was first seen or flushed. Birds flying over these belts without landing were not recorded. The censuses were supplemented by seven direct counts from specific points of the embankment perimetric to the grassland, mainly for waterbirds that form big flocks. Direct counts were carried out during the period that the Lesser White-fronted Geese was present (December and January), as the risk of disturbance by the line transect survey was high. We used 10X42 binoculars, 25-60X70 spotting scope and a tally for both kinds of surveys. We categorized species in regards to their global conservation status and presence status according to the IUCN Red List of Threatened species (2021) and the Red Book of Threatened Animals of Greece (Legakis & Maragou 2009) respectively. We used Sorensen Similarity Index (Magurran 1988) to compare seasonal variation of bird diversity.

Encounter rates for all species recorded at the 19 transect counts are reported as the number of individuals per km. Encounter rates provide a relative measure of bird abundance and allow comparisons of abundance between species within a site and within species between sites (Bibby et al. 1998). Estimations of encounter rates refer to the period in which each species was present at Dimitriadis grassland, according to its presence status, i.e., resident, summer visitor, winter visitor, passing migrant. For this categorization we used the main presence status of species in Greece (Legakis & Maragou 2009). In cases when bird species' presence status could fit in more than one category, we selected the presence status that fitted more with our results. Encounter rates were not estimated for species that form big flocks (mainly Anseriformes species) as this method is not applicable in their case (Javed & Kaul 2003). We used encounter rate classes, to characterize relative abundance of recorded species (>40: abundant, 10.1-40: common, 2.1-10: frequent, 0.1-2: uncommon, <0.1: rare), as proposed by Aynalem & Bekele (2008). Monthly species richness was estimated by listing the recorded species in each month. Density and abundance of certain common and abundant species were estimated using 'Distance 6.0' (Buckland et al.1993). Various combinations of key functions (uniform, half normal, hazard rate and negative exponential) and series adjustments were examined during the exploratory phase of the analysis. The best Distance model was selected on the basis of the minimum value of Akaike's Information Criterion (Buckland et al. 1993, 2001) (Table 1).

Livestock and vegetation data

The presence or absence of livestock in the study area was also recorded in each survey. For the analysis, we considered that livestock was present only if the cattle herd was less than 150m away from the belt zones. A generalized linear mixed model (GLMM) was used with the species richness as the dependent variable. Cattle presence/absence (two levels), season (four levels) and the interaction between cattle presence and season were used as fixed categorical factors. Year was included in this model as a random factor. Because of the relative high variance of counts of the dependent variable, we assumed a negative binomial distribution and applied the log function.

Six patches (0.2 ha each) within the study area were selected and the vegetation cover was assessed (Cook & Stubbendieck 1986) on 15 plots (1.0 x 1.0 m) randomly dispersed in each patch. For this purpose a 1m^2 grid with 100 cells (i.e., 10-by-10 cm for each cell) was used to assess vegetation cover in these plots. Data were collected monthly from November 2013 to October 2014 and averages of vegetation cover proportions per patch and month were assigned to four different classes of vegetation cover (0-25%, 25.1-50%, 50.1-75% and 75.1-100%). A to-

Table 1: Selected models that best describe the relationship between detection probability and distance for the most abundant species of the Dimitriadis grassland (Evros Delta) during the period 2012-2013 and 2013-2014

Species	Year	Key Function	Series Adjustment	AIC
Eurasian skylark	2012-2013	Hazard rate	No adjustments	1703.36
	2013-2014	Hazard rate	Cosine	1310.21
Corn bunting	2012-2013	Half normal	Cosine	303.14
	2013-2014	Half normal	No adjustments	291.41
Yellow wagtail	2012-2013	Hazard rate	No adjustments	195.41
	2013-2014	Half normal	No adjustments	96.73

Figure 1: The study area: Line transects (yellow lines), area designation (red line) at Dimitriadis grassland, Evros Delta

tal of 72 values of vegetation cover (i.e. 6 patches x 12 months) were estimated per patch and per month. Due to the dynamic character of vegetation cover throughout the year 19, 24, 19 and 10 values (72 in total) were assigned to 0-25%, 25.1-50%, 50.1-75% and 75.1-100% classes respectively. In these patches, the number of bird species was recorded every month, at 5-minute-long point counts, along with vegetation cover assessment, when cattle were absent of the area or they were at least 200 m away from the patches.

