© by PSP Volume 30– No. 06A/2021 pages 6981-6987 Fresenius Environmental Bulletin

INVESTIGATION OF THE IMPACT OF SEASONAL CHANGES ON FISH FAUNA IN THE YUMURTALIK (CAMLIK) LAGOONS (NORTHEASTERN MEDITERRANEAN)

Meltem Manasirli[1,*], Kaan Aksoy[2]

[1]Cukurova University, Fisheries Faculty 01330, Balcali Adana, Turkey
[2]Cukurova University, Institute of Natural and Applied Sciences, Department of Basic Sciences 01330, Balcali Adana, Turkey

ABSTRACT

This study investigated the seasonal changes occurring in the fish fauna found living within the Yumurtalik (Camlik) Lagoons. Fish samples were obtained, seasonally, between the dates of November 2015 and August 2016. A total of 13 species within 6 families were caught and examined. The percentages for each fish family caught are as follows: 48.91% Mugilidae, 30.1% Sparidae, 18.35% Moronidae, 1.75% Siganidae, 0.43% Anguillidae, and 0.43% Carangidae. The three most dominate fish species found were: 21.80% *Sparus aurata*, 17.9% *Dicentrarchus labrax, and* 16.15% *Liza carinata.*

KEYWORDS:
Yumurtalik Lagoons, seasonal changes, fish species

INTRODUCTION

The lagoons, the nature of the natural water treatment establishes a balance in the water cycle; the relationship between the atmosphere and the evaporation-precipitation relationships, the relations with the surface and groundwater in the basin and the feeding area, the feeding ability of underground water, flood displacement functions, climatic effects, and salinity-freshwater initiatives in coastal underground waters. In addition, lagoon systems are the most important ecosystems preferred by aquatic organisms that protect their ecological cycle best in the form of an independent aquarium that is inherently separated from the sea by rivers. Lagoons are sensitive and fragile ecosystems that are the world's natural sources of biological wealth, as well as laboratories for scientific research and have great prospects for preserving and maintaining biodiversity [1].

In recent years, lagoon systems, which are in limited numbers in the world, are under the influence of many structures such as tourism complexes, power plants, shipyards and harbors, especially in the coastal areas of the seas. In addition, due to the influence of these facilities, it may naturally prevent the formation of new lagoon lakes in the future in these regions. Theirs is geomorphological formations which should be evaluated within the framework of rational use [2].

Fluctuations in water temperatures in the oceans, seas or lakes due to factors such as global warming, nuclear power plants established on the seacoasts of today, can have a negative impact on aquatic life. As a matter of fact, the drought caused by the increase in global warming has caused the drying of the Yapi Lagoon in Yumurtalik Lagoons. For this reason, due to the negative impact of the living communities in Yapi Lagoon, it caused great damage and even destruction.

The constantly evolving technology makes us forget the importance of nature, and the environmental disasters (seller, storms, landslides, etc.) caused by the unsustainable and unplanned use of space are increasing with time. These environmental disasters also indicate that people still need natural ecosystems. As a result, the value of wetland ecosystems has begun to be understood and many measures have been taken in order to protect, to avoid damage, and to eliminate its naturalness [3]. In the interest of preserving its bountiful natural resources as well as the homes it provides for a myriad of migrating animals, the Yumurtalik Lagoons hold three (3) different protection statuses; Natural Protected Area (1993), Protected Wildlife Reserve (1994), and Ramsar Site (2005).

The fact that the changes in living species in these regions or the disappearance of these species is indeed a sign that the precautions taken here alone will not be of any benefit to itself. In addition to these, in recent years the detection of fish fauna in lagoon systems has become one of the most important measures to be taken. In order to increase the amounts of aquatic products in aquatic environments with a high biological richness, their extraction and examination is necessary in order to the fish fauna consumed as human food.

As a result of the source scans, on the related inland fish fauna species detection studies were found only on [4] and [5]. Additionally, Acıkgoz [6]

studied the monthly and seasonal changes of zooplankton, phytoplankton, benthos, temperature, EI, salinity, CO, pH, and COI organic matter as well as the amounts of nitrogen, phosphorus, and organic matter founded. And Dural and Goksu [7] investigated the seasonal changes of the concentrations of heavy metals (Pb, Cu, Zn, Cd, and Fe) in seston, benthic, and sediment samples which were taken from the Yumurtalık (Çamlık) Lagoons.

