ISSN: 2538-2152; ECOPERSIA 2023;11(4):307-318.

Tarbiat Modares University

Limnological Observations and Primary Production of Haft Barm Lakes, Fars Province, Iran Limnology of Haft Barm Lake

ARTICLEINFO

Article Type
Original Research

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How to cite this article
Zamanpoore M. Limnological Observations and Primary Production of Haft Barm Lakes, Fars Province, Iran Limnology of Haft Barm Lake. ECOPERSIA 2023;11(4): 307-318

DOR:
20.1001.1.23222700.2023.11.3.1.5

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Article History
Received: July 31, 2023
Accepted: October 1, 2023
Published: December 20, 2023

ABSTRACT

Aims: Haft Barm is a series of five small lakes in the southern Zagros region that has recently encountered rapid human settlement development. This article reports a survey on its essential ecological attributes.

Materials & Methods: Water samples were taken from three locations in March and June 2020 and analyzed regarding physical and chemical factors and plankton communities. Trophic state and primary production were estimated.

Findings: Results showed water temperature 8.2–23.1 °C, dissolved oxygen 6.3–8.3 $mg.L^{-1}$, salinity as electrical conductivity 739 – 971 $\mu S.cm^{-1}$, total nitrogen 0.1–1.1 $mg.L^{-1}$, and total phosphorus 0.4 and 3.8 $mg.L^{-1}$. Algae of the lake consisted of 24 taxa, the highest density of which counted 23360 cells per liter in June, and the Chlorophyceae were the dominant group. The Zooplankton composition was of four taxa from Cladocera (*Bosmina* sp. and *Daphnia* sp.), Copepoda (*Cyclops* sp.), and Rotifera (*Rotaria* sp.), with the highest densities in *Rotaria* (35 individuals per liter). *Phragmites* sp. and *Juncus* sp. were the dominant species in the macrophyte community besides *Polygonum amphbium* and *Potamogeton pectiatus*. The high total phosphorus concentration is a strong sign for predicting a eutrophic condition. The average trophic index is estimated at 88, which suggests a eutrophic to hyper-eutrophic state for the lake. The estimated primary production of the lake was 1114 $gC.m^{-2}.A^{-1}$.

Conclusion: The high concentrations of total Phosphorus and total Nitrogen are significant threats to a eutrophic state. Intensified development of suburban houses and agriculture are the leading causes of pollution and water depletion in the Haft Barm lakes.

Keywords: Small lakes ecology; Trophic condition; Water pollution; Zagros.

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[DOI: 10.22034/ecopersia.11.4.307]

Introduction

Small lakes and ponds are essential for the whole ecosystem due to their specific biodiversity composition and the functional features for energy and matter recycling. Among their most important roles is their significant impact on carbon sequestration [1], which is a major factor in preventing global warming from further progression. Their particular action in the retention of local waters is determined in the arid regions, where precipitations are scarce, the temperature is high, and normally, the evaporation rate is maximal [1,3]. They face consequences of human community aggregations due to various activities such as fishing, bird watching, and camping.

Small lakes have unique features that make them more vital to the landscape ecosystem than larger lakes. Many are located in restricted watershed basins or basins with low annual precipitation. The causal feature of receiving the drainage from surrounding mountains enables their hydrological function in producing soil moisture, feeding underground waters, and evaporating water to the atmosphere when water supply is a significant concern for all life forms. The aquatic biodiversity is generally very rich [1] compared to other ecosystems, and small water bodies support even more biodiversity, including rarer species compared to all other forms of freshwater ecosystems [4]. In addition to the complex aquatic food web, its diverse biota are generally a significant source of feeding for many land-dwellers, hence a crucial factor for the richness and heterogeneity of biodiversity on the local and regional scales [5].

The distribution of small lakes varies around the world. Recent studies show that ca. 304 million natural lakes have been found on the continents, covering an area of 4.2 million km^2, among which small lakes (those with less than 10 km^2) dominate [1]. Small water bodies are found in all biogeographical regions [4], but their number and extent may differ from region to region. Around 500,000 natural and man-made ponds have been recognized in Great Britain [6]. In the United States, their count is at least 2.6 million, most located in the east half of the continent and comprising ca. 20% of the standing water [7]. Data from developing and underdeveloped countries are less accurate and extensive. An early survey in Bangladesh counted 1.3 million small water bodies, covering 164,000 ha across the country [8].

