A STATISTICAL APPROACH ON SEASONAL POPULATION CHANGES AND HABITAT PREFERENCES ON COASTAL AND WATERFOWL SPECIES AROUND EKŞISU REEDS (ERZINCAN-TURKEY): USING NEGATIVE BINOMIAL REGRESSION

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Abstract. The present study was performed in order to analyze the population density of 55 coastal and waterfowl species belonging to 15 families in Ekşisu Reeds using negative binominal regression models according to their habitat preferences. For this study, *Anas crecca* was chosen as a reference species. Population changes of 55 different species were interpreted in relation to it. Accordingly, increases by 4.48 fold (p<0.001) in *Anas platyrhynchos* population, 3.45 fold (p<0.001) in *Fulica atra* population, 2.45 fold (p<0.05) in *Larus armenicus* population (p<0.05), and 1.77 fold (p<0.05) in *Tadorna ferruginea* population were noted. In addition, the population of 19 species decreased. Of the seasons, autumn was taken as a reference, thus a 1.50 fold-increase (p<0.01) was recorded in the winter season. Changes in other seasons were not statistically significant. When the reed habitat was taken as reference, it was determined that there was a 1.33 times increase (p<0.05) in the water surface habitat and 36% decrease in agricultural areas (p<0.05). Meadows and marshland habitats were not found statistically significant.
Keywords: *bird population, count data, habitat, negative binominal regression, overdispersion*

Introduction

Wetlands comprise aquatic and terrestrial areas (Keddy, 2010), exhibiting the high levels of biodiversity and biological efficiency of the ecosystems (Whittaker and Likens, 1973; Gibbs, 1993; Cassado and Montes, 1995; Sala et al., 2000; Butchart et al., 2010; Barnosky et al., 2011). Water, soil and wildlife, which are wetland components, have contributed to human society as a source of livelihood (Millennium Ecosystem Assessment, 2005; Clarkson et al., 2013). However, factors such as excessive population growth, industrialization, urbanization and unconscious agriculture negatively affected wetlands (Kiziroğlu, 2001). Due to its geographical location, Turkey possesses a favorable position for wetlands, offering habitats for many species (Kiziroğlu, 2009; Keddy, 2010). Bird species in particular are known as bio indicators of wetlands and globally endangered bird species are dependent on them (Green, 2014). Population densities and distribution of these species are determined by vegetation, which is directly related to the main sources of life (Waterhouse et al., 2002). Thus, habitats associated with vegetation ideal for these are in a constant change, as a result of many natural and anthropogenic causes. Especially, it is well-known that seasonal changes of temperature and precipitation are effective directly or indirectly on the

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habitats of birds, resulting in changes regarding distribution and population of bird species (Newton, 2008; Mengesha and Bekele, 2008). In that context, many studies have been carried out on the association of habitat preferences of coastal and waterfowl species with population sizes and distributions (Muriuki et al., 1997; Clark and Shutler, 1999; Webb, 2010; Gomes et al., 2017; Azizoğlu et al., 2019). The different processes occurring in the breeding and wintering areas of birds determine the habitats, distributions and effects on population dynamics of birds. Estimating the density of species throughout their distribution is a valuable tool for biodiversity and ecological studies (Gaston and Rodrigues, 2003). Distribution of birds depending on population densities is determined by various counting techniques. Associating ecological census data such as individual number, population density with habitat types is very important in terms of bird distribution and habitat preferences (Bibby et al., 2000; Pearce and Ferrier, 2001; Kaminski et al., 2006; O'Hara and Kotze, 2010; Erdinç et al., 2017; Azizoğlu and Adizel, 2017).

Counting is the most common method used to classify bird populations (Bibby et al., 2000). A substantial assumption is needed to use unadjusted point counts to assess populations of coastal and waterfowl species. The variations in the numbers (e.g. between seasons or types of habitat) represent a variation in the actual bird population being sampled (Farnsworth et al., 2005). The correlation between these censuses and the population size (Okosodo et al., 2016; Durmuş et al., 2018) and distribution (Joseph et al., 2009; Çelik and Durmuş, 2020) of the species with their habitats is usually done by nonlinear statistical calculations (White and Bennetts, 1996; Yeşilova et al., 2016). One approach for overcoming the effect of over-dispersion is negative binomial regression (Agresti, 1997; Hilbe, 2007; Yeşilova et al., 2010). In several study, in the identification of species richness and intensities of bird population a negative binomial regression model has been used (White and Bennetts, 1996; Rékási et al., 1997; Frost et al., 1999; Small et al., 2003; O'Hara, 2005; Durmuş et al., 2018; Çelik and Durmuş, 2020). Data from this study were fitted with negative binomial regression.

