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Seasonal Abundance and Diversity of Birds of Prey and Owls in Al Wathba Wetland Reserve in Abu Dhabi, UAE

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Abstract

Inland wetlands in Abu Dhabi Emirate are wintering and stopover sites for migratory birds of prey. We conducted long-term regular monitoring surveys in Al Wathba Wetland Reserve (AWWR) from January 1995 to December 2022. Both diurnal and occasionally nocturnal surveys were undertaken to record the migratory raptors and owls in the Wetland Reserve. During the study, a total of 1282 regular monitoring visits were undertaken and 27 species of diurnal raptors and owls representing five families and three orders were detected. These represent 57% of the total species of birds of prey recorded in the UAE. Overall, 63% of all the species that we observed were Accipitriformes followed by 26% Falconiformes and 11% Strigiformes. We found that changes in mean daily temperature have a positive effect on raptor species diversity and abundance in the Wetland Reserve. The species encounter rate was higher in low temperature as compared to high temperature and overall regression equation was statistically significant F (4, 1126) = 8.49), p = 0.00). However, the numbers of raptors did not vary significantly across the years (p = 0.51). Western Marsh-harrier (*Circus aeruginosus*) and Greater Spotted Eagle (*Clanga clanga*) were recorded to be the most abundant species in the wetland reserve followed by Common Kestrel (*Falco tinnunculus*). However, the encounter rate of globally threatened Greater Spotted Eagle was detected to have significantly decreased since 2016. Moreover, 63% of the species detected were uncommon and rarely recorded such as 1) Saker Falcon 2) Lanner Falcon 3) Long-eared Owl & Merlin, which were the rare records from the wetland reserve. Furthermore, 27 years of regular monitoring in the wetland have yielded diverse diurnal raptors and owl fauna (H) = 0.83, (E) = 1.43 (Shannon Diversity Index). The results demonstrate that long-term monitoring surveys in arid environments are essential to determine the trends in

the raptor populations and to document rare and globally important species.

Keywords

Wetland Reserve, Raptors, Abundance, Diversity, Abu Dhabi, Inland Wetland, AWWR, Greater Spotted Eagle

1. Introduction

Wetlands are significant conservation sites due to their rich biodiversity; they are among the most prolific ecosystems in the world, and they support many globally threatened species of different taxonomical groups [1] [2] [3] [4]. The term biodiversity in a wetland's ecosystem encloses all forms of life on the planet and includes all genes, ecosystems, species, and ecological processes in the world [5] [6] [7]. The most important functions of wetlands are preserving the genetic diversity of species and maintaining one of the highest biological productivities in the world [1] [8] [9] [10]. Researchers have identified a plenty of abiotic and biotic drivers directly or indirectly influence distribution of biodiversity. Among these drivers, climate and habitat have become two most important drivers of biodiversity under changing anthropogenic world [11]. Moreover, the impact of unfavourable weather conditions on the abundance and distribution of species has been recognized early during the past century [12] [13] More recently, long-term data analysis has provided the evidence that climate change is impacting the living organism. For instance, many birds have shifted the timing of breeding and/or migration in response to climate change [14] [15]. The negative effects of adverse weather conditions on different stages of breeding of migratory raptors have also been documented [16].

During the annual cycle, migratory birds spend a significant amount of time in wintering grounds compared to breeding sites. Many migratory birds of prey species depend on wetlands, which are considered the most threatened habitat [17]. Some very rare species may be especially susceptible to habitat loss on migratory stop-over sites and wintering grounds [18]. Migratory birds of prey are particularly at risk to these threats due to the often long and laborious annual journeys from their breeding grounds to wintering areas and back. Additionally, inland wetlands are biodiversity hotspots and considered productive zones in terms of providing food resources, wintering, and stopover sites for migratory birds of prey, some of these being globally threatened.

In UAE, inland wetlands, and moist grounds, including irrigated agricultural fields, mudflats, and shallow alkaline waterbodies provide critical stopover and wintering habitat for long-distant migratory birds. A total of 47 species of diurnal raptors and owls have been recorded from across the UAE and most of the species about (84 %) in UAE are migratory [19] [20] and the availability and quality of wintering habitats are therefore crucial for individual survival and popula-

tion dynamics. UAE has several resident breeding raptor populations, and it is one of the range states of many migratory raptors passing through to wintering grounds in Arabia and Africa. All 47 species of raptors and owl in the UAE makes up about 10% of the total avifauna of the country. Birds of prey face many human-induced threats such as habitat loss and degradation, illegal shooting and poisoning, collisions with structures and electrocution by power lines [21] Also, raptors in general are more threatened from the effects of trapping, hunting, poisoning as they winter or stopover during annual migration [20]. It has been found that more than 50% of migratory raptor populations in the African-Eurasian region are in poor conservation status, and many species were showing rapid or long-term declines [22]. This article describes diversity and seasonal relative abundance of resident and migratory diurnal raptors and owls and provides the baseline information of raptor species visiting Al Wathba Wetland Reserve herein after (AWWR) since 1995. Also, underlines the main drivers such as atmospheric temperature, winter and summer seasons used as predictive variables and number of individuals as response variable affecting raptor diversity and abundance in an inland wetland of Abu Dhabi Emirate. The aim of the study was to document the seasonal variations and population trends of migratory and resident species at the AWWR across multiple years, while also investigating the potential impact of atmospheric temperature on the diversity and abundance of both diurnal raptors and owls.

