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A study of Distribution and Breeding on Lapwing (*Vanellus* spp.) of Al-Malih area in Babylon Province / Iraq

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University of Babylon in Partial Fulfilment of the
Requirements for Degree of Master in Science / Biology / Ecology**

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

"أَلَمْ تَرَ أَنَّ اللَّهَ يُسَبِّحُ لَهُ مَنْ فِي السَّمَاوَاتِ وَالْأَرْضِ وَالطَّيْرِ صَافَّاتٍ ۖ كُلٌّ قَدْ عَلِمَ

صَلَاتَهُ وَتَسْبِيحَهُ ۗ وَاللَّهُ عَلِيمٌ بِمَا يَفْعَلُونَ"

صدق الله العلي العظيم

(النور . ٤١)

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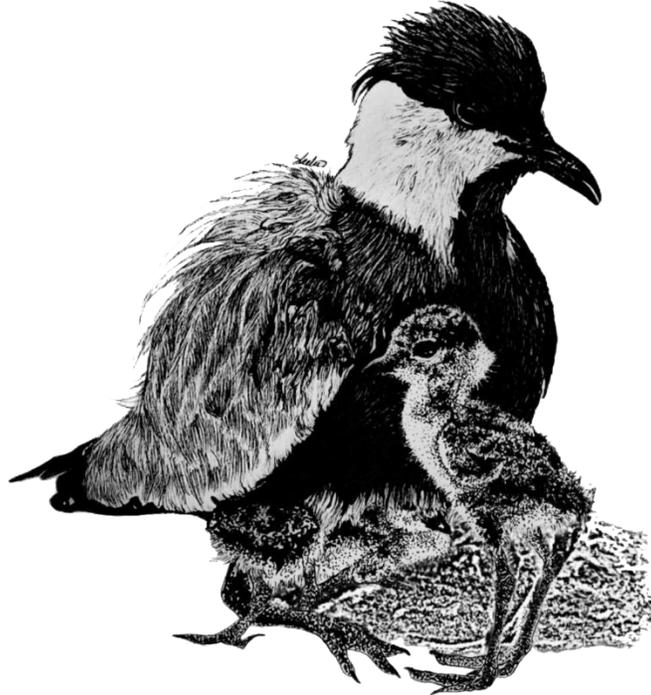
Dedication

I dedicate my work to the designer of the human civilization that is established on the Unity of Almighty Allah, to the redeemer of human volition and thought, To the Seal of the Prophets and the Master of all beings; the Holy Prophet Muhammad — peace be upon him and his Household... I dedicate this work on the Seal of his Successors, the Reviver of his Faith, and the resuscitator of his Mission: Imam Mohammad al-Mahdi, peace be upon him who shall fill the earth with justice and righteousness after it will be filled with injustice and prejudice. I thus hope for acceptance so that I will keep it as reservoir for the day on which I shall meet Almighty Allah, to Iraqi birds' father "Basheir allouse, 1905-1964" who put the basic for all scientific works on avifauna of Iraq.

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Summary

Lapwing is considered as bioindicators, which are species that provide information regarding environmental quality and are employed to evaluate agricultural land quality, they are sensitive to changes in land use and habitat degradation, and their presence or absence might refer ecosystem health. There is scarce information on lapwing community and its breeding biology in Iraq.

From September 2022-August 2023, total of 72 field surveying was conducted in al Malih area in northern Babylon in central Iraq. It is considered as wetland that encompass about 2000 ha (20 km²).

In this study, we aimed to obtain the ecological and biological Study of Lapwing (*Vanellus spp.*) Communities in Al-Malih area in Babylon Province. Also, to achieve these objectives including: identification the bird species in Al-Malih area, determine the lapwing community with population size, a morphometrical (Morphological and biometric” size, weight”) comparison and differences among clutches of lapwing species, A study of environmental factors (Soil PH, Temperature, Moisture and texture) for the lapwing spp. nests.

The line transect count method which are based on detection probability of lapwing species were practiced. This field surveying methodology was conducted in order to get reliable estimations of species densities and population size of lapwing *spp.* in the Malih wetland. Total of four line-transects (T1:6; T2:2; T3:1; T4:2km) covering a study area of 1100 ha (11km²) .

122 species were recorded in the current field surveys at al Malih area belonging to 17 orders and 38 families, However, 7 species within the red list of IUCN and represents about 30.65% of the total number of Iraqi bird species. lapwing genus (*Vanellus spp.*) were represented by 4 species.

Total of 904 individuals belong to 4 lapwing species (*Vanellus spp.*) that included in Order Charadriidae, Family Charadriiformes were recorded among 5 species occur in Iraq (Northern lapwing *V. vanellus*,78; Spur-winged lapwing *V. spinosus*,531; Red-wattled lapwing *V. indicus*,136; and White-tailed lapwing *V. leucurus*,159).

The Malih area hosted population size of lapwing community of four species, The northern lapwing *V. vanellus* (148.597- 203.454) in December-November 2022. The spur-winged lapwing *V. spinosus* (270.74 - 1248.730) in August - Aprile 2023. Red -wattled lapwing *V. indicus* (277.171 - 931.678) in January 23 - November 2022. White -tailed lapwing *V. leucurus* (163.645 - 742.694) individuals/total area, during July 2023 – November 2022.

During breeding season (March 2023-June 2023) all breeding events (e.g., adult courtship, marking of the breeding territories, nest-site selection, nest building, and eggs incubation) were carefully observed for 60 days (15 days per month). Nests of lapwing species were located, measured cautiously and 12 nests were choice to monitoring by camera traps, tested the environmental factors(Soil PH, Temperature , Moisture and Texture) and calculated nest success. The mean and SD for egg length were 46.25 ± 0.68 mm for *V. indicus*, $(42.25 \pm 0.96$ mm for *V. spinosus*, and 42.28 ± 0.67 mm for *V. leucurus*. The egg breadth Mean and SD were 33.34 ± 0.84 mm for *V. indicus*, 31.43 ± 0.55 mm for *V. spinosus*, and 31.42 ± 0.67 mm for *V. leucurus*.

The egg weight Mean and SD were 21.39 ± 0.91 gm for *V. indicus*, 16.51 ± 0.73 gm for *V. spinosus*, and 15.87 ± 0.50 gm for *V. leucurus*.

Lapwing Chicks and eggs showed many morphometrics differences. In addition, our results indicate that there are considerable differences in the morphometrical (morphological and biometric” size, weight”) measurement of the *Vanellus spp.* eggs, chicks.

Monitoring by camera traps show predators, incubation period and nest success. The incubation period was (28 days, *V. indicus*; 24 days, *V. spinosus*; 22 days, *V. leucurus*). The boars *Sus scrofa* were predators to *V. leucurus*, the Arabian red fox *V. vulpes* and hedgehog *H. auritus* were predators to *V. indicus* while the nest success was (25.23%,23.08%,*V. indicus*; 76.69%,71.43%, *V. spinosus*; 7.57%,6.25%, *V. leucurus*) in Mayfield method and Traditional method respectively.

According to statistical analysis for environmental factors of lapwing spp. nests, Soil moisture recorded a high significant value while not significant for pH and soil temperature for lapwing species.

Our preliminary results, which were obtained for the first time, may contribute to the conservation efforts of these wetlands-dwelling birds in Iraq.

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List of abbreviations

IUCN	The International Union for Conservation of Nature and Natural Resources
Ti	Surveying Transect
IBA	Important Bird Area
BTO	British trust for Ornithology
CR	Critically Endangered
EN	Endangered
VU	Vulnerable
NT	Near Threatened
LC	Least Concern
Spp.	species (plural of specie).
V.	<i>Vanellus</i>
Sw	Spur winged lapwing
Rw	Red wattled lapwing
Wt	White tailed lapwing

Chapter one

Introduction

Introduction

Iraq has a unique geographic location near the southeast corner of the Western Palearctic region, which also covers Europe, Asia (with the exception of the southern half), and North Africa. It is located along the routes taken by numerous migratory bird species from cold climates in the Siberian plateau and Europe to warm climates in Arabia and Africa. Additionally Iraq has a large number of breeding and resident birds, which contribute significantly to the national biodiversity (Al-Sheikhly, 2021). The Middle East's most important wetland for wildlife is located in Iraq, which is regarded as an important bird area (IBA) (Evans, 1994).

According to Salim *et al.*, (2012), the number of bird species in Iraq exceeds 398, with 245 land birds, 128 waterbirds, and 25 seabirds that species have been identified.

The African-Eurasian Flyways and other bird migration pathways pass through Iraq; 312 migrating birds were counted overall, the Tigris and Euphrates basins' vast open lakes, rivers annual ponds, and marshes serve as important resting and staging grounds, there are numerous bird species of conservation concern in the lower Tigris and Euphrates River basin in central Iraq. A number of significant ornithological counts have shown that several locations scattered over the central Iraqi landscape appear to offer migratory birds ideal stop-over and/or congregating sites (Al-Sheikhly, 2021).

Wetlands support a high diversity of resident and migrant waterbirds (Amezaga *et al.*, 2002). One of the basic benefits of wetlands is that they provide suitable habitat for plants and animals that live primarily in these regions, for example, migratory birds are considered the main users of wetlands for foraging, resting, and roosting sites (Ma *et al.*, 2010).

Lapwings (*Vanellus spp.*) are deemed as bioindicators, which are species that provide information regarding habitat and environmental quality and employed to evaluate agricultural land quality, they are sensitive to changes in land use and habitat degradation, and their presence or absence might be a signal ecosystem health (Noriko *et al.*, 2021). Lapwings are members of the family Charadriidae, which typically nest on wetland area, grasslands, or sandy beaches, feeding on nematodes, worms, insects and crustaceans, especially their larvae in aquatic settings as insectivores (Shrubb, 2010).

According to Salim *et al.*, (2012), there are five species of lapwings belonging to the genus *Vanellus spp.* in Iraq, including Red-wattled Lapwing *Vanellus indicus*, Spur-winged Lapwing *V. spinosus*, White-tailed Lapwing *V. leucurus*, the first three species were breeding residents, while the Sociable Lapwing *V. gregarius* and Northern Lapwing *V. vanellus* are rare passage migrants and winter visitors consequently . (Al-Sheikhly, 2021). Given the lack of sufficient

information on lapwing community and its breeding biology in Iraq, this research has been conducting.

Aim of the study

This study, we aimed to obtain the ecological and biological Study of Lapwing (*Vanellus spp.*) Community in Al-Malih area in Babylon Province-middle of Iraq, through the following objectives:

- Identification the bird species in Al-Malih area.
- Determining of lapwing community with population size.
- A morphometrical comparison and differences among clutches of lapwing species.
- A study of environmental factors (Soil PH, Temperature, Moisture and texture) for the lapwing spp. nests.

Chapter two

Literature Review

2. Literature Review

2.1 Habitat use and habitat selection

Habitat use is the process through which a species makes use of a variety of environmental elements to fulfil its needs, habitat use can be seen broadly or broken down into individual activities or needs like foraging, nesting, or roosting(Block and Brennan, 1993).

The term "habitat selection" refers to a hierarchical sequence of behavioral reactions that may lead to excessive use of habitats to affect an individual's chance of survival and fitness, Habitat usage does not imply complex behavioral and environmental processes, but habitat selection implies such an understanding; habitat-use patterns are the outcome of habitat-selection processes, a part of habitat selection that just considers nest locations is called nest-site selection(Jones, 2001).

Habitat preference is the habitat most likely to be chosen by a species given the opportunity or which habitat the species is best suited for it. Habitat suitability is a continuous variable, while macrohabitat and microhabitat are landscape-scale factors related to population distribution and abundance(Block and Brennan, 1993).

2.2 Wader Birds Distribution and Abundance

Wader birds, also known as shorebirds, are a group of birds belonging to the order Charadriiformes. They are commonly found wading along shorelines, mudflats, and wetlands, foraging for food such as small arthropods, aquatic insects, and crustaceans (Svensson *et al.*, 2010).

The distribution and abundance of a species are determined by a variety of environmental factors (Duong and Fairweather, 2011). Waders generally forage on mudflats, and both their prey and abiotic conditions affect where they are

found on these flats, these variables affect either the availability and abundance of the prey or the capacity of the shorebirds to take advantage of it (Spruzen *et al.*, 2008).

2.3 Territory and Connectivity

A territory is the area that is "staked out" and defended against rivals where abundant food and/or nesting sites are found (Weston *et al.*, 2009).

Animal fitness is impacted by local habitat through variations in resources and environmental factors, Thus, considerable selective pressure for habitat selection is created by spatial and temporal heterogeneity in habitat variables(Johnson, 2007).

Waders select a habitat that will be good for their requirements, such as nesting or feeding avoid being disturbed by humans (Schlacher *et al.*, 2013). The ability of waders to reduce egg predation has been associated with nest site selection and dispersion additionally, sensitive to predators because to their ground nesting habitats. However, they can reduce density-dependent nest predation by separating their nests(Powell, 2001).

2.4 Migration of birds

Birds possess remarkable mobility and control, allowing them to move swiftly across vast distances and navigate hostile environments. Their excellent orientation and navigational skills enable them to occupy diverse regions at different times of the year, leading to an itinerant existence. Birds' migration paths cover the globe, with most noticeable movements in spring and fall. This unique characteristic raises concerns about the ecological reasons governing bird movements and distributions (Newton, 2010).

Migration refers to an animal's periodic journey as it eventually makes its way back to the starting point. Migration frequently occurs annually and is closely

correlated with seasonal cyclicity. The best examples of it are birds, who have incredibly effective ways of moving quickly over great distances, the majority of bird species migrate on an annual cycle, there are several justifications for migration, including:

(1) Birds migrate to places with better food availability

(2) less competition for breeding sites

(3) milder climates

(4) longer daylight hours, these increase a bird's and its young's survival prospects, due to their high metabolic rates, the majority of birds need a good, sufficient supply of food often (Shackelford, 1999).

Birds use various guiding elements, including climatic changes, ecological elements, and geographical features, to navigate their environment. They can use a compass, associate release locations with their home territory, and maintain their orientation. Celestial bearings also play a role in birds' orientation, using the sun as a reference point during the day and stars at night. (Shackelford, 1999).

In the past, the marshes of Iraq were renowned for their biodiversity and cultural diversity, they served as both a flyway and a permanent habitat for millions of birds travelling between Siberia and Africa (Brasington *et al.*, 2002). In the wetlands, more than 80 different bird species were discovered during the last thorough census in the 1970s (Maltby, 1994). Two of the eight broad flyways of waders/shorebirds in the world pass in Iraq mention in (Fig.1) (Boere and Stroud, 2006)

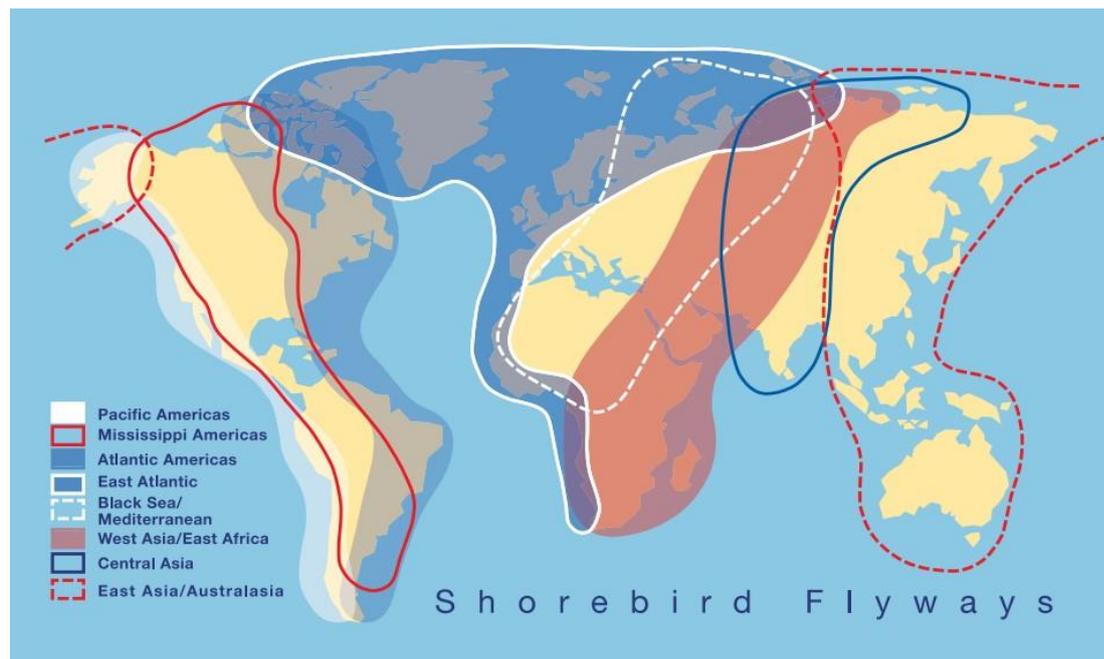


Figure 1: The eight broad flyways of waders/shorebirds. Adopted from (Boere and Stroud,2006)

2.5 Lapwing (*Vanellus spp.*)

Lapwings inhabit short grasses, cultivated areas, and bare ground that is frequently dry, but they also require marshland, pools, and the edges of rivers and lakes as crucial habitat elements. In general, lapwings share a number of similar structural and plumage traits while several species can fly in acrobatic displays and move very quickly, they structurally differ from other plovers in having wider and more rounded wings. The term "lapwing" originally referred to a type of flight that was looser and more "floppy", the feet of the majority of lapwings extend partially or completely beyond the tail while in flight, giving them a conspicuously long leg.

Three species have crests like northern lapwing *V. vanellus*. Several lapwings, like spur-winged lapwing *V. spinosus*, have noticeable carpal spurs; and many lapwings, like red-wattled lapwing *V. indicus*, have facial wattles, Some lapwings, including the Sociable *V. gregarius* and White-tailed lapwing *V.*

leucurus, are lack of these adornments, a remarkable contrast can be seen in the plumage of lapwings, which often have white underwings and underbodies, black primaries, and, in many species, prominent white bands on the upper wings. Thus, even species that have cryptic coloring when at rest have strong patterns when flying, the black/white effect is noticeable in tumbling exhibition flights, Large herbivores may be effectively prevented from trampling nests by using these striking patterns (Shrubb, 2010).

Lapwings are strongly territorial birds (Howard, 1920). Males establish secure territories for courtship, pair formation, nesting, feeding and aiding population control. Nest selection depends on ecological characteristics and food availability. Food availability influences territory selection, with sufficient food supplies providing all adults' needs. Nest selection may change based on ecology and site management (Cramp *et al.*, 1988).

2.6 Lapwing (*Vanellus* spp.) classification:

Lapwing was assigned to the monotypic genus *Vanellus*, which is a subfamily of the Vanellinae belong to the Charadriidae family of plover and home to a number of closely related and unique species (Sibley and Monroe, 1990).

Kingdom	Animalia
Phylum	Chordata
Class	Aves
Order	Charadriiformes
Family	Charadriidae
Subfamily	Vanellinae
Genus	<i>Vanellus</i>

2.7 Lapwing (*Vanellus* spp.) of western palearctic and Iraq

There are 23 species relating to lapwing *Vanellus spp.*, in the Western Palearctic, five species of lapwing breed: the Northern, Spur-winged, Sociable, White-tailed, and Red-wattled Lapwings. Only the Northern Lapwing is spread widely. Both the Sociable and Spur-winged Lapwings breed throughout Russia and Kazakhstan, as well as in Greece, Turkey, the Levant, the Middle East, Sinai, and Egypt, with the exception of infrequent records for Turkey, Syria, Armenia, Azerbaijan, and the north Caspian coast (Cramp, 1988).

The White-tailed Lapwing breeds only in Iraq in this area, though its breeding status there is likely to have been harmed by the drainage of the Euphrates marshes in the 1990s, Iraq is the only known home to the Red-wattled Lapwing (Hagemeijer and Blair, 1997). So, five species of lapwing in Iraq:

1. Spur-winged Lapwing (*V. spinosus*) Resident Breeder and Passage migrant, more often than not, it may be found in the central of Iraq, where it mostly breeds before spreading to other bodies of water following the breeding season.

The habitat: Short-growing plants along irrigation ditches, the borders of fresh and salt marshes, it nestles in surrounding sandy areas or dry clay plains.

2. Red-wattled Lapwing (*V. indicus*) Resident breeder. The majority of Iraq's wetlands have reported seeing it following the mating season.

The habitat: Generally near waters in open regions and agricultural land is preferred. On the ground, it nestles.

3. White-tailed Lapwing (*V. leucurus*) resident breeder and probably winter visitor that breeds and then disperses from north to south.

The habitat: Pools with fresh or salt water, marshes and floodplains make up the habitat.

4. Northern Lapwing (*V. vanellus*) Uncommon winter visitor, as it forms groups during the Autumn and Spring migration seasons.

The habitat: Open fields, marshes, shallow ponds and coasts.

5. Sociable Lapwing (*V. gregarius*) A rare passage migrant in suitable habitats of Iraq, but in general, their numbers are steadily declining.

The habitat: Bare or semi-barren plains, farmed fields in the winter. Rare in the mudflats and coasts (Salim *et al.*, 2012; Habeeb *et al.*, 2021).

2.8 Food and feeding behavior of lapwing

Lapwings are physically similar to other plovers, with relatively short bills that range in length from 21.7 to 28.0 mm. Many waders with longer bills have a sensitive tip that can be used to touch prey to locate it, on the other hand, the bill has a strong, horny tip that is ideally adapted to grabbing and holding prey as well as possibly extracting food from relatively firm soil structures like pastures, lapwings have eyes that are substantially bigger than their heads, They very much rely on visual detection of prey at or near the soil's surface, for which their huge eyes are particularly well adapted, despite experimental evidence that prey like earthworms can be detected acoustically (Cramp, 1988).

Due to the structure of the retina being well adapted to nocturnal feeding by sight (Rojas *et al.*, 1999). Lapwings diets generally on invertebrate like worms and insects according to analyzing stomach contents and faeces (Shrubb, 2010) .