It is known that the population densities of bird species are largely influenced by spatial ground (McCain, 2009). Site-based conservation is considered important in combating global biodiversity loss (Joppa et al., 2008; Nagendra, 2008).

Wetland identification and protection activities in the western part of Turkey are more common than the eastern regions. For this reason, the information on wetlands in eastern Anatolia very limited. Ekşisu reed is an important area with different habitats preferred by birds in the east. Therefore, the high concentration of environmental pressures on the Ekşisu reeds and habitat losses in the area, determination of seasonal population changes and habitat preferences of Ekşisu reed as a research subject has a particular importance.

To develop a sustainable conservation strategy for birds and habitats, it is important to define bird habitats and estimate how birds are distributed and how they use them. Compared to biodiversity studies, habitat uses and seasonal distribution of birds are little known. For this reason, seasonal distributions of bird species living in the Ekşisu reed and area uses were investigated.

Materials and Methods

The study area, Ekşisu reed (37 S 553321, 4397154 UTM) is located in province of Erzincan in the Eastern Anatolia Region of Turkey (*Fig. 1*). Ekşisu reed constitutes one

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of the most important wetlands of Turkey is supplied with hot and cold water springs. It is an important wetland with its healing waters, floating islands and surrounding historical settlements (Sunkar and Taşkıran, 2011).

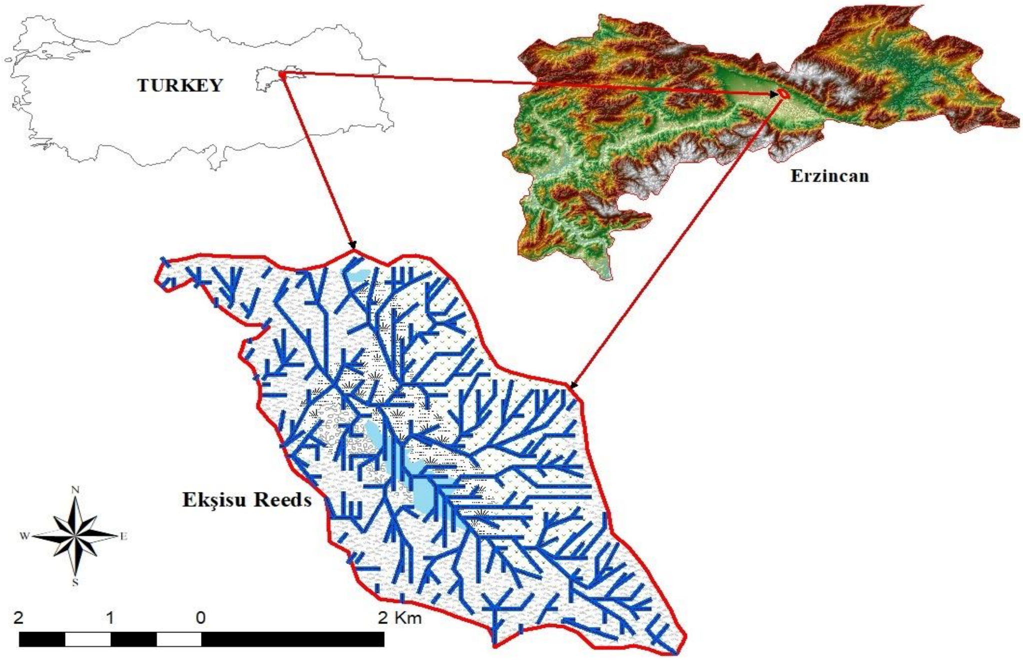

Figure 1. *Ekşisu Reeds Location Map*

For this study, the coastal and waterfowl species that use the borders of Ekşisu Reeds were investigated. In the study, this species in the area, population sizes, arrival / departure times from/to the area, seasonal distributions and statues were determined.

A monitoring methodology has been established to determine habitat preferences, population densities, ecological and biological status of these species. A 35-day field study was conducted between 2016 and 2018 for the identified species (*Table 1*). In order to determine the population densities and habitat use conditions and distribution of the determined species, observations were performed at least 15-day periods. During the migration and reproduction periods, these observations were intensified, usually starting with the sunrise, when individuals were active, and continued until sunset.

