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

AZIZOĞLU, E.^{1*} – ADIZEL, O.² – KARA, R.³

¹*Hakkari University, Çölemerik Vocational School, Department of Plant and Animal Production, 30100-Hakkari, Turkey*

²*Department of Biology, Faculty of Science, Van Yüzüncü Yıl University, 65080-Van, Turkey*

³*Hakkari University, Yüksekova Vocational School, Department of Plant and Animal Production, 30100-Hakkari, Turkey*

**Corresponding author
e-mail: erkanazizoglu@hakkari.edu.tr*

(Received 25th Sep 2020; accepted 21st Dec 2020)

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 binomial 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 binomial 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

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

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

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

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).

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

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).

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

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; Erdiñç 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 hypoleucos* ($p < 0.001$), 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 purpurea* ($p < 0.001$), 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

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 $\text{Exp}(\text{estimate}-e^{\hat{\beta}})$ values, IUCN and Region statuses of species

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

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

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.

Acknowledgements. This study was summarized from a part of the "Erzincan Province Terrestrial and Inland Water Ecosystems Biological Diversity and Inventory Monitoring Project" conducted by the Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks (Turkey). We would like to thank for their valuable contributions.

REFERENCES

- [1] Achim, Z. K., Christian, S. J. (2007): Regression Models for Count Data in R. – <http://CRAN.R-project.org>. Date of access: 15.11.2019.
- [2] Agresti, A. (1997): Categorical Data Analysis. – John and Wiley & Sons, Incorporation, New Jersey, Canada.
- [3] Austin, J., Slattey, S., Clarke, R. G. (2014): Waterfowl populations of conservation concern: learning from diverse challenges, models and conservation strategies. – *Wildfowl* 4: 470-497.
- [4] Azizoğlu, E., Adızel, Ö. (2017): Determination of Seasonal Habitat Usage and Population Distributions of Bird Species Detected in and Around of Yüksekova Nehil Reed (Hakkari -Turkey). – *ADYÜTAYAM* Cilt 5, Sayı 1: 10-19.
- [5] Azizoğlu, E., Çelik, E., Adızel, Ö. (2019): Bayburt İli (Türkiye) Kuşları ve Sulak AlanPotansiyeli, *Doğu Fen Bilimleri Dergisi*. – *Journal of Natural & Applied Sciences of East* 2(1): 16-28.

