Original paper

Investigating the Biodiversity Birds in Arak Forest Park

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Abstract
This research aims to investigate the diversity, density, and distribution of birds in Shahid Bahonar Arak Forest Park during the spring, summer, and autumn seasons. From April to December 2020, bird species in Shahid Bahonar Arak Forest Park were identified and quantified using the point counting method at 12 designated stations. A total of 21 bird species were observed in the park, with common swifts, Syrian woodpeckers, house sparrows, rock doves, and rooks identified as nesting species in the forest park. House sparrows exhibited the highest abundance across all three seasons. Calculation of biological indicators revealed that spring exhibited the highest species richness (3.07), summer demonstrated the highest species diversity (3.36), and autumn displayed the highest bird density (0.86) along with the highest species uniformity (0.58). Analyzing the distribution and species richness of bird counting stations in each season indicated that the first station had higher species richness compared to the other stations. Proximity to the water pool, the presence of birds in the zoo, audible bird calls, and an increase in insect abundance for feeding are considered contributing factors to this observation.
Keywords: *Arak forest park, Point counting, Biological indicators, Birds*

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Introduction

Understanding the distinctive patterns of species diversity is a crucial step in biodiversity conservation and a significant focus within the field of biogeography [1], [2], [3], [4], [5], [6]. Birds, given their high mobility and expansive territorial range throughout their life cycle, serve as an ideal model for elucidating the intricate relationships between animal communities and vegetation. Their widespread distribution and abundance make them valuable indicators for assessing environmental quality. Particularly in plant-covered environments, birds play a vital role in seed dispersal, energy circulation, and insect control [7], [8], [9].

Numerous researchers worldwide have explored the correlation between the distribution and abundance of bird species and various independent environmental variables. Some emphasize the significance of plant mass structure as a key factor influencing bird distribution and abundance [10], [11], [12]. Elevation, altitude, climate, and vegetation are recognized as crucial predictors for the distribution patterns of birds [13], [14], [15]. Concerning vegetation, both its structure and species composition are essential aspects [16], [17], [18]. While some birds focus on vegetation structure, others consider both aspects (structure and composition) crucial for habitat selection [16], [19], [20], [21].

This survey, by identifying the density and distribution of bird species, establishes a foundation for more specialized research. Examining the impact of various forestry and green space projects on the richness and diversity of bird species, as well as investigating changes in bird community patterns resulting from global climate change, are avenues of research that can offer insights into monitoring environmental changes and their effects on biodiversity at the park scale.

Material and Methods

- Study Area:

Shahid Bahonar Arak Forest Park is situated 5 km southeast of Arak city, with geographical coordinates at 49 degrees and 46 minutes east longitude and 34 degrees and 4 minutes north latitude. The afforestation of this park commenced in 1362 by the General Department of Natural Resources of the Central Province and concluded at the end of 1993. The park covers a total area of 320 hectares, with an additional 30 hectares allocated for the construction of the nature park (Arak Zoo) in 1993. Plant species in the park comprise 25 tree species, 13 shrub species, 42 grass species, and 23 seasonal flowering ornamental plants [22].

- Material & Method:

The point counting method was employed for bird identification and counting in Arak Forest Park during the spring, summer, and autumn seasons [23], [24], [25], [26], [27]. The initial step involved determining observation and counting stations. These stations were positioned between 125 and 200 meters from the park's border, with distances between stations ranging from 150 to 250 meters. Stations were also situated 50 to 150 meters away from water sources and main/secondary roads within the park [23], [27], [28]. In Shahid Bahonar Forest Park, a total of 12 stations were designated, the first of which was located in the zoo, and the remaining stations were spread throughout the forest park (see Map No. 1).

Subsequently, the bird counting range was defined using a circular plot with a radius of 50 meters, centered on each station. The maximum duration for counting birds at each station was set at 5 minutes, and park visits occurred twice a month from sunrise until 10 am [23], [27], [28]. Identification was conducted through both audio and visual methods, utilizing a Zeiss binocular camera with 40x10 magnification. The results of these censuses were then used to calculate the number of species, abundance, and bird density per hectare. Subsequently, ecological indicators

(richness, uniformity, and species diversity) were determined using the Ecological Methodology software with the provided formulas [29], [30].