2.9 General Ecological Factors affected the Lapwing (*Vanellus* spp.)

Agricultural expansion in Britain has led to a decrease in lapwing populations, as waders adapt breeding schedules to agricultural management. This adaptation affects species like Skylarks *Alauda arvensis*, as enclosure,

drainage, and ploughing have led to the loss of stable habitats (Beintema *et al.*, 1985) .

Wet areas are particularly valuable as feeding areas for breeding adults and their chicks, lowering water tables makes such prey increasingly accessible, although puddles and surface water are important invertebrate prey for chicks (Beintema *et al.*, 1991).

Also, damp soils may be essential in the later stages of chicks' growth, it also promotes more rapid and earlier vegetational growth and earlier crop management, factors which curtail the breeding season and reduce the chances of replacing lost nests (Green and Robins, 1993).

Lapwings can build nest successfully on tilled land but rearing the young depends largely on the availability of suitable conveniently placed grass fields, hatched depends largely upon the availability of suitable conveniently placed grass (Shrubb, 2010).

Damp soils were significantly more productive feeding sites for them and they showed retarded growth under dry soil conditions (Carroll *et al.*, 2004).

2.10 Breeding Biology of Lapwing

Breeding biology of lapwing includes information on nest and egg characteristics, incubation and nestling times, brood patches, breeding habitats, and the time of year when nesting activity occurs, several factors and nesting properties (Marini *et al.*, 2012).

2.11 Courtship Display and Pair Formation

Lapwings perform a complicated series of aerial and terrestrial displays during the breeding season. In general, aerial displays promote, establish, and preserve territory as well as provide crucial information to the female in choosing a mate, males make ground displays to entice females and strengthen the pair

relationship, females have the right to choose their partners, there is a strong diurnal regularity in display activity, with the majority occurring early in the morning, dropping near midday, and resurging in the evening, some ground displays are also territorial, early in the breeding cycle, males usually make nighttime displays additionally, show flights follow a seasonal pattern, with the majority of them taking place from the time of territorial establishment until egg-laying, after the eggs hatch, the decline gradually stops, if eggs are lost, activity will pick up again until they are replaced Likewise, if a new female enters the area, activity will pick up again until she is paired or leaves, Activity is reduced by poor weather (Dabelsteen, 1978).

2.12 Behavior of lapwing spp. to other species

Even though they cohabitate alongside species like Snipe, Curlew, and Redshank on their breeding grounds. Lapwings frequently attack invading waders, both passage and breeding birds. However, some ground-nesting species take advantage of lapwings' anti-predator behaviour by nesting next to them in order to lower their rates of nest predation (Mayo, 1974). Lapwings, such as Southern Lapwings (*V. chilensis*) and Northern Lapwings (*V. vanellus*), exhibit various behaviors when interacting with other species. Some of these behaviors include:

1. Anti-predatory responses: Lapwings have been observed to exhibit three distinct types of responses to potential predators, such as reptile alarm calls and pecking attacks, alarm calls and swooping attacks, and injury-feigning and mobbing (Walter,1990).
2. Territorial encounters: During territorial disputes, lapwings engage in ritualized displays. Territory owners and intruders run towards each other in a head-down, tail-up posture, and upon meeting, they adopt an upright posture, erecting the crest and making chattering calls.

3. Foraging behavior: Lapwings are known to engage in a characteristic plover-like behavior during foraging events, where they stand on one foot and execute trembling movements with the other foot to flush prey.
4. They also use short flights to move between feeding patches and long-distance flights between different foraging sites during the non-breeding season.
5. Social behavior: Lapwings are typically social and form pairs during the breeding season, with some populations being described as pair breeders, cooperative breeders, or having a flexible social structure.
6. Distraction displays: In the presence of predators, lapwings may use distraction displays to protect their chicks. For example, they may pretend to have a broken wing to draw predators away from the chicks.
7. Defensive behavior: Lapwings have been observed to show vigilance, food calling, and other defensive behaviors when encountering potential predators such as egrets, vultures, cattle, and observers.
8. Habitat selection: To reduce the likelihood of predation, lapwings tend to select open habitats (e.g., river banks and river islands) distant from suitable predator perches, such as field boundaries and roads (Mishra,2018).

2.13 Predation in breeding site of lapwing spp.

Birds recognize predators and respond appropriately, varying based on species and context. Ideally, birds avoid non-threatening animals and use the most effective response in each encounter (Walters, 1990).

Predation on eggs and chicks, especially those of ground-nesting species, can lower breeding success and restrict the expansion and recovery of bird populations(McMahon *et al.*, 2020). Increasing predation and habitat loss have

led to a fall in many wild bird populations, despite the fact that nest predation rates are generally high for birds living in open areas (Bodey *et al.*, 2011).

Lapwing productivity is thought to be significantly impacted by nest predation (Seymour *et al.*, 2003). Lapwing predators like Red Foxes, Hedgehogs, rats and crows (Hayward and Kerley, 2009).

2.14 Local and International Studies

2.14.1 Local Studies

There are many studies that have addressed with lapwing spp. in Iraq like (Ticehurst and Cheesman, 1922) determine the breeding season of *V. indicus* (mid-April–early June) and refer to the breeding season of *V. leucurus* in May in the southern marshes of Iraq.

Also in Chapman and McGeoch, (1956) recorded nests of *V. indicus*, *V. leucurus* and *V. spinosus* in al Habbaniyah.

As well as Moore and Boswell, (1956) recorded eggs on April 12, 19, and 26 May of *V. indicus* in Iraq.

Moreover Allouse, (1961) described the lapwing *V. spp.* in Iraq (morphological, recorded, and status) and referred to *V. indicus* as a resident, *V. leucurus* as a resident and winter visitor, *V. gregaria* as a rare winter visitor, *V. vanellus* as a winter visitor, and *V. spinosus* as a resident.

in Marchant, (1963) indicated that two species of lapwing (*V. leucurus* and *V. indicus*) are breeding in Iraq with evidence.

AL-Robae (1986) referred to two lapwing species (spur winged and red wattled lapwing) in Basra.

Also in Al-Robaae, (2006) mentioned that *V. leucurus* nests are found in late May and early June, while *V. spinosus* nests were found in June, which are small

holes on the water's surface and contain 3 or 4 eggs. He also mentioned that *V. indicus* nests and eggs were discovered in May and June.

In study of Abed, (2007) recorded two species of lapwing (*V. leucurus* and *V. indicus*) in three sites (Huwayzah , Suq Shuyukh and East Hammar) belonging to restored southern Iraqi marshes.

Salim *et al.*, (2009) referred to those four species of lapwing recorded in the marshes of southern Iraq, where Northern Lapwing *V. vanellus* was a Winter visitor. *V. spinosus* as Resident breeder and winter visitor; *V. indicus* as Resident breeder and winter visitor; and *V. leucurus* as resident breeder and winter visitor.

Also in Salim and Abed (2017) found four species belong to lapwing in Al Najaf province (*V. vanellus* , *V. spinosus* , *V. indicus* and *V. leucurus*).

As well as in Salim,*et al.* (2020) recorded four species belong to lapwing in Al Dalmaj wetland (*V. vanellus* , *V. spinosus* , *V. indicus* and *V. leucurus*).

Fazaa *et al.*, (2017) indicated that the three species of lapwings mentioned above are breeding in the Central Marshes based on the British Trust for Ornithology BTO's breeding evidence.

Habeeb *et al.*, (2018) recorded three species of lapwing (*V. leucurus* , *V. spinosus* and *V. indicus*) in east Hammer Marsh in Basra.

Finally in (Abbas, 2022) recoded one species *V. indicus* from the lapwing genus in Basra.

2.14.2 International Studies

Sheldon *et al.*, (2007) referred that lapwing *V. vanellus* nest success results showed that the different crops type had a significant difference. Nests on fields that followed the Agri-environment prescription had a better probability of surviving than nests on fields that followed conventional management practices.

The study of Narwade *et al.*, (2010) was conducted on Ground nesting birds like Red-wattled Lapwing have been shown to depend heavily on agriculture for their survival, there were both good and negative consequences of agricultural activities .

As well as Cherkaoui and Hanane, (2011) studied the breeding biology of lapwings *V. vanellus* in Morocco during five years, Breeding phenology, colony size, clutch size, egg dimensions, and hatching success were determined, average hatching success was 70.1%, but nests suffered higher losses due to human disturbance.

Also Sethi *et al.*, (2011) investigated red-wattled lapwing hatching success in ground- and roof-nests during two years in rural and suburban environments of India, the mean number of eggs per nest in roof nests larger than the average for ground nests, respectively, egg loss in both nest types was caused by several circumstances, including predation, nest damage, and hatching failure. However, compared to those on roofs, egg loss from predation was much higher in ground nests.

Study of Kubelka *et al.*, (2012) revealed arable land as the dominant nesting habitat for Northern Lapwing *V. vanellus* during breeding season 2008. Marsh patches and meadows positively correlated with lapwing abundance, while agricultural activities were a major threat.

also Özkan *et al.*, (2012) The study examined the breeding biology of the spur-winged lapwing *V. spinous* in Antalya, focusing on habitat preference, population density, nest count, clutch size, and hatchling numbers. The average clutch size was 3.6, and the population varied from 52 in 2009 to 72 in 2011. The lapwing preferred nesting locations in meadows, grasslands, and sand areas, with major predators being hooded crow, domestic dogs, and red fox.

Moreover, in Charalambidou *et al.*, (2012) conducted study on the breeding population and status of the spur-winged lapwing *V. spinous* in Cyprus from 2007

to 2009 found over 200 individuals during fall passage and 50 overwintered at five wetlands. The species population expanded since the 1990s due to Middle East population growth, milder winters, and sewage lagoon construction.

Schmidt *et al.*, (2013) referred that Lapwings had a significantly reduced clutch size in 2012 due to insufficient food supply due to an exceptionally long winter.

The study of Balkhande and Azeem, (2017) The investigation revealed that red-wattled lapwing *V. indicus* nesting is not protected, with a 50% hatching rate. However, predators like dogs, grazing cattle, and humans contributed to the destruction of the nest.

Kaur and Khera, (2017) The study examined the breeding biology of red wattled lapwing *V. indicuos*, focusing on egg volume, specific gravity, and shape index. Results showed average egg breadth, length, and shape index, while whole egg weight, albumen weight, yolk weight, shell weight, and specific gravity varied.

Also Khalil *et al.*, (2019) The breeding season in Bahawalpur District, April through June, involves male selection of territory and nest construction. The average clutch size is 4 ± 0.0 , with hatching time 25-28 days. The average hatching rate per clutch is 91.65.2, with 79.17% success. Fledged fledglings are successful, but human activity significantly increases predation.

In study of Sharma *et al.*, (2020) that described Red-wattled lapwing *V. indicus* breeding biology and egg characteristics are studied in Ramanagaram village, Haryana. Egg characteristics include clutch size, egg length, and hatching success. The male bird selects territory, while the female builds the nest. The hatching success is 75%, with hatchlings able to fly within 21-27 days.

(Kaleka, 2020) The studied red-wattled lapwing *V. indicus* in Khanna, Pakistan, revealed that egg length, nest structure, incubation, and weight were all significant factors in the nesting process. The clutch size was 3.34 ± 0.81 , and the incubation period varied from 27 to 30 days.

Ashour *et al.*, (2020) described the first spur-winged lapwing breeding in Kuwait in the spring of 2020, where one pair of adults successfully produced two broods.

Finally, in Mishra and Kumar, (2022) study that Red wattled lapwings identified nest predators and exhibited anti-predator activity during breeding seasons in 2018 and 2019. Nesting pairs varied, and numerous predators, including avian, mammalian, and reptilian species, were found.

Chapter three

Materials and Methods

3. Materials and Methods

3.1 Description of Study areas

Al-Malih area is located in the northern of Babylon province (N 32°48'56", E 44°20'37") and south of Baghdad (far about 54.78 km). However, it receives water from the Euphrates River through two channels that pass through it and cover approximately 2000 ha (20 km²), areas most of the water convert to fish farms due to the low area that helps in capturing water easily. It is considered as wetland and contain threatened animal species like Eurasian otter (*Lutra lutra*) and the Euphrates softshell turtle (*Rafetus euphraticus*) (Fig.2;Pic.1).



Figure 2: satellite image of Al-Malih Marshland involve surveying transects Ti (T1,T2,T3,T4) of the study.



Picture 1: study area during (Sep.22-Aug.23) A: transect one; B: transect two; C: transect three; D: transect four.

3.1.1 Transect one

Located between the north and east parts of Al Malih marshland (N: $32^{\circ}49'13''$ E: $44^{\circ}20'59''$), extended to 6 km and there is a feeding channel pass through it from the Euphrates River, a lot of fish farms there and also wetlands especially in the winter season with a lot of migrant birds, many anthropogenic activities there like fishing and hunting, the plants cover featured by abundance the common reed *Phragmites australis* covered about 15% and other plants species scattered like salt cedar *Tamarix spp.* (Fig.2;Pic.1).

3.1.2 Transect two

Located between the north and west-north parts of Al Malih marshland (N: 32°47'25"E: 44°21'50"), extended to 2 km and there are feeding small channels from human-made pass through it, several fish farms there and also agricultural areas, many anthropogenic activities there like farming and hunting, the plants cover featured abundance the palm *Phoenix* spp. covered about 25% and other plant species scattered like the common reed *P. australis* (Fig.2;Pic.1).

3.1.3 Transect three

Located between the north and west parts of Al Malih marshland (N: 32°47'57"E: 44°21'05"), extended to 1 km and there is feeding small channels from human-made pass through it, a lot of fish farms there and also wetlands especially in the winter season with a lot of migrant birds, many anthropogenic activities there like fishing and hunting, the plants cover featured by abundance the common reed *P. australis*, covered about 40% and other plants species scattered like and salt cedar *Tamarix* spp. (Fig.2;Pic.1).

3.1.4 Transect four

Located between the south and east parts of Al Malih marshland (N: 32°49'42"E: 44°19'06"), extended to 2 km , fish farms there and also wetlands, especially in winter season with a lot of migrant birds, many anthropogenic activities there like train road and Ya-Hussein street, the plants cover featured by abundance the common reed *P. australis* covered about 10% and other plants species scattered (Fig.2;Pic.1).

3.2 Field survey standards

During our field surveys (September 2022 - August 2023), we followed standard bird monitoring in (Sutherland *et al.*, 2004;Sutherland, 2006). The standardized field techniques that were mostly used which were:

3.2.1 Personal knowledge

The accuracy of the data obtained is determined by the observer's experience with the subject species and ability to differentiate it from other bird species (Sutherland, 2006). As a result, a 'double-observer' strategy has been employed to eliminate bias and correct differences in detection probabilities. The primary and secondary observers take shifts estimating detection probability and adjusting counts (Nichols *et al.*, 2000).

3.2.2 The weather circumstances

Sever weather may have a negative impact on field observations and identification of bird species. Extreme weather may have an effect on species behaviour, reducing the observer's detection likelihood and increasing bias. Storms, severe rain, fog, and mist may increase the noise in the observer's visual detection, shorten the surveying duration, and have an impact on species mobility and behaviour, which can be difficult to identify in such conditions. Our field surveys were conducted in sunny weather (Sutherland, 2006).

3.2.3 The timing of the survey

The field survey was conducted for twelve months (September 2022 - August 2023) with one survey per one month. The field surveys conduct through birds activity time from 6:30 a.m. to 2:00 p.m. (from September 2022 to end February) and 5:30 a.m. to 1:00 p.m. (from March 2023 to end August) (Kumar and Gupta, 2009).

3.2.4 Field survey technique

During September 2022- August 2023 field survey, we conducted Line Transect survey to detect Bird species in the Malih marshland, line transect sampling involves an observer travelling along a designated line of given length recording the number of birds, nests or other relevant objects (e.g.

burrows, droppings and footprints), detected The line transect is a very adaptive and effective method for detecting birds in large, difficult open areas. Line transects were carried out along a specified regular route, and bird species were identified and documented (visually observed/heard) on both sides of the transect (Sutherland, 2006).

Total of four distanced line transects (T1:6; T2:2; T3:1; T4:2 km) were identified by walked in the study area within the Malih area. (GPS coordinates of each transect mentioned in the Appendix II).

3.2.5 Survey maps

Transects and lapwing *spp.* nests were digitally identified and marked using online Google Earth.

3.2.6 Survey equipments

A variety of digital and manual tools were employed to detect, monitor, and document bird species in the study area. The field survey was carried out using Ansinna 12x42mm binocular was used for close-range/distance systematic monitoring/scanning of flying/soaring or perching birds and Spotting Scope (Svbony,25-75x70) for far distances. A digital camera (Nikon Coolpix p900s), was used to document birds, habitats. In order to reduce stress and disturbance on bird species and closer approach for digital photography, Camouflage field outfits were used.

3.2.7 Identification field guides

Many ornithological classification field guides were employed during the study to achieve precise morphological identification of bird species. The following field guides were used and are organized by year of publication: (Allouse, 1961 ; Porter and Aspinall, 2013 ; Svensson *et al.*, 2010)

3.3 Population Density

The density estimates for the lapwing species in each survey were computed using distance sampling based on exact distances analysis as simple density estimates from line-transect data (Sutherland, 2006). In each survey, the estimated species density (\hat{D}) was calculated using the formula:

$$\hat{D} = n \sqrt{\left[\frac{2n}{\pi \sum_i (x_i^2)} \right]} / (2L)$$

where

n = total number of birds detected

L = length of Transect

x_i = perpendicular distance of the birds detected from the transect line.

Perpendicular distance (x_i) was calculated using the formula:

$$x_i = K \sin \theta$$

Where

k = distance from observer to the bird in meter (m)

θ = measured observation angle (Fig.3). The observation distance (k) was estimated by using Rangefinder device (PF 210) That made by MILESEY Company in all stations through study and express it in (meter). The observation angle (θ) was measured using compass that made by SHENZHEN JYC company in all transects and express it in (degree).

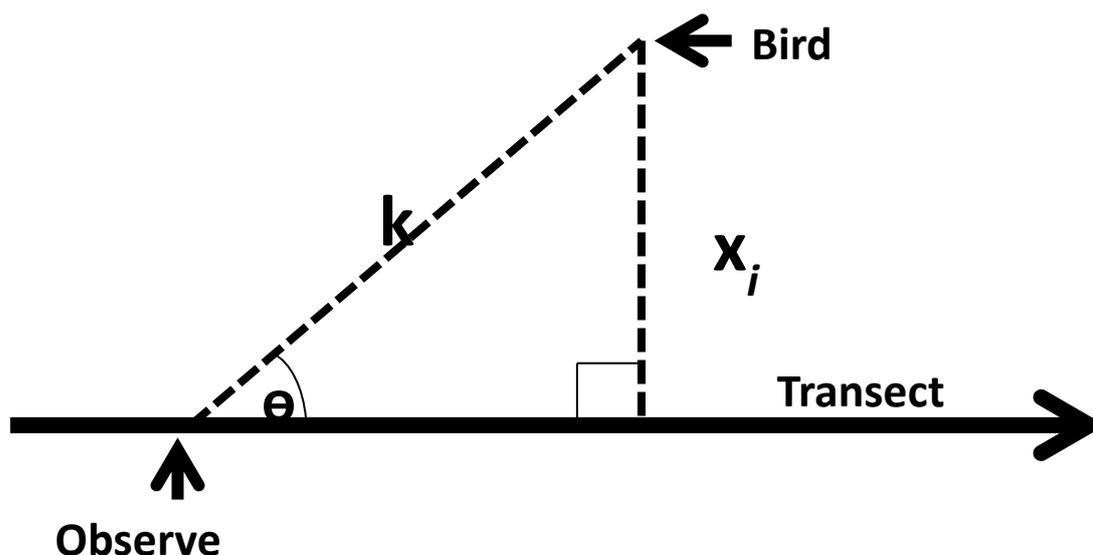


Figure 3: Calculating the perpendicular distance (x_i) of the i th bird (lapwing species) detected from the Transect line (Sutherland, 2006).

Based on common sense to provide maximum population estimate/extrapolation for each lapwing species recorded within the Malih marshland, estimated species density were then extrapolated following (Fazaa *et al.*, 2017), The extrapolation of population size was calculated by

$$\text{Population size} = \text{species density} * \text{total study area}$$

, where calculate by multiplying the species estimated density from our survey by the total area size of the Malih marshland (2000 ha).

3.4 Breeding surveys

a) The study was conducted during the breeding season (March–June 2023) for 60 days (15 days per month) from 6:00 a.m. - 10:00 a.m. and 3:00 p.m. - 6:00 p.m. The common technique for finding nests is cold searching, that involves looking visually for breeding events (e.g., adult courtship, marking of the breeding territories, nest-site selection, nest building, and egg incubation) that were carefully observed (Sutherland *et al.*, 2004), to relocate nests by using natural markers, such as stones arranged in a particular way to

mark the nests to reduce predation risk, and global positioning systems GPS to enable navigate quickly to the correct nest (Pietz and Granfors, 2000).

b) Breeding assessment

The breeding assessment for the lapwing species observed during the breeding survey in the Central Marshes in 2018-20Al-Malih area was based on the British Trust for Ornithology (BTO) breeding evidence codes (BTO, 2019). The BTO non-breeding, possible, probable, and confirmed breeding evidences were tested in regard to the observed species during summer/breeding survey in March-June 2023 (Table 1).

Table 1: The British Trust for Ornithology (BTO) breeding codes.