A generalized linear model (GLM) was used to detect the influence of vegetation cover and season (fixed factors with 4 levels each) on the number of birds recorded (dependent variable). Dependent variable was normally distributed, hence we assumed a normal distribution and applied the identity function. A level of significance of 5% was used in all statistical tests using the 'IBM SPSS Statistics 20' software.

Results

A total of 96 bird species were recorded during the study period, belonging to 29 families. From those, 81 were recorded at the line transects while 15 were recorded exclusively by the direct count method (Appendix 1). Anatidae was the most abundant group, followed by Scolopacidae and Accipitridae (Fig. 2). Altogether, 24 were resident species, 21 summer visitors, 22 winter visitors while 29 were passage migrants (Appendix 1). Among the recorded species, five were categorized as Vulnerable, four as Near threatened and 87 as Least Concern at a global level according to the IUCN Red List of Threatened Species (2021).

The most common species was the Eurasian skylark *Alauda arvensis* Linnaeus, 1758 followed by the Starling *Sturnus vulgaris* Linnaeus, 1758 while the Sand martin *Riparia riparia* Linnaeus, 1758 was abundant only during the first year of the study. Most species were recorded during spring while the least species per month were recorded during winter. Monthly variation of species richness, shows that May was the month with the highest number of species (42), followed by January (41) while December had the lowest (20) (Fig. 3).

Some species were recorded exclusively in certain seasons while others were recorded all year

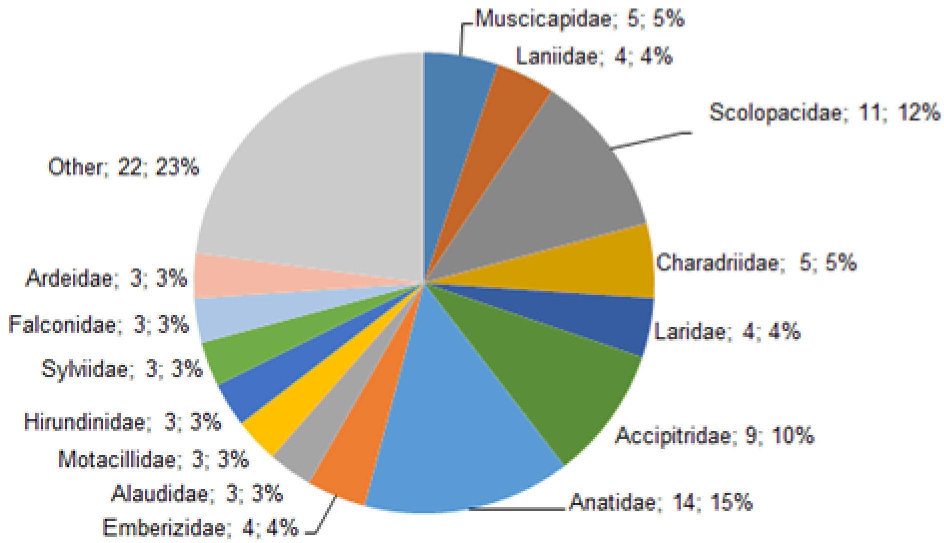

Figure 2: Family-level taxonomical classification of all recorded species in Dimitriadis grassland (Evros Delta) during 2012-2014. The number of species per family appears just after the family name and percentage refers to the number of species per family in relation to all recorded species