2. Materials & Methods

2.1. Study Area

Al Wathba Wetland Reserve is a Ramsar Site in Abu Dhabi and listed in the IUCN Green List of Protected and Conserved Areas [23]. It is one of the important bird areas (IBA) identified in Abu Dhabi Emirate. The study area is located 40 km south-east of Abu Dhabi city, at N 24.26022˚, E 54.60102˚ and the site has been under Environment Agency - Abu Dhabi (hereafter EAD) management since designation of reserve status in 1998. AWWR covers an area of 5 km^2 and is bordered by busy highways to the immediate south and 3 km to the north, with industrial development to the east and west (**Figure 1**).

The mean annual temperature of the study area is 28˚C and the coolest month is January (minimum temperature of 7˚C), and the warmest is August (maximum temperature of 48˚C). The reserve consists of several habitats and this mosaic of habitat types gives the site a high conservation value in terms of its diversity [24]. The water body of the lakes as well as different patterns of vegetation cover around and inside the lakes provides diverse habitats which supports the rich biodiversity of the wetland. Moreover, the total surface area of the waterbodies is 1.6 km^2 [25]. Furthermore, AWWR is the most important site for waterbirds in the UAE and is particularly significant in a national context for wintering populations of migratory birds of prey [26].

A total of 262 avian species have been recorded so far from AWWR since its

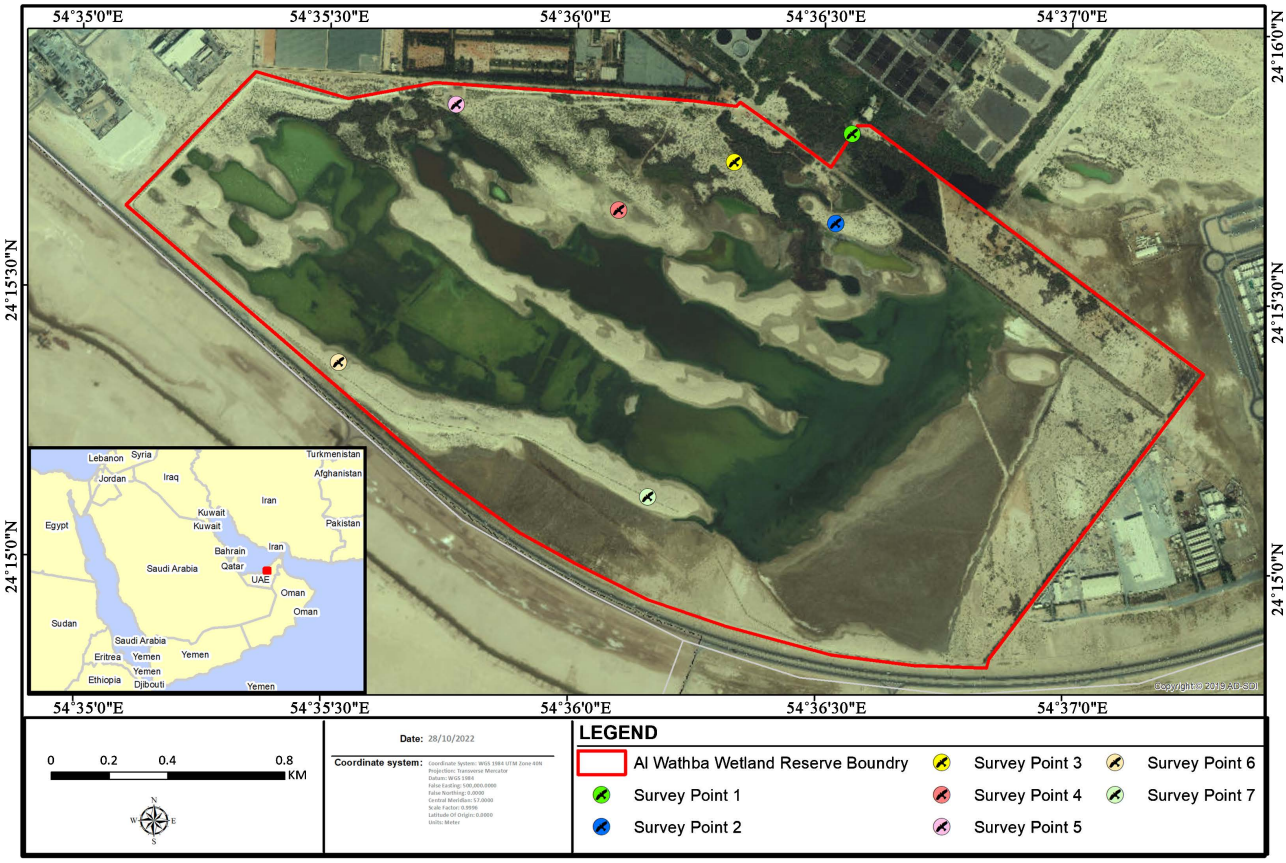

Figure 1. Map showing AWWR boundary and fixed survey points in Abu Dhabi emirate.

declaration as a protected area in 1998, of which 20% are shorebirds, 28% are predominately overwintering whilst 43% are passage migrants and 13% breeders, the 16% being vagrants [24] [26].

2.2. Methods

The study is a part of EAD's long-term wild bird monitoring programme in the terrestrial protected areas in Abu Dhabi. Fortnightly to monthly to weekly counts of wild birds were carried out from January 1995 until December 2022 in AWWR. The data was extracted from AWWR bird database of EAD and data provided by the Emirates Bird Records Committee (hereafter EBRC) to use in this paper.

