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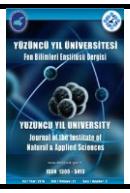

Research Article

Determination of the Ornithological Potential and Coastal Waterbirds Density Distributions of Istanbul Terkos (Durusu) Lake Using Geographical Information Systems (GIS) †

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Abstract: This study was carried out in Lake Terkos (Durusu). The aim of the study is to reveal the ornithological potential of the area using Geographic Information Systems (GIS). As a result of the study carried out between 2015 and 2018, 198 species belonging to 51 families consisting of 19 Ordo were identified. Line transects and Point counts were used to observe species, the number of the individual and population density. It was determined that 56 of these species had the "Certain" and "Probable" code for breeding. Of the 56 bird species, 31 were detected as certainly while 25 re probable breeding species. According to the immigration status of the area, it was observed that 32 (16.2%) were seen in winter only, Winter Visitor (WV) and 55 (27.8%) were using the area during spring and autumn migration season, Transit Migrant (TM), 38 (19.2%) were constantly seen in the field Residant (R) and 73 (36.9%) were seen in summer only in the area, Summer Visitor (SV) status. In addition, according to IUCN threat categories, 183 of species (92.4%) were classified as Least Concern (LC), 7 (3.5%) were classified as Near Threatened (NT), 6 (3.0%) were classified as Vulnerable (VU), 1 (0.5%) was classified as Endangered (EN) and 1 (0.5%) species were not included in the coverage. It was determined that 74 coastal and waterbirds preferred habitats such as reeds, swamps, woodlands, meadows, open water surface and agricultural land. It has been observed that coastal and water birds preferred mostly grassland and reeds to breed, and open water surface to feed. It has been detected that the study area was under intense human pressures such as hunting, irregular settlement, habitat destruction.

Keywords: Birds, Geographical Information, Habitat, Ornithofauna, Systems, Terkos (Durusu) Lake

İstanbul Terkos (Durusu) Gölü'nün Ornitolojik Potansiyeli ve Kıyı Su Kuşları Yoğunluk Dağılımlarının Coğrafi Bilgi Sistemleri (CBS) Kullanılarak Belirlenmesi

Öz: Bu çalışma Terkos (Durusu) Gölü'nde yürütüldü. Çalışmanın amacı, alanın ornitolojik potansiyelinin Coğrafi Bilgi Sistemleri (CBS) kullanarak ortaya konmasıdır. 2015 ve 2018 yılları arasında yürütülen çalışma sonucunda 19 takımdan oluşan 51 familyaya ait 198 tür tespit edildi. Türleri, birey sayısını ve popülasyon yoğunluğunu gözlemlemek için hat boyu ve nokta sayımları kullanıldı. Bu türlerden 56 tanesinin üreme için "Kesin" ve "Muhtemel" koduna sahip olduğu belirlendi. 56 kuş türünden 31'i kesin üreme ve 25'i muhtemel üreyen tür olduğu tespit edildi. Alanda tespit edilen türlerin göç durumlarına göre 32 (%16.2)'sinin sadece kış aylarında görüldüğü Kış Ziyaretçisi (KZ), 55 (%27.8)'inin alanı ilkbahar ve sonbahar göç döneminde kullandığı Transit Göçer (T), 38 (%19.2)'inin alanda sürekli görüldüğü Yerli (Y) ve 73 (%36.9)'ü ise çalışma alanını yalnız yaz aylarında kullanan Yaz Ziyaretçisi (YZ) statüsünde olduğu belirlendi. Ayrıca koruma

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statülerinden IUCN koruma kategorilerine göre türlerden 183 (%92.4)'i Düşük riskli (LC-Least Concern), 7 (%3.5)'si Tehlikeye yakın (NT-Near Threatened), 6 (%2.0)'sı Hassas (VU-Vulnerable), 1 (%0.5)'i Tehdit altında (EN-Endangered) statüsünde ve 1 (%0.5) tür ise kapsama dâhil edilmemiştir. Alanda 74 kıyı ve su kuşunun sazlık, bataklık, ormanlık, çayırlık alan, açık göl yüzeyi ve tarım arazisi gibi habitatları tercih ettiği görüldü. Kıyı ve su kuşlarının üremek için en çok çayırlık ve sazlık alanları, beslenmek için ise açık göl yüzeyi habitatını tercih ettiği tespit edilmiştir. Çalışma alanının avcılık, düzensiz yapılaşma, habitat tahribatı gibi yoğun insan baskısı altında olduğu tespit edilmiştir.

Anahtar Kelimeler: Coğrafi Bilgi Sistemleri, Habitat, Kuşlar, Ornitofauna, Terkos (Durusu) Gölü

1. Introduction

Anatolia has extremely rich on account of fauna and flora related to different geographical structure and climatic conditions it has. In addition to this richness in flora and fauna, the phenomenon of endemism makes the natural structure of Anatolia even more attractive. This diversity of natural structures gives Anatolia its continental characteristics (Kiziroğlu, 2001). Türkiye is one of the most important countries in Europe and the Middle East in terms of wetlands (Büyük & Karakaş, 2022). Turkey's location at the transition point between the continents of Europe, Asia and Africa, its being surrounded by seas on three sides, and the climate diversity resulting from altitude differences exceeding 5000 meters above sea level have made our country one of the most important countries in its geography in terms of wetlands (Balkaya & Çelikoba, 2005; Birben, 2020).