All lands in Iran are either in the mountainous Alborz-Zagros regions or the vast Central Desert (Kavir Markazi). The extensive mountainous regions imply the possibility of forming enormous catchments and, expectedly, water bodies. Many large lakes have been known and investigated for a long time. Most of the published works on large lakes have been on crustacean populations [9], hydrochemistry [10], sedimentology [11], and cladoceran stratigraphy for the related historical climatic changes [12], as well as the recent works on limnology and hydrogeochemistry [13,19]. Unfortunately, only a few documents are found describing or listing small lakes and other water bodies, and there are no documented data on the number of such ecosystems in Iran. Scattered works can be found on their fauna and flora [9,20], bathymetry [21], and hydrology [22]. However, outstanding processes and functions mediated by the small lakes necessitate a better understanding of the role of small lakes and ponds. This suggests inventories of water bodies and detailed research on their limnology [23].

Haft Barm (in Persian: seven ponds) region comprises a series of small lakes and ponds in Shiraz County, 55 km west of Shiraz. The vicinity of the location to the province capital, having ca. 2 million dwellers, has made it an attractive recreational destination. The

[DOI: 10.22034/ecopersia.11.4.307]

outcome of land-use change and dense pollution brought by visitors implied drastic changes to the natural landscape. This paper represents some ecological features resulting from field surveys on one of the lakes and the existing data on its surrounding ecosystems.

Materials &Methods

Site description: Haft Barm (the seven ponds) is a series of small lacustrine wetlands (29°48'39"N, 52°02'10) in 70 km Northwest Shiraz, in the lower mountain region of Southern Zagros (Figure 1). In recent years, two smaller lakes have become water ditches and may not be considered ponds. It is supposed that there used to be two other ponds, but they have been dried up. No streams drain the lakes, and the only water source seems to be surface water [24] from the precipitation in late autumn to mid-spring and, in a lesser amount, a few small springs in the surroundings. The lakes are close, and no apparent water connections exist between them. They also have a weak connection to the underground water currents emerging from surrounding aquifers [24]. The mean annual maximum depth in lake number 1 (southernmost) was recorded at 5.4 m in 2001 (Unpublished data by the author and colleagues). This survey is focused on Lake 1, and the results are not concluded for other lakes. Therefore, the study area is the whole of Lake 1, with an area of 163,316 m^2 and a perimeter of 1600 m.

Hydrology: Geologically, the wetlands are located in Inner Fars and on the Gachsaran Formation on the western edge of the Kore Bas fault, on Quaternary alluvial deposits in the vicinity of the northern side of the Anar karst anticline. There are three aquifers of limestone, alluvium, and Gachsaran formation in the region, which have the potential to supply water to the lakes. The geological, hydrogeological, hydrochemical, and isotopic results showed that the main source of the lakes' water is the surrounding surface waters, and the connection between the lakes and the aquifers of the nearby formations is shallow [24]. Additionally, the karst aquifer balance shows that the water level of the lakes is higher than that of the underground water [25], so it is unlikely that this lake is fed from the bottom by the Anar karst aquifer. Therefore, the most crucial source of feeding these lakes is from surface water sources (direct rain and surface runoff). Calculations of the lake's water balance showed that a part of the water (ca. 4.5 Mm^{-3}) annually enters the alluvial aquifer adjacent to the lake as a subsurface outlet [24]. This has also been shown by detecting water currents inside the lakes, towards the peripheries [26]. This continuous outflow might be why these lakes have yet to turn saline, as seen in other enclosed small lakes [26].

Climate: Measurements in 2000 showed an annual daytime average air temperature of 23.0°C (SD=5.6), with a minimum of 14.5°C and a maximum of 32.5°C (Unpublished data by the author and colleagues). The climate is recognized as semi-humid and semi-cold, with cold winters and hot summers [27]. Some of the basic climatic parameters of the region are given in Table 1. Lake areas in 2020 were 1619 m^2, 2437 m^2, and 3130 m^2, and lake peripheries were 16.5 ha, 24.5 ha, and 44.8 ha for lakes 1, 2, and 3, respectively (measured by the author on Google Earth pictures).

The lakes are in land depressions (2174 m. at Lake 1, 2167 m. at Lake 2, and 2148 m. at the Lake 3 peripheries) surrounded by higher elevations of mountains with 2428–2859 m in the north and west, and a series of low hills with less than 2230 m in the south and the east (Figure 1).

Land use: Since 2000, there has been a drastic change in land use that is still ongoing. The lakes are surrounded mainly by private orchards (grapes, apples, and pears) and gardens.