The bird counts were conducted by experienced observers using 4 × 4 vehicles and by foot in different habitat types of AWWR. All the monitoring surveys were mainly undertaken in early morning time from around 7:30 to 10:30 hrs. Moreover, occasionally night surveys were also undertaken by EAD researchers in AWWR to record the nocturnal species such as owls. Furthermore, total of seven fixed survey points was established in the entire wetland reserve to record avian species (**Figure 1**).

Total counts were made both for birds of prey with telescopes and binoculars being used to count and identify the birds seen. Birds were recorded using point

counts for terrestrial species and complete counts birds of prey species following the method outlined in [27] [28] [29]. Also, any random sightings are recorded while moving from one point to another. Wherever possible, photographs were taken for identification purpose. Bird count data was collected digitally using a custom-made offline bird application installed on iPads. Once data was recorded, with internet connectivity data was synchronized and transmitted directly to the EAD's Environment Database. Additionally, data of occasional sightings of birds of prey and owls by the management staff of AWWR were also used in the analysis.

3. Data Analysis

Each year was divided into two seasons, *viz.* the winter season, from October to March, and the summer seasons, from April to September. The analysis was carried out during these two seasons to account for the period of raptor migration. Mean daily temperature data of the inland wetland was obtained from National Centre of Meteorology (NCM) Abu Dhabi. It was hypothesized that temperature, months, seasons, and years will positively predict raptors abundance in AWWR. To test this hypothesis, generalised linear regression (GLM) model was used.

The number of species and individuals of raptors were used as response variable whereas mean daily temperature, years, seasons, and months were used as predictor variable. Season is coded as 1 = winter and 2 = summer. A confidence level of 95% was used with normal distribution and identity link. The data summarisation was carried out in Microsoft Excel and the analysis was done in Past 4.03 (2020). Descriptive analysis was carried out using SYSTAT 10 (2000). Past 4.03 and SYSTAT 10 is a statistical software package. The species diversity and evenness were calculated using Shannon-Weiner Diversity Index and Cluster analysis was done to see the similarity in months in terms of raptor observations in a software Biodiversity-Pro. In case of multiple monitoring (fortnightly, weekly) visits in AWWR, the highest count of a month for a particular species was selected and used in analysis.

4. Results

During the course of study, a total of 1282 monitoring visits were undertaken in AWWR to observe the diurnal birds of prey and owls, on an average 46 ± 6 (Mean ± SD) visits were conducted every year from January 1995 to December 2022. The highest number of 127 monitoring visits were conducted in year 2006 (**Figure 2**). During the monitoring surveys, 27 species of diurnal birds of prey and owls representing five families and three orders were detected from AWWR. These represent about 57% of the total species of raptor fauna recorded in UAE (**Figure 3**). The number of species and individuals were recorded less in numbers during the month of May, June, July, and August (**Figure 4**).

Overall, 63 % (n = 17) of all the species that we detected in AWWR were Accipitriformes (hawks & eagles) followed by 26 % (n = 7) Falconiformes (falcons)

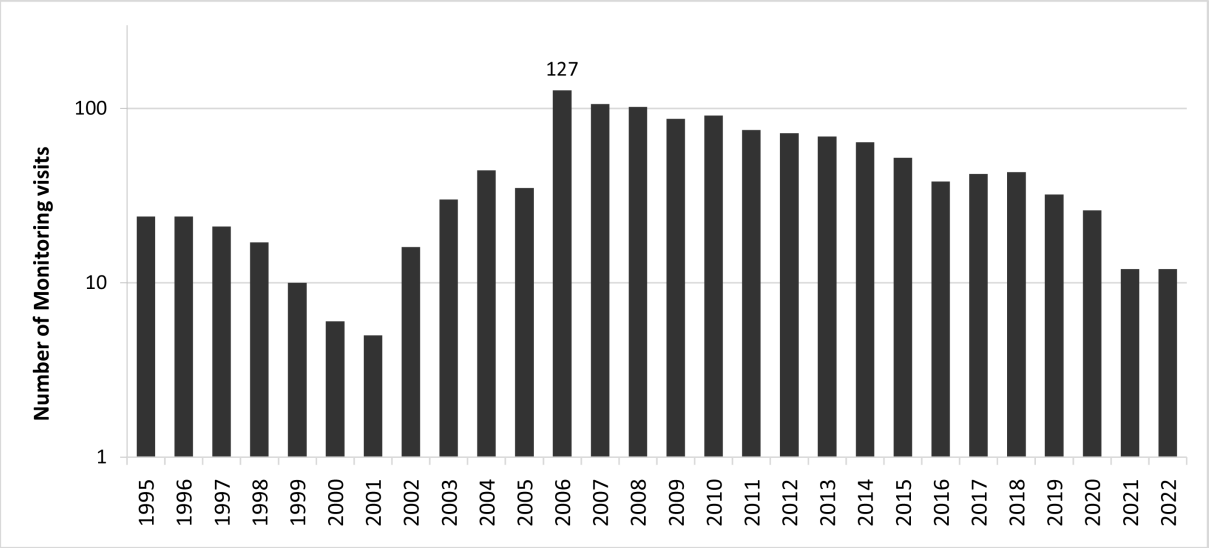

Figure 2. Number of monitoring visits undertaken in AWWR from January 1995 to December 2022.