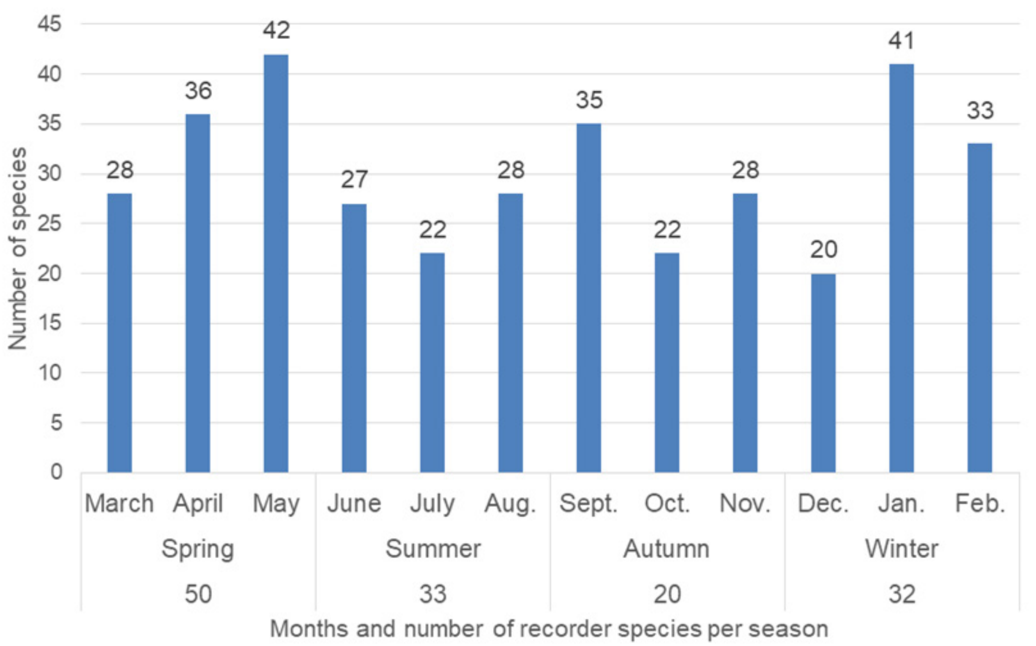

Figure 3: Monthly and seasonal variation of species richness at Dimitriadis grassland during 2012-2014

Table 2: Number of species recorded exclusively in one season

	All seasons	Winter	Spring	Summer	Autumn
Number of Species	15	13	18	6	4

round (Table 2). The rest of the species were recorded in two or three seasons. The high number of summer visitors results in high similarity between species composition of spring and summer. Twenty-four species were common in spring and summer resulting in the highest Sorensen Similarity Index of 0.72. Winter visitors which comprise mainly of Anatidae species, arrive at Dimitriadis grassland in December. Thus, only six species occurred both in winter and autumn resulting in the lowest Similarity index of 0.38 (Table 3).

Table 3: Sorensen similarity index for all seasons combinations

Seasons	Similarity index
Spring-Summer	0.72
Spring-Autumn	0.57
Spring-Winter	0.44
Summer-Autumn	0.61
Summer-Winter	0.45
Autumn-Winter	0.38

Eurasian skylark, Starling and Corn bunting *Emberiza calandra* Linnaeus, 1758 (the most common resident species) presented the highest monthly encounter rates ranging from 0.31 to 174.07 birds per km (Fig. 4). Mean encounter rates for all recorded species ranged from 0.05 to 48.30 birds per km (Appendix 1). Density (number of birds/km^2) and population size (mean number of birds/visit) of species with adequate recordings (n>60), i.e., Eurasian skylark, Corn bunting and Yellow wagtail *Motacilla flava* Linnaeus, 1758 is presented in Table 4.

The role of livestock

The grassland was grazed by 90-110 cattle from late February to middle July and late September to mid-December. Cattle were present in the study area in 52.6% of the surveys. No significant effects were found among species richness and presence/absence of cattle, seasons or their interaction (*P*>0.05 in all cases, Table 5). Akaike information criterion (corrected) was estimated at 151.728. Twenty one percent of the total number of recorded avian species were always observed when cattle were present in all surveys while another 46.9% of avian species were observed when cattle were present in more than 50% of the total surveys.

Significant effects of vegetation cover categories were revealed on the number of bird species (Table 6). Pairwise comparisons showed that the average number of species (n) was significantly higher in the 25.1-50% (n = 0.67) in relation both to 0-25% (n = 0.11) and to 75.1-100% (n = 0.10). The same trend was observed in the category of 50.1-75% (n = 0.89) vegetation cover in relation to 0-25% and to 75.1-100%. On the contrary, no significant differences were found in the number of bird species between the 0-25% and 75.1-100% categories of vegetation cover, as well as between the 25.1-50% and 50.1-75% categories of vegetation cover. Wald Chi-Square for overall results testing the effects of vegetation cover

Table 4: Density (bird/km2) and population size (mean number of bird/visit) of the most abundant species of the Dimitriadis grassland (Evros Delta) during the period 2012-2013 and 2013-2014

Species	Density (bird/km^2)		Population size (mean number of bird/visit)	
	2012-2013	2013-2014	2012-2013	2013-2014
Eurasian skylark	720.72	545.45	2025	1533
Corn bunting	44.75	166.5	126	467
Yellow wagtail	130.45	106.95	366	300