After tropical forests, the ecosystems that produce the most organic matter and contain living things on earth are wetlands (İnaç, 2001; Gomez & Bayby, 2009). These areas are considered as natural wealth museums not only for the country they are located in but also for the whole world, in terms of feeding, breeding and sheltering for many species and varieties of living beings. It is known that the geography where our country is located has a very important wetland potential in general (Hu et al., 2013; Xu et al., 2019). The importance of wetlands and the biological components they contain, which have been destroyed for various reasons, has been understood, albeit belatedly, recently (Kuchara et al., 2023). With the understanding of the importance of wetlands, the factors that threaten these areas have been investigated. These factors have been determined to be natural and human-induced, such as climate change, ecological and hydrological changes, drainage, hunting pressure, and agricultural activities. It is known that these factors have direct or indirect negative effects on both wetlands and the living creatures living in these areas (Hulme, 2005; Ferrati et al., 2005; Akın, 2009; Erwin et al., 2009; Caula et al., 2014).

Increase in human population is one of the most important human-induced factors affecting wetlands. With the rapid increase in population, human beings have used productive wetlands and their immediate surroundings to meet various needs such as shelter. This situation has caused destruction on these special areas. So, both wetlands and the animals that they host have faced many negativities and have become threatened (Çepel, 2008; Onmuş & Sıkı, 2011).

The unsustainable use of natural resources by humans in order to meet their needs has been narrowed the living habitats of living things both in water and lands (Rees & Wackernagel, 2004). So, protection of wetlands together with the biological elements they host is now a necessity and conservation plans should have a comprehensive perspective that requires considering the ecosystem as a whole (Kiziroğlu, 2004, Büyük & Karakaş, 2022). It is important to identify wetlands, which are one of the last shelters of wildlife members, to reveal their characteristics and to determine the natural and anthropogenic factors that threaten them. In addition, biological capacity of these areas and protecting them with suitable conservation plans has become a legal policy for all of the countries (Akman et al., 2004).

Wetlands are important habitats for many plant and animal species including birds, and many bird species use these areas for resting, feeding and breeding aims. Due to waterfowls depend on wetlands such as lakes, deltas, streams and marine environments for their survival, the protection of these areas have been great importance. Also, artificial wetland areas such as ponds can be important for many wild components including birds, especially in arid areas (Karakaş, 2017). In our country, 184 Important Bird Areas have been identified by the International Society for the Protection of Birds

(Bird Life International), and 97 by the World Wildlife Conservation Society. One of these important bird areas (IBA's) is the Terkos Lake (Heath et al., 2000; Eken et al., 2006).

The conservation and survival of bird species depends not only on the protection of breeding areas, but also on the protection of resting areas and wintering areas. Protected areas play a vital role in biodiversity conservation (Azizoglu & Adızel, 2017; Sun et al., 2020). The protection of areas is directly proportional to the species and species populations they host. Therefore, it has become essential to use remote sensing methods in practice to identify species, understand their distribution status and characteristics, and predict how they are distributed (Glenn & Ripple, 2004; Webb et al., 2010; Azizoğlu et al., 2023).

The use of remote sensing techniques in biology has accelerated in recent years in the world and in Türkiye. Databases have begun to be created using Geographic Information Systems (GIS) techniques in both wetland management planning and species and area protection studies (Doygun et al., 2003; Gündoğdu et al., 2007; Artar, 2008; Açıkgöz, 2010; Onmuş & Sıkı, 2010; Çelik & Durmuş, 2020).

GIS are an effective information technology that has just begun to be used in many countries. This technology has started to become a mandatory system to be used in planning activities. This system has the ability to collect the information required for planning and present it appropriately (Tecim, 2001; Çelik & Durmuş, 2017). It is possible to carry out management planning of wetlands through remote sensing using GIS techniques. Additionally, remote sensing can be used to determine the functions of wetlands and their time-dependent changes over large geographic areas. This information is integrated into GIS and information is provided using satellite imagery and area photographs. In addition, evaluations are also made in terms of living creatures living in wetlands (Jansen et al., 1999; Mironga, 2004; Holm & Clausen, 2006; Stralberg et al., 2010).

Revealing the ornithological potential of Terkos (Durusu) Lake, located in the Terkos Basin, which is one of the important bird areas, using GIS techniques will make a significant contribution to the bird atlas of Turkey. In addition, determining the periods when bird species are seasonally dense and identifying birds according to their threat categories will provide pioneering data for the creation of ecosystem-based wetland management plans for Terkos Lake.

2. Material and Methods

2.1. Geographic location of the study area

Terkos (Durusu) Lake is located in Zone 35 at 631250 North, 4578645 East UTM coordinates. The Lake is located in the Çatalca part of the Marmara Region, in the north of the Trakya Peninsula, on the Black Sea coast (Figure 1). Terkos Lake is approximately 50 km northwest of Istanbul city center. The lake and its surroundings are within the borders of the Istanbul Metropolitan area (Baylan & Karadeniz, 2006; Anonim, 2017).

Transportation to Terkos Lake and its surroundings is largely provided by stabilized roads due to dense forests. There are Ormanlı, Yazlık, Örencik, Balaban, Durusu and Hisarbeyli villages around the lake.