• Species diversity (Shannon-Wiener)

$$H' = \sum_{i=1}^{s} (Pi) Ln(Pi)$$

$Pi = ni / N$

• Species richness (Margalof)

$$R = \frac{S-1}{LnN}$$

• Species uniformity (Simpson)

$$E_{1/D} = \frac{1/D}{S}$$

In these relationships, the variables are defined as follows: *H'* represents species diversity, *R* stands for species richness, *E*1/*D* denotes Simpson's uniformity, *S* is the number of species, *N* represents the total number of individuals in the community, *ni* signifies the number of individuals of each species, *Pi* represents the relative abundance of species, and *D* is Simpson's index [29], [31], [32]. To create a bird distribution map, the observation points for each species were recorded using a GPS device. Subsequently, a bird distribution map of the park was generated using a Geographic Information System (GIS) and ArcGIS software.

Results

A total of 21 bird species were observed across the three seasons of spring, summer, and autumn in Shahid Bahonar Arak Forest Park (Table 1). Notable nesting species in the park included common swifts, Syrian woodpeckers, house sparrows, rock doves, and rooks. Spring exhibited the highest species count with 17, followed by summer with 16 species, and autumn with the least at 12 identified species. House sparrows were the most abundant species in all three seasons (refer to Table 1). The highest bird density (0.86) was recorded during the autumn season (refer to Figure1).

Calculation of biological indicators further revealed that spring had the highest species richness (3.07), summer displayed the highest species diversity (3.36), and autumn showed the highest species uniformity (0.58) (refer to Figures 2, 3, 4). Examination of species richness at bird counting stations during each season highlighted that one station consistently exhibited higher richness compared to others (refer to Figure 5). Proximity to the swimming pool and zoo, leading to an increase in insects and bird sounds from the zoo cages, coupled with its location in Plot A of the vegetation map (featuring 11 tree and shrub species), made it the most diverse area, second only to Plot B (with 12 species).

The distribution of observed species is visually represented in Maps No. 2, 3, 4, and 5. Based on the bird distribution in the park and the observed species richness at each station, Map No. 6 suggests a recommended route for bird enthusiasts interested in bird watching at Shahid Bahonar Arak Forest Park.

Results of field surveys and consultations with experts familiar with the state of Shahid Bahonar Forest Park regarding factors influencing bird attraction are summarized as follows:

- Positive Factors of Shahid Bahonar Forest Park:
    1. Migration Route: The park is situated along the migration route of birds.
    2. Ecotone Area: Located in the ecotone, the transition zone between the plain and the

mountains.
3. Zoo Birds: Presence of birds from the zoo contributes to biodiversity.
4. Water Sources: Availability of water sources within the park.
5. Security: Most days of the year are characterized by a secure environment.

- Negative Factors of Shahid Bahonar Forest Park:
1. Water Scarcity: Insufficient water availability within the park.
2. Vegetation Structure: Lack of diverse vegetation structure.
3. Roads and Streets: Impact of roads and streets within and around the park.
4. Citizen Presence: Large crowds during holidays, particularly in spring and summer.
5. Garbage Pollution: Presence of litter and garbage in the park.
6. Power Lines: High-pressure power lines affecting the park landscape.
7. Industrial Presence: Surrounding industries and factories contribute to sound and air pollution.

These findings provide valuable insights into both the positive and negative factors influencing bird abundance and diversity within Shahid Bahonar Forest Park, highlighting areas for potential conservation and improvement efforts.