MATERIALS AND METHODS

Yumurtalık (Çamlık) Lagoons located in the Eastern Mediterranean region of Çukurova, Adana, Turkey, between the mouth of the Ceyhan River and the Yumurtalık Gulf. The area of Çamlık Lagoon basin is about 3000 ha and its surface area is 1300 ha. These Lagoons consist of five (5) different wetland areas: Ömerli Lagoon (350 ha), Yapi Lagoon (300 ha), Camlik Lagoon (number of hectares unknown), and the Arapbogazi and Darbogaz (380 ha) lagoons. It merges with many points in the sea and has a very irregular shoreline. The depth between 0.5m and 1.0m is very salty due to the connection with the sea due to its wide throat and its connection length of about 1300m. At the same time, there are two Suna and Bayrakli lakes with smaller area compared to these lakes. To complement each other, Ceyhan River is the main water source that feeds the old bed, the Avciali and Esemen Lagoon. There are also freshwater entrances to the lagoon during the rainy season through the northern debris. These lagoons form a very rich, complex and dynamic structured wetland system composed of fresh and salty water marshes, mud flats, reeds, wet prairies, sand dunes, and an Aleppo pine forest. Yapi Lagoon has dried up in recent years and, presently, there are no operating fisheries in this particular area. Two cooperatives are operated the use of fishing in the Yumurtalik Lagoons.

Primarily, our study focused on investigating the seasonal changes occurring in the fish fauna found living within the Yumurtalik (Camlik) Lagoons. Specimens were caught, seasonally, between the dates of November 2015 and August 2016 from fish barriers and three (3) different stations located in Camlik Lagoon, Darbogaz Lagoon, and Arapbogazi Lagoon (Figure 1). All samples were captured using trammel nets and scoop nets of varying mesh sizes.

The specimens taken from the stations were subjected to morphometric (meridian and metric) properties and species identification. Considering the aforementioned measurements of samples analysed Turan [8], FishBase [9], Geldiay and Balık [10] and Mater et al. [11] have been used to identify families and species.

To elucidate the seasonal abundance and evenness of the species present within the Yumurtalik (Camlik) Lagoons, the Shannon-Weiner index and Pielou index was utilized [12]. The Bray-Curtis index was also used to calculate the similarity of the stations where our fish specimens were captured [13, 14].

RESULTS

In total, 229 individuals belonging to 13 different species in 6 families were obtained from the aforementioned stations and were examined using their morphometric (meridian and metric) features Turan [8], Fishbase [9], Geldiay and Balık [10], and Mater et al. [11]. The distribution of fish families and species, by percentage, are shown in Table 1 and 2, respectively.



FIGURE 1
Yumurtalik Lagoons (Google Earth)
(1. Camlik Lagoon, 2. Darbogaz Lagoon, 3. Arapbogazi, Lagoon)

TABLE 1
Distribution of fish families by percentage

Family Name	(Individual Number)	%
Mugilidae	112	48.9
Sparidae	69	30.14
Moronidae	42	18.35
Siganidae	4	1.75
Anguillidae	1	0.43
Carangidae	1	0.43
Total	229	100

TABLE 2
Distribution of fish species by percentage

Fish Name	Number	%
Sparus aurata	50	21.80
Dicentrarchus labrax	41	17.90
Liza carinata	37	16.15
Mugil cephalus	24	10.48
Chelon labrosus	23	10.04
Diplodus vulgaris	19	8.30
Liza aurata	15	6.55
Liza ramada	12	5.24
Siganus rivulatus	4	1.74
Liza saliens	1	0.45
Lichia amia	1	0.45
Dicentrarchus punctatus	1	0.45
Anguilla anguilla	1	0.45
Total	229	100