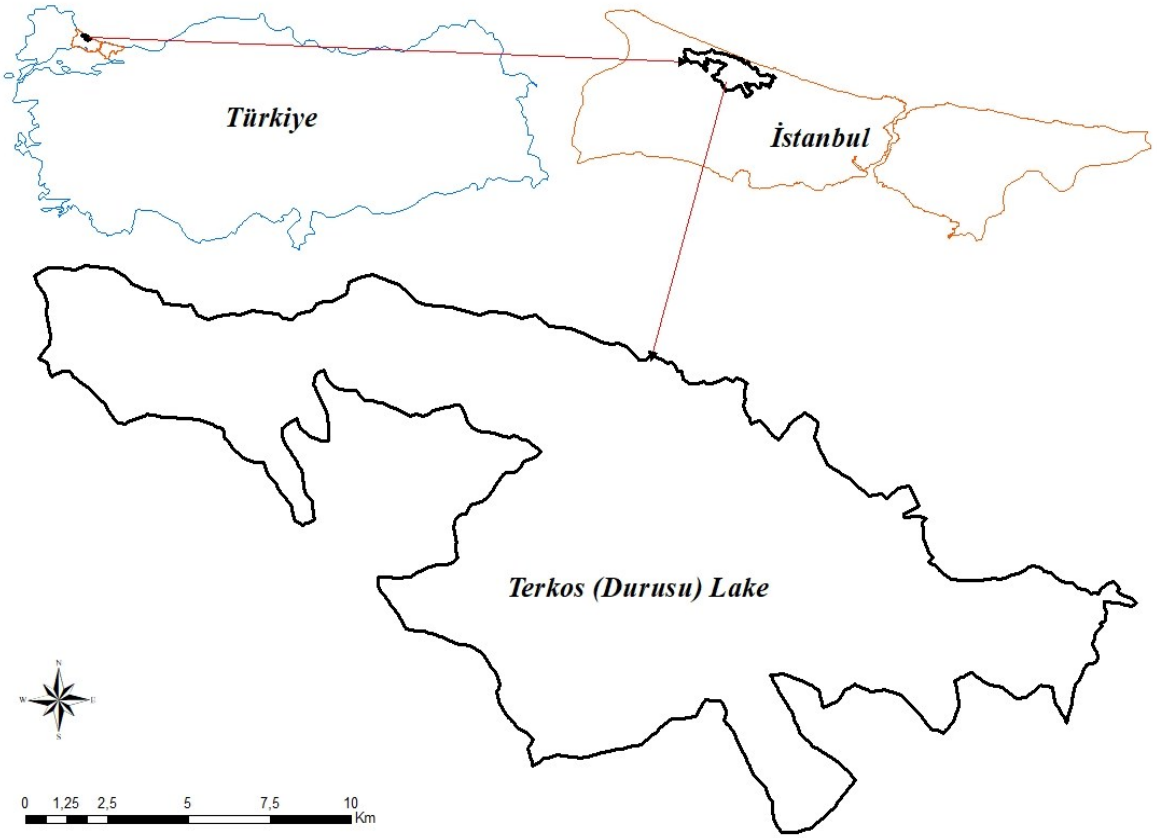

Figure 1. Terkos (Durusu) Lake location map.

This study was conducted between 2015-2018 in Istanbul Terkos (Durusu) Lake and its immediate surroundings. The main material of the study is the bird species using Terkos Lake and its surroundings.

A monitoring methodology was created to determine the area use status of bird species, their population sizes, and their ecological and biological status. In order to identify the species (Sevensson et al., 2009; Kiziroğlu, 2015), two separate field programs were carried out between 2015 and 2018, targeting the species that use Terkos Lake and its surroundings for feeding, accommodation and reproduction purposes, and the migratory species that glide around the lake during migration periods. A total of 18 days of field work was carried out on soaring migratory bird species during the 3-month periods covering the spring and autumn migration periods of 2016. In addition, a total of 34 days of field work was carried out to identify species using the study area for feeding, accommodation and reproduction purposes in an 18-month period between January 2016 and May 2018.

1/25.000 scale topographic maps were produced by taking the coordinates of different habitat types in Terkos Lake and its surroundings. These maps were then transferred to digital media, paving the way for all activities to be carried out in the GIS-based ArcMap 10.2 software environment. Six habitat types were determined in the area: meadow area, reed area, swamp area, lake mirror, woodland and agricultural land. In addition, the area covering these habitats was divided into 234 UTM squares of 1x1 km² (Figure 2) At each UTM, observations were made at intervals of at least 200 meters to represent the living areas on the surface. Observation points were determined in each UTM frame. Observations were made at these observation points for 10-15 minutes. Line transects and Point counts methods were used to observe the number of the individual and population density (Bibby et al., 1992). Bird species, population numbers and UTM coordinates detected at the point and its surroundings were recorded on field observation cards. The point records obtained as a result of the process were then assigned to UTM squares.