Table 1. *Observation work schedule for coastal and waterfowl species*

Seasons	Spring	Summer	Autumn	Winter	Total
Number of Days	10	9	7	7	35

Species data

The coordinates of the Ekşisu reeds and the track record were taken by GPS, and the boundary of the area, the boundaries of the habitat and the observation points were determined. The GPS records of the research area were transferred to the Geographic Information Systems (GIS) based digital environment. After determining the limits, each layer was converted to 0.25 km² square format using ArcMap 10.2 program. At

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least 3 coordinates were taken in each frame and the species distributions were recorded according to the determined coordinates.

The borders transferred to the digital environment were then placed on the Corine 2012 habitat boundaries from the Esri online system using the Arcmap 10.2 program. Subsequently, five habitat types such as reed area, marshland, meadow area, water surface, and agricultural land were determined and assessed for the area they cover (*Table 2*, *Fig. 2*).

Table 2. *Area covered by habitat types (ha)*

Habitat	Swamp area	Meadows area	Agricultural land	Water surface	Reeds area	**Total**
Area (ha**)**	119	215	405	28	27	**794**

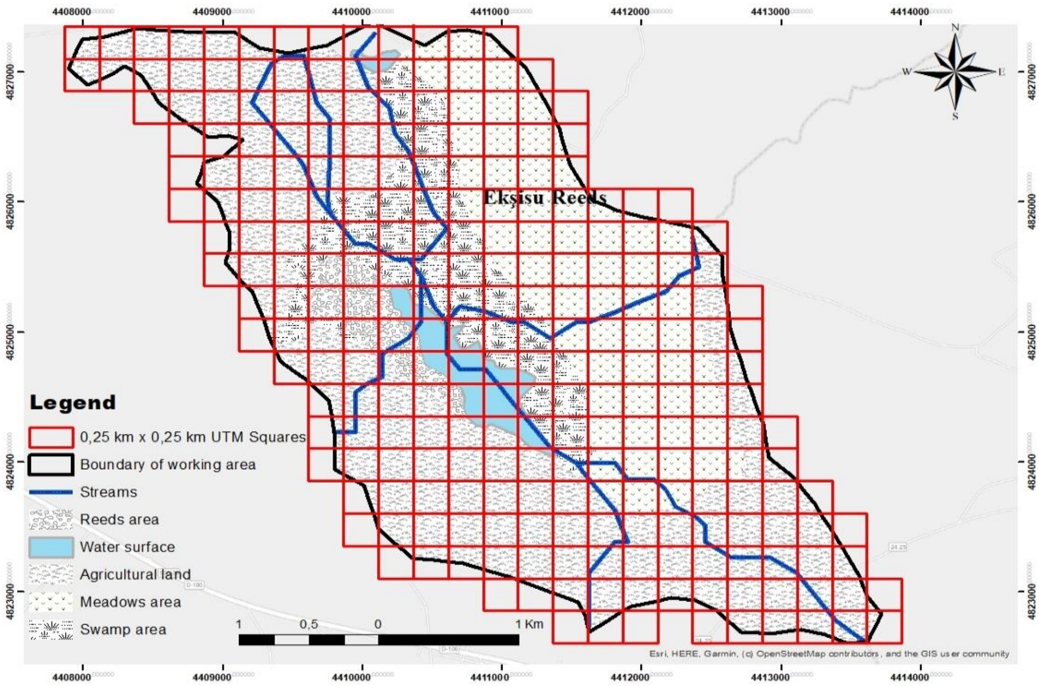

Figure 2. *Map of the study area divided into 0.25 x 0.25 km UTM squares and habitat structure (Corine, 2012)*

Species distribution modelling

Statistical analysis

Five environmental variables were selected for the Ekşisu reed, the seasonal population changes of the coastal and waterfowl around the reed, and the modeling of habitat preferences. Changes in species populations were compared using R 3.5.3 statistics program. Foreign, ggplot2 and MASS packages were used in statistical analysis.

For the analysis of the bird population in Ekşisu Reeds, the population variable is dependent whereas season, habitat and species were independent variables. Consequently, population~ season + habitat + species model has been composed. Since

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dependent variable (population) was obtained by counting (Count data), the variable is Poisson distribution (*Fig. 3*).

