

The Avifauna of Küçük Menderes Delta (Turkey): An evaluation on seasonal pattern of birds

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Abstract. We performed monthly point counts for occurrence of bird species in Küçük Menderes Delta between September 2007 and May 2008, for 3 seasons per year. During the observation period 120 bird species that belong to 10 orders and 41 families were recorded. Diversity index and analysis of similarity were applied to time series data. The results were classified using cluster analysis and were ordered using multidimensional scaling for determining seasonal pattern of bird species in delta. As a result, September and May are less similar than other months regarding the species composition. At the same time, there are differences among seasons.

Key words: Küçük Menderes Delta, avifauna, seasonal pattern, analysis of similarity.

Introduction

Wetlands are diverse, hydrologically complex ecosystems, which tend to develop within a hydrological gradient going from terrestrial to mainly aquatic habitats (WFD CIS 2003, Somay et al. 2008). Turkey has a large variety of wetlands such as flood plains, rivers, estuaries, deltas, lakes, marshes, peat bogs, coastal and human-made wetlands (Karadeniz 1995, Karadeniz et al. 2009). According to Ramsar, there are 135 wetlands in Turkey included in the "Wetland of International Importance" category (Karadeniz et al., 2009). As BirdLife International 2001, the delta is shown as potential Ramsar Area for criteria 2. Küçük Menderes Delta, located at the western coast of Turkey, is one of 97 IBAs (Important Bird Area) of Turkey and ensures this criterion for 2 bird species (*Phalacrocorax pygmeus* and *Vanellus spinosus*). The area is also one of 266 KBAs (Key Biodiversity Area) of Turkey and is important for other 13 species (Yarar & Magnin 1997, Kılıç & Eken 2004, Eken 2007). 1050 ha of the delta were declared as Wild Life Development Area in 1984 and following this, Natural SİT status (Natural Protection Status) was given to the entire delta in 1991. In addition to the presence of wetland environment, Ancient Ephesus City and Virgin Mary House is also close to this wetland area. These attributes make the area very important in view of natural resources, historical and cultural sites (Somay et al. 2008). According to BirdLife International (2009), DSI (Governmental Water Management Office of Turkey) plans to construct four dams on the Küçük Menderes River and its branches for irrigation purposes. This will

greatly reduce inflows to the wetland and may lead to loss of the marshes in the delta. Tourism developments are also a big problem in Coastal Area. Book of IBAs of Turkey (2004) reports that in spite of some negative influences over wild life, the delta can be rehabilitated with conservation studies.

The aim of this study was to determine both the avifauna and seasonal pattern of bird species in Küçük Menderes Delta.

Study area and Methods

Küçük Menderes Delta has an area of 15000 ha; the river runs a distance of 170 kilometres to reach its final destination, Aegean Sea. The basin created by Küçük Menderes River is one of 5 major basins within the coast of the Aegean Sea. The river flows through many residential, industrial and agricultural areas, so it collects domestic sewages and chemical wastes which inevitably impacts water quality (Balık & Özbek 2006). Detailed climate data are only available for Aydın, which is located approximately 40 km to the east of Küçük Menderes Delta. According to the average climate data of 33 years (1975-2008), annual mean temperature is 17.6°C and total annual rainfall is 51.6 kg/m² (DMI 2010). These data show that, approximately 7 months of the year are arid periods in Aydın and its surrounding areas (Fig. 2). Due to precipitation, river sometimes overflows and creates temporary wetlands in winter. In contrast to this it has quite low water level and many minor river branches dry in summer (Gündoğdu & Özkan 2006).

As highlighted by Uzilday et al. (2009), salt marshes, agricultural lands and orchards dominate inner parts of the delta. Almost the entire delta has salty characteristics because of excessive irrigation. Presence of halophytic plants in

agricultural lands and orchards are a proof of salty soil characteristics of delta. Ridges in study area are composed of limestone and quartz and majority of these are covered by maquis and phrygana. Coastline contains small sand flats and beaches covered with *Juncus* vegetation. Behind these habitats, widespread salt marshes (*Tamarix* vegetation) and salt pastures take place.