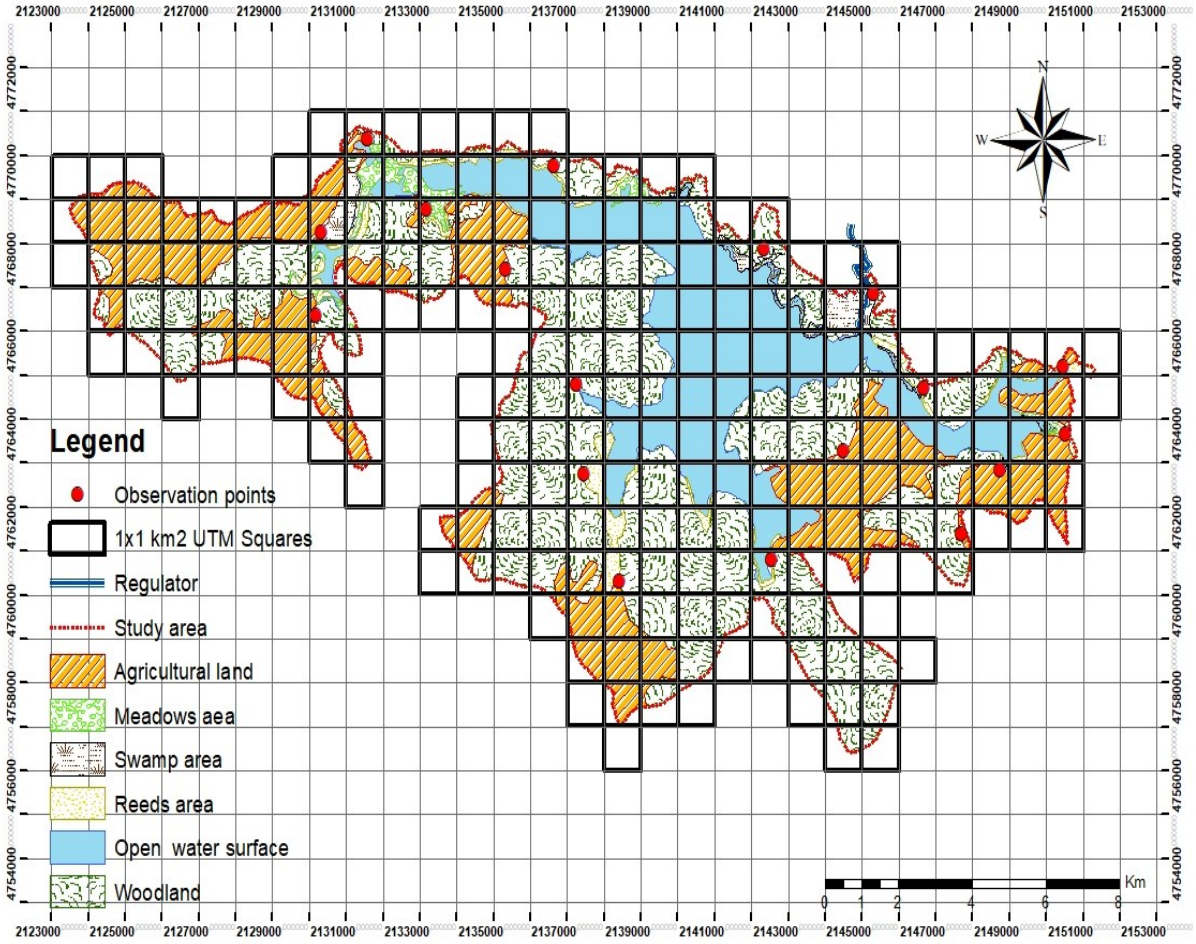

Figure 2. Map of the study area divided into 1x1 km UTM squares and habitat structure.

2.2. Breeding codes of birds

The life cycle of birds includes breeding, wintering and migration. Birds have to reproduce to continue their species. For this reason, many bird species use certain areas for breeding at certain periods. The codes established by the European Bird Atlas Committee (EOAC) were utilized in the study of avian breeding during the breeding season. The breeding codes, which consist of 16 different codes, are divided into three groups. 1-2 are evaluated as probable breeding records, 3-9 as probable breeding records and 10-16 as definite breeding records (Boyla et al., 2019; Uysal, 2021).

3. Results

As a result of the study conducted on the ornithological potential of the Terkos (Durusu) Lake and its surroundings, 198 species belonging to 51 families consisting of 19 orders were identified. According to the IUCN criteria threat categories (v.2025-1) at the global level, 183 (92.4 %) of the species were determined as LC (Least Concern), 7 (3.5 %) as NT (Near Threatened), 6 (2.0 %) as VU (Vulnerable), 1 (0.5 %) as EN (Endangered) and 1 (0.5 %) species were not included in the scope.

The seasonal status of the bird species detected in the area was categorized according to their area use, migration status and the dates they were monitored. Accordingly, 32 (16.2%) of the species are in the Winter Visitor (WV) status, which is seen only in the winter months, 55 (27. 8%) are in the Transit Migrant (TM) status, which uses the area for transition period, 38 (19.2 %) are in the Resident (R) status, which is seen constantly in the area, and 73 (36.9 %) are in the Summer Visitor (SV) status, which uses the study area only in the summer and spring months.

When the frequency of occurrence and population size of the species were examined, it was seen that the most frequently seen species in the area were the Eurasian Coot (515 times) and the Crested Grebe (425 times). The species with the largest population sizes in the area were determined to be Eurasian Coot (7 430 individuals) and Mallard (4 264 individuals) (Table 1).

Table 1. Bird species identified in Terkos (Durusu) Lake and their threat status

Ordo/ Familia/ Species	English Names of Species	IUCN Criteria	Regional Status	Number of Observations	Total Number of Individuals
Gaviiformes					
Gaviidae					
Gavia arctica	Arctic Loon	LC	TM	1	2
Podicipediformes					
Podicipedidae					
Tachybaptus ruficollis	Little Grebe	LC	R	222	1221
Podiceps cristatus	Great Crested Grebe	LC	R	425	1179
Podiceps nigricollis	Black-necked Grebe	LC	WV	47	142
Pelecaniformes					
Ardeidae					
Botaurus stellaris	Great Bittern	LC	WV	5	8
Ixobrychus minutus	Little Bittern	LC	R	3	4
Nycticorax nycticorax	Black-crowned Night-heron	LC	SV	8	63
Ardeola ralloides	Squacco Heron	LC	SV	10	47
Bubulcus ibis	Cattle Egret	LC	SV	7	51
Egretta garzetta	Little Egret	LC	R	82	181
Ardea alba	Great Egret	LC	R	196	442
Ardea cinerea	Grey Heron	LC	R	284	605
Ardea purpurea	Purple Heron	LC	TM	3	4
Pelecanidae					
Pelecanus onocrotalus	Great White Pelican	LC	TM	2	36
Suliformes					
Phalacrocoracidae					
Phalacrocorax carbo	Great Cormorant	LC	R	250	1114
Phalacrocorax aristotelis	European Shag	LC	SV	7	19
Microcarbo pygmaeus	Pygmy Cormorant	LC	R	54	311
Threskiornithidae					
Plegadis falcinellus	Glossy Ibis	LC	TM	5	37
Platalea leucorodia	Eurasian Spoonbill	LC	TM	2	20
Ciconiiformes					
Ciconia nigra	Black Stork	LC	SV	10	19
Ciconia ciconia	White Stork	LC	SV	41	1 610
Anseriformes					
Anatidae					
Cygnus olor	Mute Swan	LC	WV	20	138
Cygnus columbianus	Bewick's Swan	LC	WV	9	20
Tadorna ferruginea	Ruddy Shelduck	LC	SV	74	522
Tadorna tadorna	Common Shelduck	LC	WV	9	101