Non-Breeding	
F	Flying over
M	Species observed but suspected to be still on Migration
U	Species observed but suspected to be summering non-breeder
Possible Breeder	
H	Species observed in breeding season in suitable nesting Habitat
S	Singing male present in breeding season in suitable breeding habitat (Calls used with breeding raptors)
Probable Breeding	
P	Pair observed in suitable nesting habitat in breeding season
T	Permanent Territory presumed through registration of territorial behavior (song etc) on at least two different days a week or more at the same place or many individuals on one day
D	Courtship and Display (judged to be in or near potential breeding habitat; be cautious with wildfowl)
N	Visiting probable Nest site
A	Agitated behavior or anxiety calls from adults, suggesting probable presence of nest or young nearby
I	Brood patch on adult examined in the hand, suggesting Incubation
B	Nest Building
Confirmed Breeding	
D D	Distraction-Display or injury feigning
U N	Used Nest or eggshells found (occupied or laid within period of survey)
FL	Recently Fledged young (nidicolous species) or downy young (nidifugous species). Careful consideration should be given to the likely provenance of any fledged juvenile capable of significant geographical movement. Evidence of dependency on adults (e.g. feeding) is helpful. Be cautious, even if the record comes from suitable habitat.

O N	Adults entering or leaving nest-site in circumstances indicating Occupied Nest (including high nests or nest holes, the contents of which cannot be seen) or adults seen incubating
FF	Adult carrying faecal sac or Food for young
NE	Nest containing Eggs
N Y	Nest with Young seen or heard

3.5 Lapwing species nests study

3.5.1 Lapwing *spp.* nest measurements

A field survey was conducted for four months (March 2023 -June 2023) in three surveys per month along study period using the measurements of eggs (long, width and weight) calculated by using verna caliper (Mechanical, China) and highly sensitive digital scale (home geek, 0.001-50 gram),

Egg shape index (SI) was estimated using the equation:

$$\text{Egg shape index (SI)} = \frac{B}{L} \times 100$$

Where B =egg breadth, L= egg length

According to this the eggs were classified with respect to shape index (SI), namely as a sharp egg (SI < 72), a normal (standard) egg (SI = 72–76) or a round egg (SI > 76)(Sharma *et al.*, 2020).

3.5.2 Monitoring by camera traps

12 nests (12 camera traps, 3 lapwing species) were Monitoring by camera tarps during breeding season (March 2023-June 2023) in Al Malih area to know the predators , determine incubation period and calculate the nest success , the using of camera trap between 2-4 days and maintenance it along incubation period (Pic.2).



Picture 2: camera trap mimic with surrounding environment of lapwing *spp.* nest site.

3.5.3 Nest success

Hatching success was calculated by two methods, the first known by the traditional method with formula:

Traditional Method = % of hatched egg / total eggs laid * 100

(% of eggs that hatched successfully out of total eggs laid) was calculated by numbers of hatched eggs divided total numbers of eggs multiple 100 (Kaleka, 2020).

The second method which is known a Mayfield method was calculated by computing the exposure for each egg (how take days to success or fail) and compute all eggs that fail and total to calculate these following:

Mortality rate= lost eggs/exposure,

Success rate= 1-mortality rate and

the probability of survival = Success rate ^(incubation period)

(Mayfield, 1975).

3.6 Environmental factors

3.6.1 Soil Temperature

Soil temperature was measured by using digital thermometer that was ended with a probe (SMART) that was made by a China in all transects through study and express it in (C°).

3.6.2 Laboratory Measurements

Soil samples were collected from the nesting site of lapwing spp. Along collect of the nesting site in plastic bags and conducting some laboratory tests like soil PH and Moisture and texture.

3.6.2.1 Soil Moisture

Conduct test in laboratory depend on (George *et al*, 2013) by weight 100 gm and dried in oven (105 c° /24 h.) after that cool in a desiccator for at least 30 minutes and re-weigh, and calculate by:

$$\% \text{ Soil moisture} = \frac{\text{wet soil (g)} - \text{dry soil(g)}}{\text{dry soil (g)}} \times 100\%$$

3.6.2.2 Soil texture

Conduct test in university of Baghdad , faculty of agriculture's laboratory depend on (George *et al*, 2013) by Pipette Method (**by weight 100 gm**), Once the percentages of sand, silt, and clay have been determined, the soil can be classified using the USDA textural triangle, various soil textures exist inside the textural triangle, depending on the relative quantities of soil parts. There are twelve soil textural classifications recognized, and their compositions are designed around a textural triangle (Fig.4).

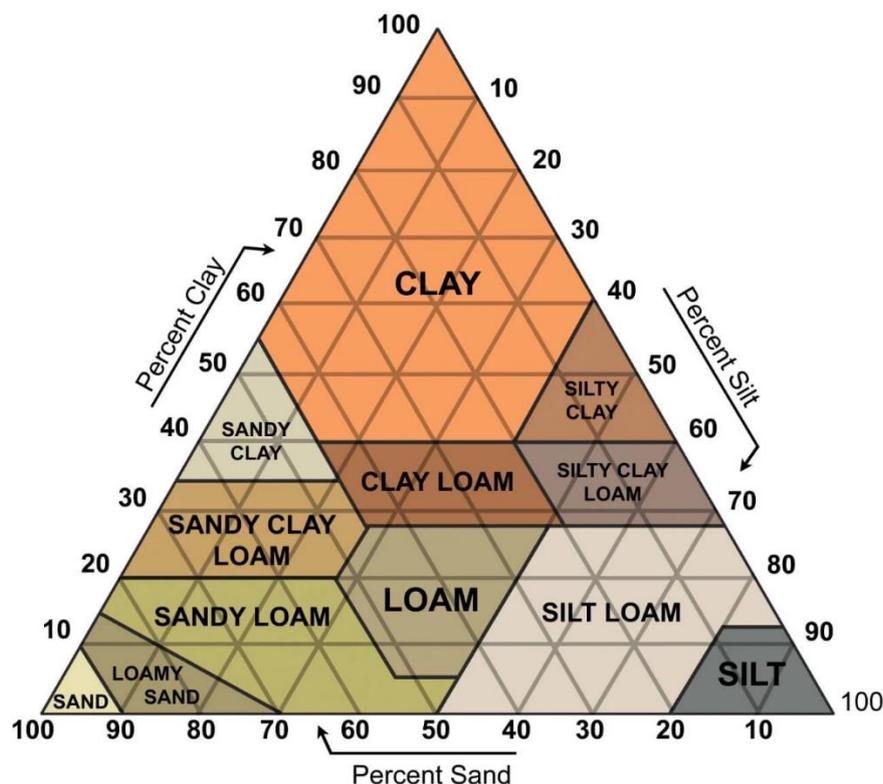


Figure 4: USDA soil textural triangle. Adopted from George *et al*, 2013

3.6.2.3 Potential Hydrogen (pH)

Conduct a test in the laboratory by weight 50 gm into a glass beaker of 100 mL and adding De-ionizing water using a graduated cylinder then mix well with a glass rod and allow to stand for 30 minutes, Stir suspension every 10 minutes during this period. After 1 hour, stir the suspension. Finally, calibrate the pH meter (DI water pH 7.0 buffer solution and pH 4.0 buffer solution) and put the combined electrode in suspension (about 3 cm deep). Take the reading after 30 seconds (George *et al*, 2013).

3.7 Bird Species conservation status

The global conservation status of the recorded bird species in the Malih marshland was based on the 15.1th version of the International Union for Conservation of Nature (IUCN) Red List guidelines, (IUCN, 2023; Birdlife, 2023a)(Fig.5).

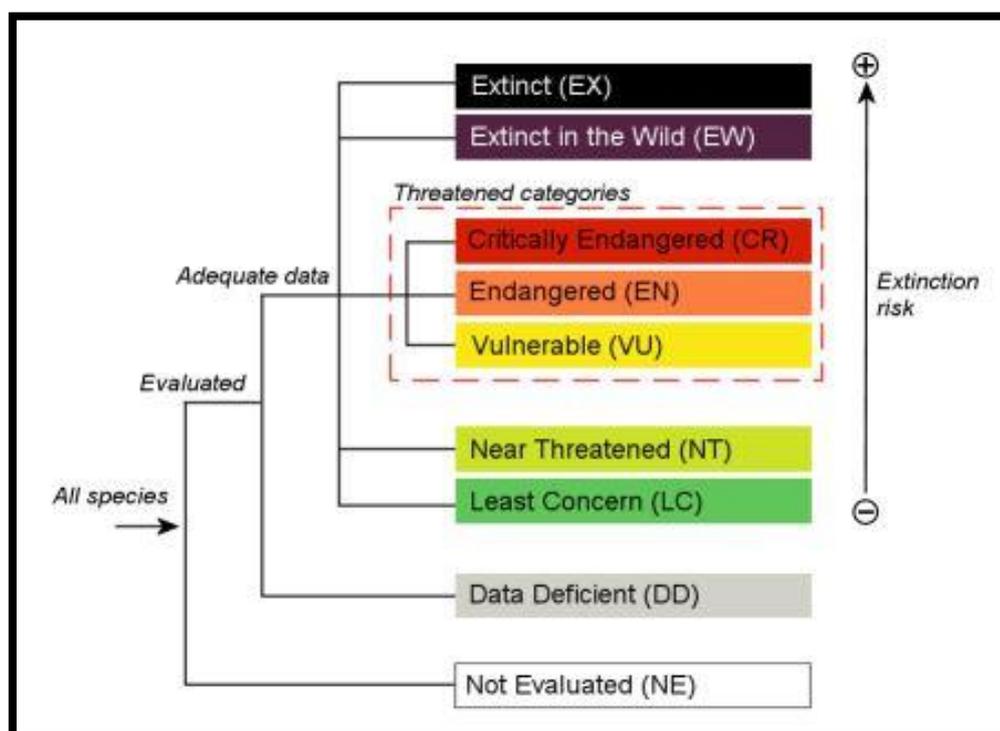


Figure 5: Structure of IUCN Red List categories. Adopted from (Birdlife, 2023a)

3.8 Statistical Analysis

Data were statistically analyzed in SPSS 22.0 version Software by using one-way ANOVA (Analysis of Variance), to determine significant differences between egg measurements, the Duncan multiple range test was employed to examine the variances among the means and environmental factors (PH, Soil moisture and temperature) of lapwing species (McCormick and Salcedo, 2017).

Chapter four

Results and Discussion

4. Results and Discussion

4.1 Classification of recorded Birds in Al-Malih area

A total of 122 species were recorded in the current field surveys at Al-Malih area (September 2022 - August 2023) belonging to 17 orders and 38 families (two sup species). However, it represents about 30.65% of the total number of Iraqi birds (total number of Iraqi bird species was 398 species, Salim *et al.* 2012), four species of lapwing genus (*Vanellus* spp.) were recorded, classification and conservation status globally in IUCN is mention in (Table.2)

Table 2: List of Bird Species Recorded in Al-Malih area (September 2022- August 2023).

	Scientific name	Common name	Order	Family	IUCN status
1.	<i>Francolinus francolinus</i>	Black Francolin	Galliformes	Phasianidae	LC
2.	<i>Tadorna tadorna</i>	Common Shelduck	Anseriformes	Anatidae	LC
3.	<i>Marmaronetta angustirostris</i>	Marbled Teal	Anseriformes	Anatidae	NT
4.	<i>Aythya ferina</i>	Common Pochard	Anseriformes	Anatidae	VU
5.	<i>A. nyroca</i>	Ferruginous Duck	Anseriformes	Anatidae	NT
6.	<i>Spatula querquedula</i>	Garganey	Anseriformes	Anatidae	LC
7.	<i>S. clypeata</i>	Northern Shoveler	Anseriformes	Anatidae	LC
8.	<i>Anas platyrhynchos</i>	Mallard	Anseriformes	Anatidae	LC
9.	<i>A. crecca</i>	Common Teal	Anseriformes	Anatidae	LC
10.	<i>Tachybaptus ruficollis</i>	Little Grebe	Podicipediformes	Podicipedidae	LC
11.	<i>Podiceps cristatus</i>	Great crested grebe	Podicipediformes	Podicipedidae	LC
12.	<i>Columba livia</i>	Rock Dove	Columbiformes	Columbidae	LC
13.	<i>C. palumbus</i>	Common Woodpigeon	Columbiformes	Columbidae	LC
14.	<i>Streptopelia decaocto</i>	Eurasian Collared-dove	Columbiformes	Columbidae	LC

15.	<i>Spilopelia senegalensis</i>	Laughing Dove	Columbiformes	Columbidae	LC
16.	<i>Caprimulgus europaeus</i>	European Nightjar	Caprimulgiformes	Caprimulgidae	LC
17.	<i>C. aegyptius</i>	Egyptian Nightjar	Caprimulgiformes	Caprimulgidae	LC
18.	<i>Apus apus</i>	Common Swift	Apodiformes	Apodidae	LC
19.	<i>Porphyrio porphyrio</i>	Purple Swamphen	Gruiformes	Rallidae	LC
20.	<i>Gallinula chloropus</i>	Common Moorhen	Gruiformes	Rallidae	LC
21.	<i>Zapornia parva</i>	Little crane	Gruiformes	Rallidae	LC
22.	<i>Fulica atra</i>	Common Coot	Gruiformes	Rallidae	LC
23.	<i>Ciconia Ciconia</i>	White Stork	Ciconiiformes	Ciconiidae	LC
24.	<i>Plegadis falcinellus</i>	Glossy Ibis	Pelecaniformes	Threskiornithidae	LC
25.	<i>Ixobrychus minutus</i>	Little Bittern	Pelecaniformes	Ardeidae	LC
26.	<i>Nycticorax nycticorax</i>	Black-crowned Night-heron	Pelecaniformes	Ardeidae	LC
27.	<i>Ardeola ralloides</i>	Squacco Heron	Pelecaniformes	Ardeidae	LC
28.	<i>Bubulcus ibis</i>	Cattle Egret	Pelecaniformes	Ardeidae	LC
29.	<i>Ardea cinerea</i>	Grey Heron	Pelecaniformes	Ardeidae	LC
30.	<i>A. purpurea</i>	Purple Heron	Pelecaniformes	Ardeidae	LC
31.	<i>A. alba</i>	Great White Egret	Pelecaniformes	Ardeidae	LC
32.	<i>Egretta garzetta</i>	Little Egret	Pelecaniformes	Ardeidae	LC
33.	<i>Pelecanus onocrotalus</i>	Great White Pelican	Pelecaniformes	Pelecanidae	LC
34.	<i>Microcarbo pygmaeus</i>	Pygmy Cormorant	Suliformes	Phalacrocoracidae	LC
35.	<i>Phalacrocorax carbo</i>	Great Cormorant	Suliformes	Phalacrocoracidae	LC
36.	<i>Recurvirostra avosetta</i>	Pied Avocet	Charadriiformes	Recurvirostridae	LC
37.	<i>Himantopus Himantopus</i>	Black-winged Stilt	Charadriiformes	Recurvirostridae	LC
38.	<i>Charadrius hiaticula</i>	Common Ringed Plover	Charadriiformes	Charadriidae	LC
39.	<i>C. dubius</i>	Little Ringed Plover	Charadriiformes	Charadriidae	LC

40.	<i>C. alexandrines</i>	Kentish Plover	Charadriiformes	Charadriidae	LC
41.	<i>Vanellus vanellus</i>	Northern Lapwing	Charadriiformes	Charadriidae	NT
42.	<i>V. spinosus</i>	Spur-winged Lapwing	Charadriiformes	Charadriidae	LC
43.	<i>V. indicus</i>	Red-wattled Lapwing	Charadriiformes	Charadriidae	LC
44.	<i>V. leucurus</i>	White-tailed Lapwing	Charadriiformes	Charadriidae	LC
45.	<i>Limosa limosa</i>	Black-tailed Godwit	Charadriiformes	Scolopacidae	NT
46.	<i>Calidris pugnax</i>	Ruff	Charadriiformes	Scolopacidae	LC
47.	<i>C. temminckii</i>	Temminck's Stint	Charadriiformes	Scolopacidae	LC
48.	<i>C. minuta</i>	Little Stint	Charadriiformes	Scolopacidae	LC
49.	<i>Gallinago gallinago</i>	Common Snipe	Charadriiformes	Scolopacidae	LC
50.	<i>Actitis hypoleucos</i>	Common Sandpiper	Charadriiformes	Scolopacidae	LC
51.	<i>Tringa ochropus</i>	Green Sandpiper	Charadriiformes	Scolopacidae	LC
52.	<i>T. erythropus</i>	Spotted Redshank	Charadriiformes	Scolopacidae	LC
53.	<i>T. tetanus</i>	Common Redshank	Charadriiformes	Scolopacidae	LC
54.	<i>T. glareola</i>	Wood Sandpiper	Charadriiformes	Scolopacidae	LC
55.	<i>T. stagnatilis</i>	Marsh Sandpiper	Charadriiformes	Scolopacidae	LC
56.	<i>Glareola pratincole</i>	Collared Pratincole	Charadriiformes	Glareolidae	LC
57.	<i>Chroicocephalus genei</i>	Slender-billed Gull	Charadriiformes	Laridae	LC
58.	<i>Larus ridibundus</i>	Black-headed Gull	Charadriiformes	Laridae	LC
59.	<i>L. ichthyaetus</i>	Pallas's Gull	Charadriiformes	Laridae	LC
60.	<i>L. armenicus</i>	Armenian Gull	Charadriiformes	Laridae	LC
61.	<i>Sternula albifrons</i>	Little Tern	Charadriiformes	Laridae	LC
62.	<i>Gelochelidon nilotica</i>	Common Gull-billed Tern	Charadriiformes	Laridae	LC
63.	<i>Hydroprogne caspia</i>	Caspian Tern	Charadriiformes	Laridae	LC

64.	<i>Chlidonias hybrida</i>	Whiskered Tern	Charadriiformes	Laridae	LC
65.	<i>C. leucopterus</i>	White-winged Tern	Charadriiformes	Laridae	LC
66.	<i>Tyto alba</i>	Barn-owl	Strigiformes	Tytonidae	LC
67.	<i>Elanus caeruleus</i>	Black-winged Kite	Accipitriformes	Elanidae	LC
68.	<i>Circaetus gallicus</i>	Short-toed Snake-eagle	Accipitriformes	Accipitridae	LC
69.	<i>Gyps fulvus</i>	Griffon Vulture	Accipitriformes	Accipitridae	LC
70.	<i>Clanga clanga</i>	Greater Spotted Eagle	Accipitriformes	Accipitridae	VU
71.	<i>Hieraaetus pennatus</i>	Booted Eagle	Accipitriformes	Accipitridae	LC
72.	<i>Circus aeruginosus</i>	Western Marsh-harrier	Accipitriformes	Accipitridae	LC
73.	<i>Accipiter nisus</i>	Eurasian Sparrowhawk	Accipitriformes	Accipitridae	LC
74.	<i>Milvus migrans</i>	Black Kite	Accipitriformes	Accipitridae	LC
75.	<i>M. migrans lineatus</i>	Black-eared Kite	Accipitriformes	Accipitridae	LC
76.	<i>Falco tinnunculus</i>	Common Kestrel	Falconiformes	Falconidae	LC
77.	<i>F. columbarius</i>	Merlin	Falconiformes	Falconidae	LC
78.	<i>Falco peregrinus</i>	Peregrine Falcon	Falconiformes	Falconidae	LC
79.	<i>Merops persicus</i>	Blue-cheeked Bee-eater	Coraciiformes	Meropidae	LC
80.	<i>M. apiaster</i>	European Bee-eater	Coraciiformes	Meropidae	LC
81.	<i>Coracias benghalensis</i>	Indian Roller	Coraciiformes	Coraciidae	LC
82.	<i>Alcedo atthis</i>	Common Kingfisher	Coraciiformes	Alcedinidae	LC
83.	<i>Ceryle rudis</i>	Pied Kingfisher	Coraciiformes	Alcedinidae	LC
84.	<i>Halcyon smyrnensis</i>	White-breasted Kingfisher	Coraciiformes	Alcedinidae	LC
85.	<i>Upupa epops</i>	Eurasian Hoopoe	Bucerotiformes	Upupidae	LC
86.	<i>Lanius collurio</i>	Red-backed Shrike	Passeriformes	Laniidae	LC

87.	<i>L. phoenicuroides</i>	Red-tailed Shrike	Passeriformes	Laniidae	LC
88.	<i>L. isabellinus</i>	Isabelline Shrike	Passeriformes	Laniidae	LC
89.	<i>L. minor</i>	Lesser Grey Shrike	Passeriformes	Laniidae	LC
90.	<i>L. senator</i>	Woodchat Shrike	Passeriformes	Laniidae	NT
91.	<i>Corvus cornix</i>	Hooded Crow	Passeriformes	Corvidae	LC
92.	<i>C. Capellanus</i>	Mesopotamian Crow	Passeriformes	Corvidae	LC
93.	<i>Pica pica</i>	Eurasian Magpie	Passeriformes	Corvidae	LC
94.	<i>C. monedula</i>	Eurasian Jackdaw	Passeriformes	Corvidae	LC
95.	<i>C. frugilegus</i>	Rook	Passeriformes	Corvidae	LC
96.	<i>Ammomanes deserti</i>	Desert Lark	Passeriformes	Alaudidae	LC
97.	<i>Galerida cristata</i>	Crested Lark	Passeriformes	Alaudidae	LC
98.	<i>Prinia gracilis</i>	Graceful Prinia	Passeriformes	Cisticolidae	LC
99.	<i>Hippolais languida</i>	Upcher's Warbler	Passeriformes	Acrocephalidae	LC
100.	<i>Acrocephalus melanopogon</i>	Moustached Warbler	Passeriformes	Acrocephalidae	LC
101.	<i>A. palustris</i>	Marsh warbler	Passeriformes	Acrocephalidae	LC
102.	<i>Hirundo rustica</i>	Barn Swallow	Passeriformes	Hirundinidae	LC
103.	<i>Pycnonotus leucotis</i>	White-eared Bulbul	Passeriformes	Pycnonotidae	LC
104.	<i>Phylloscopus collybita</i>	Common Chiffchaff	Passeriformes	Phylloscopidae	LC
105.	<i>Argya huttoni</i>	Afghan Babbler	Passeriformes	Leiotrichidae	LC
106.	<i>A. altirostris</i>	Iraq Babbler	Passeriformes	Leiotrichidae	LC
107.	<i>Sturnus vulgaris</i>	Common Starling	Passeriformes	Sturnidae	LC
108.	<i>Cercotrichas galactotes</i>	Rufous-tailed Scrub-robin	Passeriformes	Muscicapidae	LC
109.	<i>Muscicapa striata</i>	Spotted Flycatcher	Passeriformes	Muscicapidae	LC
110.	<i>Luscinia svecica</i>	Bluethroat	Passeriformes	Muscicapidae	LC
111.	<i>Phoenicurus ochruros</i>	Black Redstart	Passeriformes	Muscicapidae	LC

112.	<i>P. phoenicurus</i>	Common Redstart	Passeriformes	Muscicapidae	LC
113.	<i>Saxicola rubicola</i>	European Stonechat	Passeriformes	Muscicapidae	LC
114.	<i>S. maurus</i>	Siberian Stonechat	Passeriformes	Muscicapidae	LC
115.	<i>Oenanthe deserti</i>	Desert Wheatear	Passeriformes	Muscicapidae	LC
116.	<i>Hypocolius ampelinus</i>	Hypocolius	Passeriformes	Hypocoliidae	LC
117.	<i>Passer domesticus</i>	House Sparrow	Passeriformes	Passeridae	LC
118.	<i>P. hispaniolensis</i>	Spanish Sparrow	Passeriformes	Passeridae	LC
119.	<i>P. moabiticus</i>	Dead Sea Sparrow	Passeriformes	Passeridae	LC
120.	<i>Anthus spinoletta</i>	Water Pipit	Passeriformes	Motacillidae	LC
121.	<i>Motacilla flava</i>	Western Yellow Wagtail	Passeriformes	Motacillidae	LC
122.	<i>M. cinerea</i>	Grey Wagtail	Passeriformes	Motacillidae	LC
123.	<i>M. citreola</i>	Citrine Wagtail	Passeriformes	Motacillidae	LC
124.	<i>M. alba</i>	White Wagtail	Passeriformes	Motacillidae	LC
	LC: least concertation	NT: near threaten		VU: Vulnerable	

4.2 The globally threatened species recorded in current study

Al-Malih area seems ecologically important for globally threatened bird species, among 122 recorded species, 7 species were listed by IUCN red list during the current field surveys (Sep. 22 – Aug. 23) and represented about 5.98 % from our result of bird species in Al-Malih area, and 25.9% represented from total threatened bird species of Iraq (VU,9 species; NT,18 Spp., categories of IUCN) (Birdlife,2023a), (Table.2; Fig.,6,7;Pic.3).