In this study, we used the point count method which is suitable for observation of bird species which are hard to detect

in woody or scrubby habitats and for the study of extensive areas (Bibby et al. 1998). 15 points were visited once a month. The points were selected in intersections of habitats within delta. Location of the study area and points are shown in Figure 1. Observations were performed between September 2007 and May 2008. Daily observations were performed between 8:00 and 17:00 and 15 minutes were spent in each point. Binoculars (8X40) and a telescope (40x60) were used for observation.

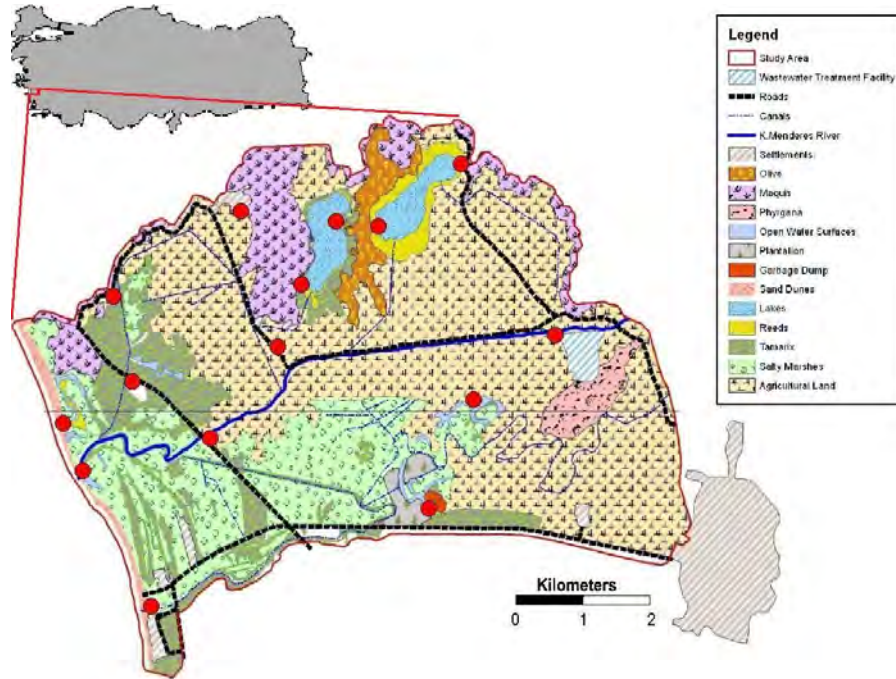


Figure 1. Location of the study (black rectangle) area and observation stations (red dots).

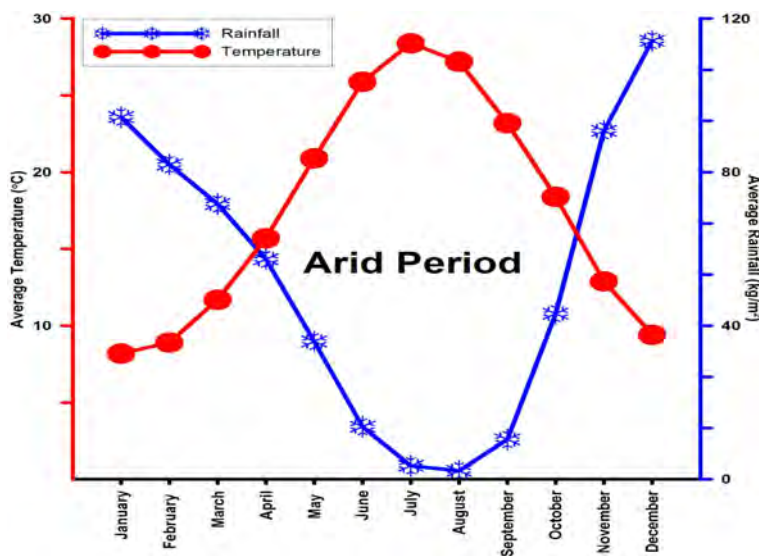


Figure 2. Ombrothermic climate diagram of Aydin.