Table 1. Bird species identified in Terkos (Durusu) Lake and their protection status (continued)

Ordo/ Familia/ Species	English names of species	IUCN Criteria	Regional Status	Number of Observations	Total Number of Individuals
Mareca penelope	Eurasian Wigeon	LC	WV	3	11
Mareca strepera	Gadwall	LC	WV	2	9
Anas crecca	Common Teal	LC	WV	98	923
Anas platyrhynchos	Mallard	LC	R	252	4264
Anas acuta	Northern Pintail	LC	WV	3	6
Spatula querquedula	Garganey	LC	SV	14	37
Spatula clypeata	Northern Shoveler	LC	WV	43	257
Netta rufina	Red-crested Pochard	LC	WV	23	106
Aythya ferina	Common Pochard	VU	R	56	231
Aythya nyroca	Ferruginous Duck	NT	TM	9	32
Aythya fuligula	Tufted Duck	LC	WV	109	1 246
Aythya marila	Greater Scaup	LC	WV	46	267
Mergellus albellus	Smew	LC	TM	5	13
Mergus serrator	Red-breasted Merganser	LC	TM	2	3
Accipitriformes					
Accipitridae					
Pernis apivorus	European Honey-buzzard	LC	SV	17	53
Milvus migrans	Black Kite	LC	TM	3	4
Haliaeetus albicilla	White-tailed Eagle	LC	TM	1	1
Neophron percnopterus	Egyptian Vulture	EN	TM	2	3
Gyps fulvus	Griffon Vulture	LC	TM	2	3
Circaetus gallicus	Short-toed Snake-eagle	LC	SV	11	25
Circus cyaneus	Northern or Hen Harrier	LC	WV	1	2
Circus aeruginosus	Western Marsh-harrier	LC	R	25	29
Circus macrourus	Pallid Harrier	NT	TM	2	2
Accipiter gentilis	Northern Goshawk	LC	TM	1	1
Accipiter brevipes	Levant Sparrowhawk	LC	SV	3	4
Accipiter nisus	Eurasian Sparrowhawk	LC	R	8	9
Buteo buteo	Common Buzzard	LC	R	30	166
Buteo rufinus	Long-legged Buzzard	LC	SV	3	5
Clanga pomarina	Lesser Spotted Eagle	LC	SV	17	45
Clanga clanga	Greater Spotted Eagle	VU	TM	1	1
Aquila heliaca	Eastern Imperial Eagle	VU	TM	1	1
Aquila chrysaetos	Golden Eagle	LC	TM	1	1
Hieraaetus pennatus	Booted Eagle	LC	TM	2	3
Pandion haliaetus	Osprey	LC	TM	1	1
Falconiformes					
Falconidae					
Falco tinnunculus	Common Kestrel	LC	R	10	15
Falco vespertinus	Red-footed Falcon	VU	SV	3	6
Falco subbuteo	Eurasian Hobby	LC	SV	9	14
Falco biarmicus	Lanner Falcon	LC	TM	2	2
Falco peregrinus	Peregrine Falcon	LC	TM	1	1

Table 1. Bird species identified in Terkos (Durusu) Lake and their protection status (continued)

Ordo/ Familia/ Species	English names of species	IUCN Criteria	Regional Status	Number of Observations	Total Number of Individuals
Galliformes					
Phasianidae					
Phasianus colchicus	Common Pheasant	LC	SV	1	2
Gruiformes					
Rallidae					
Rallus aquaticus	Water Rail	LC	WV	18	34
Gallinula chloropus	Common Moorhen	LC	R	115	256
Fulica atra	Common Coot	LC	R	515	7 430
Gruidae					
Grus grus	Common Crane	LC	SV	2	16
Charadriiformes					
Recurvirostridae					
Himantopus himantopus	Black-winged Stilt	LC	SV	15	110
Glareolidae					
Glareola pratincola	Collared Pratincole	LC	SV	5	29
Charadriidae					
Charadrius dubius	Little Ringed Plover	LC	SV	8	24
Charadrius alexandrinus	Kentish Plover	LC	WV	12	46
Pluvialis squatarola	Grey Plover	VU	WV	5	11
Vanellus vanellus	Northern Lapwing	NT	R	38	487
Scolopacidae					
Calidris minuta	Little Stint	LC	TM	1	3
Calidris alpina	Dunlin	NT	WV	5	13
Philomachus pugnax	Ruff	LC	SV	15	75
Gallinago gallinago	Common Snipe	LC	TM	6	12
Scolopax rusticola	Eurasian Woodcock	LC	SV	11	33
Limosa limosa	Bar-tailed Godwit	NT	WV	12	27
Numenius arquata	Eurasian Curlew	NT	WV	12	37
Tringa erythropus	Spotted Redshank	LC	TM	1	2
Tringa totanus	Common Redshank	LC	SV	19	113
Tringa stagnatilis	Marsh Sandpiper	LC	TM	1	5
Tringa nebularia	Common Greenshank	LC	TM	5	15
Tringa ochropus	Green Sandpiper	LC	SV	7	22
Tringa glareola	Wood Sandpiper	LC	WV	12	37
Actitis hypoleucos	Common Sandpiper	LC	R	51	197
Laridae					
Larus melanocephalus	Mediterranean Gull	LC	WV	56	475
Larus ridibundus	Black-headed Gull	LC	WV	67	976
Larus canus	Mew Gull	LC	WV	15	289
Larus fuscus	Lesser Black-backed Gull	LC	TM	2	3
Larus michahellis	Yellow-legged Gull	LC	R	122	1 303
Larus marinus	Great Black-backed Gull	LC	TM	1	1