Table 1. Abundance of birds observed in each season in Arak Forest Park

| SPECIES NAME		ABUNDANCE		
Name	**Scientific Name**	**Spring**	**Summer**	**Autumn**
Kestrel	*Falco tinnunculus*	3	2	-
Partridge	*Ammoperdix griseogulari*	5	3	3
Rock dove	*Columba livia*	11	8	8
Laughing dove	*Streptopelia senegalensi*	6	4	3
collared dove	*S. decaocto*	11	14	5
Common swift	*Apus apus*	20	13	-
European bee-eater	*Merops apiaster*	2	-	-
Hoopoe	*Upupa epops*	-	3	-
Syrian woodpecker	*Picoides syriacus*	4	2	-
White wagtail	*Motacilla alba*	13	12	10
Western Yellow Wagtail	*M. flava*	8	7	-
Common nightingale	*Luscinia megarhynchos*	2	2	-
Rufous-tailed Scrub Robin	*Cercotrichas galactotes*	3	-	-
Spotted flycatcher	*Muscicapa striata*	4	-	-
Desert finch	*Rhodospiza obsolete*	-	11	13
house sparrow	*Passer domesticus*	65	54	51
Spanish sparrow	*P. hispaniolensis*	-	-	31
Starling	*Sturnus vulgaris*	-	-	26
magpie	*Pica pica*	8	10	10
Rook	*Corvus frugilegus*	7	8	15
Hooded crow	*C. corone cornix*	9	8	12
Total		**186**	**165**	**190**
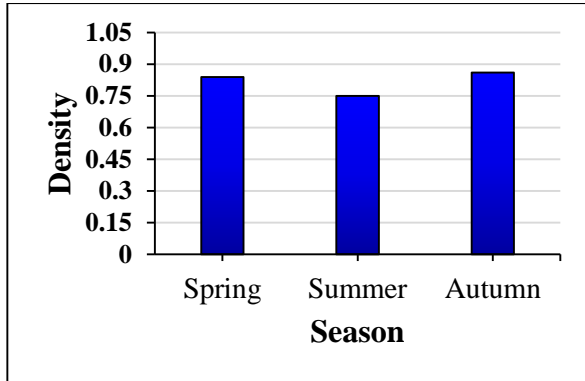
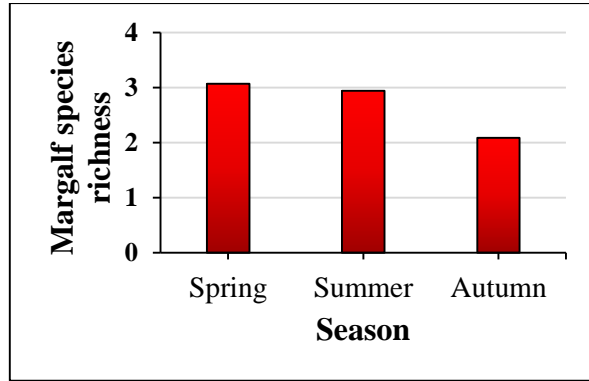**Figure 1.** Density of birds in Arak Forest Park

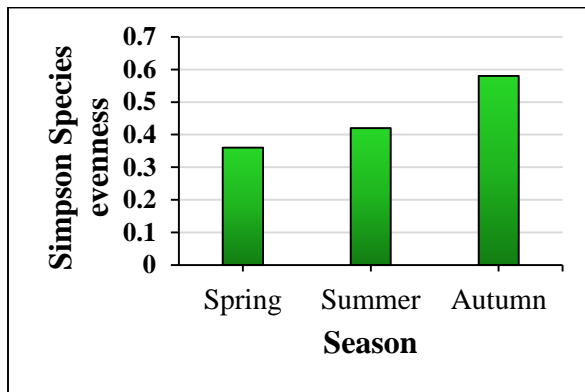**Figure 2.** Richness of birds in Arak Forest Park

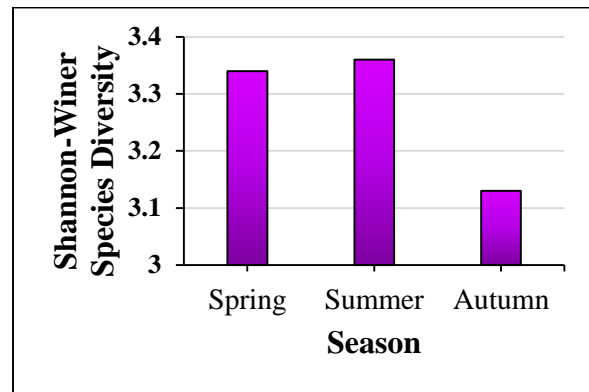**Figure 3.** Uniformity of birds in Arak Forest Park