[DOI: 10.22034/ecopersia.11.4.307]

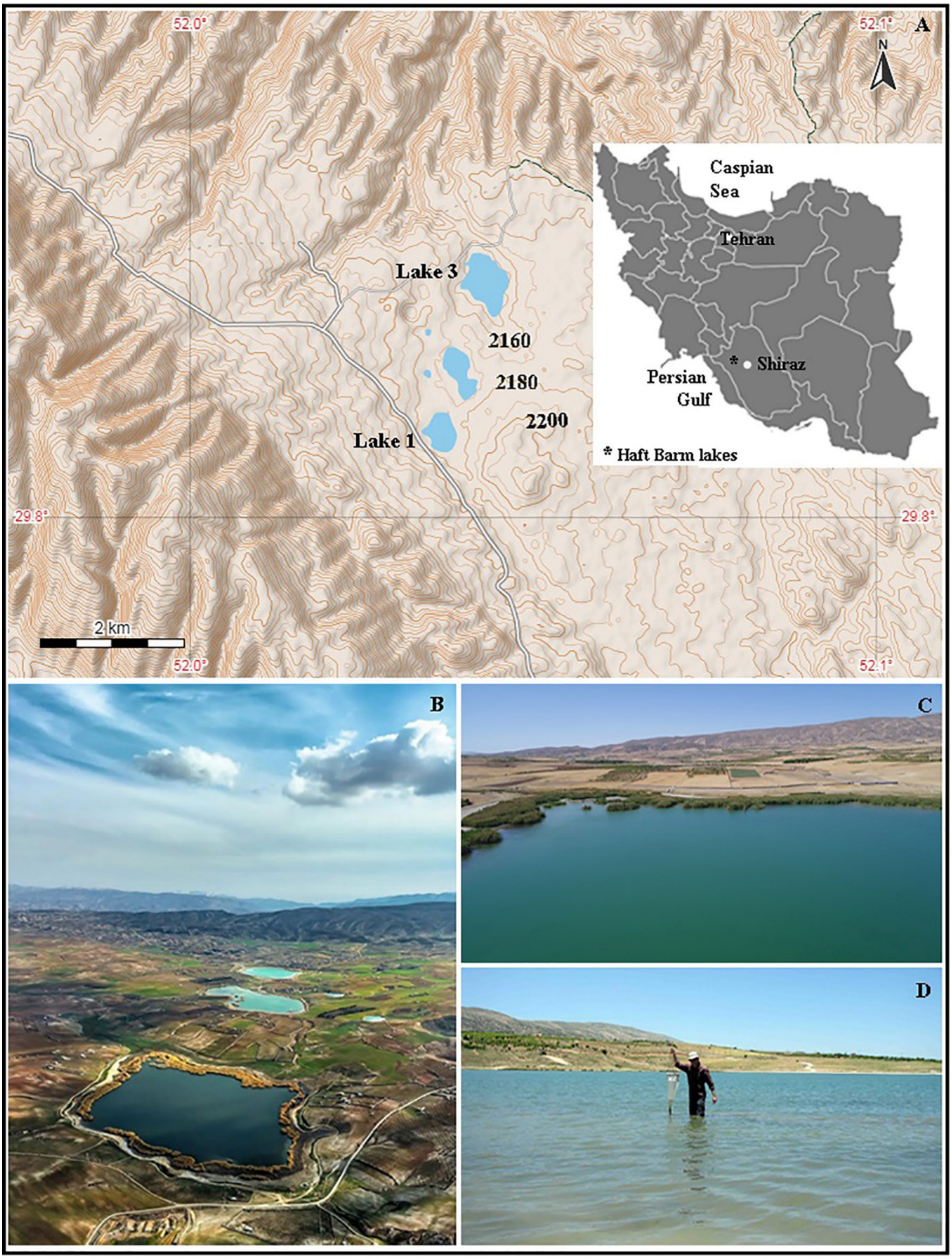

Figure 1) A, Location of Haft Barm lake series in Fars Province, Iran, and the topography of the region; B, aerial photograph of the pond series from a north-south view (photo from Ali (Hesam) Mohammadian); C, closer view from lake 3, northernmost lake (photo from Saeed Zangane); D, sampling planktons in lake 1.

[DOI: 10.22034/ecopersia.11.4.307]

Table 1) Long-term basic climatic parameters of the Haft Barm region, derived from the zonation maps [27].

Mean annual precipitation (mm)	Mean annual evaporation (mm)	Mean air temperature (°C)	Mean of min. air temperature (°C)	Mean of max. air temperature (°C)	Absolute max. of wind speed ($m.s^{-1}$)	Annual average hours of sunshine (h.)
490.7–677.1	2435.0–2556.7	16.1–17.6	10.2–11.9	25.5–26.8	29.9–31.1	3245.0–3304.6

Limnological samplings: All the lakes in Haft Barm are not large-scale lakes, and lake 1 is the smallest among them (most extended length 570 m, longest width 420 m), so it is expected to have a few various parts. Hence, selecting a single location from any of the littoral, limnetic, and profundal zones of Lake 1 effectively represents its overall condition.