Table 1. Bird species identified in Terkos (Durusu) Lake and their protection status (continued)

Ordo/ Familia/ Species	English names of species	IUCN Criteria	Regional Status	Number of Observations	Total Number of Individuals
Gelochelidon nilotica	Gull-billed Tern	LC	SV	57	193
Hydroprogne caspia	Caspian Tern	LC	TM	10	39
Sterna hirundo	Common Tern	LC	SV	13	45
Sternula albifrons	Little Tern	LC	TM	4	20
Chlidonias leucopterus	White-winged Tern	LC	TM	10	69
Columbiformes					
Columbidae					
Columba livia	Rock Pigeon	LC	R	11	445
Columba palumbus	Common Wood-pigeon	LC	WV	8	121
Streptopelia decaocto	Eurasian Collared-dove	LC	R	15	70
Streptopelia turtur	European Turtle-dove	VU	SV	9	24
Spilopelia senegalensis	Laughing Dove	LC	R	16	44
Cuculiformes					
Cuculidae					
Cuculus canorus	Common Cuckoo	LC	SV	8	14
Strigiformes					
Strigidae					
Athene noctua	Little Owl	LC	R	5	6
Asio otus	Long-eared Owl	LC	R	1	1
Caprimulgiformes					
Apodidae					
Apus apus	Common Swift	LC	TM	4	50
Tachymarptis melba	Alpine Swift	LC	SV	69	1 123
Coraciiformes					
Alcedinidae					
Alcedo atthis	Common Kingfisher	LC	R	7	10
Meropidae					
Merops apiaster	European Bee-eater	LC	SV	7	10
Coraciidae					
Coracias garrulus	European Roller	LC	SV	21	55
Bucerotiformes					
Upupidae					
Upupa epops	Eurasian Hoopoe	LC	SV	7	14
Piciformes					
Picidae					
Jynx torquilla	Eurasian Wryneck	LC	TM	1	2
Dendrocopos major	Great Spotted Woodpecker	LC	TM	1	1
Dendrocopos syriacus	Syrian Woodpecker	LC	TM	1	1
Passeriformes					
Alaudidae					
Galerida cristata	Crested Lark	LC	SV	21	50
Lullula arborea	Wood Lark	LC	SV	5	9
Hirundinidae					

Table 1. Bird species identified in Terkos (Durusu) Lake and their protection status (continued)

Ordo/ Familia/ Species	English names of species	IUCN Criteria	Regional Status	Number of Observations	Total Number of Individuals
Riparia riparia	Sand Martin	LC	TM	3	20
Hirundo rustica	Barn Swallow	LC	SV	94	1 436
Cecropis daurica	Red-rumped Swallow	LC	TM	5	28
Delichon urbicum	Northern House-martin	LC	SV	11	150
Motacillidae					
Anthus campestris	Tawny Pipit	LC	TM	3	4
Anthus trivialis	Tree Pipit	LC	SV	3	5
Anthus pratensis	Meadow Pipit	LC	TM	1	1
Motacilla flava	Yellow Wagtail	LC	SV	47	421
Motacilla cinerea	Grey Wagtail	LC	TM	2	4
Motacilla alba	White Wagtail	LC	SV	22	44
Troglodytidae					
Troglodytes troglodytes	Winter Wren	LC	SV	2	4
Prunellidae					
Prunella modularis	Hedge Accentor	LC	TM	1	2
Muscicapidae					
Muscicapa striata	Spotted Flycatcher	LC	SV	22	39
Ficedula parva	Red-breasted flycatcher	LC	TM	4	7
Ficedula semitorquata	Semi-collared Flycatcher	LC	SV	4	7
Ficedula hypoleuca	European Pied Flycatcher	LC	SV	4	4
Cercotrichas galactotes	Rufous-tailed Scrub-robin	LC	SV	15	19
Erithacus rubecula	European Robin	LC	WV	11	22
Luscinia megarhynchos	Common Nightingale	LC	SV	10	13
Phoenicurus ochruros	Black Redstart	LC	WV	24	45
Phoenicurus phoenicurus	Common Redstart	LC	SV	11	18
Saxicola rubetra	Whinchat	LC	SV	3	5
Saxicola torquatus	Common Stonechat	LC	SV	2	5
Oenanthe oenanthe	Northern Wheatear	LC	SV	9	22
Turdidae					
Turdus merula	Eurasian Blackbird	LC	R	54	102
Turdus philomelos	Song Thrush	LC	SV	5	7
Turdus viscivorus	Mistle Thrush	LC	SV	4	8
Acrocephalidae					
Acrocephalus scirpaceus	Eurasian Reed-warbler	LC	SV	5	8
Acrocephalus arundinaceus	Great Reed-warbler	LC	SV	3	6
Iduna pallida	Eastern Olivaceous Warbler	LC	SV	5	9
Iduna caligata	Booted Warbler	LC	TM	1	1
Hippolais icterina	Icterine Warbler	LC	TM	1	1
Sylviidae					
Sylvia melanocephala	Sardinian Warbler	LC	SV	8	12
Sylvia ruppeli	Rueppell's Warbler	LC	TM	2	3

Table 1. Bird species identified in Terkos (Durusu) Lake and their protection status (continued)