TABLE 3
Seasonal distribution of fish samples

Fish name	Fall	Winter	Spring	Summer
Sparus aurata	*		*	*
Dicentrarchus labrax	*	*	*	*
Liza carinata	*			
Mugil cephalus		*	*	*
Chelon labrosus	*			*
Diplodus vulgaris	*			
Liza aurata	*			
Liza ramada		*		
Siganus rivulatus	*			
Liza saliens			*	
Lichia amia				*
Dicentrarchus punctatus	*			
Anguilla anguilla				*

Thirteen (13) species from six (6) different families were identified amongst the 229 samples caught at the Yumurtalık (Çamlık) Lagoons*: Sparus aurata, Dicentrarchus labrax, Liza carinata, Mugil cephalus, Chelon labrosus, Diplodus vulgaris, Liza aurata*, *Liza ramado, Siganus rivulatus, Liza saliens*, *Lichia amia*, *Dicentrarchus punctatus,* and *Anguilla anguilla* (Table 2). The most dominate family discovered during our research was the Mugilidae family (Table 1). *Sparus aurata*, belonging to the Sparidae family, was the most prevalent species captured. Table 3 displays data concerning the seasonal distribution of the fish specimens we obtained.

Several species within the Mugilidae family, who spend much of their lives living in freshwater sources, such as lagoons, were observed a great deal during the course of our research. Although *Mugil*

cephalus appeared in all seasons but fall, *Liza carinata* and *Liza ramada* appeared only during the fall and winter seasons, respectively. *Chelon labrosus* appeared in both the summer and fall seasons. *Anguilla anguilla*, a catadromous fish belonging to the Anguillidae family, was observed during the summer season. This fish, who had not yet reached reproductive maturity, likely remained in the lagoon to find nourishment and complete its physiological development before heading out to the open sea to spawn during the winter and early spring. *Dicentrarchus labrax,* from the Moronidae family, was captured during all four seasons and is the second most prevalent species we found within the Yumurtalık (Çamlık) Lagoons. *Sparus aurata*, a Sparidae with the highest number of specimens captured, was found in all seasons but winter its spawning period. *Lichia amia*, of the family Carangidae, was seen only in the summer season (Table 3).

Throughout the course of this study, specimens were caught and examined, seasonally, from fish barriers as well as three (3) different stations within the Yumurtalik Lagoons (Camlik Lagoon, Darbogaz Lagoon, and Arapbogazi Lagoon). For analyses purposes, we have designated a number for each station: 1 = Fish barriers, 2 = Camlik Lagoon, 3 = Darbogaz Lagoon, and 4 = Arapbogazi Lagoon. To illustrate the similarities between the seasons and stations, MDS graphics displaying Bray-Curtis index values (Figure 2) and cluster analyses methods were used (Figure 3).

Concerning the distribution similarities of fish species between the seasons and stations, *Dicentrarchus punctatus, Anguilla anguilla, Lichia amia, Dicentrarchus labrax, Sparus aurata, Mugil cephalus, Liza carinata, Diplodus vulgaris, Chelon labrosus,* and *Siganus rivulatus* show the most similarity amongst each other while *Liza ramado* and *Liza aurata* showed the least amount of similarity between each other (Figure 2).