Water samples were taken two times in March and June 2020. Abiotic factors were measured locally, including electrical conductivity, pH (By using Hanna-HI 1281), temperature, and dissolved oxygen (Hach HQ40d Multimeter). Water transparency was measured using a Secchi disc. The water samples were kept in a cool box and brought to the lab within 1 hour. Total phosphorus (acid digestion method [28]) and total nitrogen (sum of nitrate, nitrite, and ammonia)[28] were measured.

Plankton samples were taken from the three mentioned zones (littoral, limnetic, and profundal) at 11:00 each day to prevent probable vertical migrations. Zooplankton was sampled with a 60 µm plankton net. Two liters of water were passed through the net, the remaining content was transferred to the sampling glasses, and five drops of Lugol's iodine were added for fixation [29, 30]. Another 2 L of the whole water (unfiltered) sample was taken for phytoplankton collection and fixed by Lugol's iodine. All samples were left for three days. The sediments in the storage containers were stirred to create a uniform mixture. A pipette was used to prepare a subsample from this mixture. The phytoplankton samples were then identified and counted using Sedgewick Rafter Cell (for zooplankton) and hemocytometric slide (for phytoplankton) under a stereo microscope. The data were statistically analyzed for comparison between two seasons using one-way ANOVA. Macrophyte samples with roots were collected from the lake periphery.

Trophic status: Simple Trophic state index (TSI) models were used to check the trophic conditions. These models determine the trophic state of the lakes and reservoirs based on the phytoplankton standing crop. The trophic index based on algal biomass (with Secchi depth) and total phosphorus was obtained with the Eqs. (1 and 2) [31].

$$TSI\ (SD) = 60 - 14.41\ \ln\ (SD)\ (m) \qquad \text{Eq. (1)}$$

$$TSI\ (TP) = 14.42\ \ln\ (TP) + 4.15\ (\mu g.L^{-1}) \qquad \text{Eq. (2)}$$

SD is Secchi disc depth, and TP is total phosphorus. If the index value is less than 30, the lake is oligotrophic; if it is 30 to 50, it is mesotrophic; if it is 50 to 70, it is eutrophic; and if it is more than 70, it is hypertrophic [31]. Primary production (PP) was estimated based on Eq. (3) [32, 33].

$$PP\ (gC.m^{-2}.A^{-1}) = 148.\log TP - 39.6 \qquad \text{Eq. (3)}$$

Findings

Minimum and maximum water temperatures were recorded at 8.2 °C and 23.1 °C (total annual: 16.1 ± 5.8°C), and dissolved oxygen levels were between 6.3 and 8.3 $mg.L^{-1}$ (total annual: 7.4 ± 0.6 $mg.L^{-1}$). The salinity of the lake water ranged from 739 – 971 $\mu S.cm^{-1}$ (total annual: 850 ± 60 $\mu S.cm^{-1}$).

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The lowest and most recorded pH values were 7.5 and 8.3 (total annual: 7.9 ± 0.2). Total nitrogen and phosphorus were measured between a minimum and maximum of 1.1 and 3.8 $mg.L^{-1}$ (total annual: 2.43 ± 0.79), and 0.01 and 0.04 $mg.L^{-1}$ (total annual: 0.02 ± 0.01), respectively. Transparency of the lake was between 145 and 65 cm in March and June, respectively, with an annual average of 111 ± 43 cm). Mean water temperature was higher in June (21.7 °C ± 1.0) than in March (10.5 °C ± 1.3); dissolved oxygen was lower in June (6.9 $mg.L^{-1}$± 0.3) than in March (7.9 $mg.L^{-1}$± 0.3); pH was lower in June (7.8 ± 0.1) than March (8.2 ± 0.1); electrical conductivity was lower in June (806 $\mu S.cm^{-1}$ ± 44) than March (893 $\mu S.cm^{-1}$ ± 41); and total nitrogen and total phosphorus were higher in June (3.2 $mg.L^{-1}$ ± 0.4 and 0.027 $mg.L^{-1}$± 0.005) than in March (1.7 $mg.L^{-1}$ ± 0.2 and 0.021 $mg.L^{-1}$ ± 0.008). Transparency of the lake's open waters was 152 cm in March (± 6) and 71 cm (± 5) in June. Mean values of water temperature, dissolved oxygen, pH, electrical conductivity, and total nitrogen did not show a significant difference among zones (Figure 2). However, they all showed a significant difference ($P<0.005$) between March and June. The concentration of total phosphorus was significantly different both among lake zones ($P<0.005$) (Figure2) and between March (0.027 $mg.L^{-1}$) and June (0.021 $mg.L^{-1}$) ($P<0.025$) samplings.