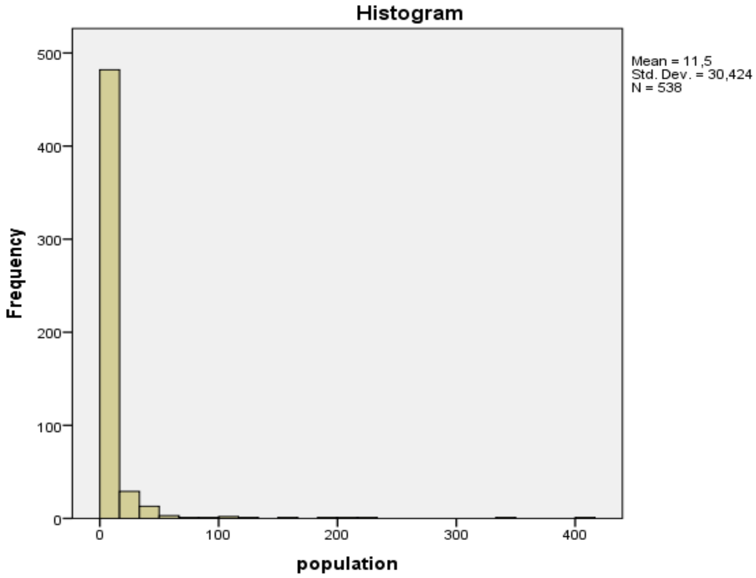

Figure 3. *Distribution of bird population in Ekşisu Reeds*

As the dependent variable, the population obtained by counting (Count data), is Poisson distribution (*Fig. 3*). Log-likelihood function for Poisson regression (PR) model (*Eq.1*) can be written as in the previous reports (Khoshgoftaar et al., 2005; Achim et al., 2007).

$$L(\beta / y_i, x_i) = \sum_{i=1}^{n} y_i x_i^{'} \beta - \exp(x_i^{'} \beta) - \ln y_i!) \qquad \text{(Eq.1)}$$

The graph of the population was obtained as skewed to the right. Variance and average were recorded as 925.602 and 11.5, respectively (*Table 3*). Variance> mean status is called over dispersion (Agresti, 1997). Excessive spill test result was obtained as 12.681, indicating excessive distribution in the dependent variable.

Table 3. *Descriptive statistics of "population"*

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Population	538	1	415	11.50	30.424	925.602

Therefore, Poisson and negative binomial regressions were applied to the model. The AIC value of the Poisson regression was 7489.5 and the BIC value was 7755.38. In Poisson and negative binomial regressions, a method with smaller AIC and BIC values is preferred (Liu and Cela, 2008). For this reason, negative binomial regression parameter estimates, which also model over-spread, are used. Negative binomial regression (NB) model log likelihood function (*Eq.2*) is computed (Lawles, 1987).

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$$L(\beta,\alpha,y)=\sum_{i=1}^{n}[\frac{1}{\alpha}\log(1+\alpha\mu_i)-y_i\log(1+\frac{1}{\alpha\mu_i})+\log\Gamma(y_i+\frac{1}{\alpha})-\log\Gamma(\frac{1}{\alpha})-\log y_i!) \quad \text{(Eq.2)}$$

Results and Discussion

The present study revealed that 55 coastal and waterfowl species belonging to 15 families have been identified. According to IUCN conservation status, 50 (90.9%) of these species are LC (Least Concern), 4 (7.3%) (Ferruginous duck-*Aythya nyroca*, Northern Lapwing-*Vanellus vanellus*, Armenian Gull-*Larus armenicus*, Eurasian Oystercatcher-*Haematopus ostralegus* NT (Near Threatened) was noted as 1 (1.8%) (Common Pochard-*Aythya farina*, VU (Vulnerable) status. In addition, according to the area uses and periods, the bird species were classified as local visitor (LV), (N=14; 25.5%), Summer Visitor (SV) (N= 25; 45.5%), Transit Migratory (T) (N=11; 20.0%), and Winter Visitor (WV) (N=5; 9.0%) (*Table 4*).

It is important to relate data based on ecological censuses to habitat types (Beerens et al., 2011; Gomes et al., 2017) to determine their density and distribution, to reveal the species-field relationship (Bibby et al., 2000; Pearce and Ferrier, 2001; Kaminski et al., 2006; O'Hara and Kotze, 2010; Girma et al., 2017). These counts are generally performed using various parameters with nonlinear statistical calculations (White and Bennetts, 1996; Joseph et al., 2009; Luo and Qu, 2015; Okosodo et al., 2016; Yeşilova et al., 2016; Erdinç et al., 2017; Durmuş et al., 2018; Çelik and Durmuş, 2020).