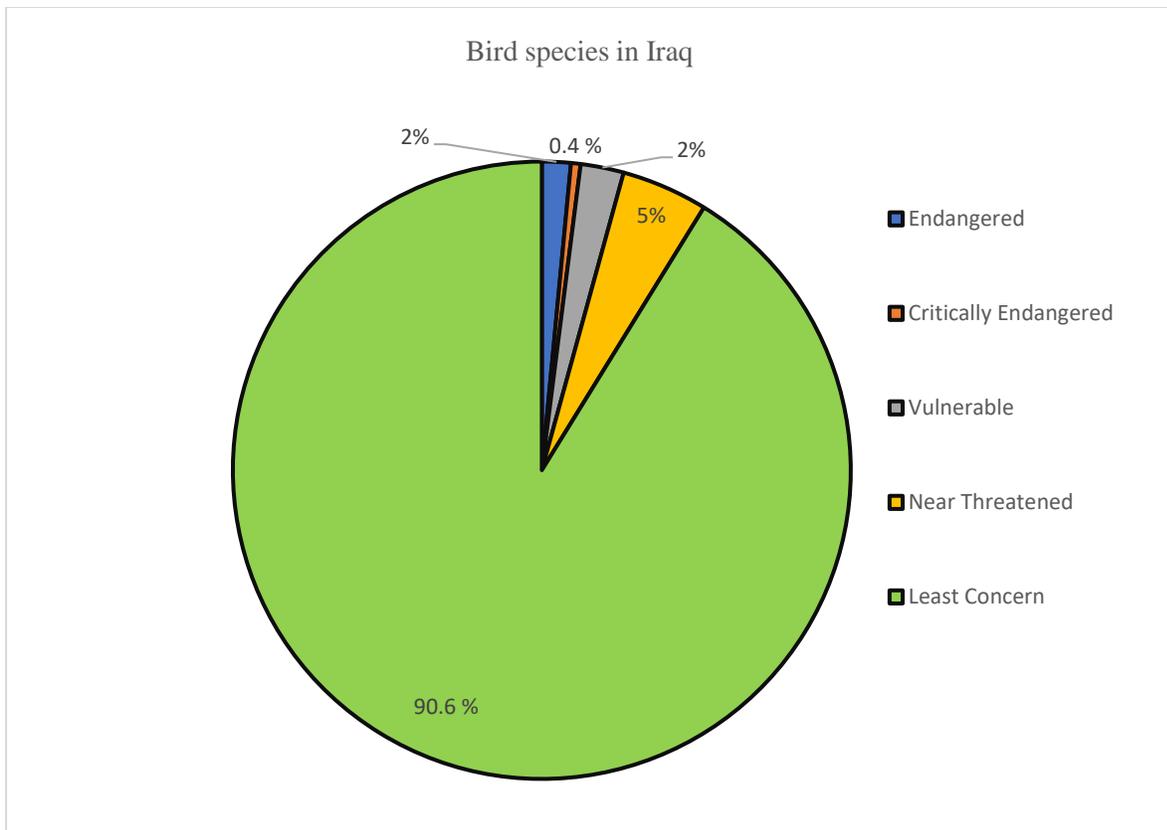


Figure 6: percentage of IUCN categories of Iraqi bird.

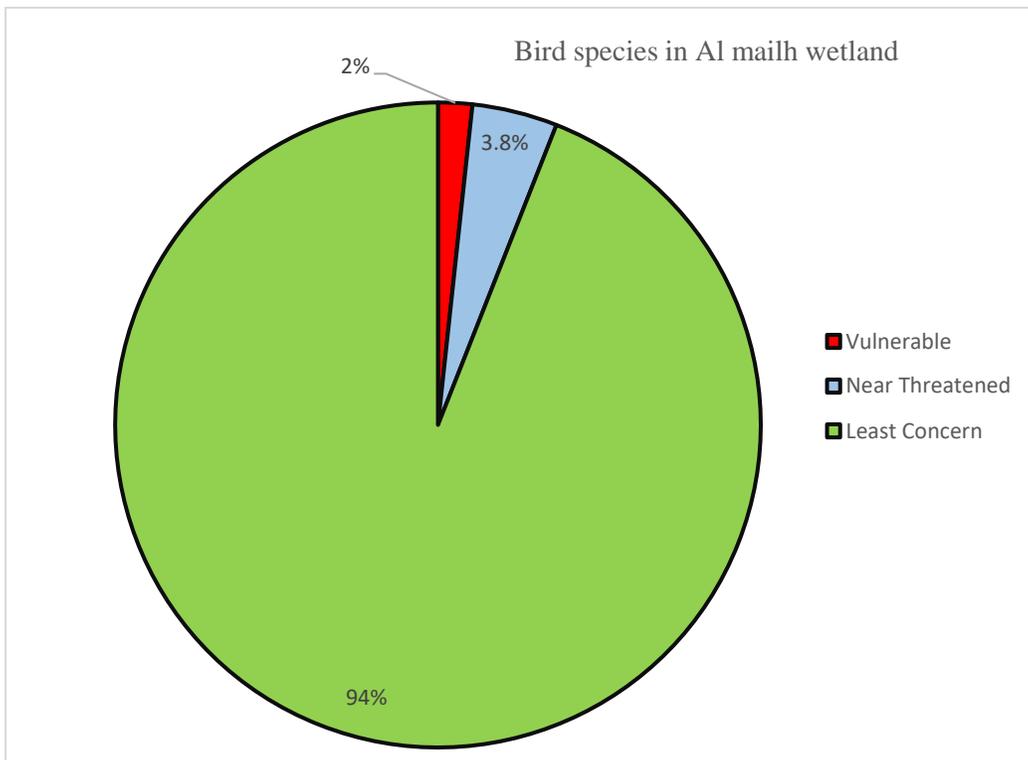


Figure 7: percentage of IUCN categories of birds in Al-Malih area.

Common Pochard *A. ferina* (Vulnerable), a flock of five individuals were recorded in October 2022 in transect 2.

Greater spotted eagle *C. clanga* two ages (Vulnerable), two individuals were recorded in November 2022 in transect 1, one individual was in December 2022, two individuals in January and two in February 2023 in transect 1.

Marbled teal *M. angustirostris* (Near threatened), 4 individuals were recorded in November 2022 in transect 2, mother duck with its eight ducklings were recorded in April 2023 in transect 4, 16 individuals were recorded in June 2023 in transect 1.

Black tailed Godwit *L. limosa* (Near threatened), 30 individuals were recorded in March 2023 in transect 1, 20 individuals were recorded in April 2023 in transect

Ferruginous Duck *A. nyroca* (Near threatened), 6 individuals were recorded in December 2022 in transect 1, 2 individuals were recorded in January 2023 in transect 1, mother duck with its eight ducklings were recorded in April 2023 in transect 1. 8 individuals were recorded in June 2023 in transect 1.

Woodchat shrike *L. senator* (Near threatened), 2 individuals were recorded in April 2023 in transect 1, 3 individuals were recorded in May 2023 in transect 1, 2 individuals were recorded in June 2023 in transect 1.

Northern lapwing *V. vanellus* (Near threatened). 5 individuals were recorded in November 2022 in transect 1, 41 individuals were recorded in December 2022 in transect 1, 26 individuals were recorded in January 2023 in transect 1, 6 individuals were recorded in February 2023 in transect 1.



Picture 3: A: Marbled teal *M. angustirostris* (Near threatened), B: Common Pochard *A. ferina* (Vulnerable), C: Black tailed Godwit *L. limosa* (Near threatened) , D: Ferruginous Duck *A. nyroca* (Near threatened), E: Greater spotted eagle *C. clanga* two age (Vulnerable), F: Woodchat shrike *L. senator* (Near threatened), G: Northern lapwing *V. vanellus* (Near threatened).

4.3 Composition of Lapwing (*Vanellus spp.*) community in Al-Malih area

During field surveys (Sep. 2022–Aug. 2023), total of 904 individuals of 4 lapwing species (*Vanellus spp.*) belong to Order Charadriidae, Family Charadriiformes were recorded (Table.2) among 5 species occur in Iraq (Salim *et al.* 2012). The highest count of lapwing species was made in December 2022 when total of 121 individuals were recorded, while the lowest count was made in August 2023 when total of 21 individuals were recorded.

The highest count of lapwing species was spur-winged lapwing with 531 individuals, while the lowest count was the Northern lapwing with 78 individuals (Table.3)

Table 3: list of the lapwing species with their counts recorded at each surveying transect during field surveys in Al-Malih area (Sep. 22- Aug. 23), Ti=surveying transect.

No.	Common name	Scientific name	2022												2023												Total Number of Individuals															
			Sep.22			Oct.22			Nov.22			Dec.22			Jan.23			Feb.23			Mar.23			Apr.23				May.23			Jun.23			Jul.23			Aug.23					
			T1	T2	T3		T1	T2	T3																																	
1	Northern Lapwing	<i>V. vanellus</i>	0	0	0	0	0	0	5	0	0	0	4	1	0	0	0	2	6	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78
2	Spur Winged Lapwing	<i>V. spinosus</i>	2	9	4	5	3	3	1	7	3	4	2	5	5	1	2	4	2	8	3	6	2	2	4	5	2	1	3	2	0	6	4	1	0	2	4	3	2	0	6	5
3	Red Wattled Lapwing	<i>V. indicus</i>	8	5	6	1	8	0	0	0	0	5	8	1	1	2	3	2	1	3	2	2	2	9	7	0	0	4	3	0	0	6	7	5	0	1	2	1	0	1	0	1
4	White Tailed Lapwing	<i>V. leucurus</i>	4	1	0	0	3	2	0	0	3	1	4	0	0	2	1	0	0	1	8	1	1	0	2	0	0	6	5	0	0	7	9	0	0	8	2	0	2	4	0	1
5	Total number of species/transect		3	3	2	2	3	2	1	1	4	3	2	2	4	2	2	4	2	4	2	3	2	4	3	1	1	3	3	1	1	3	3	2	1	3	3	2	2	3	2	3
	Total number of individuals /transect		4	1	0	1	4	2	9	3	4	6	6	1	7	2	3	6	9	3	5	1	9	4	7	0	6	5	1	5	5	4	1	0	3	4	6	9	5	6	2	8
7	Total number of individuals/month		6	6		5	8		1	1	2	1	2	1	2	1	1	2	1	2	1	1	1	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	9
			6	6		5	8		1	1	2	1	2	1	2	1	1	2	1	2	1	1	1	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	9
			66			58			112			121			96			74			63			110			45			74			54			21			904			

4.4 Population size of Lapwing (*Vanellus spp.*) community in Al-Malih area

To determine the population size of lapwing community in Al-Malih area and the species density by using distance sampling during current study in September 2022- August 2023, the data analysis indicate that the total area of Al-Malih area (2000 ha) seems to be ecologically significant for 4 lapwing species.

Al Malih area hosted lapwing community with population size of four species, The northern lapwing (148.597-203.454) in November- December 2022; the spur-winged lapwing (270.74 - 1248.730) in August - April 2023; red-wattled lapwing (277.171 - 931.678) in January 2023 - November 2022; white-tailed lapwing (163.645 - 742.694) in July 2023 - November 2022(Table.4).

The spur-winged lapwing was the most abundant species with high estimated species density, 0.424 individual/ha and its population size was 1248.730 (individual/total area of Al-Malih area) estimated of based on 76 observations detected in April 2023. However, the lowest estimated species density was 0.078 individual/ha of the northern lapwing and its population size was 148.597 (individual/total area of Al-Malih area) based on 5 observations detected in November 2022 (Table.4; Fig.8)

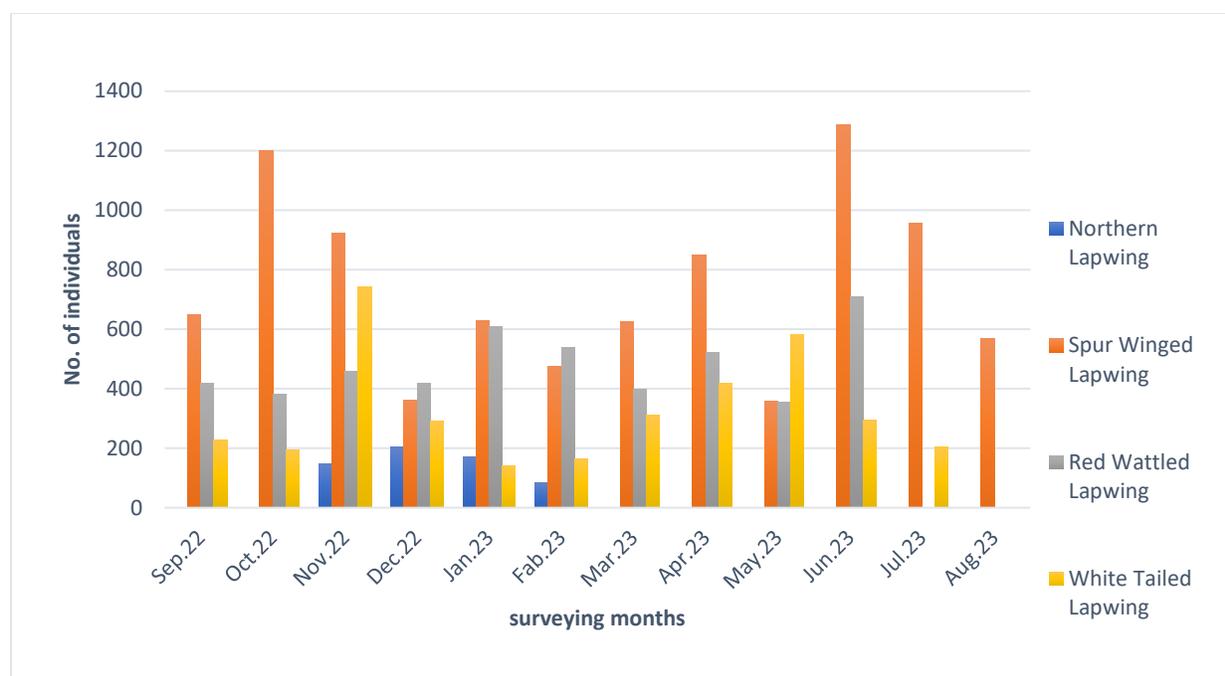


Figure 8 : population size of Lapwing (*Vanellus spp.*) community in Al-Malih area (Sep.22-Aug.23)

Table 4: population size of Lapwing (*Vanellus spp.*) community in Al-Malih area (Sep.22-Aug.23)

No.	Common name	Scientific name	species Estimated population individuals/Al-Malih area (2000 ha)	Months
1	Northern Lapwing	<i>Vanellus vanellus</i>	148.597-203.454	November - December 2022
2	Spur Winged Lapwing	<i>V.spinosus</i>	270.74 - 1248.730	August - April 2023
3	Red Wattled Lapwing	<i>V. indicus</i>	277.171 - 931.678	January 2023 - November 2022
4	White Tailed Lapwing	<i>V.leucurus</i>	163.645 - 742.694	July 2023 - November 2022

4.5 The recorded Lapwing species

4.5.1 Northern lapwing *V. vanellus* (Linnaeus, 1758)

The northern lapwing was recorded in four months (November, December 2022 and January, February 2023) in transect1 with total number 78 adult individuals. The adult northern lapwing can be distinguished from Pigeon-sized, unmistakable black and white, Plover with a stocky build, has a distinctive long, thin, wispy crest with gorgeous green and purple iridescence on dark upperparts at close range. In flight has exceptionally highly rounded wing-tips and deliberate, wings alternately showing white below and dark above (Svensson *et al.*, 2010).

In November 2022, lowest count was recorded, 5 individuals were recorded (T1,5) and estimated density for it that was 0.078 individual/ha and the estimated population size was 148.597 individuals/ha that migrating across Al-Malih area.

In December 2022, the highest count was recorded with 41 individuals were recorded (T1,41) and estimated density for it that was 0.107 individual/ha and the estimated population size was 203.454 individuals/ha that migrating across Al-Malih area.

In January 2023, 26 individuals were recorded (T1,26) and estimated density for it that was 0.090 individual/ha and the estimated population size was 170.806 individuals/ha that migrating across Al-Malih area.

In February 2023, 6 individuals were recorded (T1,6) and estimated density for it that was 0.0809 individual/ha and the estimated population size was 161.893 individuals/ha that migrating across Al-Malih area (Table.5; Fig.9;Pic.4).

Our results recorded the northern lapwing *V. Vanellus* in winter months only and this agree with Salim *et al.*, (2012) who indicated that species regarded as winter visitor to Iraq in small numbers and considered the first attempt to calculated species

density and population size in Iraq by using distance sampling technique (Line transect count).

The population density and size of northern lapwings *V. vanellus* can vary depending on the species itself and its location, The global population of this species is estimated to be between 5,600,000 and 10,500,000 individuals, with the European population estimated at 1,590,000-2,580,000 pairs, which is equivalent to 3,190,000-5,160,000 mature individuals (Birdlife.2023 b).

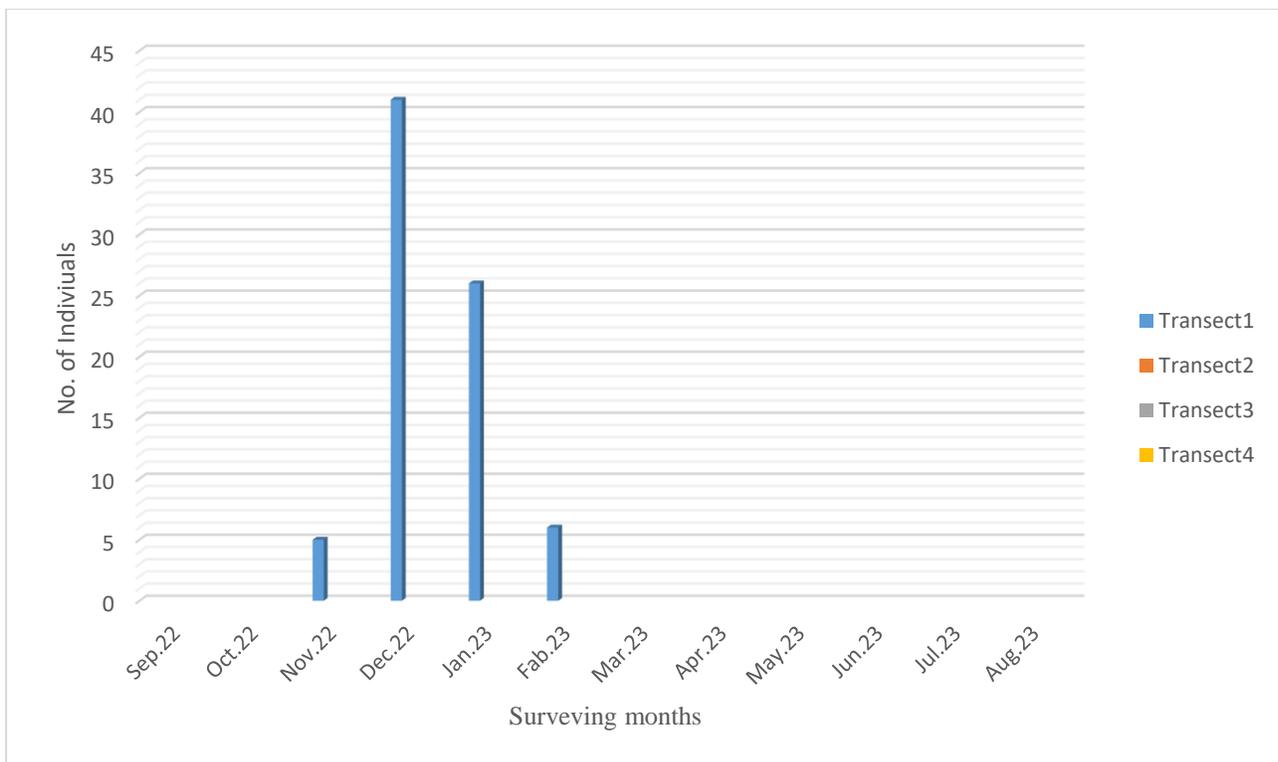


Figure 9: No. of individuals of the Northern lapwing *V. vanellus* in Al-Malih area(Sep.22-23Aug.)