All six parameters showed significant differences between their March and June values; total phosphorus differences were significant between the three lake zones ($P < 0.05$). Trophic indices estimated by transparency and TP were 59 and 117, respectively, with an average of 88. The estimated primary production of the lake was 1114 $gC.m^{-2}.A^{-1}$. Macrophyte populations in the littoral periphery of the lake consisted of *Polygonum amphbium*, *Potamogeton pectiatus*, *Phragmites* sp., and *Juncus* sp., with the two latter as the dominant species. Twenty-four phytoplankton populations from 22 families and three classes were recognized (Table 2). Mean total phytoplankton counts in the three lake zones were 6820 (SD = 3249) and 23360 (SD = 7796) cells per liter in March and June, respectively. Chlorophyceae were the dominant group both in March with 4230(SD = 1624) cells per liter and in June with 18960 (SD = 8649) cells per liter, and Chrysophyceae counted 1532 (SD = 1092) and 2691 (SD = 582) cells per liter in March and June (Figure 3, left).

Table 2) Identified algae from the Haft Barm Lake.

Class Chlorophyceae	**Family Chlorellaceae**	**Closteriopsis sp.**
	Family Oocystaceae	*Eremosphaera* sp.
	Family Hydrodictyaceae	*Pediastrum* sp.
	Family Scenedesmaceae	*Tetradesmus* sp.
		Coelastrum sp.
	Family Desmidiaceae	*Sphaerozosma* sp.
		Tetmemorus sp.
	Family Closteriaceae	*Closterium* sp.
	Family Peniaceae	*Penium* sp.
	Family Gonatozygaceae	*Gonatozygon* sp.
	Family Cladophoraceae	*Rhizoclonium* sp.
	Family Chaetophoraceae	*Stigeoclonium* sp.
	Family Sphaeropleaceae	*Sphaeroplea* sp.
	Family Uronemataceae	*Uronema* sp.
	Family Chlorellaceae	*Dictyosphaerium* sp.
	Family Dinobryaceae	*Dinobryon* sp.
	Family Schizogoniidae	*Schizogonium* sp.
Class Xanthophyceae	Family Heterococcaceae	*Monocilia* sp.
	Family Gloeobotrydiaceae	*Gloebotrys* sp.
	Family Botrydiaceae	*Botrydium* sp.
	Family Characiopsidaceae	*Chlorothecium* sp.
Class Chrysophyceae	Family Chrysocapsaceae	*Chrysocapsa* sp.
	Family Chrysothallaceae	*Phaeoplaca* sp.
	Family Hydruraceae	*Hydrurus* sp.

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The Zooplankton community was comprised of only four populations from Cladocera (*Bosmina* sp. and *Daphnia* sp.), Copepoda (*Cyclops* sp.), and Rotifera (*Rotaria* sp.). In June, all groups exhibited higher population densities compared to March. (Figure 3, right). Mean density of the three lake zones was 4 (SD = 2) and 13 (SD= 6) individuals per liter for *Bosmina*, 1 (SD = 1) and 5 (SD = 3) individuals per liter for *Daphnia*, 10 (SD = 3) and 21 (SD = 5) individuals per liter for *Cyclops*, and 26 (SD = 14) and 35 (SD = 12) individuals per liter for *Rotaria*, in March and June respectively (Figure 3, right).

Discussion

Physical and chemical parameters of the Haft Barm wetland showed similarities and differences with some other studied small lakes in Iran. During the sampling period, water temperature ranged between 8.2 °C and 23.1 °C, which is colder than many normal lakes in the southern hot regions. However, freshwater lakes in northern, cold parts of the country are in the same ranges, like in the Kani-Brazan wetland, West Azarbaijan, with 9.4–24.8 °C [34] and 8–26 °C in Bazangan Lake, Khorasan Razavi Province [35], or lower measures of 0–17 °C in Neor Lake, Ardebil Province, ranges [36] and 3.5–30 °C in Zarivar Lake, Kurdistan Province [37]. Dissolved oxygen ranged from 6.3–8.3 mg.L^{-1}, showing a more or less uniform, highly oxygenated water throughout the year, which does not exceed the saturation maximum, probably showing that the lake is not in eutrophic condition. This situation is more like Bazangan Lake with DO of 7–11 mg.L^{-1} [35], in contrast to those lakes with strict differences between seasonal DO concentrations, e.g. Kani-Brazan wetland with 1.5–13.8 mg.L^{-1} [34], Zarivar Lake with 2.7–11.2 mg.L^{-1} [37], Shoormast Lake with 1.7 Spring, 7.9 mg.L^{-1} [38], and Neor Lake with DO of 0.4–11.23 mg.L^{-1} [36]. In all these water bodies, the mean temperature was higher in summer, and dissolved oxygen was lower in winter or early spring. The salinity of the lake water was measured at 739–971 µS.cm^{-1}, introducing it as a freshwater lake well below the limits of the freshwater category. Different conductivities are seen in other freshwater lakes, including the less saline Zarivar Lake, ranging from 295–426 µS.cm^{-1} [37], and Bazangan Lake, Khorasan Province, with conductivities of 12300–20000 µS.cm^{-1} [35]. The pH values were measured between 7.5 and 8.3 in the same range as other recorded lakes, like 7.28–8.3 in Zarivar [37], 7.4–8.4 in Kani-Brazan [34], and 7.5–8.1 in Bazangan [35].