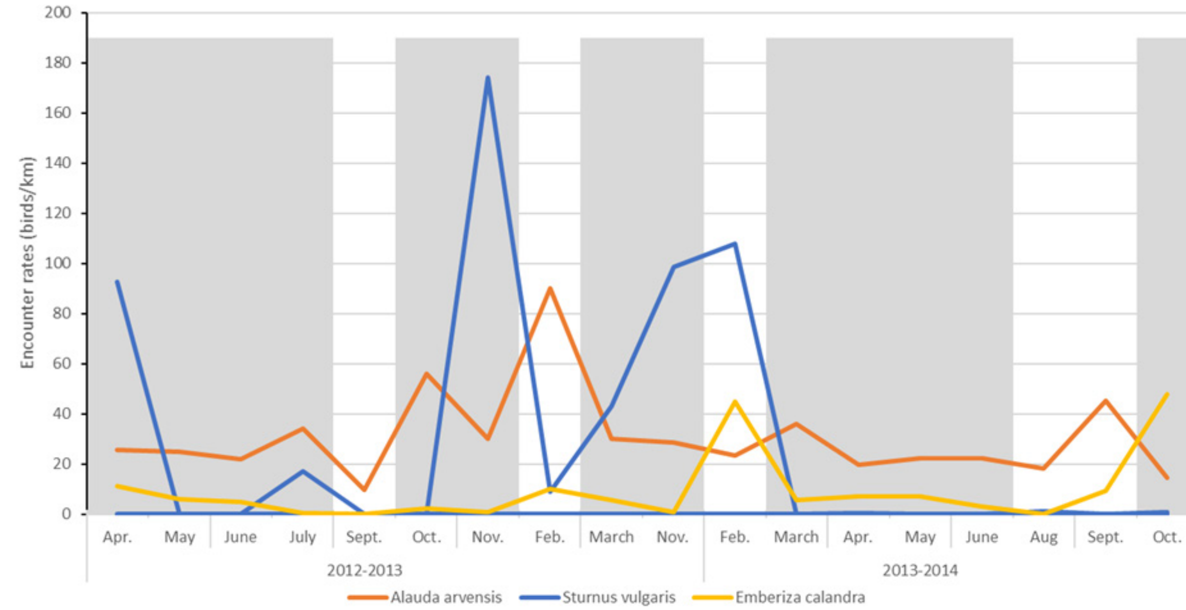

Figure 4: Monthly encounter rates for the most common resident species recorded at the line transects during 2012-2014. The shaded areas depict the months that cattle graze in the study area

Table 5: F tests, degrees of freedom and level of significance for the fixed effects (cattle presence / absence, season and their interaction) of Generalized Linear Mixed Model on the bird species richness recorded in transects during the years 2012-2014

Source	F	df	Sig.
Corrected model	2.062	7	0.059
Cattle presence / absence	0.217	1	0.543
Season	2.716	3	0.051
Cattle presence / absence *Season	1.854	3	0.146

Table 6: Pairwise comparisons (mean difference, SE, df, level of significance and 95% Wald confidence intervals) of the number of bird species between pairs of the four different vegetation cover classes

Pairwise Comparisons							
(I) Vegetation cover (%)	(J) Vegetation cover (%)	Mean Difference (I-J)	Std. Error	df	Sig.	95% Wald Confidence Interval for Difference	
						Lower	Upper
0-25	25.1-50	-1.83[a]	.567	1	0.001	-2.94	-0.72
	50.1-75	-2.59[a]	.564	1	0.000	-3.69	-1.48
	75.1-100	-0.35	.655	1	0.598	-1.63	0.94
25.1-50	0-25	1.83[a]	.567	1	0.001	0.72	2.94
	50.1-75	-0.75	.494	1	0.128	-1.72	0.22
	75.1-100	1.49[a]	.593	1	0.012	0.33	2.65
50.1-75	0-25	2.59[a]	.564	1	0.000	1.48	3.69
	25.1-50	0.75	.494	1	0.128	-0.22	1.72
	75.1-100	2.24[a]	.594	1	0.000	1.08	3.41
75.1-100	0-25	0.35	.655	1	0.598	-0.94	1.63
	25.1-50	-1.49[a]	.593	1	0.012	-2.65	-0.33
	50.1-75	-2.24[a]	.594	1	0.000	-3.41	-1.08

a. The mean difference is significant at the ,05 level.

was estimated at 27.830 (df: 3, $P < 0.001$). However, no significant effects were found for seasons as Wald Chi-Square for overall results testing the effects of season, was estimated at 3.773 (df: 3, $P = 0.292$).