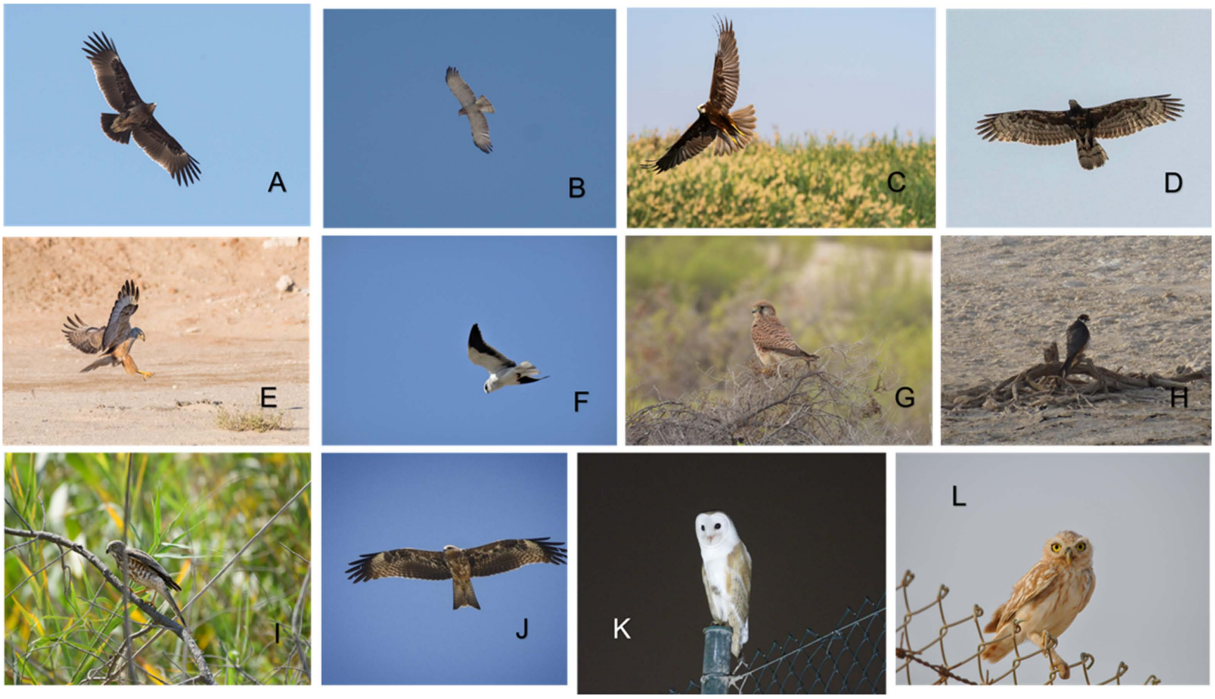

Figure 3. Some birds of Prey in AWWR. (A) Greater Spotted Eagle; (B) Short-toed Snake Eagle; (C) Western Marsh Harrier; (D) European Honey Buzzard; (E) Long-legged Buzzard; (F) Black-winged Kite; (G) Common Kestrel; (H) Eurasian Hobby; (I) Eurasian Sparrowhawk; (J) Black Kite; (K) Barn Owl; (L) Little Owl. (All photos were photographed by Shakeel Ahmed & Mustafa Hamid).

and 11% (n = 3) Strigiformes (owls). Moreover, 52% of the total species were winter and passage migrants followed by 30% resident breeding and winter and passage migrants, whereas 18% were vagrant species and the balance being only the passage migrants to UAE.

Furthermore, 27 years of regular monitoring in the wetland reserve have yielded diversified raptor fauna (H) = 0.83, (E) = 1.43 (Shannon Diversity In-

dex), however the number of raptor species were not evenly distributed across the survey points in the Wetland Reserve (Figure 5).

The highest abundance of birds of prey was recorded in the winter compared to the summer season as most species of birds of prey were winter migrants. Results reveals that only 03% of the variance can be explained by the fours predictor variables collectively F (4, 1126) = 8.49), p = 0.00), with an R^2 of 0.029 (Figure 5). Looking at the unique individual contributions of the predictor variables, results show that for mean daily temperature a significant regression equation was found (t = −2.28, p = 0.02), that predicted raptor abundance positively in AWWR. Furthermore, results also indicates that years (t = 0.656, p = 0.511,) and the months (t = 1.17, p = 0.085) did not positively influence the abundance of raptors in AWWR.