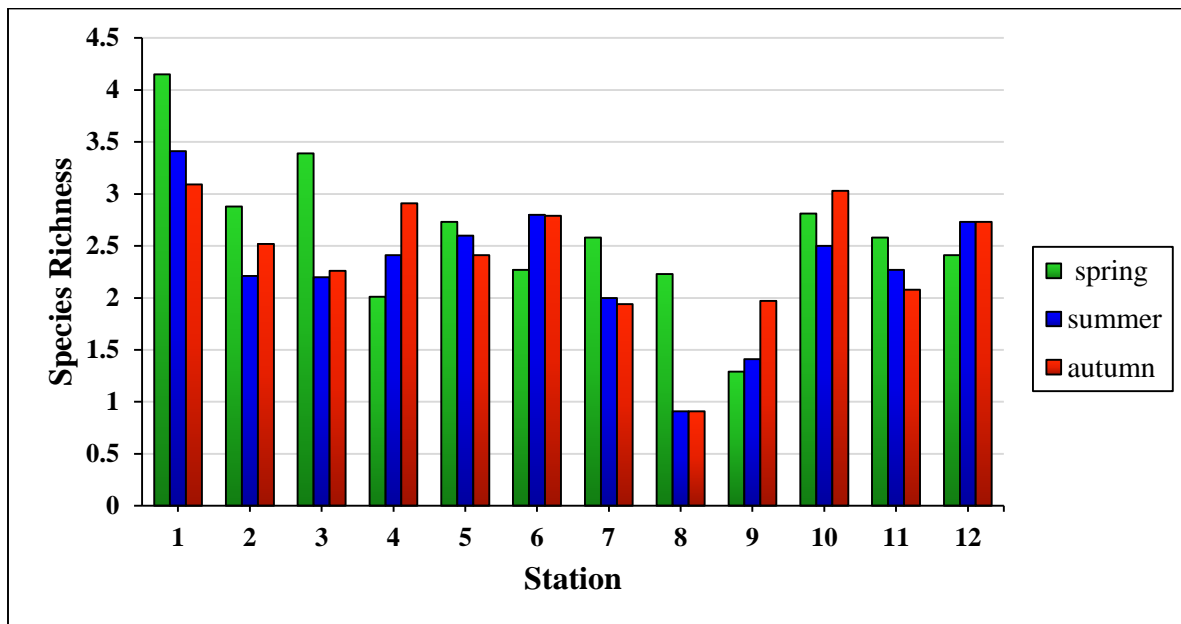**Figure 4.** Species diversity of birds in Arak Forest Park