In our study, according to parameter estimates, habitat ($p < 0.05$), season ($p < 0.01$) and species ($p < 0.001$) were found statistically significant. In addition, since the number of individuals observed in every season in the area constantly varies, *Anas crecca* was considered as the reference species. Population changes of 55 different species were interpreted according to this species.

According to the species of *Anas crecca*, 53% decrease in the population of *Actitis hypoleucost* (p<0.001), 89% decrease in the population of *Anas acuta* (p<0.001), 4.48 fold- increase in the population of *Anas platyrhynchos* (p<0.001), 72% decrease in the population of *Ardea alba* (p <0.001), 29% decrease in the population of *Ardea cinerea* (p<0.001), 90% decrease in the population of *Ardea purpuea* (p<0.001), 29% decrease in the population of *Ardea ralloides* (p<0.01), 81% decrease in the population of *Aythya ferina* (p<0.001), 88% decrease in the population of *Botaurus stellaris* (p<0.001), 80% decrease in the population of *Calidris minuta* (p<0.001), 62% decrease in the population of *Charadrius dubius* (p<0.01), 53% decrease in the population of *Ciconia ciconia* (p<0.05), 75% decrease in the population of *Ciconia nigra* (p<0.001), 89% decrease in the population of *Cinclus cinclus* (p<0.001), 63% decrease in the population of *Egretta garzetta* (p<0.001), 3.45 fold-increase in the population of *Fulica atra* (p<0.001), 86% reduction in the population of *Haematopus ostralegus* (p<0.001), 81% decrease in the population of *Ixobrychus minutus* (p<0.001), 2.45 fold-increase in the population of *Larus armenicus* (p<0.05), 68% reduction in the population of *Netta rufina* (p<0.001), 76% decrease in the population of *Spatula querquedula* (p<0.05), 1.77 fold-increase in the population of *Tadorna ferruginea* (p<0.05), and 76% decrease in the population of *Tringa ochropus* (p<0.05) were recorded. The changes in the populations of other species were not statistically significant (*Table 4*).

As the changes in the number of species and their distribution between seasons are mostly observed in autumn, autumn was taken as reference among season. According to

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this season, 1.50 fold- increase was noted in the winter season (*p*<0.01). Changes in other seasons were not statistically significant (*Table 5*). Of the habitats, the reed habitat was taken as reference, it was determined that there were 1.33 fold- increase in the water surface habitat (*p*<0.05) and 36% decrease in agricultural areas (*p*<0.05). Meadowland and marshland habitats were not statistically significant (*Table 6*).

Table 4. *Parameter estimates of negative binomial regression and Exp(estimate-*$e^{\hat{\beta}}$*) values, IUCN and Region statuses of species*