Discussion

Evros Delta is the main wintering wetland for waterbirds in Greece and among the most important in the southeastern Mediterranean zone supporting high diversity and numbers of species (Handrinos et al. 2015). Heterogeneity of available habitats in the study area (Dimitriadis grassland) due to the livestock grazing as well as to the fluctuation of water levels and probably to other factors is justifying the presence of many waterbird species. Coastal areas such as river deltas, lagoons etc. usually support high levels of bird diversity in the Mediterranean zone, e.g., at Ebro Delta (Spain) where around 140 bird species in total were recorded during the years 2005-2015 (Belmar et al. 2019), as well as in the National Park of Axios - Loudias - Aliakmon Delta in northern Greece where 71 species were recorded from 2012 until 2017 (Soulopoulou et al. 2020).

Concerning the three most abundant species in this study, the Eurasian skylark's density was considerably high in relation to other areas of Europe where density was estimated with a similar method (territory mapping) (Bibby et al. 1992; Chamberlain et al. 1999; Browne et al. 2000; Toepfer & Stubbe 2001; Eraud & Boutin 2002; Henning et al. 2003; Donald 2004). As such it is of special importance, especially considering the fact that since 1980, Eurasian skylark populations have suffered a moderate decline (up to 50%) in Europe ((Keller et al. 2020; PECBMS database 2021), as well as in England since the mid-1970s (Browne et al. 2000). On the contrary, the Eurasian skylark's population size in Greece has increased by 96.5% between 1992 and 2014 (Vavylis et al. 2020).

The population size of Yellow wagtail in Europe, has declined by approximately 76% between 1980 and 2017 according to the PECBMS database (2021), and by 4% according to Keller et al. (2020). Declines in wet grasslands in Britain had been steeper than other breeding habitats (Wilson & Vickery 2005). In Greece, its population size has been increasing by an average of 8.3% per year from 1992 to 2014 (Vavylis et al. 2020). The Corn bunting has also suffered severe population declines and losses in distribution in Europe mostly due to various kinds of changes in agricultural practices (Keller et al. 2020). However, in southern and eastern Europe its population size is more or less stable (Taylor & O'Halloran 2002; Keller et al. 2020). In Greece the population trend is increasing by 6.1% per year between 2007-2016 (EKPAA 2018). In this context the Yellow wagtail's and the Corn bunting's densities at the Dimitriadis grassland are noteworthy.

Migrant species constituted 75% of total species, underlining the importance of the area for migratory species during spring and autumn. Additionally, the presence of many threatened wintering bird species (including Lesser white-fronted goose and Red-breasted goose *Branta ruficollis* Pallas, 1769) further indicates the importance of this habitat (Portolou et al. 2009; Handrinos et al. 2015). The high similarity among bird species between spring and summer found in this study (27 common species) indicates that these species probably used this area for nesting, as well. The fluctuation of monthly encounter rates of resident species between the two years of the study period can be explained by the changes of their abundance, as individuals or flocks of birds either arrive to this grassland from northern countries or even from nearby sites with higher altitude (Handrinos & Akriotis 1997). Differences in species density between years can be attributed to specific local conditions that can affect the number of birds that migrate towards this area.

Livestock impacts on wildlife can be direct, such as preventing the usage of shared limited resources (physical presence of livestock - interference competition), or indirect, e.g., through modifications they frequently cause in vegetation structure and the availability of resources (Milchunas et al. 1998; Schieltz & Rubenstein 2016). The absence of significant effects among species richness and presence/absence of cattle, seasons or their interaction in the present study indicates that the direct effects of the physical presence of cattle does not influence species richness. This finding indicates that most of the bird species have been familiar with the physical presence of cattle in the study area, hence any direct impacts, such as interference competition due to the physical presence of livestock, are probably insignificant, or totally absent.

Indirect effects of livestock of avian diversity are evident in this study, as it is expressed by the significant differences in the average number of bird species detected in the patches with different levels of vegetation cover. It is well documented that varying grazing can influence plant communities in different ways. On the one hand, no grazing at all or light grazing intensities usually promotes the accumulation of biomass, increases the vegetation cover and induces secondary succession (e.g., Rupprecht et al. 2015). On the other hand, heavy grazing intensities (overgrazing) and cattle trampling hinder plant succession, diminish stand density and create habitats with sparse vegetation (e.g., Paine et al. 1996). Under this aspect, intermediate grazing intensity is usually more preferable than the previous two options, and this is confirmed in the present study. However, the presence of a mosaic of habitats within a range of vegetation cover from very low to very high can be considered as a keystone structure for avian diversity. This is in accordance with the habitat-heterogeneity hypothesis proposed by MacArthur and MacArthur (1961), i.e., animal species diversity is driven by habitat heterogeneity (e.g., Wiens & Rotenberry 1981; Thiollay 1990; Poulsen 2002; Tews et al. 2004).