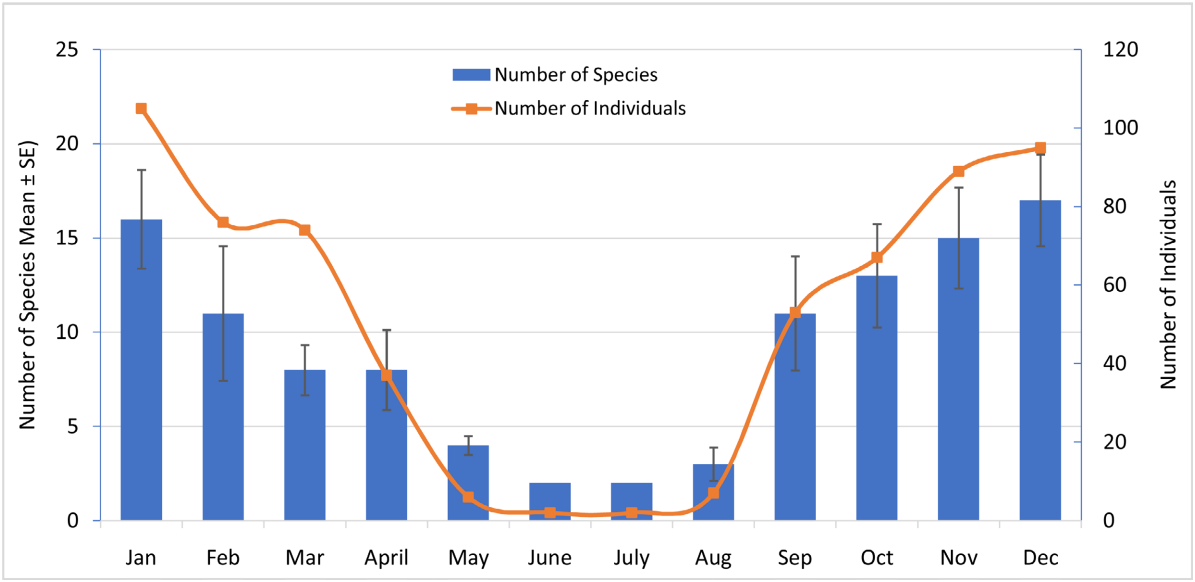

Figure 4. Number of Species and individuals of diurnal Raptors and owls recorded from AWWR from January to December.

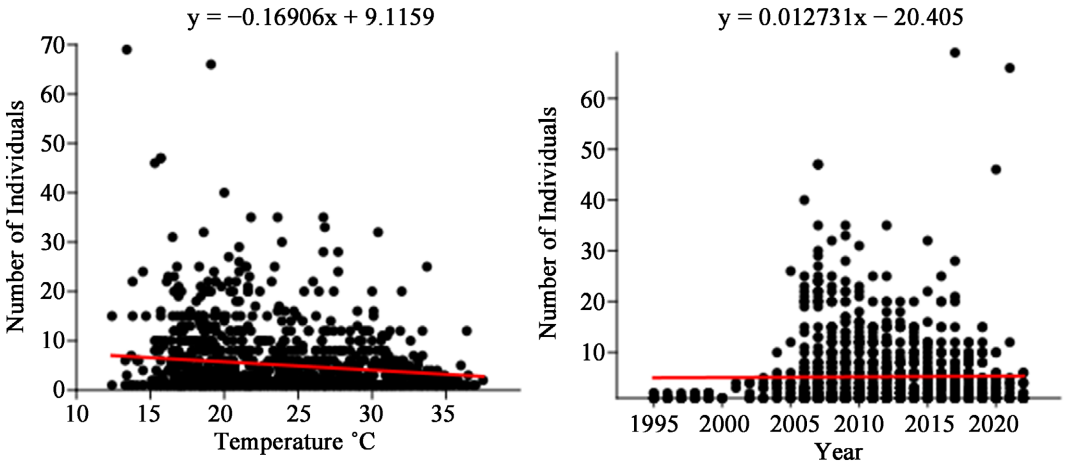

Figure 5. Generalized Linear Model (GLM) Regression line fit plots for raptor abundance in AWWR from 1995 to 2022. Abundance was modelled separately for mean daily temperature and years.

Western Marsh-harrier (*Circus aeruginosus*) was detected to be the most abundant species in the Wetland Reserve, on an average (8.4 ± 0.55) (Mean ± SE) individuals were detected every monitoring visit and the highest number of 69 individuals were recorded roosting in AWWR in December 2021. Since this bird is a winter migrant, the number of individuals were recorded higher in winter as compared to summer months and the difference was statistically significant across the months (df = 9, F = 11, $p = 0.00$) and across the years (df = 27, F = 2.27, $p = 0.00$) (one-way ANOVA). Whereas mean daily temperature was found to have minimal effect on harriers' abundance in the AWWR (df = 205, F = 1.40, $p = 0.02$) (one-way ANOVA).

Furthermore, results show that on an average 1.6 ± 0.08 (mean ± SE) individual of globally threatened Greater Spotted Eagle were detected in every monitoring visit and the highest number of five individuals were detected in year 2012 from AWWR. However, the encounter rate of globally threatened Greater Spotted Eagle was recorded to have substantially decreased since 2016 (**Figure 6**) and the results were statistically substantiated (df = 17, F = 1.90, $p = 0.018$) (one-way ANOVA). It was found that mean daily temperature and months had minimal effect on migratory population of this soaring threatened eagle. The lowest number of only one individual was encountered in year 2021. Also, results show that 1) Saker Falcon *(Falco cherrug)* 2) Lanner Falcon (*Falco biarmicus*) 3) Long-eared Owl (*Asio otus*) were the vagrant species and detected only a few times in 27 years of regular monitoring in AWWR. During the study period, only two species of diurnal raptor or owl was detected during the month of July from AWWR and similarities between the months in terms of species occurrence, abundance and diversity can be seen as monthly cluster in (**Figure 7**). Also, 48 % (n = 13) out of total 27 species which were detected in AWWR were uncommon species.