Total nitrogen changes were recorded as 1.1–3.8 mg.L^{-1} (1.6–3.4 mg.L^{-1}). Lakes with total nitrogen (inorganic and organic nitrogen) between 1.2 and 2.7 mg.L^{-1} is known to be eutrophic and will be hypereutrophic if it is more than 2.7 mg.L^{-1} [39] takes nitrogen as the criterion. According to this, the total nitrogen values in Haft Barm were very high, i.e., the lake was in eutrophic–hypereutrophic condition. They were also close to other recorded lakes like Zarivar, which showed broad limits of 0.7–11.3 mg.L^{-1} [37], while some other lakes showed lower limits, such as Kani-Brazan with 0.4-0.8 mg.L^{-1} [34], and Bazangan Lake with 0.35–0.55 mg.L^{-1} [35]. All these lakes were in hypereutrophic condition. The total phosphorus minimum and maximum in Haft Barm were 0.012 and 0.036 mg.L^{-1} (means of 0.014–0.032 mg.L^{-1}). Minimum TP was in the same range as other recorded small lakes of the country, but its maximum value was much less than their higher limits. Choghakhor, Zarivar Lake, and Bazangan Lake had TP ranges of 0.018–1.412 mg.L^{-1} [40], 0.019–1.45 mg.L^{-1} [37], and 0.06–0.63 mg.L^{-1} [35], respectively, with the highest maximum in Kani-Brazan with 0.023–4.2 mg.L^{-1} [34]. Unpolluted surface waters are expected to

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contain total phosphorus between 0.01 to 0.05 mg.L^{-1}, and the relationship of their productivity to average TPs puts them in 5 classes of ultra-oligotrophic (<0.005 mg.L^{-1}) to hypereutrophic levels (>0.1 mg.L^{-1}) [39]. It is clear that all the mentioned lakes have TPs much higher than normal in periods of the year, most probably because of the runoffs containing phosphorus from the surrounding lands under agriculture; the TP in Haft Barm put this lake in a meso-eutrophic range (0.01–0.03 mg.L^{-1} [39]) in both March and June. The lake transparency in the open waters was about twice as high in March (152 cm) than in June (71 cm) due to the increase in the plankton community. The mean transparency ofChoghakhor wetland was reported as 135 cm [40]. Transparency data were used in the determination of trophic state. Trophic indices estimated by transparency and TP were 59 and 117, respectively, with an average of 88. As