Analysis of similarity and diversity index were used for evaluating time series data (Clarke & Gorley 2001). Bray-Curtis similarity index was used with absence/presence transformation and was classified using Cluster analyses. Relationships were ordered using MDS (Multidimensional scaling) by Primer 5 Software (Clarke & Gorley 2001).

Results

A total number of 120 bird species were recorded during the study. Observed number of bird species for each month is shown in Table 1. The table shows bird species which are winter migratory, summer migratory and resident. Numbers of individuals for each Order are given in Figure 3 for each month. During the study, maximum numbers of species were recorded in April 2008 (72 species), maximum numbers of individuals were recorded in February 2008 (1560 individuals). 27 species were observed in only one month of the study.

According to collected data, species compositions of seasons are different. Graphic of monthly species

richness index is shown in Figure 4. The index values of the months in each season have similar values. This can be clearly seen on the MDS plot and hierarchical clustering. As a result of multivariate analyses, months can be separated into 4 major groups; "March", "September", "autumn - winter months" and "spring months" (Fig. 5). Composition of September and March differ substantially. These two months are not grouped within their season because of having different values. Winter and autumn are more similar to each other compared to spring. Results of MDS and hierarchical clustering for only major groups' winter and autumn are given in Figure 6. Seasonal differences can be seen with MDS from this figure. Results of multivariate and univariate methods show that there is a seasonal characteristic for bird diversity in the study area. Because September and March are at the beginning of the migration seasons, in these months, the area has some transit species of birds. Because of this, these months differ compared to other months in the seasons which they are included in.

Table 1. Determined species of birds in alphabetical order as Order of birds and their dispersion as observation months.

Species	Recorded by	2007				2008				
		IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.
<i>Accipiter nisus</i>	Kuşbank 2010, this study	0	1	1	1	0	0	0	1	0
<i>Buteo buteo</i>	Kuşbank 2010, this study	0	0	2	4	5	1	0	7	3
<i>Buteo rufinus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	1	0	0	0	0	1	0
<i>Circaetus gallicus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	3	6	4	3	2	0	0
<i>Circus aeruginosus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	1	0	1	0	0	0
<i>Circus cyaneus</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	3	2
<i>Anas acuta</i>	Sıkı 1997, this study	0	1	0	0	0	0	0	0	0
<i>Anas clypeata</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	20	0	6	0	0	0
<i>Anas crecca</i>	Kuşbank 2010, this study	0	5	44	28	20	1	0	0	0
<i>Anas penelope</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	8	45	121	0	0	0	0
<i>Anas platyrhynchos</i>	Kuşbank 2010, this study	0	0	0	0	111	7	2	3	1
<i>Anas strepera</i>	Kuşbank 2010, this study	0	0	0	0	0	8	0	0	0
<i>Cygnus olor</i>	This study (first record)	0	0	0	0	0	0	2	0	0
<i>Tadorna ferruginea</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	76	25	140	39	20	14
<i>Tadorna tadorna</i>	Kuşbank 2010, this study	0	0	0	1	31	24	12	0	0
<i>Charadrius alexandrinus</i>	Kuşbank 2010, this study	0	0	0	22	0	6	7	7	21
<i>Charadrius dubius</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	0	0	0	3	4
<i>Charadrius hiaticula</i>	This study (first record)	0	0	0	0	0	10	0	2	3
<i>Vanellus spinosus</i>	This study (first record)	0	0	0	0	0	0	0	0	4
<i>Vanellus vanellus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	17	17	6	0	0	0