- [6] Barnosky, A. D., Matzke, N., Tomiya, S., Wogan, G. O. U., Swartz, B., Quental, T. B., Marshall, C., McGuire, J. L., Lindsey, E. L., Maguire, K. C., Mersey, B., Ferrer, E. A. (2011): Has the Earth's sixth mass extinction already arrived? – *Nature* 471: 51-57.
- [7] Beerens, J. M., Gawlik, D. E., Herring, G., Cook, M. I. (2011): Dynamic habitat selection by two wading bird species with divergent foraging strategies in a seasonally fluctuating wetland. – *The Auk* 128(4): 651-662.
- [8] Bibby, C. J., Burgess, D. N., Hill, A. D., Mustoe, S. (2000): *Bird Census Techniques*. – Second Edition, Academic Press, ISBN 0-12-095831-7, London, United Kingdom, 86p.
- [9] Butchart, S. H. M., Walpole, M., Collen, B., Van Strien, A., Scharlemann, J. P., Almond, R. E., Baillie, J. E., Bomhard, B., Brown, C., Bruno, J., Carpenter, K. E., Carr, G. M., Chanson, J., Chenery, A. M., Csirke, J. (2010): Global biodiversity: indicators of recent declines. – *Science* 328(5982): 1164-1168.
- [10] Cassado, S., Montes, C. (1995): *Guia de los Lagos y Humedales de Espania*. – J.M. Reyero Editor, Madrid, 255p.
- [11] Clark, R. G., Shutler, D. (1999): Avian Habitat selection: Pattern from process in nest-site use by ducks? – *Ecology* 80(1): 272-287.
- [12] Clarkson, B. R., Ausseil, A. E., Gerbeaux, P. (2013): *Wetland Ecosystem Services*. – In: Dymond J. R. (ed.) *Ecosystem services in New Zealand - conditions and trends*. Manaaki Whenua Press, Lincoln, New Zealand.
- [13] Çelik, E., Durmuş, A. (2020): Nonlinear Regression Applications in Modeling Over-Dispersion of Bird Populations. – *The J. Anim. Plant Sci.* 30(2): 345-354.
- [14] Durmuş, A., Yeşilova, A., Çelik, E., Kara, R. (2018): Using Poisson and Negative Binomial Regression Models on Birds Population in Dönemeç Delta. – *Yuzuncu Yıl University Journal of Agricultural Sciences* 28(1): 78-85.
- [15] Erdinç, S., Yeşilova, A., Ser, G. (2017): Using The Poisson and Negative Binomial Regression Modeling of Zooplankton Aquatic Insect Count Data. – *Yyü Tar Bil Derg (YYU J Agr Sci)* 27(1): 58-64.
- [16] Farnsworth, G. L., Nichols, J. D., Sauer, J. R., Fancy, S. G., Pollock, K. H., Shriner, S. A., Simons, T. R. (2005): *Statistical Approaches to the Analysis of Point Count Data: A Little Extra Information Can Go a Long Way*1. – USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.
- [17] Fraixedas, S. (2017): *Bird populations in a changing world: implications for Nort European conservation*. – Doctoral School in Environmental, Food and Biological Sciences (YEB) University of Helsinki Finland, 61p.
- [18] Frost, K. J., Lowry, L. F., Ver Hoef, J. M. (1999): Monitoring the trend of harbor seals in Prince William Sound, Alaska, after the Exxon Valdez oil spill. – *Mar. Mam. Sci.* 15(2): 494-506.
- [19] Gaston, K. J., Rodrigues, A. S. L. (2003): Reserve selection in regions with poor biological data. – *Conservation Biology* 17: 188-195.
- [20] Gibbs, J. P. (1993): The importance of small wetlands for the persistence of local populations of wetland associated animals. – *Wetlands* 13: 25-31.
- [21] Girma, Z., Mamo, Y., Mengesha, G., Verma, A., Asfaw, T. (2017): Seasonal abundance and habitat use of bird species in and around Wondo Genet Forest, south central Ethiopia. – *Ecol. Evol.* 7(10): 3397-3405.
- [22] Gomes, M., Rabaça, J. E., Godinho, C., Ramos, J. A. (2017): Seasonal variation in bird species richness and abundance in riparian galleries in Southern Portugal. – *Acta Ornithol.* 52(1): 69-80.
- [23] Gómez, M. C., Bayly, N. J. (2010): Habitat use, abundance, and persistence of Neotropical migrant birds in a habitat matrix in northeast Belize. – *Journal Field Ornithol.* 81(3): 237-251.
- [24] Green, A. J., Elmberg, J. (2014): Ecosystem services provided by waterbirds. – *Biological Reviews* 89: 105-122. doi: 10.1111/brv.12045.
- [25] Hilbe, J. M. (2007): *Negative Binomial Regression*. – Cambridge, U.K.