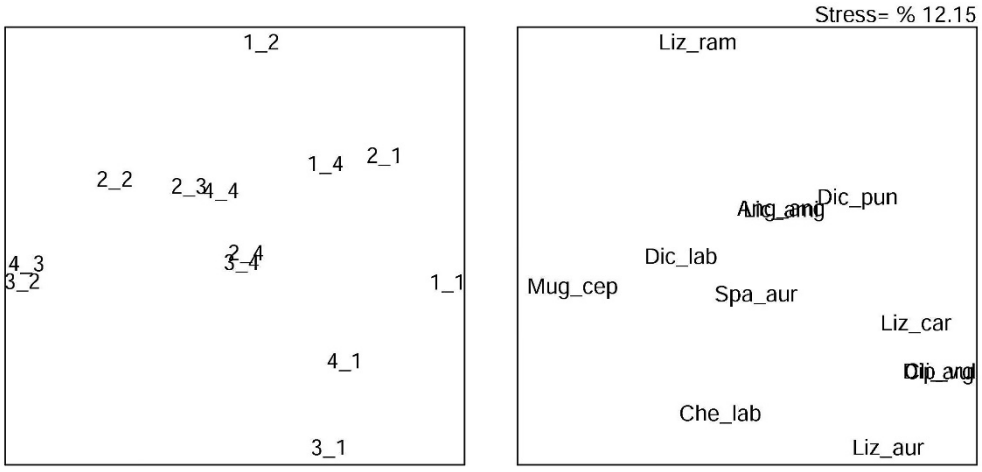


FIGURE 2

Graphs showing the similarities between the seasons and stations; 1_2: 1. Station 2. Season, 1_4: 1. Station 4. Season. (Seasons; 1: Fall, 2: Winter, 3: Spring, 4: Summer)

Species names: Liz_ram (*Liza ramada*), Dic_pun (*Dicentrarchus punctatus*), Ang_ang (*Anguilla anguilla*), Lic_amg (*Lichia amia*), Dic_lab (*Dicentrarchus labrax*), Spa_aur (*Sparus aurata*), Mug_cep (*Mugil cephalus*), Liz_car (*Liza carinata*), Dip_vul (*Diplodus vulgaris*), Che_lab (*Chelon labrosus*), and (*Siganus rivulatus*)

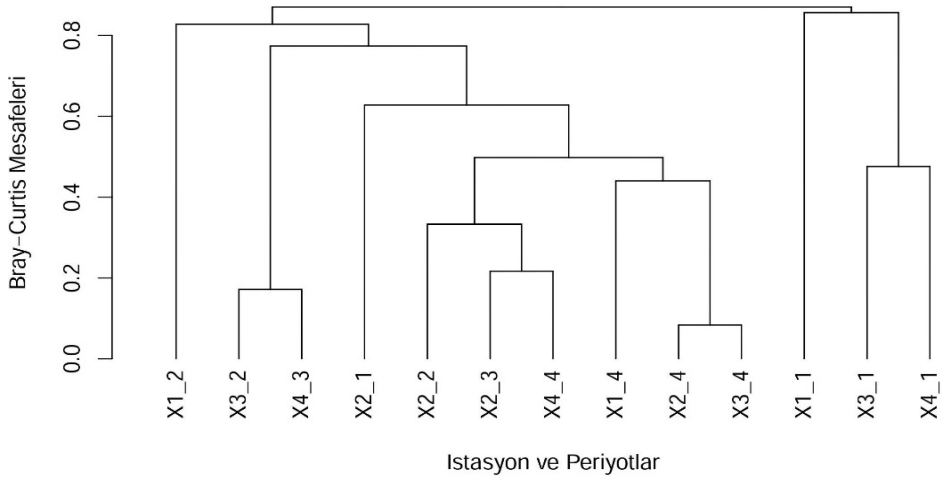


FIGURE 3

A dendrogram showing the similarity of stations and seasons by specimen

TABLE 4
The Shannon-Wienner index graph below shows the density of fish species diversity within the stations during each of the four seasons. (S:Species Numbers, J': Pielou Regularity Index H' (loge): Shannon-Wienner Richness Index (loge))

Season/Station	H'	J'	S
Fall 1	1.42	0.89	5
Fall 2	1.16	0.84	4
Fall 3	0.7	1	2
Fall 4	0.6	0.97	2
Winter 1	0.4	0.6	2
Winter 2	0.6	0.98	2
Winter 3	0	-	1
Winter 4	0	0	0
Spring 1	0	0	0
Spring 2	0.9	0.83	3
Spring 3	0	0	0
Spring 4	0	-	1
Summer 1	0.99	0.72	4
Summer 2	1.27	0.92	4
Summer 3	1.21	0.87	4
Summer 4	0.83	0.75	3

For the similarities between the stations with their sampling seasons, 2 and 3 stations in summer season, 3 and 4 stations in spring and winter seasons, were shown most similarities at the Figure 3.

The similarity of the seasons within the stations winter and spring are the most similar stations compare to others. The fish richness of stations by Shannon-Wiener index analysis is shown in Table 4.