Paramaters Species	**English name of species**	**Estimate Std. Error z value Pr(>|z|)**	**Exp (estimate)**	**IUCN**	**Region Status**
(Intercept)		**2.144831 0.239373 8.960 < 2e-16**	**8.533 *****		
1.Actitis hypoleucos	Common Sandpiper	-0.835050 0.238699 -3.498 0.000468	0.436 ***	LC	SV
2.Anas acuta	Northern Pintail	-2.146227 0.521270 -4.117 3.83e-05	0.117 ***	LC	SV
4.Anas platyrhynchos	Mallard	1.504085 0.233522 6.441 1.19e-10	4.480 ***	LC	L
5.Anser anser	Greylag Goose	-1.124608 0.858197 -1.310 0.190050	0.320	LC	TM
6.Ardea alba	Great Egret	-1.263021 0.299121 -4.222 2.42e-05	0.283 ***	LC	SV
7.Ardea cinerea	Grey Heron	-1.166908 0.241113 -4.840 1.30e-06	0.313 ***	LC	SV
8.Ardea purpurea	Purple Heron	-2.280732 0.635432 -3.589 0.000332	0.102 ***	LC	TM
9.Ardeola ralloides	Squacco Heron	-1.151349 0.382971 -3.006 0.002644	0.316 **	LC	TM
10.Aythya ferina	Common Pochard	-1.634037 0.301301 -5.423 5.85e-08	0.190 ***	VU	SV
11.Aythya fuligula	Tufted Duck	-1.450031 0.856617 -1.693 0.090505	0.234	LC	WV
12.Aythya nyroca	Ferruginous Duck	0.107587 0.339193 0.317 0.751103	1.112	NT	TM
13.Botaurus stellaris	Great Bittern	-2.065417 0.594480 -3.474 0.000512	0.127 ***	LC	SV
14.Bubulcus ibis	Cattle Egret	0.055279 0.351524 0.157 0.875044	1.05	LC	SV
15.Calidris minuta	Little Stint	-1.605148 0.385357 -4.165 3.11e-05	0.201 ***	LC	SV
16.Charadrius dubius	Little Ringed Plover	-0.972232 0.317229 -3.065 0.002178	0.379 **	LC	SV
17.Ciconia ciconia	White Stork	-0.752995 0.316584 -2.379 0.017383	0.472 *	LC	SV
18.Ciconia nigra	Black Stork	-1.384599 0.342754 -4.040 5.35e-05	0.251 ***	LC	SV
19.Cinclus cinclus	White-throated Dipper	-2.143179 0.991863 -2.161 0.030714	0.117 *	LC	L
20.Coturnix coturnix	Common Quail	-0.025996 0.754874 -0.034 0.972529	0.980	LC	SV
21.Egretta garzetta	Little Egret	-0.995373 0.239918 -4.149 3.34e-05	0.371 ***	LC	SV
22.Fulica atra	Common Coot	1.240324 0.243449 5.095 3.49e-07	3.45 ***	LC	L
23.Gallinago gallinago	Common Snipe	-0.696260 0.567199 -1.228 0.219619	0.501	LC	WV
24.Gallinula chloropus	Common Moorhen	-0.418034 0.295555 -1.414 0.157243	0.663	LC	L
25.Gelochelidon nilotica	Gull-billed Tern	-1.097766 0.625142 -1.756 0.079084	0.336	LC	TM
26.Grus grus	Common Crane	-0.062657 0.307483 -0.204 0.838531	0.641	LC	L
27.Haematopus ostralegus	Eurasian Oystercatcher	-1.924204 0.774970 -2.483 0.013030	0.146 *	NT	SV
28.Himantopus himantopus	Black-winged Stilt	-0.038286 0.417713 -0.092 0.926971	0.962	LC	SV
29.Ixobrychus minutus	Little Bittern	-1.646111 0.446147 -3.690 0.000225	0.193 ***	LC	TM
30.Larus armenicus	Armenian Gull	0.901105 0.449180 2.006 0.044844	2.459 *	NT	L
31.Larus genei	Slender-billed Gull	-0.640851 0.605780 -1.058 0.290103	0.527	LC	TM
32.Larus michahellis	Yellow-legged Gull	0.190526 0.239315 0.796 0.425955	1.209	LC	L
33.Larus ridibundus	Black-headed Gull	-0.458530 0.809035 -0.567 0.570876	0.631	LC	WV
34.Mareca penelope	Eurasian Wigeon	-2.250289 1.219783 -1.845 0.065063	0.105	LC	TM
35.Netta rufina	Red-crested Pochard	-1.148147 0.518620 -2.214 0.026839	0.319 *	LC	SV
36.Nycticorax nycticorax	Black-crowned Night-heron	0.164509 0.344229 0.478 0.632716	1.178	LC	SV
37.Phalacrocorax carbo	Great Cormorant	-0.717197 0.791077 -0.907 0.364614	2.04	LC	TM
38.Philomachus pugnax	Ruff	-0.031402 0.464392 -0.068 0.946089	0.969	LC	SV
39.Platalea leucorodia	Eurasian Spoonbill	-0.863995 0.858994 -1.006 0.314501	2.370	LC	TM