Table 1. (Continued)

Species	Recorded by	2007				2008				
		IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.
<i>Glareola pratincola</i>	This study (first record)	0	0	0	0	0	0	0	2	0
<i>Larus cachinnans</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	1	110	0	6	0	110	162
<i>Larus fuscus</i>	This study (first record)	0	0	0	0	0	0	0	1	0
<i>Larus melanocephalus</i>	Sıkı 1997, Kuşbank 2010, this study	350	0	0	0	0	0	0	0	16
<i>Larus minutus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	10	15	3	0	0	0
<i>Larus ridibundus</i>	Sıkı 1997, Kuşbank 2010, this study	0	150	340	305	153	636	904	0	0
<i>Himantopus himantopus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	0	0	0	30	28
<i>Recurvirostra avosetta</i>	This study (first record)	0	0	0	0	0	0	1	0	1
<i>Actitis hypoleucos</i>	This study (first record)	0	0	0	0	0	0	0	1	0
<i>Arenaria interpres</i>	This study (first record)	0	0	0	0	0	0	0	2	3
<i>Calidris alpina</i>	This study (first record)	0	0	0	0	0	11	0	0	12
<i>Calidris ferruginea</i>	This study (first record)	0	0	0	0	0	0	0	0	5
<i>Calidris minuta</i>	This study (first record)	0	7	0	3	0	6	0	7	46
<i>Gallinago gallinago</i>	Sıkı 1997, this study	1	0	0	8	25	7	0	0	0
<i>Philomachus pugnax</i>	Kuşbank 2010, this study	0	0	0	0	0	0	1	133	15
<i>Tringa ochropus</i>	Sıkı 1997, this study	0	0	0	0	0	0	1	1	1
<i>Tringa totanus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	7	6	19	4	0	6	1
<i>Chlidonias leucopterus</i>	This study (first record)	0	0	0	0	0	0	0	24	0
<i>Chlidonias niger</i>	This study (first record)	0	0	0	0	0	0	0	11	0
<i>Sterna hirundo</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	11	0
<i>Gelochelidon nilotica</i>	This study (first record)	0	0	0	0	0	0	0	4	0
<i>Sterna sandvicensis</i>	Kuşbank 2010, this study	0	0	0	0	0	3	0	3	0
<i>Ardea cinerea</i>	Sıkı 1997, Kuşbank 2010, this study	2	16	14	14	9	3	81	5	3
<i>Ardea purpurea</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	0	0	0	13	5
<i>Ardeola ralloides</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	0	0	0	9	5
<i>Casmerodius albus</i>	Kuşbank 2010, this study	0	0	6	4	0	1	1	0	0
<i>Egretta garzetta</i>	Sıkı 1997, Kuşbank 2010, this study	4	5	1	6	15	1	1	14	16
<i>Ixobrychus minutus</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	1	0
<i>Nycticorax nycticorax</i>	Kuşbank 2010, this study	0	0	0	0	0	0	0	1	3
<i>Ciconia ciconia</i>	Sıkı 1997, Kuşbank 2010, this study	1	0	0	0	0	0	0	10	18
<i>Columba livia</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	150	0	0	0	0	0
<i>Streptopelia decaocto</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	85	0	0	0	0	0	0
<i>Streptopelia turtur</i>	Sıkı 1997, this study	11	0	33	24	38	52	23	24	42
<i>Alcedo atthis</i>	Sıkı 1997, this study	5	4	3	2	0	0	0	0	0
<i>Coracias garrulus</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	1	0
<i>Merops apiaster</i>	Sıkı 1997, this study	38	0	0	0	0	0	0	56	24
<i>Upupa epops</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	0	0	0	0	1
<i>Cuculus canorus</i>	This study (first record)	0	0	0	0	0	0	0	1	0
<i>Clamator glandarius</i>	This study (first record)	0	0	0	0	0	0	0	1	0

Table 1. (Continued)