Table 5: population size and density of the Northern lapwing in Al-Malih area (Sep.22-Aug.23), * lowest value, ** highest value.

Months	Species density per months (individuals/area size in ha))	Estimated population (individuals/Al-Malih wetland area (2000 ha))
Sep.22		
Oct.22		
Nov.22	0.078	148.597*
Dec.22	0.107	203.454**
Jan.23	0.090	170.806
Feb.23	0.0809	161.893
Mar.23		
Apr.23		
May.23		
Jun.23		
Jul.23		
Aug.23		



picture 4: a flock of the Northern lapwing in Al-Malih area (Sep.22-23Aug.)

4.5.2 Spur-winged lapwing *V. spinosus* (Linnaeus, 1758)

The spur-winged lapwing was recorded in all months and all 4 surveying transects (Sep.22-Aug.23) with total number 531 individuals. The adult of spur-winged lapwing can be identified from a big white cheek patch on the otherwise, black head, as well as a black breast, flanks, and tail, a black bill, and dark grey legs. In flight, it is distinguished by black secondaries and uniform pale brown upperparts while the juvenile is similar to the adult, except for some pale scaly feather fringe above and black areas that appear brownish gray (Svensson *et al.*, 2010), additionally the chick morphology was distinguished by dark brown in the base bill ended black, brown iris, and pale green legs. a small black stripe extends from the

eye ring, and a distinct black stripe on the crown base with a sandy head contains small black spotted. nape, chin, throat, and downside parts are distinct with white color.

In September 2022, 41 adult individuals were recorded (T1,29;T2,4;T3,5;T4,3) and estimated density for it that was 0.325 individual/ha and the estimated population size was 649.506 individuals/ha across Al-Malih area.

In October 2022,45 adult individuals were recorded(T1,31;T2,7;T3,3;T4,4) and estimated density for it that was 0.373 individual/ha and the estimated population size was 746.992.3 individuals/ha across Al-Malih area.

In November 2022,46 adult individuals were recorded(T1,25;T2,5;T3,12;T4,4) and estimated density for it that was 0.461 individual/ha and the estimated population size was 922.293 individuals/ha across Al-Malih area.

In December 2022, 39 adult individuals were recorded(T1,28;T2,3;T3,6;T4,2) and estimated density for it that was 0.181 individual/ha and the estimated population size was 362.978 individuals/ha across Al-Malih area.

In January 2023, 44 adult individuals were recorded(T1,24;T2,5;T3,2;T4,13) and estimated density for it that was 0.314 individual/ha and the estimated population size was 627.217 individuals/ha across Al-Malih area.

In February 2023, 40 adult individuals were recorded(T1,20;T2,6;T3,4;T4,10) and estimated density for it that was 0.237 individual/ha and the estimated population size was 473.518 individuals/ha across Al-Malih area.

In March 2023, 45 adult individuals were recorded(T1,24;T2,6;T3,6;T4,9) and estimated density for it that was 0.312 individual/ha and the estimated population size was 624.964 individuals/ha across Al-Malih area.

In April 2023, the highest account ,76 (adults ,68; chicks,8) individuals were recorded (T1,43;T2,12;T3,9;T4,12) and estimated density for it that was 0.624 individual/ha and the estimated population size was 1248.73 individuals/ha across Al-Malih area.

In May 2023, 29 (adult,26;juvenile,1;chicks,2) individuals were recorded (T1,18;T2,3;T3,3;T4,5) and estimated density for it that was 0.179 individual/ha and the estimated population size was 358.573 individuals/ha across Al-Malih area.

In June 2023, 56 (adults,53; juvenile,1; chicks,2) individuals were recorded(T1,39;T2,1;T3,4;T4,12) and estimated density for it that was 0.549 individual/ha and the estimated population size was 1097.27 individuals/ha across Al-Malih area.

In July 2023, 49 (adult,38; juveniles,11) individuals were recorded (T1,21;T2,5;T3,11;T4,12) and estimated density for it that was 0.479 individual/ha and the estimated population size was 957.208 individuals/ha across Al-Malih area.

In August 2023, the lowest count ,21 adult individuals were recorded(T1,6;T2,2;T3,4;T4,9) and estimated density for it that was 0.135 individual/ha and the estimated population size was 270.740 individuals/ha across Al-Malih area(Table.6;Fig.10;Pic.5) .

Our result referred that Spur-winged lapwing *V. spinosus* was resident in study area by recorded it in all months and this agree with other literatures in wetlands of Iraq like (Fazaa *et al.*,2017; Habeeb *et al.*,2018), also considered the first attempt to calculated the species density and population size in Iraq by using distance sampling technique (Line transect count), and described the chick *V. spinosus* morphology.

The population size is very large and the distribution in area extended about 24,600,000 km² from realm – Afrotropical and realm – Palearctic (Birdlife,2023c).

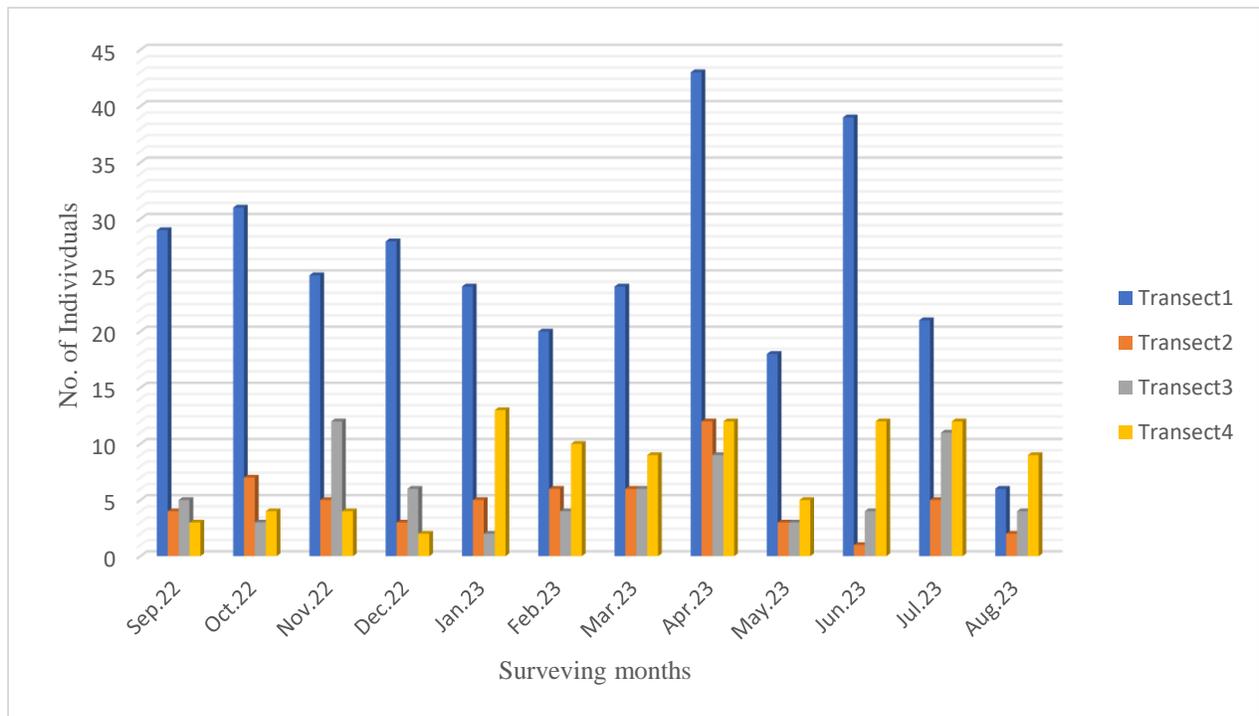


Figure 10: No. of individuals of the spur winged lapwing *V. spinosus* in Al-Malih area (Sep.22-23Aug.)

Table 6: population size and density of the spur-winged lapwing *V. spinosus* in Al-Malih area (Sep.22-Aug.23), * lowest value, ** highest value.

Months	Species density per months (individuals/area size in ha))	Estimated population (individuals/Al-Malih wetland area (2000 ha))
Sep.22	0.325	649.506
Oct.22	0.373	746.799
Nov.22	0.461	922.293
Dec.22	0.1815	362.978
Jan.23	0.314	627.217
Feb.23	0.237	473.518
Mar.23	0.312	624.964
Apr.23	0.624	1248.730**
May.23	0.179	358.573
Jun.23	0.549	1097.270
Jul.23	0.479	957.208
Aug.23	0.135	270.740*



Picture 5: The spur-winged lapwing *V. spinosus* A: adult, B: juvenile, C: chick.

4.5.3 Red-wattled lapwing *V. indicus* (Boddaert, 1783)

The red-wattled lapwing was recorded in all months except July and August 2023 (during Sep.22-Aug.23) with total number 136 individuals. The adult of red-

wattled lapwing can be identified from Spur-winged structure, movements, and overall color lapwing, but slightly larger. Long yellowish legs are a distinct feature. Black throat and center breast, but white flanks, white tail crossed by an even-width, somewhat narrow" black band in flight, and red bill-base, lore, and orbital ring at close range while Juvenile is distinguished by a white forehead and chin, as well as a white-spotted black throat patch (Svensson *et al.*, 2010) , additionally the chick morphology was distinguished by has a dark brown bill, a brown iris, and pale green legs. the black distinct stripe on the crown base with sandy head contains a small black spotted with a black throat. The black strip on the flank extends to the tail. nape, chin, and downside parts are distinct with white color.

In September 2022, 20 individuals were recorded(T1,8;T2,5;T3,6;T4,1) and estimated density for it that was 0.209 individual/ha and the estimated population size was 418.789 individuals/ha across Al-Malih area.

In October 2022, 8 individuals were recorded(T1,8) and estimated density for it that was 0.190 individual/ha and the estimated population size was 380.26 individuals/ha across Al-Malih area.

In November 2022, the highest count, 26 individuals were recorded (T1,5;T2,8;T3,11;T4,2)and estimated density for it that was 0.466 individual/ha and the estimated population size was 931.678 individuals/ha across Al-Malih area.

In December 2022, 20 individuals were recorded (T1,3;T2,2;T3,13;T4,2)and estimated density for it that was 0.21 individual/ha and the estimated population size was 419.91 individuals/ha across Al-Malih area.

In January 2023, the lowest count, 6 individuals were recorded (T1,2;T2,0;T3,2;T4,2) and estimated density for it that was 0.139 individual/ha and the estimated population size was 277.171 individuals/ha across Al-Malih area.

In February 2023, 16 individuals were recorded (T1,9;T2,7) and estimated density for it that was 0.27 individual/ha and the estimated population size was 539.17 individuals/ha across Al-Malih area.

In March 2023, 7 individuals were recorded (T1,4;T2,3) and estimated density for it that was 0.199 individual/ha and the estimated population size was 397.11 individuals/ha across Al-Malih area.

In April 2023, 18 individuals were recorded (T1,6;T2,7;T3,5) and estimated density for it that was 0.260 individual/ha and the estimated population size was 520.785 individuals/ha across Al-Malih area.

In May 2023, 7 (adult,6;chick,1) individuals were recorded (T1,4;T2,2;T3,1) and estimated density for it that was 0.177 individual/ha and the estimated population size was 354.345 individuals/ha across Al-Malih area.

In June 2023, 11 (adult,9;juvenile,1;chick,1) individuals were recorded (T1,1;T4,10) and estimated density for it that was 0.156 individual/ha and the estimated population size was 312.247 individuals/ha across Al-Malih area. (Table.7;Fig.11;Pic.6).

Our results indicated that red wattled lapwing *V. indicus* was resident to the study area and this agree with other literatures in wetlands of Iraq like (Fazaa *et al.*,2017; Habeeb *et al.*,2018), also considered the first attempt to calculated the species density and population size in Iraq by using distance sampling technique (Line transect count), and described the chick *V. indicus* morphology.

The global population is estimated at 50,000-60,000 individuals ,the European population is estimated at 50-100 pairs, which equates to 100-200 mature individuals (Birdlife,2023d).

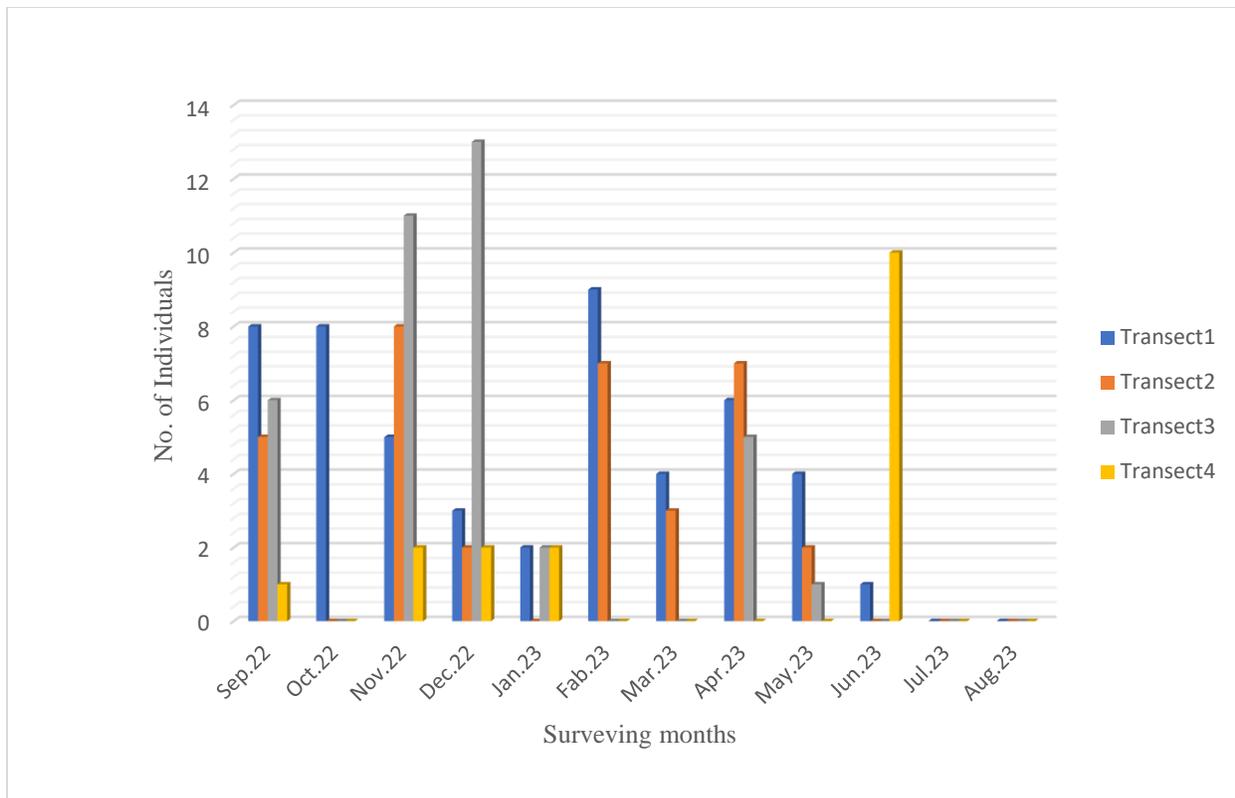
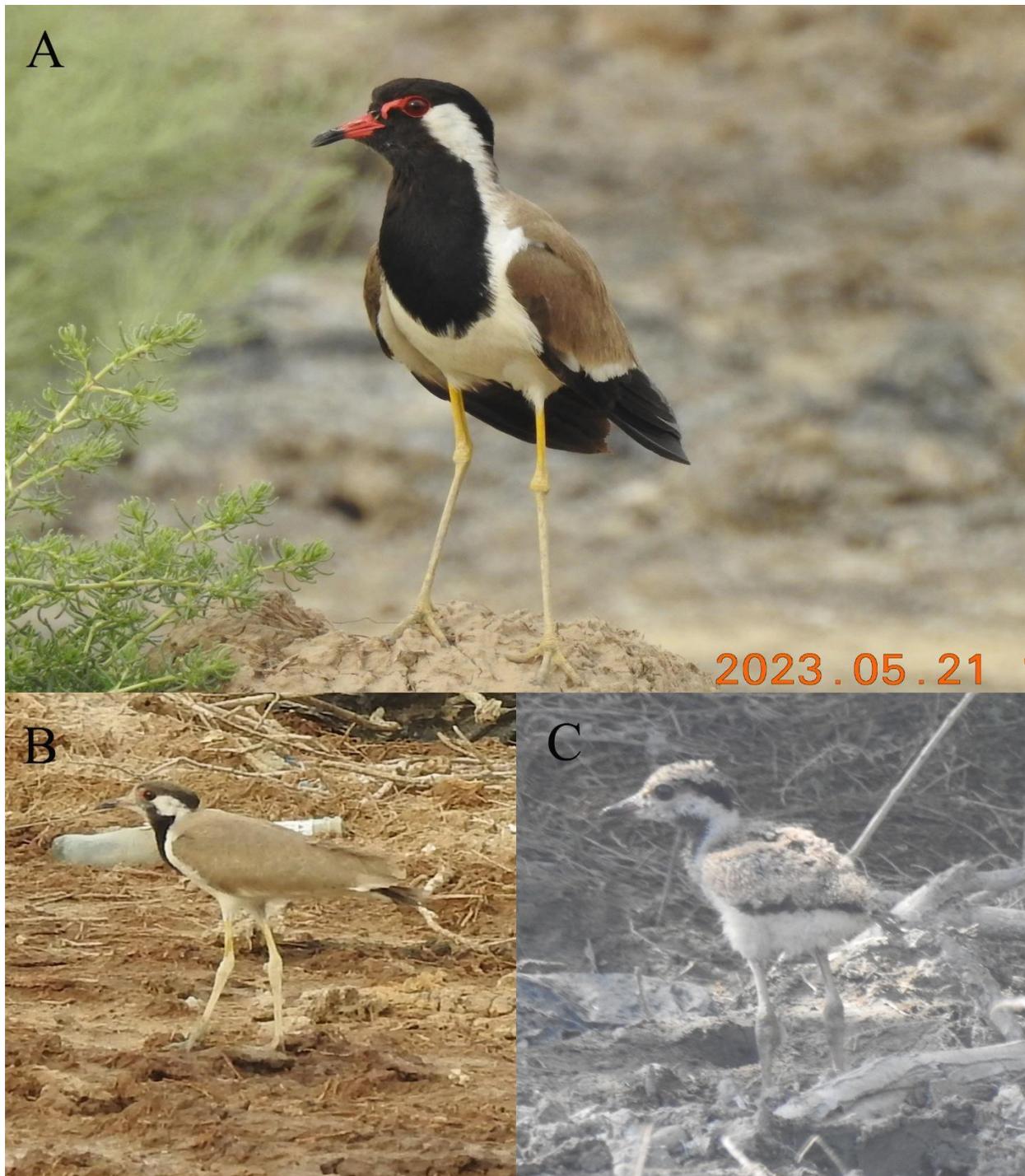


Figure 11: No. of individuals of the red-wattled lapwing *V. indicus* in Al-Malih area (Sep.22-23Aug.)

Table 7: population size and density of the red-wattled lapwing *V. indicus* in Al-Malih area (Sep.22-Aug.23), * lowest value, ** highest value.

Months	Species density per months (individuals/area size in ha))	Estimated population (individuals/Al-Malih wetland area (2000 ha))
Sep.22	0.209	418.789
Oct.22	0.190	380.26
Nov.22	0.466	931.678**
Dec.22	0.21	419.91
Jan.23	0.139	277.171*
Feb.23	0.27	539.17
Mar.23	0.199	397.11
Apr.23	0.260	520.785
May.23	0.177	354.345
Jun.23	0.156	312.247
Jul.23	0	0
Aug.23	0	0



Picture 6 : The red-wattled lapwing *V. indicus* A: adult, B: juvenile, C: chick.

4.5.4 White-tailed lapwing *V. leucurus* (Lichtenstein, 1823)

The white-tailed lapwing was recorded in all months except August 2023 (during Sep.22-Aug.23) with total number 159 individuals. The adult of white-tailed lapwing can be identified from attractive design and extremely long legs. Even before sight of the remarkable flying pattern with all-white tail, the relatively consistently pale grey-brown head and body with no conspicuous supercilium and very long yellow legs are diagnostic while the juvenile has a seen scaly pattern (Svensson *et al.*, 2010), additionally the chick morphology was distinguished by a black bill, brown iris, and green legs. spotted a distinct black pattern on the sandy buff head and back. white stripe on the nape and chin, throat, and downside parts.

In September 2022, 5 individuals were recorded (T1,4;T2,1)and estimated density for it that was 0.113 individual/ha and the estimated population size was 226.989 individuals/ha across Al-Malih area.

In October 2022,5 individuals were recorded (T1,3;T2,2) and estimated density for it that was 0.096 individual/ha and the estimated population size was 192.804 individuals/ha across Al-Malih area.

In November 2022, the highest count, 35 individuals were recorded (T1,31;T2,4)and estimated density for it that was 0.371 individual/ha and the estimated population size was 742.694 individuals/ha across Al-Malih area.

In December 2022, 21 individuals were recorded (T1,21)and estimated density for it that was 0.145 individual/ha and the estimated population size was 290.404 individuals/ha across Al-Malih area.

In January 2023, 20 individuals were recorded (T1,18;T2,1;T3,1) and estimated density for it that was 0.107 individual/ha and the estimated population size was 213.667 individuals/ha across Al-Malih area.

In February 2023, 22 individuals were recorded (T1,20;T2,2) and estimated density for it that was 0.186 individual/ha and the estimated population size was 372.187 individuals/ha across Al-Malih area.