Management implications - Future research

Conservation management of a site involves knowing which bird species are present and when (Hirons et. al. 1995). Habitat heterogeneity is a common phenomenon in grazed lands and has been attributed in many cases to the activities of herbivores (grazing, trampling, deposition of urine and faeces) (e.g. Lutge et al. 1998; Morris et al. 1999; McIvor et al. 2005), as well as to the fact that free grazing herbivores usually select their food in a non-random way and concentrate their grazing efforts in preferred patches (Wallis DeVries et al. 1999). These heterogeneous grazing patterns promotes the formation of patches with different vegetation characteristics (Bakker et al. 2003; Marion et al. 2010), as it is observed in our study area (Platis et al. 2013). Given to the absence of negative interactions to species richness by the physical presence of cattle revealed in this study, the current grazing regime (free-grazing of about 100 cattle for 7-7.5 months in a yearly basis) should be maintained as it contributes to the creation of favourable habitats for a relatively high variety of species. Both the abandonment of traditional livestock grazing and the implementation of heavy grazing intensity (beyond carrying capacity of the study area) have been criticized for negative impacts on bird's richness (Ogada et al. 2008; Lengyel et al. 2016; Smith et al. 2020), and are expected to reduce significantly the biodiversity level in the study area.

Future research should focus on the impact of other indirect effects of livestock grazing on avian diversity, such as the effects on the formation of heterogeneous patches and the response of avian species, on the soil disturbance due to cattle trampling and dunging, on the nesting success of ground-nesting birds, as well as on the food availability to birds including invertebrate fauna both for insectivorous bird species and for chick rearing.

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Supplementary Material

Appendix 1: Mean encounter rates (bird/km) ±standard error of the mean for the most frequent species (encounter rate>1) recorded at the Dimitriadis grassland (Evros Delta) during transect counts (2012-2013 and 2013-2014) and cattle presence expressed as the percentage of the surveys that cattle were present for the 81 species recorded at the line transects during the study period. R: Resident, WV: Winter visitor, SV: Summer visitor nesting at the Dimitriadis grassland or the neighboring area, PM: Passage migrant. Encounter rate classification: (A): Abundant, (F): Frequent, (C): Common, (U): Uncommon, (R): Rare. *Fifteen more species were recorded by the direct count method. These were: *Cygnus olor*, *Anser albifrons*, *Anser erythropus* (VU), *Anser anser*, *Branta ruficollis (VU), Tadorna tadorna, Anas platyrhynchos, Anas acuta, Anas crecca, Mareca penelope, Mareca strepera, Spatula querquedula, Spatula clypeata, Phoenicopterus roseus* and *Falco subbuteo.* In parenthesis at the species column the conservation status is stated. VU stands for Vulnerable and NT for Near Threatened. All other 87 species are of Least Concern.

Species	Presence status	Mean encounter rate (bird/km) 2012-2013	Mean encounter rate (bird/km) 2013-2014	Number of surveys recorded	Cattle presence (% of surveys recorded)
Dunlin *Calidris alpina*	PM	3.70 (April) (F)	3.22±1.88 (October & November) (F)	6	100.00
Glossy ibis *Plegadis falcinellus*	PM	5.93 (May) (F)	0.46±0.13 (April & May) (U)	3	100.00
Marsh sandpiper *Tringa stagnatilis*	PM	0.74 (April) (U)	2.45 (April) (F)	2	100.00
Lesser grey shrike *Lanius minor*	PM	0.74 (May) (U)	2.15 (May) (F)	2	100.00
Common nightingale *Luscinia megarhynchos*	PM	0.37 (April) (U)	0.31 (May) (U)	2	100.00
Spanish sparrow *Passer hispaniolensis*	SV	0.00	1.35±0.83 (U)	2	100.00
Eurasian sparrowhawk *Accipiter nisus*	WV	0.00	0.10±0.10 (U)	1	100.00
Robin *Erithacus rubecula*	WV	0.00	0.20±0.20 (U)	1	100.00
White stork *Ciconia ciconia*	SV	2.76±2.76 (F)	0.00	1	100.00
Spur-winged lapwing *Vanellus spinosus* (NT)	SV	0.09±0.09 (R)	0.00	1	100.00
Black-headed bunting *Emberiza melanocephala*	SV	0.00	0.61±0.61 (U)	1	100.00
Garganey *Spatula querquedula*	PM	2.40 (May) (F)	0.00	1	100.00
Eurasian reed-warbler *Acrocephalus scirpaceus*	PM	0.37 (April) (U)	0.00	1	100.00