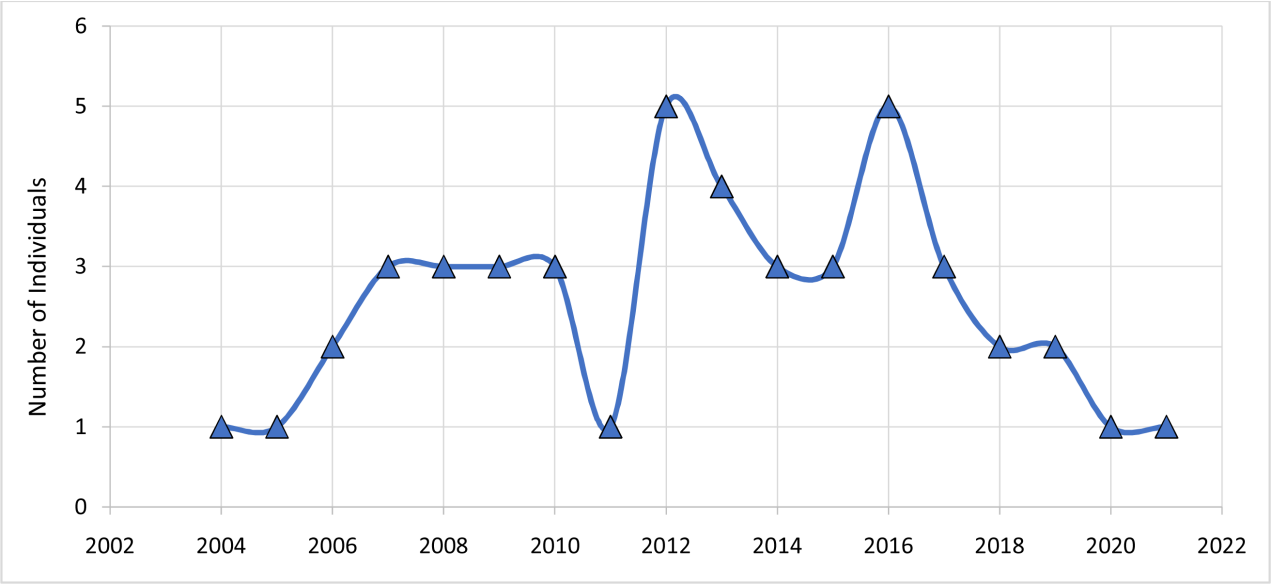

Figure 6. Graph showing highest number of Greater Spotted Eagle detected every years in AWWR.

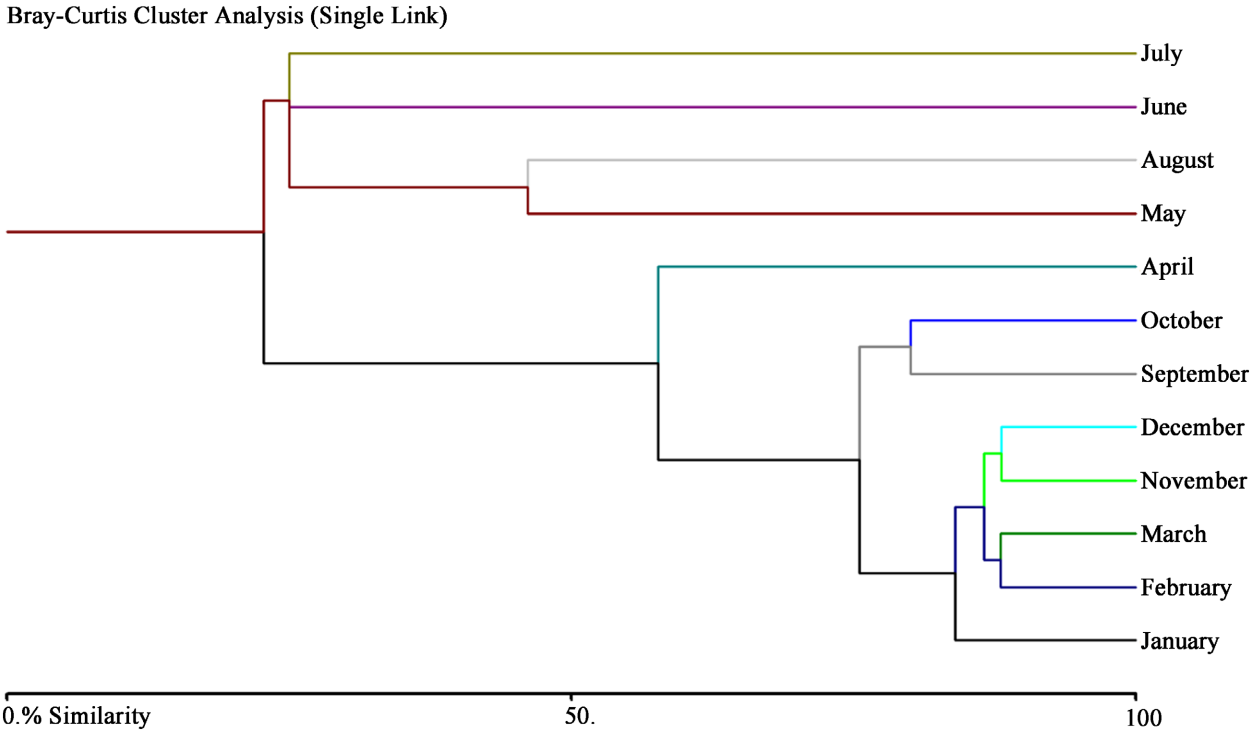

Figure 7. Cluster analysis to show similarities between the months based on raptor abundance in AWWR from 1995 to 2022.

5. Discussion

Temperature is the main driver of species diversity and abundance in our study. Our study confirms that raptor population respond positively to the high temperature, only two individuals of raptors could be detected during the month of July between 1995 and 2022. Many raptor species are experiencing negative population trends due to various human induced factors affecting them on their breeding grounds, migration pathways and in the wintering areas [30].