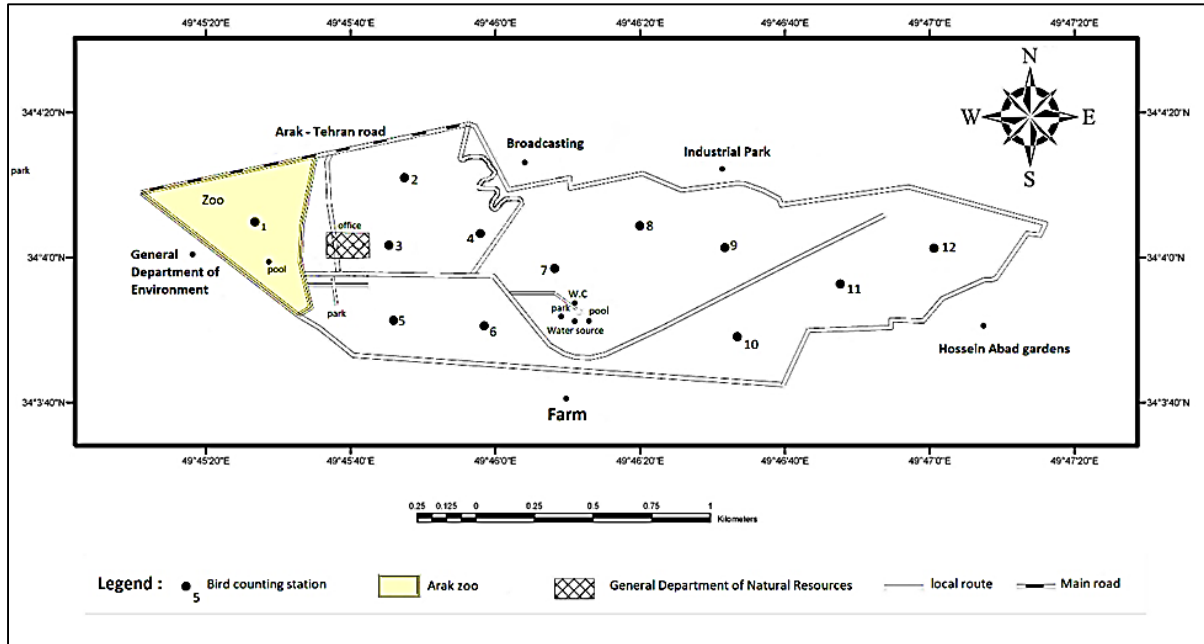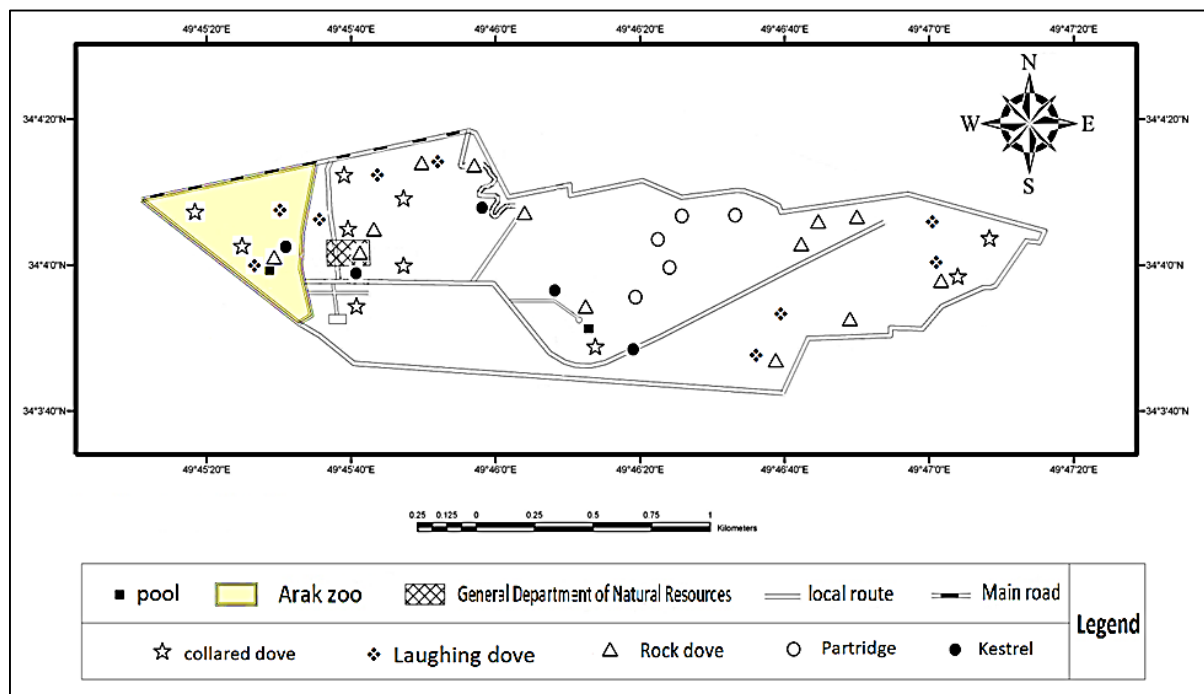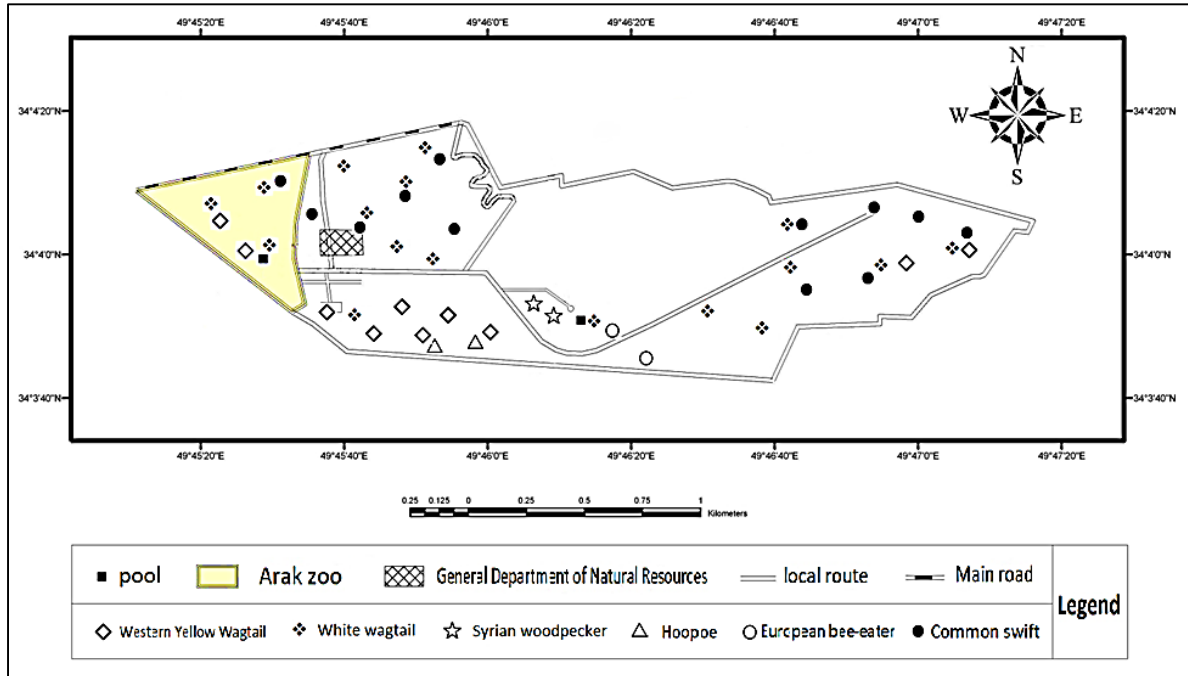**Figure 5.** Species richness of bird