In March 2023, 11 individuals were recorded (T1,6;T2,5) and estimated density for it that was 0.155 individual/ha and the estimated population size was 310.862 individuals/ha across Al-Malih area.

In April 2023, 16 individuals were recorded (T1,7;T2,9) and estimated density for it that was 0.209 individual/ha and the estimated population size was 418.229 individuals/ha across Al-Malih area.

In May 2023, 12 (adult,10;chick,2) individuals were recorded (T1,8;T2,2;T4,2) and estimated density for it that was 0.291 individual/ha and the estimated population size was 582.552 individuals/ha across Al-Malih area.

In June 2023, 7 (adult,6;juvenile,1) individuals were recorded (T1,4; T3,1;T4,2) and estimated density for it that was 0.147 individual/ha and the estimated population size was 293.603 individuals/ha across Al-Malih area.

In July 2023, the lowest count, 3 (adult,1;juvenile,2) individuals were recorded (T1,3) and estimated density for it that was 0.082 individual/ha and the estimated population size was 163.645 individuals/ha across Al-Malih area. (Table.8;Fig.12;Pic.7)

Our results indicated that white tailed lapwing *V. leucurus* was resident to the study area and this agrees with other literatures in wetlands of Iraq like (Fazaa *et al.*,2017;

Habeeb *et al.*,2018), also considered the first attempt to calculated the species density and population size in Iraq by using distance sampling technique (Line transect count) and described the chick *V. leucurus* morphology.

Population wintering in east Africa and southern west Asia numbers 10,000–100,000 birds, with similar numbers in SC Asia; 500–1000 birds in Sudan; very common in marshes of Euphrates, with expansion into Syrian parts of the valley noted in recent decades; c. 300–500 pairs in Iran in 1970s (the vast majority in Khuzestan and Central Fars) (Wiersma and Kirwan ,2020).

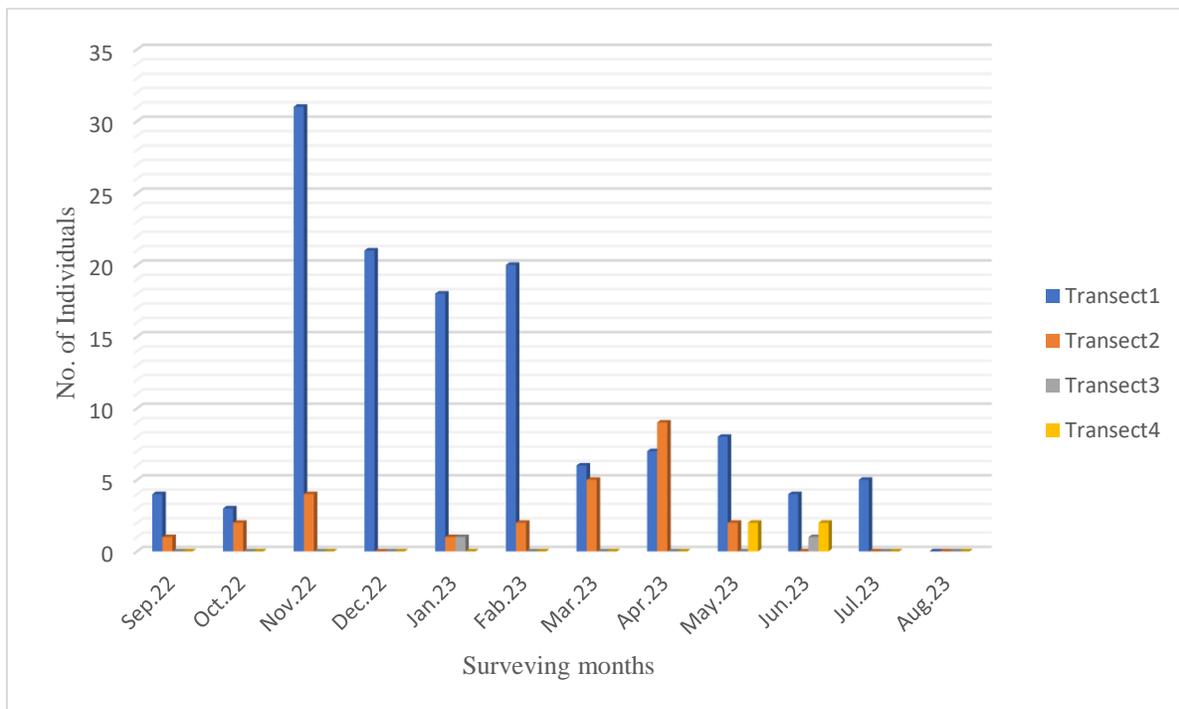
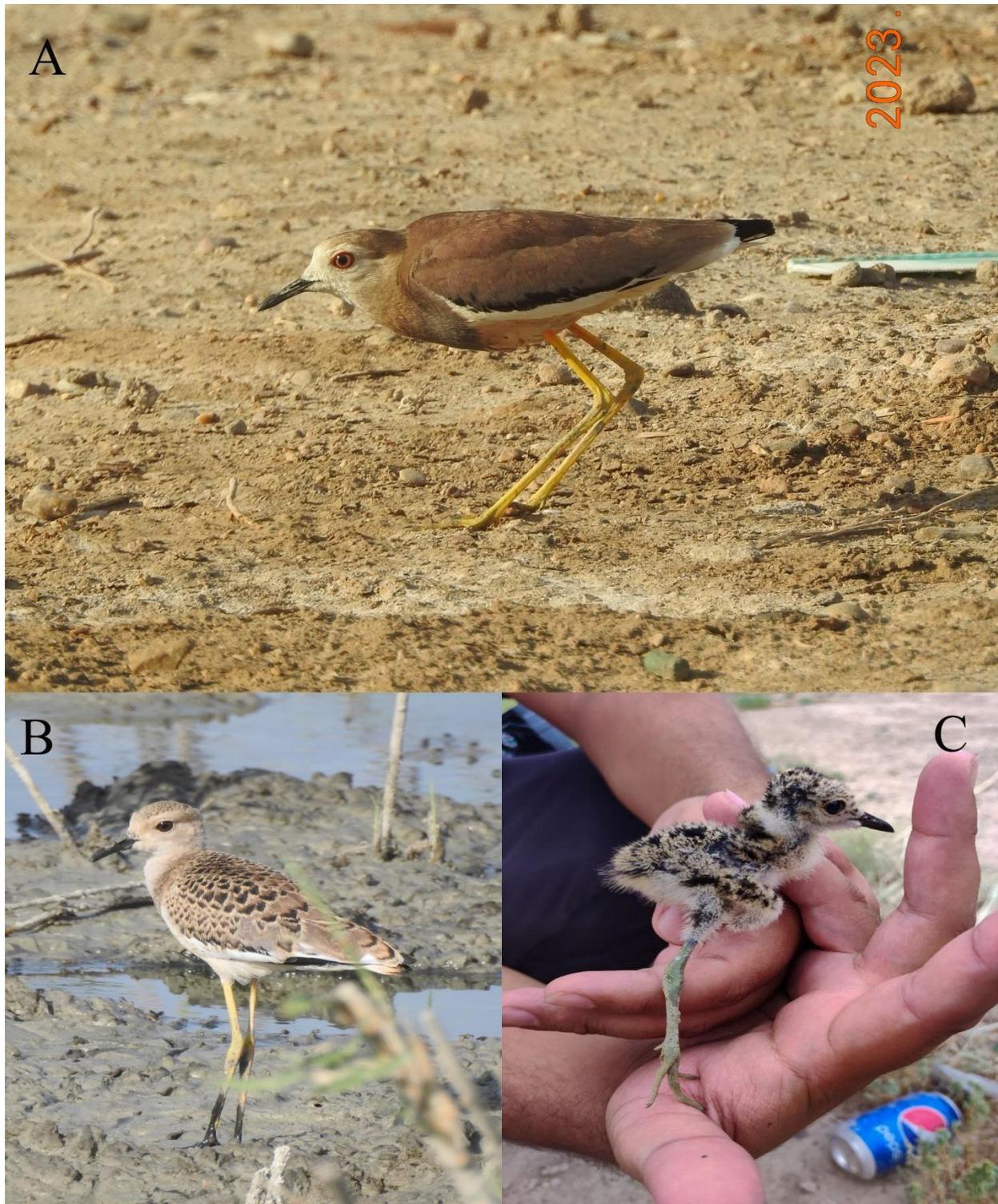


Figure 12: No of individuals of the white-tailed lapwing *V. leucurus* in Al-Malih area (Sep.22-23Aug.)

Table 8: population size and density of the white-tailed lapwing *V. leucurus* in Al-Malih area (Sep.22-Aug.23), * lowest value, ** highest value.

Months	Species density per months (individuals/area size in ha))	Estimated population (individuals/Al-Malih wetland area (2000 ha))
Sep.22	0.113	226.989
Oct.22	0.096	192.804
Nov.22	0.371	742.694**
Dec.22	0.145	290.404
Jan.23	0.107	213.667
Feb.23	0.186	372.187
Mar.23	0.155	310.862
Apr.23	0.209	418.229
May.23	0.291	582.552
Jun.23	0.147	293.603
Jul.23	0.082	163.645*
Aug.23	0	0



Picture 7: The white-tailed lapwing *V. leucurus* A: adult, B: juvenile, C: chick.

4.6 Breeding season of lapwing species in Al-Malih area

During breeding season (March 2023-June2023) all breeding events (e.g., adult courtship, marking of the breeding territories, nest-site selection, nest building, and eggs incubation) were carefully observed for 60 days (15 days per month). Nests of lapwing species were located, measured cautiously and 12 nests were chosen to monitor by camera traps, tested the environmental factors and calculated nest success, breeding events (mates, nests and chick) mention in (Fig.13)

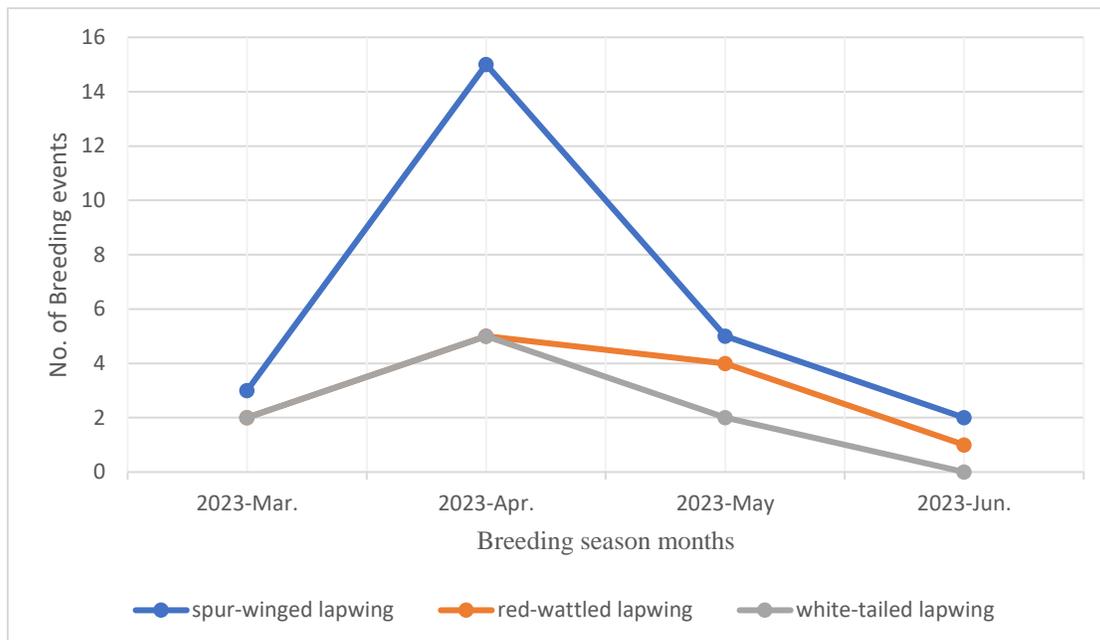


Figure 13: Breeding events of lapwing species in Al-Malih area (Mar.23-June.23)

4.6 lapwing community (*Vanellus spp.*) nests measurement

19 nests were founded belong to lapwing species (*V. spinosus*,8; *V. indicus*,6; *V. leucurus*,5).

The Mean, Standard Deviation, and Coefficient of variation for the egg's

external morphological characteristics are displayed in (Table.9).

The mean and Standard Deviation for clutch size were (3.87 ± 0.34 , *V. indicus*). (3.8 ± 0.41 , *V. spinosus*), (4.0 ± 0.0 , *V. leucurus*); the highest significant value was belonging to *V. leucurus*, the differences in this trait according to different species of lapwing Genus (*Vanellus Spp.*) were not significant (P-value =0.05) according to Duncan test .

The clutch size of lapwings can vary depending on the species and location. here are clutch size estimates for two lapwing species, first in Red-wattled Lapwing *V. indicus*: The mean clutch size of Red-wattled Lapwings was found to be 4 ± 0.0 (range 0-4) in a study conducted in Pakistan (Khalil *et al.*, 2019). Second in Spur winged lapwing *V. spinosus* in study of Özkan *et al.*, (2012) that indicated that the average clutch size was 3.6 in his study in turkey.

The mean and Standard Deviation for egg length were (46.25 ± 0.68 mm, *V. indicus*). (42.25 ± 0.96 mm, *V. spinosus*), (42.28 ± 0.67 mm, *V. leucurus*); the highest significant value (46.25 ± 0.68 mm) was belonging to *V. indicus*, the differences in this trait according to different species of lapwing Genus (*Vanellus Spp.*) were high significant (P-value less 0.001) according to Duncan test.

In Kaur and Khera, (2017) study on *V. indicus* found that egg length was less than this study (41.29 ± 0.573 mm). also in Özkan *et al.*, (2012) indicated to *V. spinosus* egg length Mean (Mean₂₀₁₀, 40.8 ± 0.22 – Mean₂₀₁₁, 40.3 ± 0.13).

Egg breadth mean and Standard Deviation were (33.34 ± 0.84 mm, *V. indicus*), (31.43 ± 0.55 mm, *V. spinosus*), (31.42 ± 0.67 mm, *V. leucurus*); the significant value was in *V. indicus*) and the differences among the values of lapwing (*Vanellus spp.*) were high significant ($p \leq 0.001$) according to Duncan test.

Current result of *V. indicus* was high compare (Sharma *et al.*, 2020) who recorded 30.17 mm as over mean for egg breadth. As well as Kaur and Khera, (2017) reported that egg breadth was slightly differing between two years (2012,2013),

which were (29.89 mm and 30.39 mm) respectively. Also Özkan *et al.*, (2012) indicated to *V. spinosus* egg width Mean (Mean₂₀₁₀, 29.006 ±0.08mm – Mean₂₀₁₁, 28.790±0.07mm).

Egg weight mean and Standard Deviation were (21.39±0.91gm, *V. indicus*), (16.51±0.73gm, *V. spinosus*), (15.87±0.50gm, *V. leucurus*) the high significant value was in *V. indicus* and the differences among the values of species were high significant ($p \leq 0.001$) according to Duncan test. Our result slightly differ from a study Özkan *et al.*, (2012) that indicated to *V. spinosus* egg weight Mean (Mean₂₀₁₀, 16.8±0.14gm – Mean₂₀₁₁, 16.9±0.10gm).

Egg shape index mean and Standard Deviation were (72.38±1.9 a, *V. indicus*); (74.67±2.14 b, *V. spinosus*); (74.72±2.13 b, *V. leucurus*); the significant value was in *V. indicus*, and the differences among the values of lapwing (*Vanellus spp.*) were high significant ($p \leq 0.001$) according to Duncan test.

Our results refer that all eggs of lapwing species were standard eggs or normal and *V. indicus* was differ and smaller than *V. vanellus* and *V. leucurus*. Egg shape index of *V. indicus* results agree slightly with (Kaur and Khera, 2017) results (72.83±0.930) . Egg shape index results of *V. spinosus* was larger than (Özkan *et al.*, 2012) that indicated to *V. spinosus* egg shape index Mean (Mean₂₀₁₀, 71.1 – Mean₂₀₁₁, 71.2).

The environment, the amount of food available, the size of the parents, and the evolutionary stage all have an impact on the external egg features (Stadelman *et al.*, 2017), and to female differences (Föger and Pegoraro, 1996). Environmental or genetic factors could be responsible for this difference (Kaur and Khera, 2017).

Pearson correlation between different types of Lapwing Genus (*Vanellus spp.*) in (Table.10) shown a significant value between (*V. indicus*, *V. spinosus* and *V.*

leucurus) where (p -value less 0.05) and high significant value between (*V. spinosus*) And *V. leucurus*) where (p-value less 0.001) (Fig.14). in (Appendix III) shown *Vanellus spp.* GPS coordinators in study area.



Figure 14: satellite image for Study area with lapwing community (*Vanellus Spp.*) Nests location.

Table 9: Morphometric Comparison between different nests of lapwing genus (*Vanellus spp.*), N= number of eggs .

		N	Mean \pm SD
Clutch size	Red wattled lapwing	23	3.87 \pm 0.34 a b
	Spur winged lapwing	30	3.8 \pm 0.41 a
	White tailed lapwing	20	4.0 \pm 0.0 b
	P – value		0.110
	Red wattled lapwing	23	46.25 \pm 0.68 a
	Spur winged lapwing	30	42.25 \pm 0.96

Eggs length (mm)	White tailed lapwing	20	42.28±0.67 b
	P – value		0.001 ^{HS}
Egg breadth (mm)	Red wattled lapwing	23	33.34±0.84 a
	Spur winged lapwing	30	31.43±0.55 b
	White tailed lapwing	20	31.42±0.67 b
	P – value		0.001 ^{HS}
Egg weight (gm)	Red wattled lapwing	23	21.39±0.91 a
	Spur winged lapwing	30	16.51±0.73 b
	White tailed lapwing	20	15.87±0.50 b
	P – value		0.001 ^{HS}
Egg shape index	Red wattled lapwing	23	72.38±1.9 a
	Spur winged lapwing	30	74.67±2.14 b
	White tailed lapwing	20	74.72±2.13 b
	P – value		0.001 ^{HS}
^{HS} : High Significant difference between groups (p value < 0.001), Groups with different letters are significantly different.			

Table 10: Pearson correlation between different species of Lapwing (*Vanellus spp.*)

Correlations		Red-wattled lapwing	Spur-winged lapwing	White-tailed lapwing
Red-wattled lapwing (<i>V. indicus</i>)	Pearson Correlation	—	0.637*	0.542*
	p – value		0.031	0.047
Spur-winged lapwing (<i>V. spinosus</i>)	Pearson Correlation	—	—	0.853**
	P – value			<0.001
White-tailed lapwing (<i>V. leucurus</i>)	Pearson Correlation	—	—	—
	P – value			

4.7 Environment factors affected on lapwing (*Vanellus spp.*) nests

Environmental condition like (PH, soil temperature, soil moisture and soil texture) were tested carefully for the 12 nests (4 nests each one specie) that monitoring during breeding season (March 2023-June 2023) . Soil moisture recorded a high significant value while not significant for PH and soil temperature for lapwing species.

The mean and standard deviation of spur-winged lapwing nests were (8.2±0.11 b;27.5±9.03 a;35.75±1.71 a) for (pH, soil moisture and temperature) respectively.

The mean and standard deviation of red-wattled lapwing nests were (7.94±0.104a;8.38±7.2b;33.5±5.1a) for (pH, soil moisture and temperature) respectively.

The mean and standard deviation of white-tailed lapwing nests were (8.16±0.23 ab;19.57±0.38a;30.5±1.29a) for (pH, soil moisture and temperature) respectively (Table.11).

Soil pH is a factor that can affect the distribution and nesting success of Northern Lapwings *V. vanellus* (McCallum *et al.*, 2015; McCallum *et al.*,2016).

Soil moisture is a factor that can affect the nesting success of Northern Lapwings *V. vanellus*,a study found that nest and nest site moisture served as a predictor of Lapwing nest success, with nests in drier sites having higher success rates. (Seymour *et al.*,2003).

Soil temperature is not a factor that is commonly studied in relation to lapwing spp. however, a study on British Lapwings *V. vanellus* found that mean winter soil temperature was one C⁰ of the weather variables that explained variation in adult survival rates (Peach *et al.*,1994).

Table 11: Environmental factors affected on lapwing species nests in Al-Malih area. ^{HS} high significant value, different letters mean different groups in Duncan test. SW1,,, =Spur winged lapwing ; RW1,,,,=Red wattled lapwing; WT1,,White tailed lapwing

No.	Lapwing Spp.	PH	Soil moisture %	Temperature c°	Soil Texture
1	SW1	8.34	21.99	34°	Loam
2	SW2	8.09	18.16	38°	Loam
3	SW3	8.23	32.13	36°	sandy loam
4	SW4	8.15	37.77	35°	sandy loam
	Mean ± SD	8.2±0.11 b	27.5±9.03 a	35.75±1.71 a	
1	RW1	7.97	2.69	26°	sandy loam
2	RW2	7.93	4.06	36°	sandy loam
3	RW3	7.8	8.18	40°	silt loam
4	RW4	8.05	18.59	32°	Loam
	Mean ± SD	7.94±0.104 a	8.38±7.2 b	33.5±5.1 a	
1	WT1	8	19.7	29°	silt loam
2	WT2	8.1	19.76	31°	silt loam
3	WT3	8.05	19	32°	silt loam
4	WT4	8.5	19.8	30°	silt loam
	Mean ± SD	8.16±0.23 ab	19.57±0.38 a	30.5±1.29 a	
	P value	0.086	0.009 ^{HS}	0.182	

4.8 lapwing genus (*Vanellus spp.*) nests monitoring by camera traps

12 nests of lapwing species (4 nests for each one specie) were monitoring carefully during breeding season (March 2023- June 2023) to determine incubation period, predator's type and nest success by camera traps that mimic with its surrounding environment as well as environmental factors (Table.11,12,13).