Short-eared owl *Asio flammeus*	PM	0.37 (April) (U)	0.00	1	100.00
Woodchat shrike *Lanius senator*	PM	0.74 (May) (U)	0.00	1	100.00
Masked shrike *Lanius nubicus*	PM	0.31 (May) (F)	0.00	1	100.00
Little stint *Calidris minuta*	PM	0.00	3,37 (May)	1	100.00
Black-billed magpie *Pica pica*	R	0.36±0.15 (U)	0.17±0.11 (U)	8	75.00
Ruff *Calidris pugnax*	PM	3.49±2.15 (April & May) (F)	8.12±5.89 (October & November) (F)	4	75.00
Great white egret *Ardea alba*	PM	0.74±0.00 (April & May)	0.38±0.23 (April & May) (U)	4	75.00
Black-winged stilt *Himantopus himantopus*	SV	2.57±1.85 (F)	0.12±0.27 (U)	7	71.43
Calandra lark *Melanocorypha calandra*	SV	8.61±3.08 (F)	4.75±1.36 (F)	15	66.67
Northern lapwing *Vanellus vanellus*	R	0.63±0.24 (U)	0.34±0.25 (U)	6	66.67
European bee-eater *Merops apiaster*	SV	2.52±1.50 (F)	0.67±0.76 (U)	6	66.67
Little egret *Egretta garzetta*	PM	0.45±0.24 (May, June & September) (U)	4,09 ±1.42 (May, June & September)(F)	6	66.67
Crested lark *Galerida cristata*	R	0.11±0.08 (U)	0.03±0.04 (R)	3	66.67
Common tern *Sterna hirundo*	SV	1.41±0.51 (U)	0.00	3	66.67
Wood sandpiper *Tringa glareola*	PM	18.52 (April) (C)	9.04±2.38 (March & April) (F)	3	66.67
Common greenshank *Tringa nebularia*	PM	4.07 (April) (F)	0.46±0.13 (April & August) (U)	3	66.67
Eurasian hoopoe *Upupa epops*	PM	0.29±0.16 (May & March) (U)	0.31 (May) (U)	3	66.67
Corn bunting *Emberiza calandra*	R	4.71±1.21 (F)	14.01±11.93 (C)	16	62.50
Common buzzard *Buteo buteo*	R	0.66±0.43 (U)	0.33±0.22 (U)	10	60.00

Grey heron *Ardea cinerea*	PM	1.72±0.75 (May & June) (U)	0.92±0.61 (May & June) (U)	10	60.00
House sparrow *Passer domesticus*	R	0.80±0.74 (U)	1.23±2.27 (U)	5	60.00
Eurasian oystercatcher *Haematopus ostralegus* (NT)	R	0.00	0.34±0.11 (U)	5	60.00
Carrion crow *Corvus cornix*	R	0.55±0.19 (U)	0.44±0.11 (U)	14	57.14
Sand martin *Riparia riparia*	SV	48.30±15.35 (A)	6.81±3.12 (F)	7	57.14
Red-backed shrike *Lanius collurio*	SV	0.75±0.38 (U)	0.80±0.44 (U)	7	57.14
Tawny pipit *Anthus campestris*	SV	0.49±0.14 (U)	0.55±0.18 (U)	7	57.14
Eurasian skylark *Alauda arvensis*	R	35.82±7.23 (C)	25.59±3.22(C)	18	55.56
Starling *Sturnus vulgaris*	R	37.30±18.2 (C)	23.24±15.16 (C)	18	55.56
Western marsh-harrier *Circus aeruginosus*	R	0.71±0.23 (U)	1.23±2.13 (U)	9	55.56
Eurasian curlew *Numenius arquata* (NT)	WV	7.24±3.49 (F)	2.04±1.08 (U)	11	54.55
Yellow wagtail *Motacilla flava*	SV	11.06±3.59(C)	5.32±1.82 (F)	14	50.00
Little grebe *Tachybaptus ruficollis*	R	1.78±1.78 (U)	0.68±0.73 (U)	8	50.00
Northern harrier *Circus cyaneus*	WV	0.15±0.09 (U)	0.61±0.18 (U)	6	50.00
Common snipe *Gallinago gallinago*	WV	1.02±0.35 (U)	0.61±0.35 (U)	4	50.00
Common kestrel *Falco tinnunculus*	R	0.14±0.11 (U)	0.14±0.06 (U)	4	50.00
Whinchat *Saxicola rubetra*	PM	1.44±0.70 (May & September) (U)	0.92±0.61 (May & June) (U)	4	50.00
Black-headed gull *Larus ridibundus*	R	0.00	0.61±0.41 (U)	2	50.00
Cirl bunting *Emberiza cirlus*	R	0.00	0.03±0.03 (R)	2	50.00