Birds of prey are excellent bio-indicators of environmental well-being and extensively preferred for monitoring of taxonomic diversity and conservation programmes [31] [32]. Moreover, raptors are placed at top of the food chains and therefore their population fluctuations provide good information for the existence of natural ecosystems [33] [34].

Our results have shown that AWWR represents about 60% of the total species of diurnal raptors and owls recorded in Abu Dhabi Emirate. Other studies have shown that long-term monitoring of bird's populations is crucial for efforts to identify species at risk, suggest potential limiting factors, and provide feedback for management actions [35] [36] [37]. Our study is a part long-term wild bird monitoring program by EAD across several sites of different habitats in Abu Dhabi Emirate.

Results shows that four species: 1) Greater Spotted Eagle (*Aquila clanga*); 2) Eastern Imperial Eagle (*Aquila heliaca*); 3) Pallid Harrier (*Circus macrourus*); 4) Saker Falcon (*Falco cherrug*) encountered during the monitoring surveys were globally threatened species by IUCN Redlist of Species.

AWWR harbour nearly 61% of the total avifauna of Abu Dhabi Emirate [24] and regular wild bird monitoring surveys are continued since 2002. In response to the outbreak of Avian Influenza in 2005 [38] [39] and following years, the monitoring intensity in AWWR was increased from once in a month to up to four times a month. Our results shows that the highest number of 127 monitoring visits were undertaken during 2006 in AWWR (**Figure 2**), the number of monitoring visits were increased in response to the possible outbreaks of High Pathogenic Avian Influenza Virus (HPAI) in wild birds across the wetlands and other coastal sites across the Emirate [40] With increased number of monitoring visits in year 2006 and 2005 the species encounter rate in AWWR was also high.

Generally, the results of this study indicate that the area despite its small size is a home to a wide variety of migratory diurnal raptor species. This could be due to the uniqueness of AWWR in providing heterogeneous habitats for the birds of prey and other avian species. Our findings indicate that a total 27 species of migratory and resident raptors and owls have been listed from AWWR since 1995. We relied on and used the most authenticated bird database by EAD and EBRC in this paper, therefore it is unlikely that additional raptor species would be reported by other bird enthusiasts and conservationists who visited AWWR. This wetland reserve is particularly known for harbouring a wide variety of fauna and flora; thus, it opens its doors for the visitors, bird watchers, research students local and international conservationists [24].

The study shows that six species: 1) Common Kestrel; 2) Western Osprey; 3) Bonelli's Eagle; 4) Short-toed snake eagle; 5) Long-legged Buzzard; 6) Little Owl are the year-round resident breeding and winter migrants in UAE. Bonelli's Eagle is a rare breeding resident in mountains areas [41] was recorded only for a few times in the wetland reserve. Western Osprey breeds in large numbers in Bul Sayaeef (Marine Protected Area) which is 18 km away from AWWR and the satellite telemetry done on some ospreys indicates that adult ospreys remain at sites while the young ones disperse from their natal sites to the adjoining Gulf countries [42]. Raptors are highly influenced by anthropogenic landscape alterations as they are sensitive to environmental changes [43]. Prey diversity and habitat heterogeneity among other factors play an important role in the distribution, status, and diversity of raptors in an ecosystem [44]. Better protection and management in AWWR which is in a predominantly desert ecosystem is remarkable [24]. In AWWR, water bodies of different depths allow migratory raptors species to hunt and sustain themselves in this area. Migratory raptors arrive at the start of winter and use the wetland as a stopover or wintering site.

Two species: 1) Barn Owl; 2) Little Owl (*Athene noctua*) breeds locally in the deserts and low dunes areas in the Emirate, however only a few individuals of these two owl species were detected from AWWR. Nevertheless, Long-eared Owl *(Asio otus*) is a vagrant species and was first recorded in October 1999 and the second record was documented in January 2022 [45]. The two owl species were mostly detected and photographed by the management staff of the AWWR.

The similarities in months in terms of raptors sightings and abundance are

given in (**Figure 7**). The month of June and July were found to be unrelated with only 20% similarity with other months. This is probably due the high average temperature and humidity in Abu Dhabi Emirate [46]. Local weather conditions affect, the start and duration of migration, energy cost, migratory routes, flight speed and flight strategy of raptors [47].

Furthermore, during the monitoring surveys a total of seven species of Falconiformes: 1) Peregrine Falcon; 2) Eurasian Hobby; 3) Lesser Kestrel; 4) Common Kestrel; 5) Lanner Falcon; 6) Merlin; 7) Saker Falcon were detected from the Wetland Reserve. Two species of falcons Saker Falcon and Lanner falcon are vagrant species in the UAE and recorded only for once in AWWR. Moreover, Peregrine Falcon is a common winter and passage migrant to UAE and a significant record from AWWR, whereas Eurasian Hobby and Lesser Kestrel are the passage migrant [41] and rare records from AWWR. Our results revealed that AWWR lake area acts as important habitat for the threatened bird of prey species. The reserve consists of several habitats and this mosaic of habitat types gives the site a high conservation value in terms of sustaining migratory raptor population.

AWWR is a very small area in terms of providing breeding grounds to the resident breeding species of diurnal raptors and owls, none of the species was found breeding in AWWR. During the long-term monitoring surveys in AWWR, 30% were resident breeding, winter, and passage migrants and 18% were vagrant species and all the species used the site for foraging. Sightings of these rare species indicate the importance of AWWR as a hotspot for raptor species diversity and better management of the protected area. Moreover, during 27 years of regular monitoring exercise, a very few individuals of Booted Eagle was also detected from AWWR this species is a winter and passage migrant to UAE and a significant record in Abu Dhabi Emirate.