Ordo/ Familia/ Species	English names of species	IUCN Criteria	Regional Status	Number of Observations	Total Number of Individuals
Sylvia nisoria	Barred Warbler	LC	TM	1	1
Sylvia curruca	Lesser Whitethroat	LC	SV	6	10
Sylvia communis	Common Whitethroat	LC	SV	2	3
Sylvia atricapilla	Blackcap	LC	SV	5	9
Phylloscopidae					
Phylloscopus collybita	Common Chiffchaff	LC	SV	22	41
Phylloscopus trochilus	Willow Warbler	LC	SV	7	10
Reguliidae					
Regulus regulus	Goldcrest	LC	SV	5	8
Regulus ignicapilla	Firecrest	LC	TM	1	1
Panuridae					
Panurus biarmicus	Bearded Parrotbill	LC	WV	2	10
Aegithalidae					
Aegithalos caudatus	Long-tailed Tit	LC	TM	1	5
Paridae					
Poecile lugubris	Sombre Tit	LC	TM	2	3
Periparus ater	Coal Tit	LC	SV	5	10
Cyanistes caeruleus	Blue Tit	LC	R	16	29
Parus major	Great Tit	LC	R	26	50
Sittidae					
Sitta europaea	Wood Nuthatch	LC	SV	2	2
Certhiidae					
Certhia familiaris	Eurasian Treecreeper	LC	TM	1	1
Certhia brachydactyla	Short-toed Treecreeper	LC	SV	4	6
Remizidae					
Remiz pendulinus	Penduline tits	LC	SV	2	5
Oriolidae					
Oriolus oriolus	Eurasian Golden Oriole	LC	SV	6	16
Laniidae					
Lanius collurio	Rufous-tailed Shrike	LC	SV	31	54
Lanius minor	Lesser Grey Shrike	LC	SV	5	7
Lanius excubitor	Great Grey Shrike	LC	TM	1	1
Lanius senator	Woodchat Shrike	NT	TM	3	4
Corvidae					
Garrulus glandarius	Eurasian Jay	LC	R	104	184
Pica pica	Black-billed Magpie	LC	R	56	106
Corvus monedula	Eurasian Jackdaw	LC	R	43	626
Corvus frugilegus	Rook	LC	WV	10	98
Corvus cornix	Carrion Crow	KD	R	52	122
Corvus corax	Common Raven	LC	R	12	40
Sturnidae					
Sturnus vulgaris	Common Starling	LC	WV	17	543
Passeridae					

Table 1. Bird species identified in Terkos (Durusu) Lake and their protection status (continued)

Ordo/ Familia/ Species	English names of species	IUCN Criteria	Regional Status	Number of Observations	Total Number of Individuals
Passer domesticus	House Sparrow	LC	R	27	404
Passer hispaniolensis	Spanish Sparrow	LC	TM	1	12
Passer montanus	Eurasian Tree Sparrow	LC	WV	5	48
Fringillidae					
Fringilla coelebs	Eurasian Chaffinch	LC	R	139	977
Fringilla montifringilla	Brambling	LC	WV	2	13
Serinus serinus	European Serin	LC	TM	6	41
Chloris chloris	European Greenfinch	LC	R	11	50
Carduelis carduelis	European Goldfinch	LC	R	10	87
Spinus spinus	Eurasian Siskin	LC	TM	5	17
Linaria cannabina	Eurasian Linnet	LC	R	9	74
Coccothraustes coccothraustes	Hawfinch	LC	SV	7	59
Emberizidae					
Emberiza cirlus	Cirl Bunting	LC	SV	16	114
Emberiza hortulana	Ortolan Bunting	LC	SV	8	56
Emberiza melanocephala	Black-headed Bunting	LC	SV	8	19
Emberiza calandra	Corn Bunting	LC	SV	14	76

R: Resident, SV: Summer Visitors, WV: Winter Visitors, TM: Transit Migrant

Terkos Lake is an important stop-over site for migratory birds, especially in spring and autumn. According to the observations, it was seen that coastal and water bird species were more spread out in the areas where fresh water mixes with the lake and in UTM squares where reeds and swamp habitats occur in areas where water is more stagnant. It was also observed that coastal and water bird species frequently preferred areas with lake surface habitat for feeding. It has been determined that these species also use meadows and woodlands for breeding or different food sources (Figure 3).