Species	Recorded by	2007				2008				
		IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.
<i>Falco tinnunculus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	2	1	0	0	0	1	0
<i>Falco vespertinus</i>	This study (first record)	0	0	0	0	0	0	0	1	0
<i>Fulica atra</i>	Sıkı 1997, Kuşbank 2010, this study	0	11	109	45	11	75	7	0	0
<i>Gallinula chloropus</i>	Sıkı 1997, Kuşbank 2010, this study	3	4	9	6	3	3	0	6	9
<i>Rallus aquaticus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	2	1	0	0	0
<i>Alauda arvensis</i>	Sıkı 1997, this study	0	0	0	13	32	30	6	0	0
<i>Galerida cristata</i>	Sıkı 1997, Kuşbank 2010, this study	10	7	6	9	27	9	0	75	94
<i>Lullula arborea</i>	Kuşbank 2010, this study	0	0	7	0	0	0	0	0	0
<i>Melanocorypha calandra</i>	Kuşbank 2010, this study	0	0	2	3	0	0	0	1	2
<i>Corvus corone pilleolus</i>	Sıkı 1997, this study	0	0	2	0	0	8	0	8	15
<i>Corvus monedula</i>	Kuşbank 2010, this study	15	0	2	0	0	0	0	9	25
<i>Garrulus glandarius</i>	Kuşbank 2010, this study	0	3	3	4	0	0	0	6	1
<i>Pica pica</i>	Sıkı 1997, Kuşbank 2010, this study	37	8	17	17	2	20	22	52	60
<i>Emberiza cirius</i>	This study (first record)	0	0	0	0	0	0	0	2	0
<i>Emberiza melanocephala</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	5	3
<i>Emberiza schoeniclus</i>	Sıkı 1997, Kuşbank 2010, this study	0	2	0	1	0	1	0	0	0
<i>Miliaria calandra</i>	Sıkı 1997, Kuşbank 2010, this study	1	0	0	0	0	0	0	7	11
<i>Carduelis carduelis</i>	Sıkı 1997, Kuşbank 2010, this study	5	3	3	42	0	3	3	43	27
<i>Carduelis chloris</i>	Kuşbank 2010, this study	0	0	0	0	0	0	0	1	2
<i>Fringilla coelebs</i>	Kuşbank 2010, this study	13	5	11	232	153	241	0	0	0
<i>Delichon urbica</i>	This study (first record)	16	0	0	0	0	0	0	4	10
<i>Hirundo rustica</i>	Sıkı 1997, Kuşbank 2010, this study	96	2	0	0	0	0	4	21	17
<i>Lanius collurio</i>	Sıkı 1997, Kuşbank 2010, this study	14	2	0	0	0	0	0	7	5
<i>Lanius minor</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	0	2
<i>Lanius senator</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	1	3
<i>Anthus pratensis</i>	Sıkı 1997, Kuşbank 2010, this study	0	2	13	3	3	0	0	1	4
<i>Motacilla alba</i>	Sıkı 1997, Kuşbank 2010, this study	1	1	8	6	0	8	0	0	0
<i>Motacilla flava</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	0	0	0	4	16
<i>Muscicapa striata</i>	Sıkı 1997, this study	12	0	0	0	0	0	0	0	1
<i>Parus major</i>	Kuşbank 2010, this study	1	1	1	1	0	0	0	4	2
<i>Passer domesticus</i>	Sıkı 1997, Kuşbank 2010, this study	87	4	9	25	0	150	0	213	0
<i>Passer hispaniolensis</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	152	0
<i>Remiz pendulinus</i>	Sıkı 1997, Kuşbank 2010, this study	0	3	0	1	0	0	2	13	35
<i>Sitta neumayer</i>	Sıkı 1997, this study	0	0	1	0	0	0	0	1	0
<i>Acrocephalus arundinaceus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	0	0	0	12	4
<i>Acrocephalus melanopogon</i>	This study (first record)	0	0	0	1	0	0	0	0	0
<i>Acrocephalus scirpaceus</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	14	11
<i>Cettia cetti</i>	Sıkı 1997, Kuşbank 2010, this study	5	6	5	2	0	5	0	86	73
<i>Cisticola juncidis</i>	Sıkı 1997, this study	0	0	0	0	0	0	0	2	2