As it is shown on the Table 4 the most richness station is investigated first in fall season (H'=1.4). Because of the out of fish season the lowest richness is in the first station of spring. During the summer season, the reason of the equality of 2 and 3 stations is similarity of richness (J') and regularity (S) valid. For that reasons 2 nd and 3rd stations showed the most similarity of fish samples. Due to the out of season (spring), there were very few numbers of fish species occurred at the stations so the richness valid in this season was generally H':0.

DISCUSSION AND RESULTS

In this seasonal study between May 2014 and February 2015, 13 different species belonging to 6 families (Anguillidae, Moronidae, Carangidae, Sparidae, Mugilidae, Siganidae) were identified Table 1 and 2). Among these species, *Lichia amia* and *Siganus rivulatus* species, which were not seen in previous studies in the region, were encountered for the first time in this study. The species *Gambussia affuniss, Pomatomus saltatrix* [5], *Epinephelus aeneus* and *Epinephelus marginatus* reported by Balik [15] were not found in the research process.

Kulan [4] [reported that Mugilidae, Sparidae, and Moronidae were the most dominate fish families found in the Camlik lagoon in 1984, our study reported similar data. It can be said that there have been no major changes in the fish families dominating these waters between 1984 and 2016.

Balik [15] reported finding the following fish species: *Mugil cephalus, Liza ramada, Liza aurata, Liza saliens, Dicentrarchus labrax, Sparus aurata, Epinephelus aeneus, Epinephelus marginatus,* and *Anguilla anguilla*. In comparison, we also observed the families of Mugilidae, Sparidae, Anguillidae, and Moronidae. However, two species fish mentioned, *Epinephelus aeneus* and *Epinephelus marginatus*, which are listed as endangered species by the International Union for Conservation of Nature (IUCN) [16], were not observed during our research.

Çagirankaya and Meric [5] reported the following fish species in the Yumurtalık lagoon in their 2013 study: *Dicentrarchus labrax, Mugil spp., Liza spp., Sparus aurata, Gambussia affinis, and Pomatomus saltatrix*. Unlike Çağırankay and Meriç [5], we did not encounter the species of *Gambussia affinis* or Pomatomus saltatrix, but we were able to identify and divide two of the other genus names (Mugil spp and Liza spp.) into their respective species: *Mugil cephalus, Chelon labrosus, Liza aurata, Liza carinata, Liza saliens,* and *Liza ramado*.

The first three species of fish species *Sparus aurata*, in all seasons except for the winter season, *Dicentrarchus labrax* in all seasons, and lastly only

in the autumn season *Liza carinata* (Table 3). According to this: Seasonal species diversity of fish caught in the lagoon was examined with the largest variety of fish species in the autumn, while the lowest variety of 3 different fish species in the lowest winter season, fish species diversity was found (Table 3).

According to the Bray-Curtis similarity analysis of the stations, the Darbogaz station shows high similarities with the Camlik and Arapbogazi stations. *Anguilla anguilla* and *Lichia amia* and *Diplodus vulgaris* and *Siganus rivulatus* species were found to have a high similarity in terms of their similarities to fish species (Figure 2 and 3).

CONCLUSIONS

Lagoons is biological diversity, nutrition for fishes and birds, accommodation, breeding environment, economic richness of fish stocks and bird migration routes. Yumurtalık lagoons are one of the lagoon systems that have an important place in terms of geographical location, which is the place frequented by migratory water birds in terms of fish species diversity.

As a result of the there have been no studies on the related lagoons (inland) fish fauna for years. The results of their work, such as fish fauna, provide concrete sources for the knowledge of fish species living in the region. In order to increase the number of aquatic products with a high biological richness, their extraction and examination is necessary in order to the fish fauna consumed as human food.

However, as the world population and nutritional needs increase day by day, the trend towards natural resources is increasing. The one most important of these is lagoon fishing. For fishing in the lagoon lakes usage of fish trapping systems; increased fish species diversity in the lagoon lakes due to the risk of being under the pressure of excessive fishing and to maintain the continuity of the fish fauna determined in the region and to protect the fish species which are in danger of extinction (*Epinephelus aeneus* and *Epinephelus marginatus*) for is considered to be one of the most important studies fish fauna dedected to be done in certain periods.