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Paramaters Species	English name of species	Estimate Std. Error z value Pr(>|z|)	Exp (estimate)	IUCN	Region Status
40.Plegadis falcinellus	Glossy Ibis	-0.113007 0.759875 -0.149 0.881776	0.895	LC	SV
41.Podiceps cristatus	Great Crested Grebe	-0.513334 0.312978 -1.640 0.100972	0.600	LC	L
42.Porphyrio porphyrio	Purple Swamphen	-0.507203 0.378870 -1.339 0.180660	0.602	LC	L
43.Scolopax rusticola	Eurasian Woodcock	-0.931936 0.834295 -1.117 0.263980	0.394	LC	WV
44.Spatula clypeata	Northern Shoveler	-0.466308 0.330623 -1.410 0.158423	0.631	LC	L
45.Spatula querquedula	Garganey	-1.410002 0.281190 -5.014 5.32e-07	0.244 ***	LC	L
46.Sternaula hirundo	Common Tern	-0.338820 0.347773 -0.974 0.329929	0.718	LC	SV
47.Sternula albifrons	Little Tern	-0.346917 0.576518 -0.602 0.547344	0.707	LC	SV
48.Tachybaptus ruficollis	Little Grebe	0.299071 0.278810 1.073 0.283420	1.34	LC	L
49.Tadorna ferruginea	Ruddy Shelduck	0.574302 0.249532 2.302 0.021363	1.775 *	LC	SV
50.Tadorna tadorna	Common Shelduck	-0.244156 0.547760 -0.446 0.655788	0.783	LC	WV
51.Tringa glareola	Wood Sandpiper	-0.997045 0.609558 -1.636 0.101905	0.368	LC	TM
52.Tringa nebularia	Common Greenshank	-0.289097 0.476692 -0.606 0.544207	0.749	LC	SV
53.Tringa ochropus	Green Sandpiper	-1.402836 0.553126 -2.536 0.011206	0.246*	LC	L
54.Tringa totanus	Common Redshank	-0.141490 0.239035 -0.592 0.553904	0.868	LC	SV
55.Vanellus vanellus	Northern Lapwing	-0.362271 0.246952 -1.467 0.142385	0.696	NT	SV

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1,/LC- Least Concern, NT-Near Threatened, VU-Vulnerable /L-Local, TM-Transit Migrant, SV-Summer Visitor, WV-Winter Visitor; Species reference: "*Anas crecca* -Common Tea

Table 5. *Parameter estimates of negative binomial regression and Exp(estimate-*$e^{\hat{\beta}}$*) values (Seasons)*

Paramaters (Seasons)	Estimate Std. Error z value Pr(>|z|)	Exp (estimate)
1.Spring	0.231974 0.100789 2.302 0.021358	1.259*
2.Summer	-0.180844 0.120778 -1.497 0.134307	0.835
3.Winter	0.405192 0.132748 3.052 0.002271	1.50**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1, -Season Reference: Autumn

Table 6. *Parameter estimates of negative binomial regression and Exp(estimate-*$e^{\hat{\beta}}$*) values (Habitat)*

Paramaters (Habitat)	Estimate Std. Error z value Pr(>|z|)	Exp (estimate)
1. Swamp area	-0.008649 0.139583 -0.062 0.950590	0.992
2. Meadows area	0.134097 0.131472 1.020 0.307742	1.143
4.Water Surface	0.286303 0.118213 2.422 0.015439	1.331 *
5.Agricultural land	-0.447072 0.218313 -2.048 0.040575	0.639 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1, -Habitat Reference: Reeds Area

Many studies have been performed in order to ascertain the population dynamics and habitat preferences of bird species (Webb, 2010; Fraixedas, 2017; Gomes et al., 2017; Azizoğlu et al., 2019; Çelik and Durmuş, 2020). In particular, the effects of seasonal changes in population densities of coastal and waterfowl, different environmental changes in wintering and breeding areas on species distribution and habitat preferences are well-documented (Muriuki et al., 1997; Clark and Shutler, 1999; Gómez and Bayly, 2010; Webb, 2010; Beerens et al., 2011; Austini et al., 2014; Azizoğlu and Adizel, 2017; Çelik and Durmuş, 2020). Along with this study, five habitat types, which were the reed area, meadow area, water surface, swamp area and agricultural lands preferred by the coastal and waterfowl species, were determined. Also, the population size of the species and their distribution according to the habitats and their differences according to the seasons were evaluated (*Fig. 4*). Accordingly, a total of 6187 individuals belonging to 55 species were counted (*Tables 7-8*). The species were mostly seen in the water surface (N=3079) habitat. The habitat with the lowest population density was determined as agricultural land (N=104) (*Table 7*). The season with the highest number of species was determined as the spring period (N= 3236), and the summer with the lowest number (N= 728) (*Table 8*). The findings of this study were largely consistent with the previous reports.