Table 1. (Continued)

Species	Recorded by	2007				2008				
		IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.
<i>Hippolais pallida</i>	This study (first record)	0	0	0	0	0	0	0	26	38
<i>Phylloscopus collybita</i>	Sıkı 1997, Kuşbank 2010, this study	0	4	18	26	1	2	0	0	0
<i>Phylloscopus trochilus</i>	This study (first record)	1	0	0	0	0	0	0	0	0
<i>Sylvia atricapilla</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	1	0	0	0	0	0
<i>Sylvia melanocephala</i>	Kuşbank 2010, this study	0	1	8	3	3	0	0	0	0
<i>Sturnus vulgaris</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	0	0	0	0	1	2
<i>Panurus biarmicus</i>	This study (first record)	0	0	0	2	0	0	0	0	0
<i>Erithacus rubecula</i>	Kuşbank 2010, this study	0	7	3	8	4	0	0	0	0
<i>Phoenicurus ochruros</i>	Kuşbank 2010, this study	0	0	1	6	3	0	0	0	0
<i>Saxicola torquata</i>	Sıkı 1997, this study	0	2	3	5	1	1	0	1	0
<i>Turdus merula</i>	Sıkı 1997, Kuşbank 2010, this study	10	1	8	3	6	0	0	15	6
<i>Turdus philomelos</i>	Kuşbank 2010, this study	0	0	2	0	12	2	0	0	0
<i>Pelecanus crispus</i>	Sıkı 1997, Kuşbank 2010, this study	0	1	0	12	11	1	0	0	0
<i>Phalacrocorax carbo</i>	Kuşbank 2010, this study	0	4	21	55	7	31	2	2	1
<i>Phalacrocorax pygmeus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	0	4	1	5	2	0	0
<i>Phoenicopterus roseus</i>	Sıkı 1997, Kuşbank 2010, this study	0	0	8	3	0	12	0	0	5
<i>Dendrocopos syriacus</i>	Kuşbank 2010, this study	0	1	0	1	0	0	0	1	1
<i>Podiceps cristatus</i>	Sıkı 1997, Kuşbank 2010, this study	0	1	8	11	16	4	0	0	0
<i>Podiceps nigricollis</i>	Kuşbank 2010, this study	0	0	5	8	0	0	0	0	0
<i>Tachybaptus ruficollis</i>	Sıkı 1997, Kuşbank 2010, this study	0	9	26	31	2	2	8	0	0
<i>Calonectris diomedea</i>	This study (first record)	0	0	0	0	0	0	0	0	6
<i>Athene noctua</i>	Sıkı 1997, Kuşbank 2010, this study	0	1	0	0	0	0	0	2	1