ACKNOWLEDGEMENTS

This study is supported by Research and Project Unit (FYL 2014-2815) of Cukurova University

REFERENCES

[1] Cevik, F., Polat, S., Dural, M. (2008) Akyatan and Tuzla Lagoons of (Adana, Turkey) phytoplankton and seasonal changes. Journal of Fisheries Sciences.com, 2, (1), 19-29.

[2] Dincer, A. (2007) Relationship between the develop of water resources and lagoons in lower Seyhan Plain (Lsp). Cukurova University Institute of Natural and Applied Sciences, Department of Environmental Engineering, Msc Thesis, Adana 72.

[3] Demir, A. (2008) Determining salinity and some pollution levels in Akyatan lagoon and supporting geographical information system supported distribution. Cukurova University Institute of Natural and Applied Sciences, Department of Environmental Engineering. Msc Thesis, Adana, 158.

[4] Kulan, H. (1984) Investigation of fish species, age and size in Karatas and Camlik Lagoons. Cukurova University Institute of Natural and Applied Sciences, Department of Aqriculture Engineering, PhD Thesis. Adana 105.

[5] Cagirankaya, S.S, Meric, B.T. (2013). Turkey's Important Wetlands: Ramsar Areas. Republic of Turkey Ministry of Agriculture and Forestry, Directorate General of Nature Conservation and National Parks, Department of Sensitive Areas, Ankara. 120-123.

[6] Acikgoz, B. (2001) Water Pollution and Control in Yumurtalik Gulf Lagoons. Cukurova University Institute of Natural and Applied Sciences, Department of Environmental Engineering, Msc Thesis, Adana, 145.

[7] Dural, M., and Goksu, M.Z.L. (2006) Variations of heavy metal levels of seston benthos and sediment seasonally in Camlik Lagoon (Karataş, Adana). E.U. Journal of Fisheries & Aquatic Sciences. 23(1/1), 65-69.

[8] Turan, C. (2007) Turkey Atlas of Marine Fishes and Systematics. Nobel Bookstore. ISBN: 978-9944-73-018-1, 550.

[9] Fishbase. (2016) http://www.fishbase.Org/ (05/01/2016)

[10] Geldiay, R., and Balik, S. (1996) Turkey Freshwater Fish. Ege University, Bornova-Izmir. 532.

[11] Mater, S., Kaya, M., Bilecenoğlu, M. (2002) Turkey Atlas of Marine Fishes. Ege University Printing, Bornova-Izmir. 169.

[12] Clarke, K.R., Warwick, R.M. (2001) Change in Marine Communities, an Approach to Statistical Analysis and Interpretation. 2. Edition. Premier E: Plymouth. 177.

[13] Krebs, C.J. (1989) Ecological Methodology. Harper Collins Publishers. USA. 654.

[14] Clarke, K.R., and Gorley, R.N. (2001). Change in Marine Communities (2. Edition) Primer-E Ltd. 91.

[15] Balik, K. (2006) The structural properties of fisherıes located in Turkey and the modernization of Homa Fishery. Ege University Institute of Natural and Applied Sciences, Department of Fisheries Basic Sciences, Msc Thesis, Izmir. 116.
[16] Abdul Malak, D., Livingstone, S.R., Pollard, D., Polidoro, B.A., Cuttelod, A., Bariche, M., Bilecenoglu, M., Carpenter, K.E., Collette, B.B., Francour, P., Goren, M., Kara, M.H., Massuti, E., Papaconstantinou, C., Tunesi, L. (2011) Overview of the Conservation Status of the Marine Fishes of the Mediterranean Sea. Gland, Switzerland and Malaga, Spain: IUCN. VII-61.

Received: **25.01.2021**
Accepted: **06.03.2021**

CORRESPONDING AUTHOR

Meltem Manasirli
Laboratory Fisheries Faculty
Cukurova University
Balcali 01330 Adana – Turkey

e-mail: mozutok@cu.edu.tr
manasirlimeltem@gmail.com