Ruddy shelduck *Tadorna ferruginea*	SV	1.20±0.80 (U)	0.00	2	50.00
Black stork *Ciconia nigra*	SV	0.05±0.05 (R)	0.12±0.12 (U)	2	50.00
Eurasian spoonbill *Platalea leucorodia*	PM	0.61 (September) (U)	2.76 (June) (F)	2	50.00
Spotted redshank *Tringa erythropus*	PM	0.00	0.61 (August, October)	2	50.00
Peregrine falcon *Falco peregrinus*	R	0.15±0.11 (U)	0.03±0.03 (R)	3	33.33
Yellow-legged gull *Larus michahellis*	R	0.00	0.41±0.30 (U)	3	33.33
Red-rumped swallow *Hirundo daurica*	SV	0.62±0.2 (U)	0.00	3	33.33
Northern wheatear *Oenanthe oenanthe*	PM	3.74 (September) (F)	0.46±0.13 (April & August) (U)	3	33.33
Green sandpiper *Tringa ochropus*	PM	0.61 (July)	0.00	3	33.33
Barn swallow *Hirundo rustica*	SV	1.60±1.24 (U)	0.18±0.25 (U)	7	28.57
Greater spotted eagle *Clanga clanga* (VU)	WV	1.23±1.06 (U)	0.23±0.29 (U)	4	25.00
White-tailed eagle *Haliaeetus albicilla*	R	0.67±0.67 (U)	0.56±0.04 (U)	3	0.00
Reed bunting *Emberiza schoeniclus*	WV	2.22±1.28 (F)	0.41±0.71 (U)	3	0.00
Pygmy cormorant *Microcarbo pygmaeus*	WV	3.33±3.33 (F)	0.10±0.10 (U)	2	0.00
Spotted flycatcher *Muscicapa striata*	PM	0.00	0.31(August, September)	2	0.00
Common redshank *Tringa totanus*	PM	0.00	3,22 (March, August)	2	0.00
Common ringed plover *Charadrius hiaticula*	PM	0.00	0.61±0.00 (August, September)	2	0.00
Golden eagle *Aquila chrysaetos*	R	0.11±0.11 (U)	0.00	1	0.00
Eastern imperial eagle *Aquila heliaca* (VU)	R	0.11±0.11 (U)	0.00	1	0.00

Little bustard *Tetrax tetrax* (NT)	WV	3.10±3.09 (F)	0.00	1	0.00
Water pipit *Anthus spinoletta*	WV	2.22±2.22 (F)	0.00	1	0.00
Black-necked grebe *Podiceps nigricollis*	WV	0.00	0.2 (U)	1	0.00
Eurasian blackcap *Sylvia atricapilla*	WV	0.00	0.08±0.08 (R)	1	0.00
Mediterranean gull *Larus melanocephalus*	SV	0.69±0.8 (U)	0.00	1	0.00
Eurasian nightjar *Caprimulgus europaeus*	SV	0.31 (U)	0.00	1	0.00
European turtle-dove *Streptopelia turtur* (VU)	SV	0.06±0.07 (R)	0.00	1	0.00
Little ringed plover *Charadrius dubius*	SV	0.05±0.05 (R)	0.00	1	0.00
Montagu's harrier *Circus pygargus*	PM	0.31 (September) (U)	0.00	1	0.00
Grey plover *Pluvialis squatarola*	PM	0.00	0.31 (August) (U)	1	0.00
Willow warbler *Phylloscopus trochilus*	PM	0.00	0.31 (September)	1	0.00