counting stations in each season
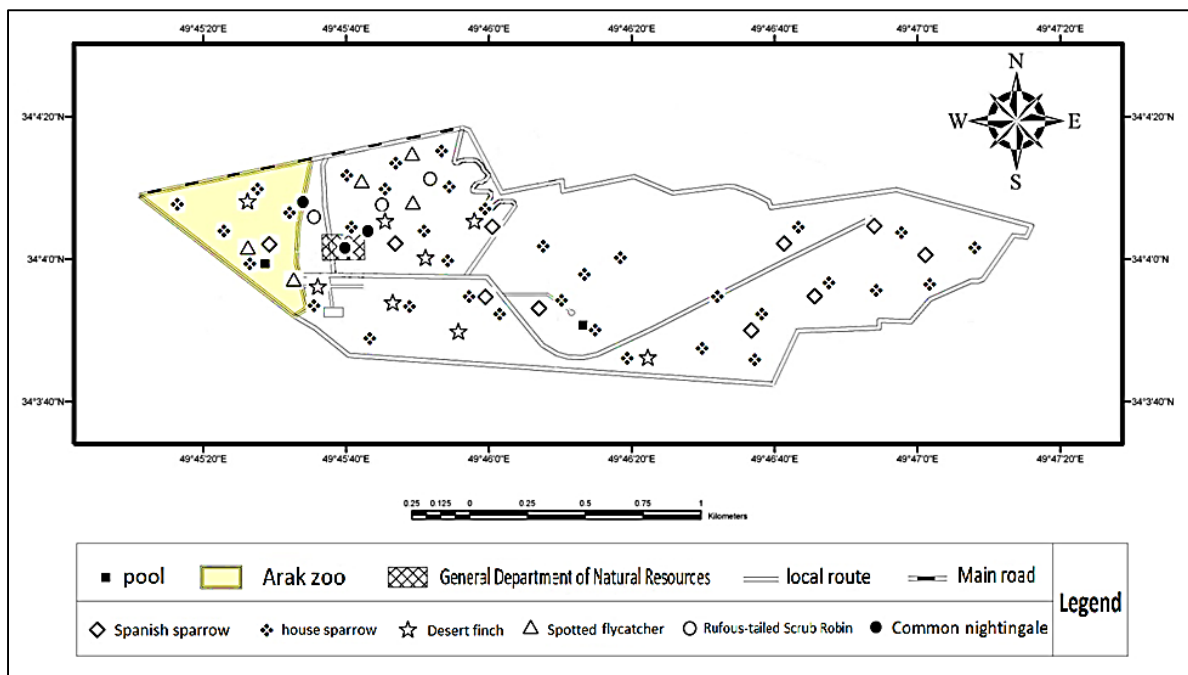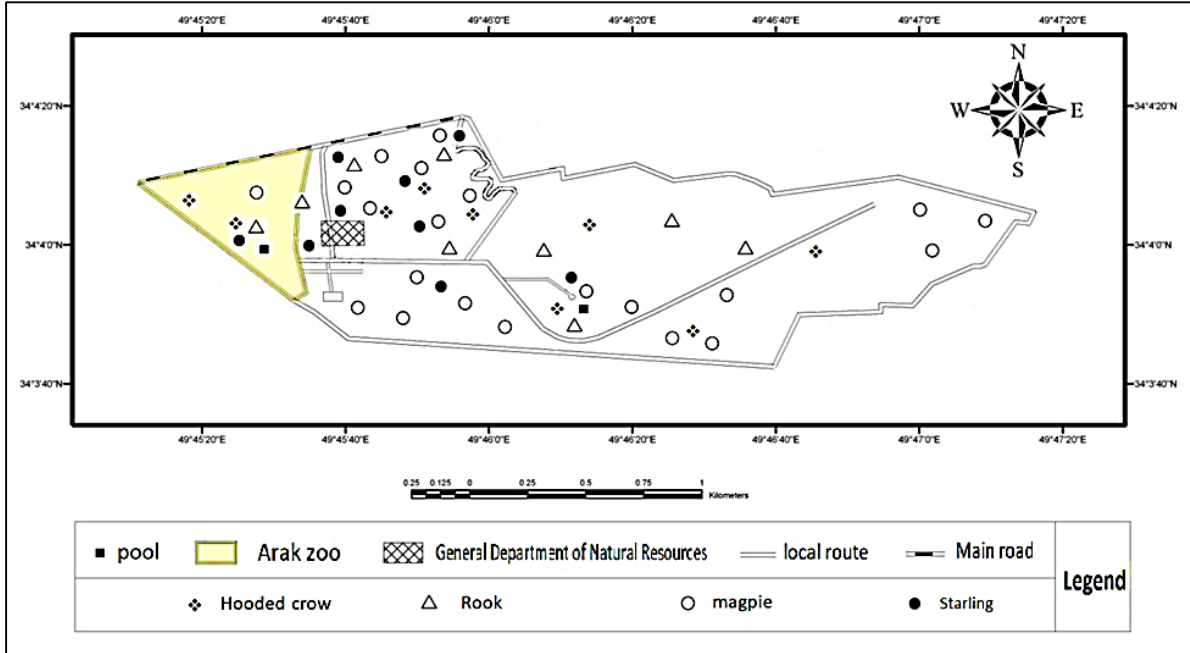
Map 1. Location of bird counting stations