Unlike many passerines, birds of prey typically occur at low densities and are difficult to detect on their breeding and wintering grounds [48] [49]. Efforts were made to detect diurnal raptor species in flight and at the roosting areas of different habitats in AWWR. The vulnerable Greater Spotted Eagle was recorded visiting AWWR regularly during the winter months (October to March) and a very few individuals were also recorded during the month of April which is the time when they do return migration to their breeding grounds. The species was not detected during the regular monitoring survey in summer months, from May to September. Greater Spotted Eagle is listed Critically Endangered by the IUCN Local Red List of Species in Abu Dhabi and facing threats such as trapping and illegal shooting along its migratory routes. EAD satellite tracking studies indicated that two individuals of Greater Spotted Eagle went missing during their migratory journey, one each in Saudi Arabia and one in Kuwait [50]. This study shows that population of Greater Spotted Eagle have significantly decreased since 2016 and the number have come to only one individual recorded in year 2021 (**Figure 6**). One of the reasons could be its global population decline that may have negatively impacted seasonal abundance of the species in the

Wetland Reserve [51]. The significant variation in seasonal abundance of diurnal raptors in AWWR is due to the temperature variation and can also be due to migratory behaviour, the availability of food in AWWR, habitat condition, and breeding season of the species [52] [53]. The leafless tops and branches of dead trees provide perches for hunting, and unhindered views are often favoured by hawks and eagles when hunting and keeping competitors away and AWWR provides the roosting and foraging site for these species. EAD has so far tracked five Greater Spotted Eagles and six Western Marsh-harriers from AWWR to understand the migratory patterns of the species to and from Abu Dhabi Emirate [54].

The Western Marsh-harrier is highly migratory and dispersive. It is an abundant passage migrant and winter visitor to UAE [55]. Our results show that Western Marsh-harrier was the most commonly occurring and the most abundant winter migrant in AWWR followed by Greater Spotted Eagle and Common Kestrel. Previous studies conducted by EAD to detect the distribution of Western Marsh-harrier during the migration period indicates that the 31% of the total sightings of the species were recorded from coastal area followed by 13% from inland wetlands in Abu Dhabi [55]. Inland Wetlands in Abu Dhabi provide roosting and foraging sites to the species. In AWWR, the encounter rate was higher about 8 individuals detected per monitoring visit and recorded to be the most encountered species. Satellite telemetry studies on Western Marsh-harrier conducted by EAD in AWWR indicates that the wintering population return to their breeding grounds in Central Asia in the month of May [54] [55]. The highest number of 30 to 69 individuals were recorded in a group roosting in AWWR, otherwise they are usually solitary, associated only temporarily at especially rich feeding sites [56] [57]. Our findings indicate that AWWR has adequate protection and provide disturbance free habitats to the long-distance migratory raptors and owls. Furthermore, for migratory species various factors in breeding and wintering grounds determine the pattern of habitat occupancy which eventually affects the seasonal abundance and distribution [58] [59].

In recent decades, birds of prey populations are facing a catastrophic decline due to anthropogenic and climatic threat impacts [60] [61] [62] [63]. According to [20], major threats faced by migratory and resident raptors in the UAE are mainly due trapping of migrating raptors and threats to wild birds from the large number of hybrids which escape from captivity and habitat loss. However, hunting is one of the threats to the raptor species in Abu Dhabi, as one of the tagged Western Marsh-harriers—fitted with satellite transmitter by EAD was recovered dead in one of the locations in western region of Abu Dhabi [50].

The wetlands are considered fragile parts of an ecosystem and once they are fractured, the whole ecosystem gets affected. The plantation of additional trees in the undisturbed areas in the wetland reserve can be very beneficial for the diurnal raptor species such as hawks and eagles. The population reduction of the Greater Spotted eagle in AWWR since 2016 may also reflect the overall population decline [64] of the species across its distribution range and it needs further inves-

tigations. Furthermore, to get the better understanding of the effect of temperature on migratory and resident raptors in Abu Dhabi more studies are needed.

6. Conclusion

The present study concluded that extensive monitoring efforts spanning over 27 years in AWWR have provided valuable data in the seasonal variations and population patterns of migratory raptors and owls. The study documented 27 species belonging to five families and three orders that represented significant proportion of raptor fauna recorded in the UAE. Winter migrants dominated the abundance of raptors. Moreover, detection of vagrant species and presence of uncommon species indicates the importance of AWWR as a habitat for diversity of raptors and owl species. Also, impact of environmental variable particularly mean daily atmospheric temperature on raptors abundance was noted. Regular monitoring is important to document the rarity in species visiting the country during their annual migration cycles. For conservation of raptors inland wetlands in Abu Dhabi may be important for harbouring viable population of raptors that are globally threatened. The habitat heterogeneity in inland wetlands is the key to provide foraging habitat to the migratory raptor including the endangered ones. Further, to increase the knowledge about diurnal raptors and owls in Abu Dhabi and to evaluate their populations, a coordinated education and research program is essential. The study has proved that the better management can enable even a small sized protected and conserved area to serve as a key foraging and roosting fields for a wide variety of migratory birds. Long-term monitoring surveys in AWWR are ongoing activities and will continue to collect data on raptors.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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