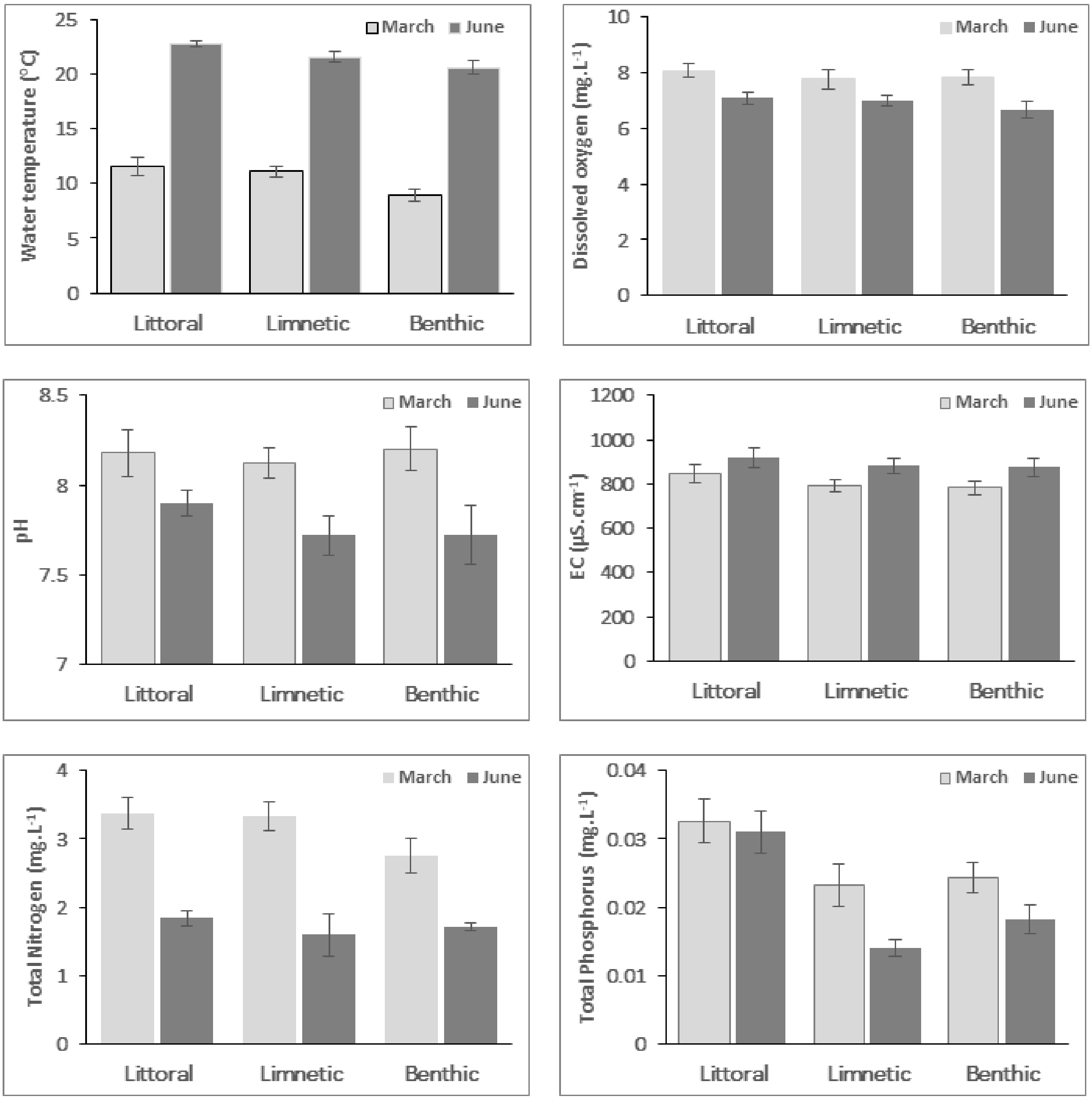

Figure 2) Physical and chemical parameters of water in pond 1 of the Haft Barm lakes in March and June.

[DOI: 10.22034/ecopersia.11.4.307]

transparency depths of 100 – 200 cm are proposed to indicate the eutrophic state of the lake, and when it decreases to as low as 50 –100 cm, it approaches hyper-eutroph conditions [41], we can conclude that Haft Barm is in somewhere between being eutrophic and hyper-eutroph, based on the water transparency. The estimated primary production of the lake was 1114 $gC.m^{-2}.A^{-1}$. Temperate lakes of the world have primary productions of 2–290 $gC.m^{-2}.A^{-1}$, and tropical lakes 30–2500 $gC.m^{-2}.A^{-1}$ [42]. Fars Province is in a subtropical region, so the estimated production is in the normal range.

The lake's three zones (littoral, limnetic, benthic) were not significantly different regarding the main physicochemical factors (T, DO, pH, EC) and total nitrogen. As Haft Barm is a small shallow lake, it is predictable that local water currents made by daily winds are compelling enough to mix up the water in all parts and make its contents more uniform throughout the lake's volume. Additionally, we did not investigate the lake's stratification, so the effect of separated layers on the chemical zonation has yet to be discovered. On the other hand, total phosphorus concentration was significantly different among lake zones, being higher in the littoral zone in the lake's periphery. This can be explained by the fact that phosphorus is used in agricultural fertilizers in all orchards in the surroundings and released from the sewage discharge, entering the lake periphery. The highest phytoplankton density in the Haft Barm Lake was 23360 cells per liter in June, with Chlorophyceae (18960) as the dominant group, proceeded by Chrysophyceae (2691). In Einak wetland, Gilan Province, which is in the middle of the capital city of Rasht, Cyanophyta was dominant. However, their density was 4.2 M cells per liter [20], much higher than Haft Barm, clearly due to nutrient input from the urban drainage. The number of identified genera was also higher in Einak (30 genera) than in Haft Barm (24). The diversity of phytoplankton was higher (30 species) in Yadgarlu, a temporary eutrophic wetland, but much higher (94 species) in the Hasanlu reservoir, both in Kurdistan Province [43]. Dominant classes were Streptophyata in Hasanlu, while in Yadgarlu, Chlorophyceae were dominant. In Esteel wetland, west of Gilan Province, 42 genera were identified, with Cyanophyta as the dominant class [44]. Gholami et al. [35] found 33 species in Bazangan Lake, Khorasan Razavi, where the primary dominant class was Chrysophyta. In Band Ali Khan wetland, Tehran Province, Bacillariophyceae were dominant phytoplankton [45].In June, the zooplankton exhibited higher population densities compared to March (74 individuals per liter), while *Rotaria* [36] and *Cyclops* [21] were dominant. Data regarding zooplankton communities in small lakes are less produced. However, the zooplankton community of Band Alikhan wetland consisted of *Brachionus* (Rotifera), *Daphina* and *Cyclops* (Crustacea), and *Vorticella* (Ciliata) with *Vorticella* (119 individuals per liter) as the dominant taxon.