**Map 2.** Distribution of Kestrel, Partridge, Rock dove, Laughing dove, and Collared dove

Map 3. Distribution of Common swift, Bee-eater, Hooded, Syrian woodpecker, White wagtail, Western Yellow Wagtail

Map 4. Distribution of nightingale, Rufous-tailed Scrub Robin, Spotted flycatcher, Desert finch, House sparrow, Spanish sparrow

Map 5. Distribution of Starlings, Magpies, Rooks, Hooded crows
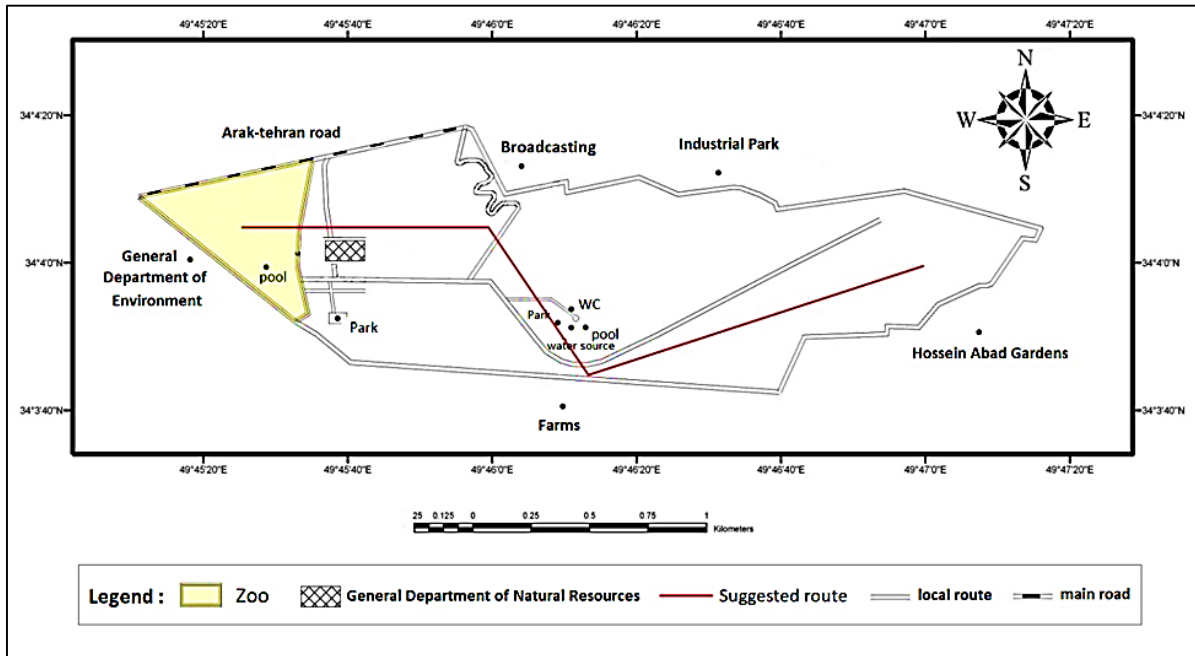
Map 6. Suggested route for bird watching in Shahid Bahonar Forest Park of Arak