Table12: Monitoring the lapwing species nest by camera traps. SWi=spur-winged, RWi=red-wattled lapwing, WTi=white tailed lapwing.

Days /spp.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Notes
SW1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4						eggs hatched
SW2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2					one egg not hatched
SW3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2					one egg not hatched	
SW4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2					two eggs not hatched	
RW1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	hedgehog as predators
RW2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0										weather condition
RW3	3	3	3	0																											Arabian red fox as predators
RW4	4	4	4	4	4	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	two eggs not hatched
WT1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0													boar as predators
WT2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0														boar as predators
WT3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1					3 eggs eaten by Arabian red fox
WT4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0												boar as predators

Table 13: nest success of lapwing species in Al-Malih area by two methods.

No	lapwing spp.	Mayfield method			Nest success	
		exposure= egg/day	Mortality rate	Success rate	Mayfield method	Traditional method
1	Spur winged lapwing	336	0.012	0.988	76.69 %	71.43 %
2	Red wattled lapwing	206	0.049	0.951	25.23 %	23.08 %
3	White tailed lapwing	280	0.054	0.946	7.57 %	6.25 %

4.8.1 Spur-winged lapwing (*V. spinosus*) Monitoring

Four nests were selected from Al-Malih area during breeding season (March2023-June2023; breeding events were carefully observed.

The nest success was in Mayfield method started with the Mortality rate was 0.012(4 eggs lost/exposure days ,336), success rate was 0.988, the probability of survival was 76.69 % (Success rate ^(incubation period=24 days)), while nest success by traditional method was 71.43 % (eggs hatched,10/total number of eggs,14) (Table.13).

Eggs outwardly distinguished by a pyriform shape, a non-glossy surface with olive green to light brownish color, and were patterned with irregularly sized dark brownish black spots and streaks.

The following nests that monitoring:

I. First Spur-winged (SW1) nest:

It located in N 32°49'29", E 44°20'48" coordinators, in 27-3-2023, contain 4 eggs and continuous monitoring by camera trap for 24 days (the maintenance takes place each 2-4 days) and 4 eggs hatched successfully in 20-4-2023, Nidifugous chicks (those that leave the nest shortly after hatching) left the nest, moving with parents in few hours later. Habitat cover by *Tamarix spp.* and the environmental factors were (8.34;21.99%;34°) for (PH; soil moisture; soil temperature) respectively and soil texture was loam (Table.11,12 ;Pic.8).

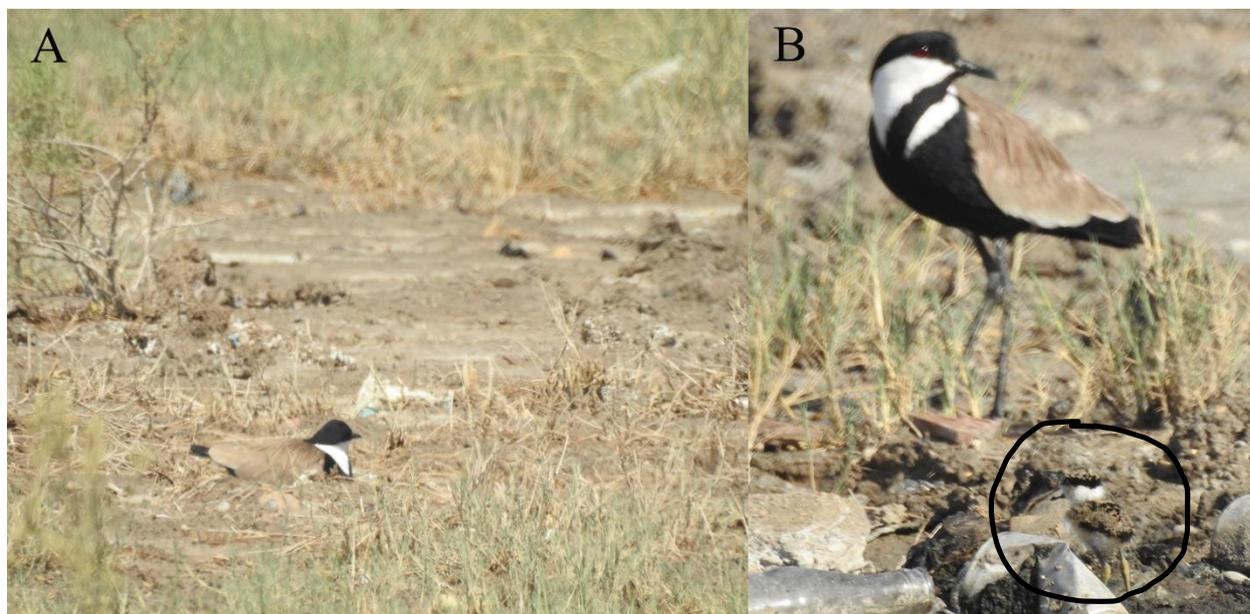


Picture 8: A: two chicks *V. spinosus* hatched newly, B: one parents incubating nest with camera trap

II. Second Spur-winged (SW2) nest:

It located in N 32°49'07", E 44°19'30" coordinators, in 1-4-2023, contain 3 eggs and continuous monitoring by camera trap for 24 days (the maintenance takes place each 2-4 days) and 2 eggs hatched successfully in 25-4-2023, Nidifugous

chicks left the nest, moving with parents in few hours later. Habitat cover by *Tamarix spp.* and grasses. The environmental factors were (8.09;18.16%;38°) for (PH; soil moisture; soil temperature) respectively and soil texture was loam. (Table.11,12 ;Pic.9).



Picture 9 : A: one parents *V. spinosus* incubating nest, B: one parents with one chick newly fledged.

III. Third Spur-winged (SW3) nest:

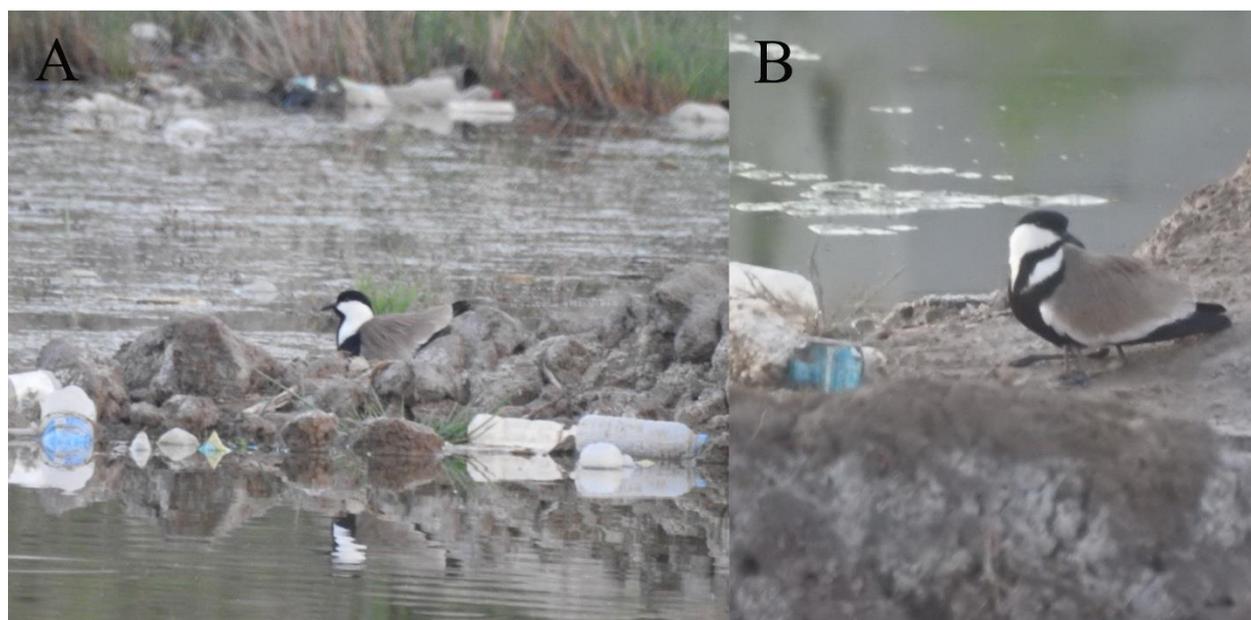
It located in N 32°50'10", E 44°20'04" coordinators, in 17-4-2023, contain 3 eggs and continuous monitoring by camera trap for 24 days (the maintenance takes place each 2-4 days) and 2 eggs hatched successfully in 10-5-2023, Nidifugous chicks left the nest, moving with parents in few hours later. Habitat cover by *Tamarix spp.* and the environmental factors were (8.23; 32.13%;36°) for (PH; soil moisture; soil temperature) respectively and soil texture was sandy loam (Table.11,12 ;Pic.10).



Picture 10: A: one parents *V. spinosus* incubation the nest; B: one parents with one chick fledged.

IV. Fourth Spur-winged (SW4) nest:

It located in N 32°50'19", E 44°19'53" coordinators, in 10-5-2023, contain 4 eggs and continuous monitoring by camera trap for 24 days (the maintenance takes place each 2-4 days) and 2 eggs hatched successfully in 2-6-2023, Nidifugous chicks left the nest, moving with parents in few hours later. Habitat cover by *Tamarix spp.* and some grasses. The environmental factors were (8.15;37.77%;35°) for (PH; soil moisture; soil temperature) respectively and soil texture was sandy loam (Table.11,12 ;Pic.11).



Picture 11: A: one parents *V. spinosus* incubation the nest; B: one parents incubate one chick newly fledged.

Our results show the first scientific field work by using camera traps to Monitoring the lapwing species that resident in Al-Malih area and Iraq with high success rate for Spur winged lapwing *V. spinous* that may because its aggressive behavior in defense on their territory and high parental care and initial described the eggs morphology, soil textures were loam, sandy loam.

the breeding success rate of Spur-winged Lapwings *V. spinosus* can vary depending on the location and year, a study conducted in Boğazkent, Turkey found that the breeding success of Spur-winged Lapwings was 58.1% in 2010 and 62.3% in 2011, Incubation period was 23 days(Özkan *et al.*,2012) and slightly different from our results.

4.8.2 Red-wattled lapwing (*V. indicus*) Monitoring

Four nests were selected from Al-Malih area during the breeding season (March2023-June2023); breeding events were carefully observed.

The nest success was in Mayfield method was begun with the Mortality rate was 0.049 (10 eggs lost/exposure days ,206), success rate was 0.951, the

probability of survival was 23.08 % (Success rate ^(incubation period=28 days)), while nest success by traditional method was 23.08 % (eggs hatched,3/total number of eggs,13) (Table.13).

Eggs Outwardly distinguished by their pyriform shape and non-glossy surface; their color is pale olive green with black spots.

The following nests that monitoring:

I. First Red-wattled (RW1) nest:

It located in N 32°48'11", E 44°21'30" coordinators, in 7-4-2023, contain 3 eggs and continuous monitoring by camera trap for 28 days (the maintenance takes place each 2-4 days) and 1 egg hatched successfully in 4-5-2023(two eggs eaten by long eared hedgehog *Hemiechinus auritus*), Nidifugous chick left the nest, moving with parents in few hours later. habitat cover by *Suaeda spp.* . the environmental factors were (7.97;2.69%;26°) for (PH; soil moisture; soil temperature) respectively and soil texture was sandy loam (Table.11,12 ;Pic.12).



Picture 12: A: one parents *V. indicus* defend its nest against Hedgehog *H. auritus* ; B: red-wattled lapwing nest with 3 eggs in dates residual .

II. Second Red-wattled (RW2) nest:

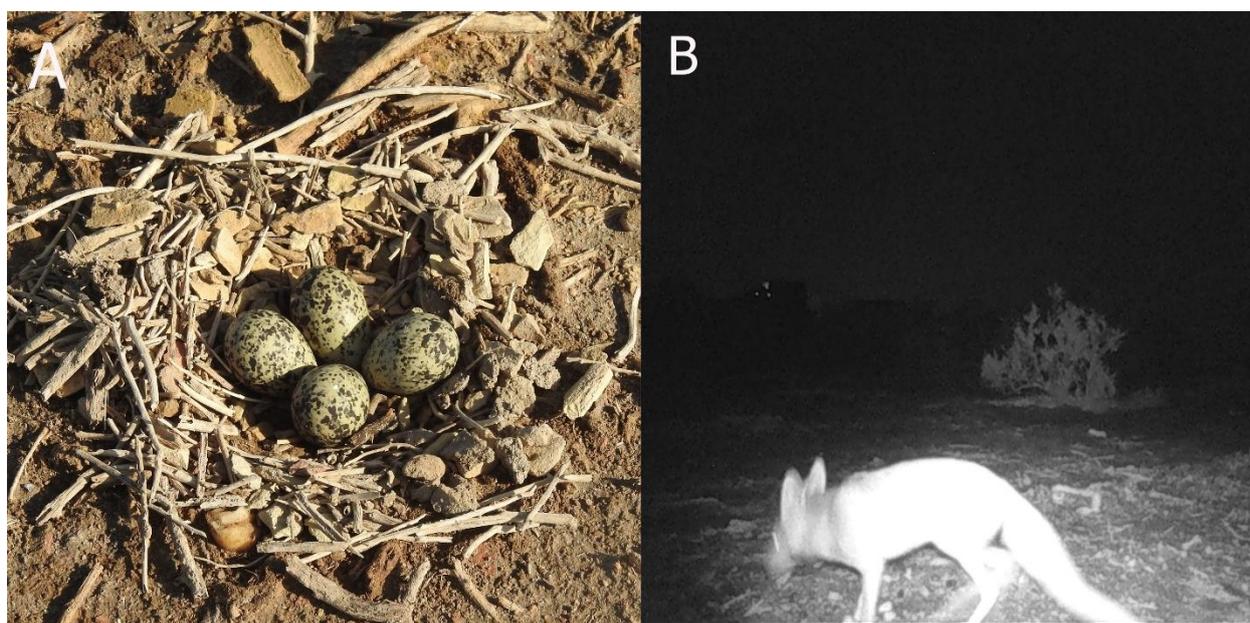
It located in N 32°49'38", E 44°20'14" coordinators, in 10-4-2023, contain 3 eggs and continuous monitoring by camera trap for 20 days (the maintenance takes place each 2-4 days) and all eggs not hatched successfully in 30-4-2023 due to bad weather (rainfall) cause its eggs attached in ground so parents can't incubated the nest and left the nest. habitat cover by *Suaeda spp.* . the environmental factors were (7.93; 4.06%;36°) for (pH; soil moisture; soil temperature) respectively and soil texture was sandy loam (Table.11,12 ;Pic.13).



Picture 13: A: one parents *V. indicus* incubation the nest with camera trap mimics its environment; B: attached eggs in ground due to bad weather.

III. Third Red-wattled (RW3) nest:

It located in N 32°48'14", E 44°20'02" coordinators, in 20-4-2023, contain 3 eggs and continuous monitoring by camera trap for 3 days (the maintenance takes place each 2-4 days) and 3 eggs eaten by Arabian red fox *Vulpes vulpes arabica* in 24-4-2023. habitat cover by *Tamarix spp.* and some grasses. the environmental factors were (7.8; 8.18%;40°) for (pH; soil moisture; soil temperature) respectively and soil texture was silt loam (Table.11,12 ;Pic.14).



Picture 14: A: red wattled *V. indicus* lapwing nest.; B: Arabian red fox *V. vulpes* attacked the nest.

IV. Fourth Red-wattled (RW4) nest:

It located in N 32°47'40", E 44°22'06" coordinators, in 20-4-2023, contain 4 eggs and continuous monitoring by camera trap for 28 days (the maintenance takes place each 2-4 days) and 2 eggs hatched successfully in 18-5-2023, Nidifugous chicks left the nest, moving with parents in few hours later. habitat cover by *Tamarix spp.* and *Suaeda spp.*. the environmental factors were (8.05;18.59%;32°)

for (PH; soil moisture; soil temperature) respectively and soil texture was loam (Table.11,12 ;Pic.15).



Picture 15: A: one parents *V. indicus* with two chicks fledged; B: one parents incubation the nest.

Our results in current study show success rate less than 25%, low success rate may because increase their predators, and initial described the eggs morphology, soil texture showed three types of soil (loam, sandy and silt loam).

the success rate of Red-wattled Lapwing *V. indicus* nests can be affected by various factors such as agricultural activities, nest predation, and breeding habitats, also can vary depending on the location and year (Narwade, *et al.*,2010).

The incubation period of Red-wattled Lapwing (*V. Indicus*) is 25-28 days, with an average of 27.1 ± 0.4 days (Khalil *et al.*, 2019) and this slightly agree with our result.

Nest predators of red wattled lapwing was the same in study of (Mishra and Kumar,2022) and for first time recoreded Hedhodge as predator.

4.8.3 White-tailed lapwing (*V. leucurus*) Monitoring

Four nests were selected from Al-Malih area during breeding season (March2023-June2023); breeding events (e.g., adult courtship, marking of the breeding territories, nest-site selection, nest building, and eggs incubation) were carefully observed.

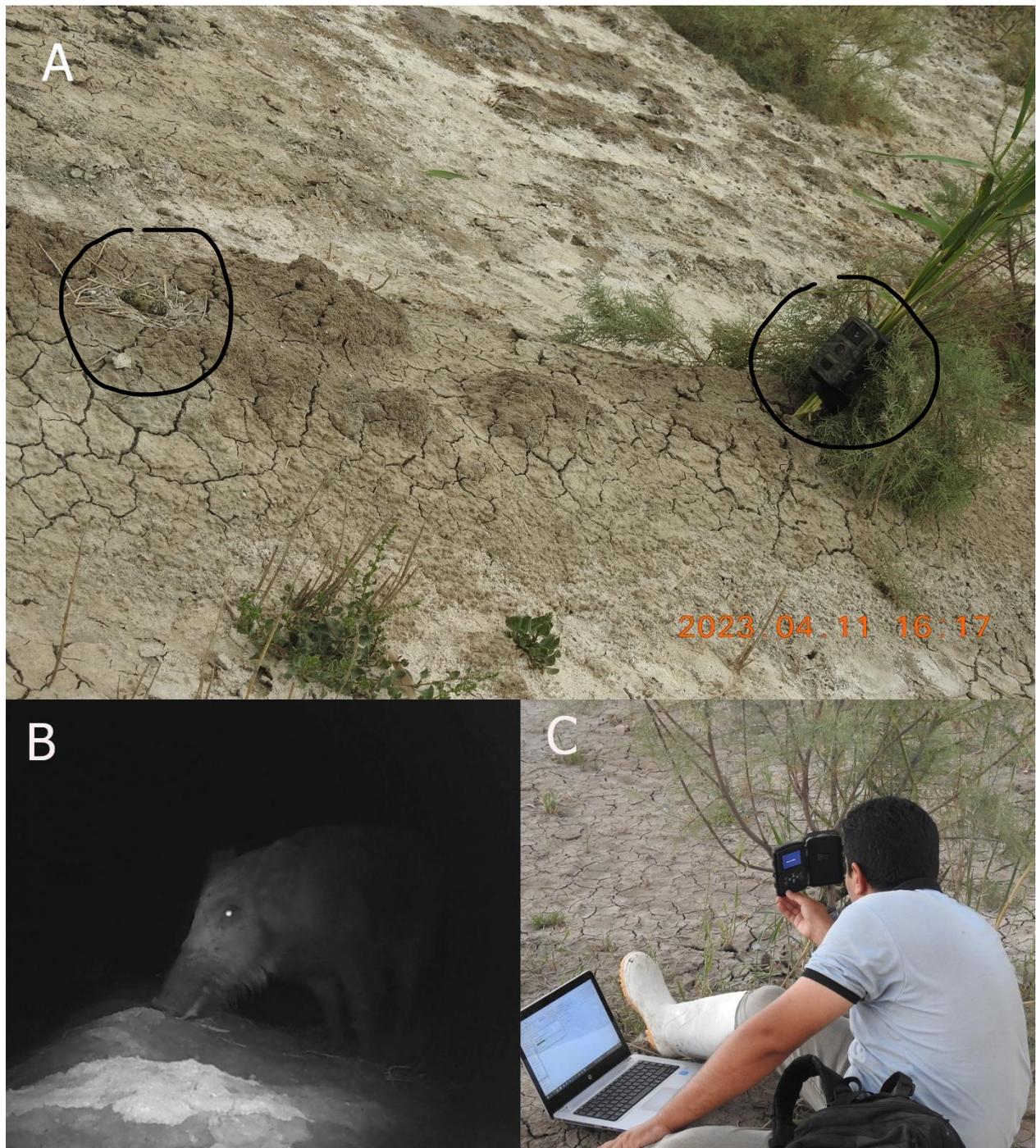
The nest success was in Mayfield method was started with the Mortality rate was 0.054 (10 eggs lost/exposure days ,280), success rate was 0.946, probability of survival 7.57 % (Success rate ^(incubation period=22days)), while nest success by traditional method was 6.25 % (eggs hatched,1/total number of eggs,16) (Table.13).

Eggs outwardly distinguished by pyriform shape and non-glossy surface with pale olive eggs with large irregular dark-brown stained patterns.

The following nests that monitoring:

I. First White-tailed (WT1) nest:

It located in N 32°49'58", E 44°19'25" coordinators, in 11-4-2023, contain 4 eggs and continuous monitoring by camera trap for 17 days (the maintenance takes place each 2-4 days) and all eggs eaten by a wild boar *S. scrofa* in 26-4-2023. Habitat cover by *Tamarix spp.* . the environmental factors were (8;19.7%;29°) for (PH; soil moisture; soil temperature) respectively and soil texture was silt loam (Table.11,12 ;Pic.16).



Picture 16: A: white tailed lapwing *V. leucurus* nest; B: a boar *S. scrofa* attacked the nest; C: maintenance the camera trap.