- [26] Joppa, L. N., Loarie, S. R., Pimm, S. L. (2008): On the protection of “protected areas”. – *Proc. Natl. Acad. Sci. USA* 105: 6673-6678.
- [27] Joseph, L. N., Elkin, C., Martin, T. G., Possingham, H. P. (2009): Modeling Abundance Using N-Mixture Models: The Importance of Considering Ecological Mechanisms. – *Ecological Applications* 19(3): 631-642.
- [28] Kaminski, M. R., Baldassarre, G. A., Pearse, A. T. (2006): Waterbird responses to hydrological management of wetlands reserve program habitats in New York. – *Wildlife Society Bulletin* 34(4): 921-926.
- [29] Keddy, P. A. (2010): *Wetland ecology: principles and conservation*. – Cambridge University Press, Cambridge, 497p.
- [30] Khoshgoftaar, T. M., Gao, K., Szabo, R. M. (2005): Comparing software fault predictions of pure and zero- inflated Poisson regression models. – *International Journal of Systems Science* 36(11): 707-715.
- [31] Kiziroğlu, İ. (2001): *Birds, Our Flying Friends*, Chapter 6: Ecological Potpourri (Ekolojik Potpori). – Takav Printing ouse. Pub. Inc. Ankara, 391.
- [32] Kiziroğlu, İ. (2009): *Birds of Turkey. Species List, and Red List of Birds of Turkey*. – Hacettepe University, Environmental Education, Bird Investigations and Public Relations Center, Ankara, 86.
- [33] Lawles, J. F. (1987): Negative binomial and mixed Poisson regression. – *The Canadian Journal of Statistics* 15(3): 209-225.
- [34] Liu, W., Cela, J. (2008): Count data models in SAS. – *SAS Global Forum*, 371.
- [35] Luo, J., Qu, Y. (2015): Estimation of group means when adjusting for covariates in generalized linear models. – *Pharm Stat.* 14(1): 56-62.
- [36] McCain, C. M. (2009): Global analysis of bird elevation diversity. – *Global Ecology and Biogeography* 18: 346-360.
- [37] Mengesha, G., Bekele, A. (2008): Diversity and relative abundance of birds of Alatish National Park. – *International Journal of Ecology and Environmental Sciences* 34: 215-222.
- [38] Millennium Ecosystem Assessment (2005): *Ecosystems and human well-being: Wetland and water Synthesis*. – Available online: <http://www.millenniumassessment.org/proxy/Document 358>.
- [39] Muriuki, J. N., De Klerk, H. M., Williams, H. P., Bennun, A. L., Crowe, T. M., Berge, E. B. (1997): Using patterns of distribution and diversity of Kenyan birds to select and prioritize areas for Conservation. – *Biodiversity and Conservation* 6: 191-210.
- [40] Nagendra, H. (2008): Do parks work? Impact of protected areas on land cover clearing. – *Ambio* 37: 330-337.
- [41] Newton, I. (2008): *The ecology of bird migration*. – London, UK, Academic Press.
- [42] O'Hara, R. B. (2005): Species richness estimators: How many species can dance on the head of a pin? – *J. Anim. Ecol.* 74: 375-386.
- [43] O'Hara, R. B., Kotze, D. J. (2010): Do not log-transform count data. – *Methods in Ecology and Evolution* 1: 118-122.
- [44] Okosodo, E. F., Orimaye, J. O., Ogunyemi, O. O. (2016): Habitat Effects on Avian Species Abundance and Diversity in Idanre Forest Reserve South Western Nigeria. – *International Journal of Plant, Animal and Environmental Sciences* 6(3).
- [45] Pearce, J., Ferrier, S. (2001): The practical value of modelling relative abundance of species for regional conservation planning: a case study. – *Biological Conservation* 98: 33-43.
- [46] Rékási, J., Rozsa, L., Kiss, B. J. (1997): Patterns in the distribution of avian lice (Phthiraptera: Amblycera, Ischnocera). – *J. Avian Biol.* 28(2): 150-156.
- [47] Sala, O. E., Chapin III., F. S., Armesto, J., Berlow, E., Bloomfield, J., Dirzo, R., Huber-Sanwald, E., Huenneke, L. F., Jackson, R. B., Kinzig, A., Leeman, S. R., Lodge, D. M., Mooney, H. A., Oesterheld, M., Poff, N. L., Sykes, M. T., Walker, B. H., Walker, M., Wall, D. H. (2000): Global biodiversity scenarios for the year 2100. – *Science* 287: 1770.

- [48] Small, R. J., Pendleton, G. W., Pitcher, K. W. (2003): Trends in abundance of Alaska harbor seals, 1983-2002. – *Mar. Mam. Sci.* 19(2): 344-362.
- [49] Sunkar, M., Taşkiran, P. (2011): Ekşisu Sazlığı (Erzincan) Oluşumu, Sorunlar ve Çözüm Önerileri. – II. Türkiye Sulak Alanlar Kongresi, 22-24 Haziran 2011 S.1-10.
- [50] Waterhouse, F. L., Mather, M. H., Seip, D. (2002): Distribution and abundance of birds relative to elevation and biogeoclimatic zones. – *B.C. Journal of Ecosystems and Management* 2(2).
- [51] Webb, E. (2010): Effect of management strategy on waterfowl food availability and selection at wetland reserve program sites in the Mississippi Alluvial Valley. – Arkansas Center for Energy, Natural Resources and Environmental Studies Grant Final Report, 1-10.
- [52] White, G. C., Bennetts, R. E. (1996): Analysis of frequency count data using the negative binomial distribution. – *Ecology* 77(8): 2549-2557.
- [53] Wittaker, R. H., Likens, G. E. (1973): Primary production: the biosphere and man. – *Human Ecology* 1: 257-369.
- [54] Yeşilova, A., Kaydan, B., Kaya, Y. (2010): Modeling insect-egg data with excess zeros using zero inflated regression models. – *Hacet. J. Math. Stat.* 39(2): 273-282.
- [55] Yeşilova, A., Özgökçe, M. S., Atlihan, R., Polat Yıldız, Ş., Karaca, İ., Ser, G. (2016): Modeling of the arthropod population densities in the coastal band of Lake Van using mixture poison regression. – *Fresenius Environmental Bulletin* 25: 1768-1778.