Discussion

The uniformity in tree cover conditions across different sections of Shahid Bahonar Forest Park, encompassing factors such as age, density, distribution, and fragmentation, has led to reduced structural diversity among the park's plants. This, in turn, has had an impact on the abundance and species diversity of the park's avian population. The limited diversity in vegetation structure is

identified as a contributing factor to the comparatively low number of bird species observed in the park. This finding aligns with studies conducted by Diaz et al. in 2005 and Chapman et al. in 2004 [10], [19].

Comparative studies conducted by Khil Tash in 2007 in Chitgar Forest Park [33] and Gohani in 2010 in Kohsar Forest Park of Tehran [34], both with conditions akin to Shahid Bahonar Forest Park, demonstrated a higher number of bird species (48 in Chitgar and 27 in Kohsar). Notably, the primary distinction among these parks lies in their size, with Chitgar covering 1420 hectares, Kohsar around 600 hectares, and Shahid Bahonar Park spanning 320 hectares. The difference in observed species richness across these parks can be reasonably attributed to their respective areas. Tigman's studies in 1987 and Watson et al. in 2004 also emphasize the significance of the park's area in predicting bird species richness.

During the surveys in Shahid Bahonar Forest Park, birds were observed in the vicinity of the park (within a radius of 500 to 1000 meters) but were not spotted inside the park. This supports Tigman's and Watson et al.'s findings that emphasize the importance of park area in predicting bird species richness. The relatively small number of observed bird species in Shahid Bahonar Park aligns with these conclusions [35], [36]. Additionally, the survey conducted in 1389 indicates a positive correlation between bird species richness and park area, reinforcing the suggestion to expand the park, particularly towards its southern side.

The survey also highlights a negative correlation between bird species richness and the ratio of environment to area [37]. The considerable ratio of environment to area in Shahid Bahonar Forest Park, increasing the park's vulnerability and decreasing its richness, underscores the recommendation for park expansion. Expanding the park's area, and consequently reducing its perimeter relative to the area, is proposed as a measure to enhance bird species richness and maintain overall species diversity within the park. This strategic expansion could involve shaping the park towards a more circular layout from its current rectangular form.

Conclusion

The uniformity in tree cover conditions across various sections of Shahid Bahonar Forest Park, including age, density, distribution, and fragmentation, has led to reduced structural diversity among the park's plants. This has impacted the abundance and species diversity of birds. The lack of diverse vegetation structure is likely a key reason for the limited number of observed bird species, aligning with previous studies. A comparative analysis with similar parks, such as Chitgar and Kohsar, indicates that the observed difference in species richness can be attributed to the park's size. Expanding the park, particularly towards its southern side, is recommended to increase species richness and maintain overall species diversity. The study underscores the importance of park area in predicting bird species richness and highlights the negative correlation between species richness and the ratio of environment to area in Shahid Bahonar Forest Park.

Acknowledgment

Conflict of interests

The authors state that there are no conflicts of interest regarding the publication of this article.

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