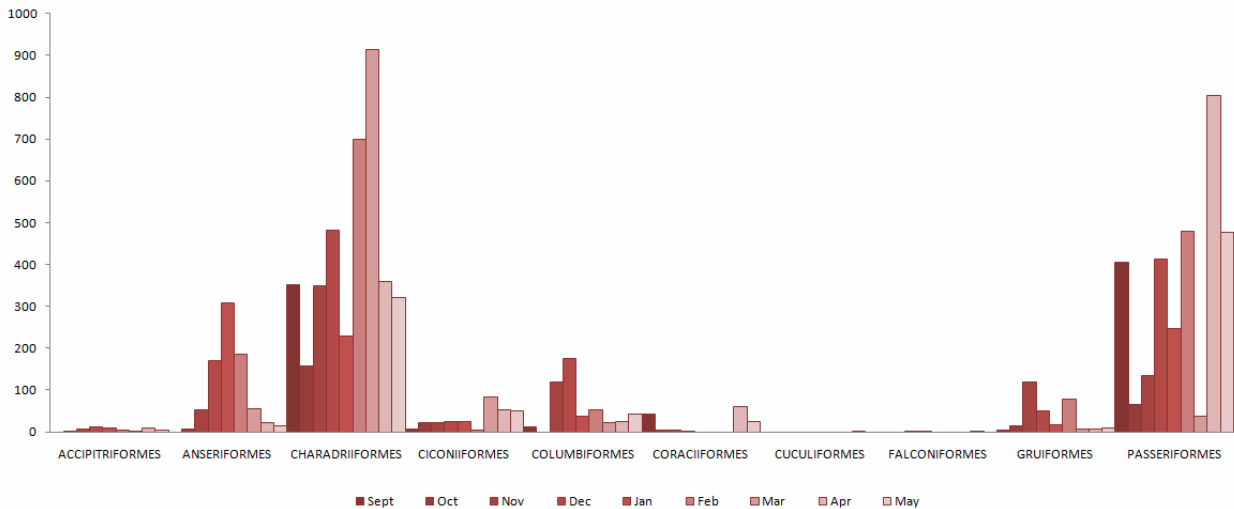


Figure 3. Monthly chances of cumulative numbers of individual classified order

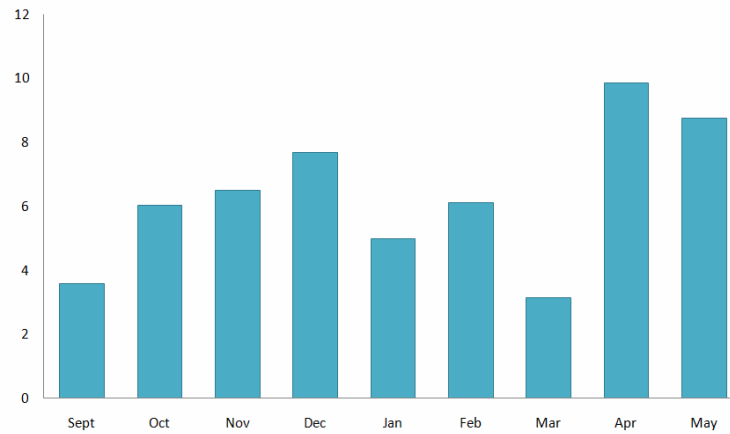


Figure 4. Species Richness (d) according to Margelef's index.



Figure 5. Hierarchical clustering and MDS (stress 0.01) for all study time.

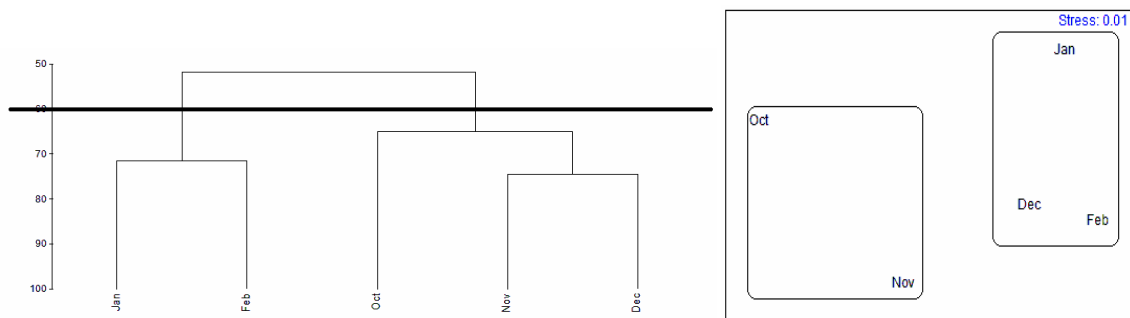


Figure 6. Hierarchical clustering and MDS (stress 0.01) for Winter and Autumn Months

Discussion

153 species of birds were determined in the area in previous studies (Sıkı 1997, Kuşbank 2010). In this study, 24 bird species were recorded for the first time in the delta. A list of the new recorded species and common species with previous studies is given in Table 1.