In comparison, the density of crustaceans and rotifers was lower than 15 individuals per liter. Like in the Haft Barm, their total density in summer was higher than in winter [45]. The composition of zooplankton in Amirkalayeh lagoon, Gilan Province, was populations of Protozoa, Crustacea, Platyhelminthes, Nematoda, and Rotifera, where Ostracoda (35 individuals per liter) was the dominant taxon.

Conclusion

The data from this short-term investigation showed that the lake condition is acceptable based on oxygen content. However, the high level of total phosphorus and total nitrogen is a big threat, which may lead the lake wa-

[DOI: 10.22034/ecopersia.11.4.307]

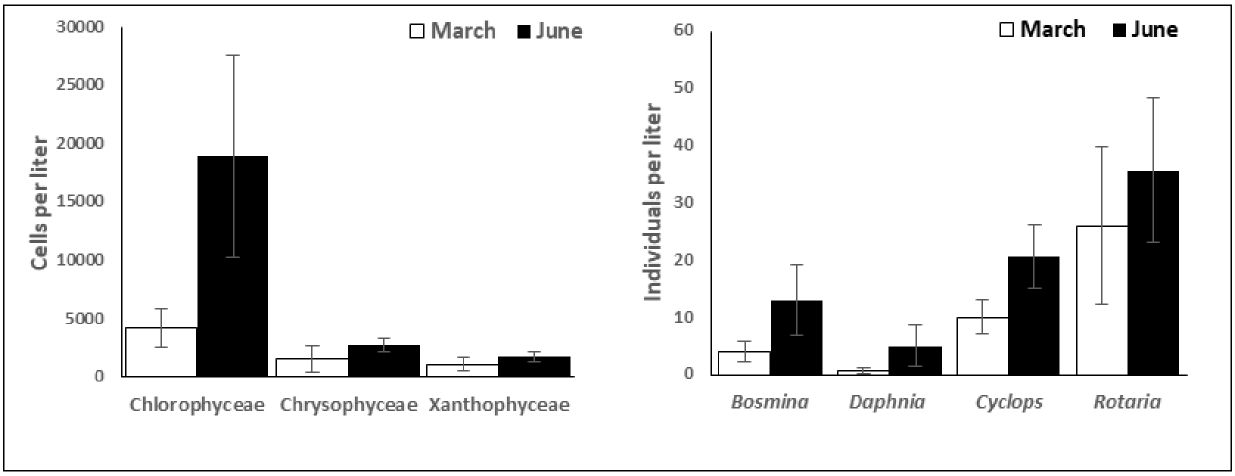

Figure 3) Density of phytoplankton (left) and zooplankton (right) in March and June in Haft Barm Lake.

ter towards eutrophic and hyper-eutrophic states. Dense construction of country houses and vacation homes, the growing residents, and the consequently produced home sewage discharge, in addition to the pollution from the use of fertilizers in the gardening activities around the lakes, dissipated and washed into the lake, are growing sources of phosphorus and nitrogen accumulation in the lake water. It must be noted that all these land-uses need water, coming from the newly dug wells and even directly from the body of lake water. Moreover, an uncountable number of illegal water tankers pump the water directly from the lake to sell it to gardeners in the region. All these newly increasing land-uses in such an arid environment, in times of low precipitation and extensive warming, will end up in total drought in the imminent future.

Acknowledgments

I am thankful to Dr. G. Ghahari, Fars Research and Education Center for Agriculture and Natural Resources, for his advice on the extraction of the climatic history of the region. The English text of the article was read and corrected by Miss Salma Khademi. I am very grateful to her.

Funding/Support. All parts of this survey were done with the author's funding.

Ethical permissions. The author declares that research ethics approval was not required for this study.

Conflict of interest. The author has no conflict of interest regarding this research and manuscript.

Authors contribution. The author declares that he planned and conducted all parts of this research, made data analysis, and wrote the whole manuscript. Chemical analyses were sent to a private lab.

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