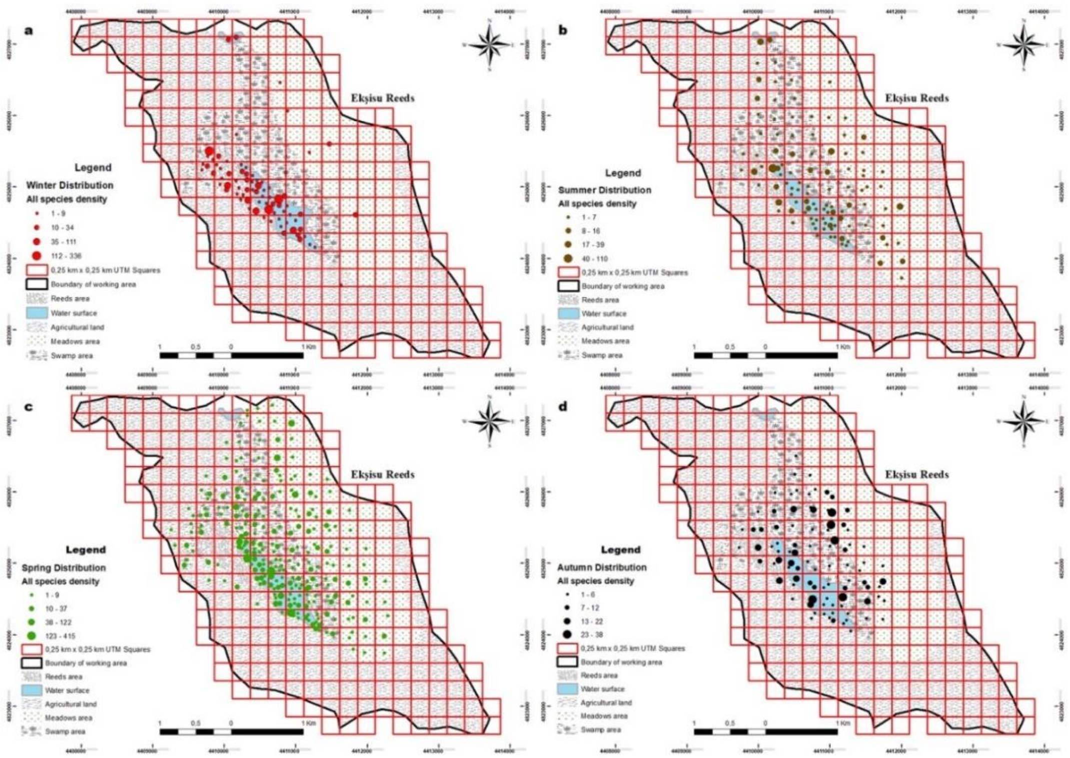

Figure 4. *Seasonal population distribution maps of the species identified in Ekşisu Reeds (**a**:Winter Distribution, **b**: Summer Distribution, **c**: Spring Distribution, **d**: Autumn Distribution)*

Table 7. *Distribution of species populations according to the habitats*

Habitat	Mean	N	Std. Deviation	Sum
Swamp area	7.46	108	8.205	806
Meadows area	8.05	146	12.761	1175
Reeds area	14.41	71	40.796	1023
Water surface	16.12	191	42.318	3079
Agricultural land	4.73	22	3.693	104
Total	11,5	538	30.424	6187

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Table 8. *Distribution of species populations according to the seasons*

Season	Mean	N	Std. Deviation	Sum
Spring	11.85	273	32.798	3236
Summer	7.51	97	12.574	728
Autumn	7.56	91	7.512	688
Winter	19.94	77	48.086	1535
Total	11.5	538	30.424	6187

Conclusion

Bird populations vary according to species, seasons and habitats and it was noted that the areas were used reproduction, feeding and accommodation. The spring season has gained ornithological importance as the migratory birds migrated to the region for breeding periods. This season was mostly preferred by coastal and waterfowl species. Of the habitat types, water surface was the most preferred habitat, which was preferred by waterfowl species for feeding purposes. Although the limited coverage of the area, reeds, meadows and marshland habitats, which are important for breeding and feeding opportunities, have been determined to be effective in using the area.

Herewith the study, changes in species populations were compared statistically. The variance of the population variable, which was taken as a dependent variable, was higher than the mean, which indicated excessive distribution. For this reason, negative binomial regression parameter estimates, which also model over-spread, are used.

As a conclusion, Ekşisu Reeds were found to be an important habitat for many bird species and other living things like all wetlands but it was noted that the area has been exposed to many anthropogenic pressures such as unconscious agricultural activities, hunting, drainage works, overgrazing. Therefore, conservation of the area is important for the continuation of the generation of bird species and other living things.

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