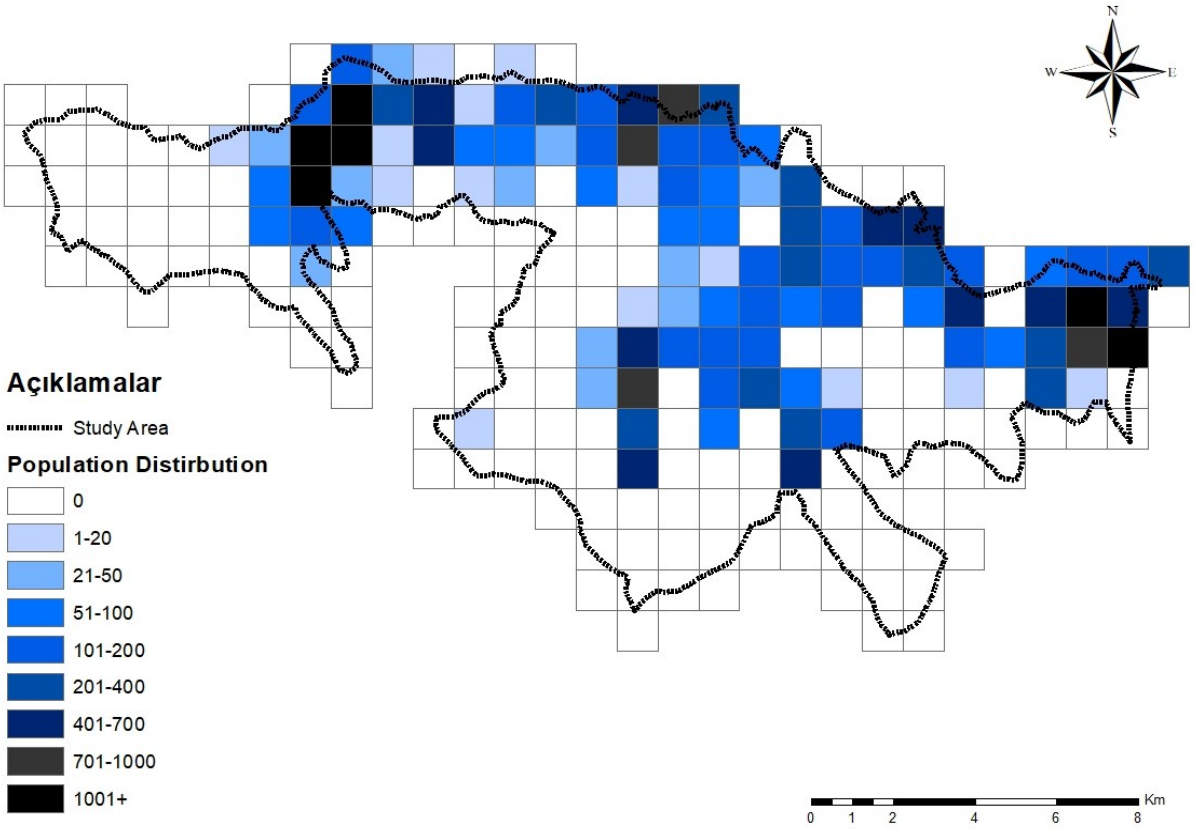

Figure 3. Distribution map of the population densities of coastal and water birds detected in Terkos Lake.

4. Discussion and Conclusion

When ornithological research conducted in Anatolia is examined, it is seen that the first research conducted began in the late 1800s. In her work titled “Important Developments in Anatolian Birds”, Danford (1880) discussed the general characteristics of the species seen in our country and made a general species list. Ergene's (1945) work titled "Birds of Türkiye" served ornithologists for many years as the first reference work in our country. In Turkey; Turan (1990) reported 421, Kasparek & Bilgin (1996) 450, Kirwan et al. (1998) 453 bird species, and this number could increase to 465 with the random species. In addition, Kiziroğlu (2009) reported 465 bird species. In addition, Kiziroğlu (2015) stated in her pocket book titled “Birds of Türkiye” that there are 513 bird species and 9 subspecies identified in Türkiye. In addition, the distribution of species, their migration status and regional status are discussed. In this study, it was determined that the 199 bird species identified in this study largely overlap with the species in the literature given above, although there are some differences in terms of distribution and seasonality.

It has been determined that the province of Istanbul, where this study area carried out, is an ornithologically important area and many ornithological studies have been conducted in earlier times (Kirwan et al., 2010; Uysal, 2021). More than 350 bird species have been reported from the Istanbul province based on earlier ornithological studies that conducted in the region (Kirwan et al., 2010). It is also known that Istanbul is one of the important migration routes in the western Palearctic region and therefore provides feeding and resting opportunities for many migratory bird species (Kirwan et al., 2008; Atabey & Karakaş 2024). In their study, Boyla & Arslan (2008) determined that a total of 313 bird species were observed in Istanbul. Arslangündoğdu (2005) conducted studies on populations of native species breeding in the Istanbul-Belgrade Forest among 146 bird species. This study is directly related to our study area. Also, due to the similarity of habitats in forest and meadow areas, there is a large overlap in terms of raptor and passerinebirds species.

Yalçın et al. (2002), in their study on the Terkos basin, stated that the Terkos basin is one of the important bird migration routes passing through the Bosphorus and is also a stopover and transition area. However, studies have reported that it hosts 140 bird species, 16 of which are breeding. In our study, a total of 56 breeding bird species were recorded, 25 of which were probable breeding in the area and 31 were definite breeding species. It was observed that the region was similar in terms of breeding species. However, we think that the high number of breeding species in our study is due to the fact that the area is on the migration route and the habitat diversity.

Bacak (2012) revealed the avifauna of Istanbul Büyükçekmece Lake, one of the Important Bird Areas. In his study, 170 species belonging to 42 families from 14 orders were identified. Additionally, the distribution and population densities of the identified species were mapped. Büyükçekmece Lake is one of the wetlands closest to our study area. The species we identified in our study are compatible with the species mentioned in this study. However, their conservation status varies due to environmental and anthropogenic factors. In addition, the higher number of species in our study is due to the greater urbanization around the other study area, its smaller surface area, and less habitat diversity.

It is known that many bird species migrate north in the spring to breed and migrate through our country in the autumn to reach their wintering grounds in the south of our country. Migratory bird species use migration routes and bottlenecks to complete their migrations comfortably and safely. There are two main migration routes used by birds in our country and three narrow straits, namely the Bosphorus, the Coruh Valley and the Belen Pass, and many studies on the bird species passing through these areas. In these studies, the general migration status of birds was evaluated and their maps were revealed (Newton, 2008; Kiziroğlu et al., 2013; Bilgin, 2015; Elvan et al., 2022). In the Türkiye bird migration map created in the studies, the main migration route passing through the Bosphorus also passes through the Terkos Lake Basin. These studies support the data we obtained in our study on soaring migratory birds.

According to our study, the basin's large area and ability to support a variety of habitat types are significant from an ornithological point. It is also seen as a place where migratory species passing through the Bosphorus are intensely active. Terkos Lake's location on the Bosphorus, one of the important migration routes, and the absence of transportation problems increases the ornithological richness and shows that the region has a great ecotourism and biotourism potential. For this reason, the area needs to be protected and supported by public institutions.

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