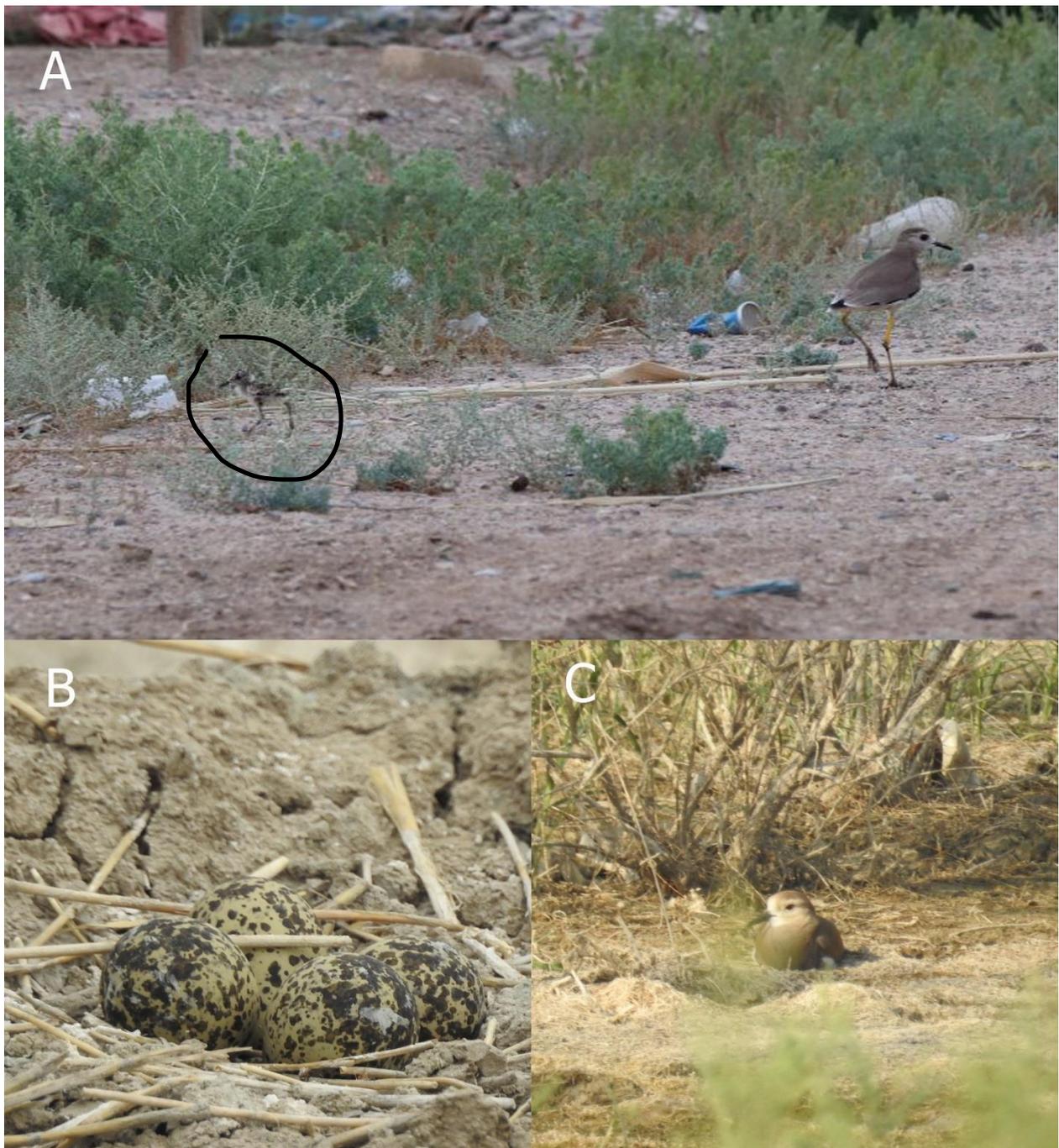
II. Second White-tailed (WT2) nest:

It located in N 32°47'52", E 44°21'24" coordinators, in 14-4-2023, contain 4 eggs and continuous monitoring by camera trap for 16 days (the

maintenance takes place each 2-4 days) and all eggs eaten by a wild boar *S. scrofa* in 29-4-2023. habitat cover by *Tamarix spp.* . the environmental factors were (8.1;19.76%;31°) for (PH; soil moisture; soil temperature) respectively and soil texture was silt loam (Table.11,12).

III. Third White-tailed (WT3) nest:

It located in N 32°47'51", E 44°21'55" coordinators, in 20-4-2023, contain 4 eggs and continuous monitoring by camera trap for 22 days (the maintenance takes place each 2-4 days) and 1 egg hatched successfully and two eggs eaten by wild boar *S. scrofa* in 18-5-2023, Nidifugous chick left the nest, moving with parents in few hours later. habitat cover by *Tamarix spp.* the environmental factors were (8.05;19%;32°) for (PH; soil moisture; soil temperature) respectively and soil texture was silt loam (Table.11,12 ;Pic.17).



Picture 17: A: one parents *V. leucurus* with one chick newly fledged; B: white tailed lapwing nest; C: one parents incubation the nest.

IV. Fourth White-tailed (WT4) nest:

It located in N 32°47'49", E 44°22'06" coordinators, in 14-4-2023, contain 4 eggs and continuous monitoring by camera trap for 18 days (the maintenance takes place each 2-4 days) and all eggs eaten by wild boar *S. scrofa* in 1-5-2023. Habitat

cover by *Tamarix spp.*, the environmental factors were (8.5;19.8%;30°) for (PH; soil moisture; soil temperature) respectively and soil texture was silt loam (Table.11,12).

Our results show low success rate for white tailed lapwing *V. leucurus* that may be because habitat loss and may be to nesting as group that enhanced the predation to all monitoring nests. we described the eggs morphology too; soil texture was silt loam and need more samples in future to be investigated.

We conducted the first scientific research on breeding biology for *V. leucurus* in Iraq and the world.

4.9 threats impact on Bird species in al Malih area

Many threats were observed during the current study in the study area (Sep.22-Aug.23) but need more special investigations in future like IUCN threatened Model, we show it as following:

- The major threat was natural system modification (water management) to make fish farms that destroy suitable habitat for all bird species.
- The threat included illegal hunting for birds by hunting guns, traps and also electro-fishing that destroy food resources for waterbirds.
- The pollution by wastes and manure water disposal along months of years especially transect (1,4) was observed.
- Invasive species like Tilapia fish *Tilapia zillii* .
- Agriculture expansion, climate change and drought especially during summer season (June, July 2023)(Pic.18).



Picture 18: A: drought area during summer season (July); B: water management (Fish farm); C: invasive species (Tilap Fish, *Tilapia zillii*); D; pollution by waste and cattle that refer agriculture expansion.

Conclusions

- Al Malih area is an important site for birds as total one third species number of Iraqi birds with seven threatened bird species within IUCN red list and this site deserve to be as natural reserve according to its high diversity.
- Four species of lapwing spp. (*V. spinosus* ; *V. leucurus*; *V. Vanellus* and *V. indicus*) were recorded in Al-Malih area except the threatened social lapwing *V. gregarius* and this result show the importance of study area for lapwing genus in Iraq.
- The highest count of lapwing species was in *V. spinosus* that its resident specie along year in study area, while the lowest count was in the *V. Vanellus* that its winter visitor only.
- Morphometrical Clutch Uniformity in the Lapwings community show significant differences between three species of lapwing (*V. indicus* especially differ from *V. spinosus* and *V. leucurus* in egg measurements).
- Monitoring by camera traps show many aspects-like predators identifying, incubation period and nest success.
- The incubation period was the highest days in *V. indicus* and lowest days in *V. leucurus*.
- the highest nest success was in *V. spinosus* that may due to aggressive behaviour while lowest nest seccess in *V. leucurus* that may due to habitat loss in study area.
- According to statistic analysis in the environmental factors , Soil moisture recorded a high significant value while not significant for pH and soil temperature for lapwing species and need more investigation in the future.

Recommendations

- Further studies in al Malih area continuous many years to know the population trends of lapwing spp. with threats.
- Study the diversity for lapwing species and make the phylogenetic tree.
- Study the environmental factors that deal with lapwing spp. nest success.
- Assessment the pollution effect on nestling of lapwing species and other life stages especially the red-wattled lapwing in agriculture areas.
- Comprehensive study to determine the bird diversity in Al-Malih area with environmental factors.
- More studies on threatened species in Al-Malih area like Eurasian otter (*L. lutra*) and the Euphrates softshell turtle (*R. euphraticus*)

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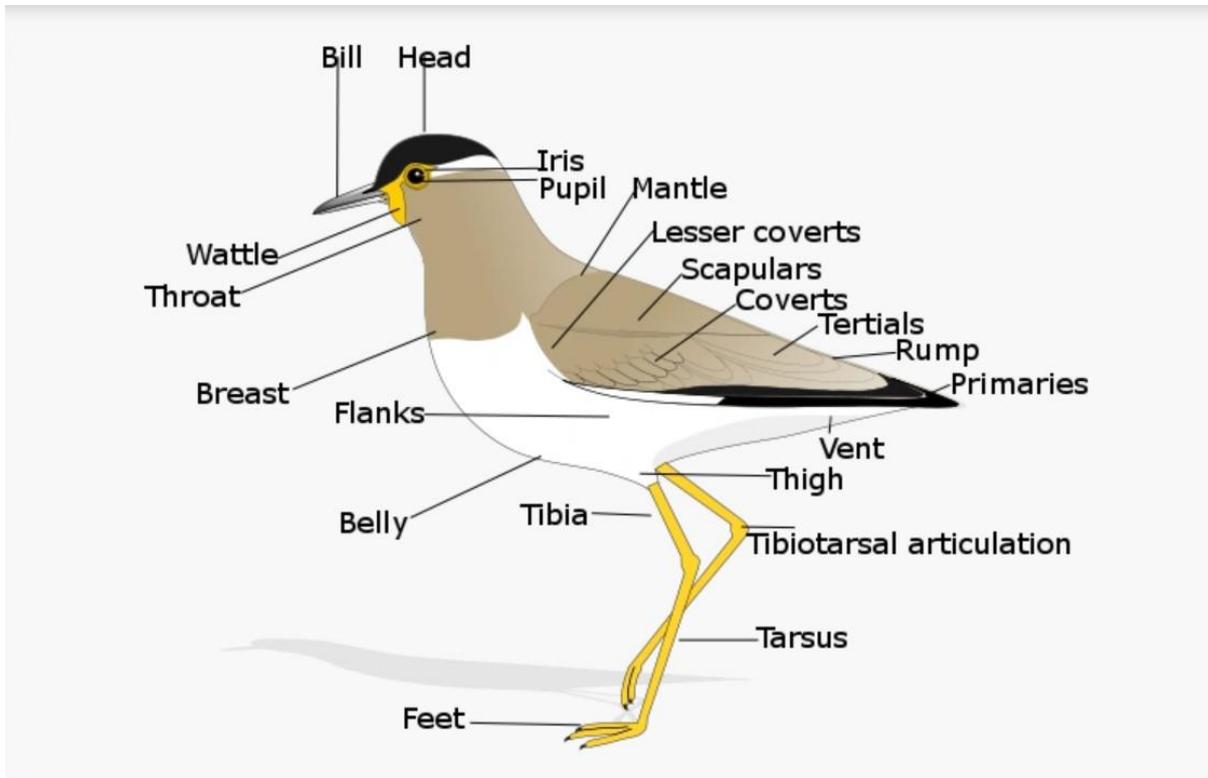
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Appendix I. Bird topography glossary



Appendix II. a. coordinates of study transect

Station number	Coordinate	
	Start	End
Station one	32°50'45"N 44°19'51"E	32°49'46"N 44°20'16"E
	32°49'46"N 44°20'16"E	32°49'30"N 44°20'51"E
	32°49'30"N 44°20'51"E	32°48'14"N 44°21'24"E
Station two	32°48'13"N 44°21'26"E	32°48'16"N 44°21'38"E
	32°48'16"N 44°21'38"E	32°48'03"N 44°21'39"E
	32°48'03"N 44°21'39"E	32°48'01"N 44°21'51"E
	32°48'01"N 44°21'51"E	32°47'50"N 44°21'53"E
	32°47'50"N 44°21'53"E	32°47'42"N 44°22'05"E
Station three	32°48'59"N 44°19'21"E	32°49'02"N 44°19'18"E
	32°49'02"N 44°19'18"E	32°49'05"N 44°19'19"E
	32°49'05"N 44°19'19"E	32°49'07"N 44°19'18"E

	32°49'07"N 44°19'18"E	32°49'09"N 44°19'12"E
	32°49'09"N 44°19'12"E	32°49'22"N 44°19'00"E
Station four	32°49'25"N 44°18'55"E	32°50'47"N 44°19'49"E

b. lapwing species nests GPS coordinators.

No.	Common name	<i>Vanellus spp.</i>	Coordinators
1.	Rw1	<i>V. indicus</i>	N 32°48'11", E 44°21'30"
2.	Rw2	<i>V. indicus</i>	N 32°49'38", E 44°20'14"
3.	Rw3	<i>V. indicus</i>	N 32°48'14", E 44°20'02"
4.	Rw4	<i>V. indicus</i>	N 32°47'40", E 44°22'06"
5.	RW	<i>V. indicus</i>	N 32°48'32", E 44°21'16"
6.	RW	<i>V. indicus</i>	N 32°47'34", E 44°22'04"
7.	Wt1	<i>V. leucurus</i>	N 32°49'58", E 44°19'25"
8.	Wt2	<i>V. leucurus</i>	N 32°47'52", E 44°21'24"
9.	Wt3	<i>V. leucurus</i>	N 32°47'51", E 44°21'55"
10.	Wt4	<i>V. leucurus</i>	N 32°47'49", E 44°22'06"
11.	WT	<i>V. leucurus</i>	N 32°47'47", E 44°22'00"
12.	Sw1	<i>V. spinosus</i>	N 32°49'29", E 44°20'48"
13.	Sw2	<i>V. spinosus</i>	N 32°49'07", E 44°19'30"
14.	Sw3	<i>V. spinosus</i>	N 32°50'10", E 44°20'04"
15.	Sw4	<i>V. spinosus</i>	N 32°50'19", E 44°19'53"
16.	SW	<i>V. spinosus</i>	N 32°49'29", E 44°20'48"
17.	SW	<i>V. spinosus</i>	N 32°49'15", E 44°19'23"
18.	SW	<i>V. spinosus</i>	N 32°50'22", E 44°19'34"
19.	SW	<i>V. spinosus</i>	N 32°50'03", E 44°20'04"

بحذر وتم اختيار ١٢ عشًا للمراقبة بواسطة كاميرات المراقبة واختبار العوامل البيئية (الاس الهيدروجيني للتربة وقياس الحرارة والرطوبة وقوام التربة) وحساب مدى نجاح العش.

تراوحت القيم للمتوسط الحسابي والانحراف المعياري لطول البيض ($V. leucurus$ ملم ل $0,68 \pm 46,25$), ($V. spinosus$ ملم ل $0,96 \pm 42,25$), ($V. indicus$ ملم ل $0,67 \pm 42,28$).

بينما تراوحت القيم لعرض البيض ($V. indicus$ ملم ل $0,84 \pm 33,34$), ($V. leucurus$ ملم ل $0,55 \pm 31,43$), ($V. spinosus$ ملم ل $0,67 \pm 31,42$).

وتراوحت القيم لوزن البيض ($V. indicus$ غم ل $0,91 \pm 21,39$), ($V. leucurus$ غم ل $0,50 \pm 15,87$), ($V. spinosus$ غم ل $0,50 \pm 15,87$).

وتراوحت قيم معامل الاختلاف لطول وعرض ووزن البيض بشكل متتالي $1,47$, $2,51$, $4,27$ ل $V. indicus$, ($2,26$, $1,76$, $4,44$ ل $V. spinosus$), ($3,16$, $2,13$, $1,57$ ل $V. leucurus$).

اظهرت فراخ الطيطوي والبيوض العديد من الاختلافات الشكلية بالإضافة إلى ذلك، تشير نتائجنا إلى وجود اختلافات كبيرة في قياس التحليل الكمي لمتائل لأنواع *Vanellus spp.* الثلاثة في البيوض و الفراخ.

اظهرت المراقبة بواسطة كاميرات المراقبة الفخية عدة جوانب مثل تحديد الحيوانات المفترسة وفترة الحضانة ونجاح العش. وكانت فترة الحضانة 28 ، $V. indicus$ ؛ 24 ، $V. spinosus$ ؛ 22 ، $V. leucurus$. كانت الخنازير *Sus scrofa* من الحيوانات المفترسة لـ $V. leucurus$ ، وكان الثعلب الأحمر العربي $V. vulpes$ والقنفذ $H. uratus$ من الحيوانات المفترسة لـ $V. indicus$ بينما كان نجاح العش 23 ، 25 ، 08 ، 23 ، $V. indicus$ ؛ 43 ، 71 ، 69 ، 76 ، $V. spinosus$ ؛ 6 ، 25 ، 57 ، 7 ، $V. leucurus$ في طريقة مايفيلد والطريقة التقليدية على التوالي.

وفقاً لاختبارات الاحصائية للعوامل البيئية لاعتشاش طيور الطيطوي سجلت رطوبة التربة قيمة معنوية عالية بينما لم تكن قيمة معنوية بالنسبة للاس الهيدروجيني ودرجة الحرارة.

قد تساهم نتائجنا الأولية، والتي تم الحصول عليها لأول مرة، في جهود الحفاظ على هذه الطيور التي تعيش في الأراضي الرطبة في العراق.

الخلاصة

يعتبر مجتمع الطيطوي مؤشرات حيوية وهي أنواع توفر معلومات تتعلق بالجودة البيئية وتستخدم لتقييم جودة الأراضي الزراعية، وهي حساسة للتغيرات في استخدام الأراضي وتدهور الموائل، وقد يشير وجودها أو غيابها إلى صحة النظام البيئي. هناك معلومات نادرة عن مجتمع الطيطوي وحياتية تكاثره في العراق.

اجري مسح حقلي من ٢٠٢٢ سبتمبر إلى أغسطس ٢٠٢٣ ، بإجمالي ٧٢ مسح حقلي في منطقة المالح في شمال بابل – وسط العراق، والذي يعتبر من الأراضي الرطبة ، وتبلغ مساحته حوالي ٢٠٠٠ هكتار (٢٠ كم^٢).

هدفت الدراسة الى الحصول على دراسة بيئية وحياتية لمجتمع طيور الطيطوي (*Vanellus spp.*) في منطقه المالح في محافظة بابل. ولأجل تحقيق عدة أهداف تضمنت: تصنيف أنواع الطيور في منطقة المالح وتحديد مجتمع الطيطوي مع حجم السكان، دراسة التحليل الكمي لتمائل بيوض مجتمع طيور الطيطوي والاختلافات بين مجموعات أنواع الطيطوي ودراسة العوامل البيئية (الاس الهيدروجيني ورطوبة التربة وحرارتها وقوامها) لاعشاش طيور الطيطوي

استخدمت طرق المسح الحقلي أخذ العينات عن بعد والمعتمدة على احتمال اكتشاف طيور الطيطوي واجريت طرق المسح الميداني هذه من أجل الحصول على تقديرات موثوقة لكثافة الأنواع وحجم السكان طيور الطيطوي في منطقة المالح، تم تحديد إجمالي أربعة خطوط عرضية تغطي منطقة دراسة تبلغ مساحتها ١١٠٠ هكتار (١١ كم^٢).

سجلت ١٢٢ نوعاً في المسوحات الميدانية الحالية في منطقة المالح تنتمي إلى ١٧ رتبة و ٣٨ فصيلة، و أن ٧ أنواع ضمن القائمة الحمراء للاتحاد الدولي لحفظ الطبيعة وتمثل انواع الطيور حوالي ٦٥,٣٠٪ من العدد الإجمالي للطيور العراقية وتم تسجيل ٤ أنواع من جنس الطيطوي (*Vanellus spp.*)

سجل ٩٠٤ فرداً من أربعة أنواع من طيور الزقزاق (*Vanellus spp.*) ينتمون إلى رتبة Charadriidae، عائلة Charadriiformes بين ٥ أنواع موجودة في العراق). الزقزاق الشمالي *V. vanellus*, 78; *vanellus* ناتىء الجناح *V. spinosus*, 531; احمر اللغد *V. indicus*, 136; and ابيض الذيل *V. leucurus*, 159).

استضافت منطقة المالح مجتمع طيور الطيطوي بحجم سكان المكون من أربعة أنواع، الزقزاق الشمالي *V. vanellus* (١٤٨,٥٩-٢٠٣,٤٥) في شهري كانون الاول و تشرين الاول ٢٠٢٢: ناتىء الجناح *V. spinosus* (٢٧٠,٧٤-١٢٤٨,٧٣) في نيسان و أب ٢٠٢٣; احمر اللغد *V. Indicus* (١٧, ٢٧٧-٦٧, ٩٣١) في تشرين الاول ٢٠٢٣ و كانون الثاني ٢٠٢٣; ابيض الذيل *V. leucurus* (٦٤, ١٦٣-٦٩, ٧٤٢) في تشرين الاول ٢٠٢٢ ويوليو ٢٠٢٣.

لوحظ خلال موسم التكاثر (٢٠٢٣ مارس – ٢٠٢٣ يونيو) جميع أحداث التكاثر (على سبيل المثال، مغازلة البالغين و وضع علامات على مناطق التكاثر واختيار موقع العش وبناء العش وحضانة البيض) بعناية لمدة ٦٠ يوماً (١٥ يوماً في الشهر)، تم تحديد مواقع أعشاش طيور الطيطوي وقياسها



جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة بابل
كلية العلوم
قسم علوم الحياة

دراسة توزيع وتفريخ مجتمع طيور الطيئوي (*Vanellus spp.*) لمنطقة المالح في محافظة بابل - العراق

الرسالة مقدمة الى كلية العلوم/ جامعة بابل كجزء من المتطلبات لدرجة الماجستير في العلوم
/ علوم الحياة / بيئة

اعداد

كامل حسن ياسر حسن

بأشراف

د. عمر فاضل عبدالرحمن الشيلخي

مدرس

د. مؤيد جاسم ياس العماري

استاذ

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