Observation times of the previous studies were limited and the collected data were not only focused on breeding and wintering seasons. Due to these facts, there is a difference in the number of observed bird species between studies.

Cumulative species count field graphic is shown in Figure 7. The curve on the graphic presents that sample

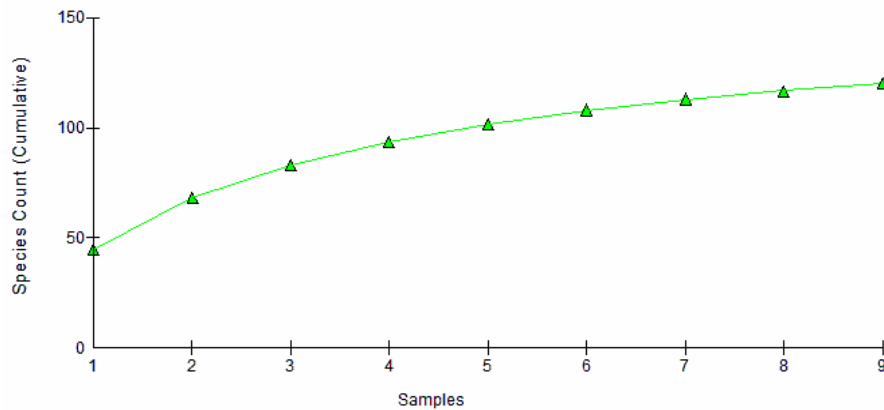


Figure 7. Cumulative Species count-area graphic for the study

count is enough for a representation of avifaunistic character of the delta. An important limitation of this study is the short term of the field work, only 9 months (3 seasons). There may be year to year variation in diversity of birds using the delta. Additionally, long-term studies in the future may help to better show seasonal patterns. Also, separation of characteristics of terrestrial and aquatic parts of delta should be taken into account in future studies. Because the delta has a large diversity of habitats, it may be required to do stratification on both survey design and analysis according to different habitats.

Multivariate methods are very suitable for evaluating this kind of data. Combination of clustering and ordination can be very effective, and using them together gives more robust results on evaluation of seasonal pattern (Anonymous, 1991). Differences between winter and autumn seasons can be seen better using MDS than hierarchical clustering. MDS is one of the best ordination techniques and uses only rank order of dissimilarities and it makes the weakest possible assumptions about quality of the data (Everitt 1978, Kenkel et al 1986, Anonymous 1991).

In the study area, 33 bird species are on the European Conservation Concern List and 31 are on Least Concern, 1 is on Near Threatened (*Clamator glandarius*) and 1 is on Vulnerable (*Pelecanus crispus*). During the study, *Phalacrocorax pygmeus* and *Vanellus spinosus* which ensure IBA and KBA criteria were observed in a limited number of individuals. Maximum number of *Phalacrocorax pygmeus* observed was 5 and maximum numbers of breeding pairs of *Vanellus spinosus* were 2. According to these results the delta no longer satisfies IBA criteria for these species.

In conclusion, irregular water regime, water quality and human activities have negative effects on birds.

Illegal burning of reed beds which are important for sheltering and breeding of birds were observed around Lake Gebekirse (Wild Life Development Area) and Lake Akgöl. In addition to this, there are not enough precautions for illegal hunting in the protected areas. Thus, Controls must be increased by officials for preventing habitat loss caused by human activities and illegal hunting in the area. Beside of this, inspections on waste water treatment plans in residential and industrial areas must be stricter to decrease the water pollution in Küçük Menderes River. For preservation and sustainability of the wild life in the delta, these measures must be taken.

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