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ORIGINAL ARTICLE

ASSESSING THE POTENTIAL RISK OF IMPACTS BY FOUR NON-NATIVE BIRDS SPECIES ON BIODIVERSITY IN IRAQ

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ABSTRACT

Invasive bird species pose a significant threat to biodiversity and ecosystems worldwide. In Iraq, non-native avifaunal species are increasing, leading to various environmental challenges. This study aims to evaluate the risk of invasiveness and potential impacts of four non-native, extant bird species on Iraq's biodiversity under both current and predicted climate change conditions. Surveys were conducted in November 2023 and 2024 on four non-native bird species present in local animal markets throughout Iraq. The study sites included the provinces of Baghdad, Basra, and Erbil, which harbour commercial centres and the largest local animal markets in the country for trading non-native species. In this study, the target species for screening were selected after an extensive literature search and review of non-native bird species in Iraq. Using the Terrestrial Animal Species Invasiveness Screening Kit (TAS-ISK), this study evaluated the potential risk of invasiveness in Iraq of four of these non-native bird species: bank myna *Acridotheres ginginianus* Latham, 1790, common myna *Acridotheres tristis* (Linnaeus, 1766), Namaqua dove *Oena capensis* (Linnaeus, 1766), and rose-ringed parakeet *Psittacula krameri* (Scopoli, 1769). The findings revealed that for commercial, environmental, and species or population nuisance traits, *A. tristis* and *P. krameri* pose a high risk of invasiveness, whereas *A. ginginianus* and *O. capensis* pose a medium risk. The present results highlight the need to include these species in decision-making and management programmes to mitigate their impacts on Iraq's biodiversity.

Keywords: Biological invasion, Non-native, Potential impact, Risk screening, TAS-ISK.

INTRODUCTION

The deliberate or accidental translocation of species by humans beyond their natural distribution is a well-documented outcome of the new 'geological era' (Ricciardi, 2007; Hulme, 2009) that has resulted in the transportation of live animals across different locations for many years (Mori *et al*., 2017). Animals have been introduced for pet trading (Lockwood *et al*., 2019), and the establishment of non-native species in areas where they are able to multiply, disperse, and, eventually, negatively affect native biota is referred to as biological

invasion (Pearson, 2022). On a global scale, biological invasions represent a significant problem leading to a reduction in the numbers of native species (Dove *et al*., 2011). Measures to counteract the impacts resulting from the spread of non-native species are therefore necessary (Al-Sheikhly, 2023).

Invasive species are one of the five primary factors leading to global environmental change, alongside the conversion of land and sea, direct overexploitation, climate change, and pollution (IPBES, 2023). While biological invasions are widely acknowledged as a major aspect of contemporary global change, there is substantial disagreement between scientists and stakeholders about the magnitude of the changes caused by non-native species and the degree to which management interventions are justified (Richardson and Ricciardi, 2013). This debate stems partly from the absence of a widely acceptable framework for assessing impacts and an integrated terminology for describing impacts to enable effective communication (Blackburn *et al*., 2014; Jeschke *et al*., 2014). However, throughout the past years, a rapid advancement has occurred in studies related to invasion impacts (Pyšek *et al*., 2020). These have resulted in an enhanced understanding of the underlying mechanisms of biological invasions and the establishment of a well-grounded theoretical foundation and conceptual framework (Jeschke *et al*., 2014; Kumschick *et al*., 2017).

Iraq covers a total area of 438,317 square kilometres and is situated between latitudes 29°–38° N and longitudes 39°–49° E, hence spanning both the northern and eastern hemispheres (southeast corner of the Palearctic biogeographical realm). Iraq harbours substantial biodiversity because of its unique and diverse geography, which ranges from a mountainous region extending to an altitude of 3607 m in Halgurd Mountain in the north to desert plains in the west and to marshes in the south (Yaseen *et al*., 2021).

Iraq's biodiversity is rich and encompasses various ecosystems and species. The country's geographical location and its varied landscapes contribute to its biodiversity (Rubec *et al*., 2009). The river systems of the Tigris and Euphrates, along with their tributaries, support a diverse variety of flora and fauna (Al-Zubaidi *et al*., 2017). In addition, they supply the Central Marshes with water, forming a broad wetland with freshwater lakes (Taher and Abdulhay, 2024a). The presence of the historical marshes in southern Iraq is important ecologically and climatically for many species (Taher and Abdulhay, 2024b). The native avifauna of Iraq, which comprises about 409 species, is a crucial indicator of the country's biological resources. In this regard, conservation concerns in Iraq revolve around several factors, including invasive species significantly impacting native bird populations (Al-Rammahi and Mohammad, 2022).

The climate of Iraq (the risk assessment area of this study) is generally characterized as subtropical semi-arid, with a Mediterranean climate in the northern and north-eastern regions and a more arid climate in the southern areas. Winter typically shows an average day temperature of about 16 °C, while it reaches up to 43 °C during summer. Mean annual rainfall is ≈ 220 mm; however, it varies significantly across the country depending on geography, ranging from approximately 100 mm in the southern regions to up to 1200 mm in the northern

areas (Nolan *et al*., 2022). This risk assessment area has three climatic zones of Köppen classification: (i) desert (BWh) in the middle and south, (ii) steppes or transitional (BSh) in the north, and (iii) Mediterranean (Csa) in the upper northern region (Mustafa, 2017).

The first step in the non-native species risk analysis process is risk screening (or risk identification), whose aim is to identify those non-native species that are more likely to be or become invasive in a certain risk assessment area (Vilizzi *et al*., 2022a). Identifying the risks posed by (potentially) invasive non-native species contributes to the refinement of policies and management protocols to prevent or mitigate the impacts of biological invasion. This first component of the risk analysis process facilitates decision-makers in allocating resources for follow-up risk assessment and management of the species ranked as posing a high risk of invasiveness (Copp *et al*., 2016; Vilizzi *et al*., 2022a). In this regard, the development of electronic decision-support tools has facilitated more effective implementation of risk screening studies (Pheloung *et al*., 1999; Copp *et al*., 2016). Recently, this development has led to the creation of the Terrestrial Animal Species Invasiveness Screening Kit (TAS-ISK) (Vilizzi *et al*., 2022b).

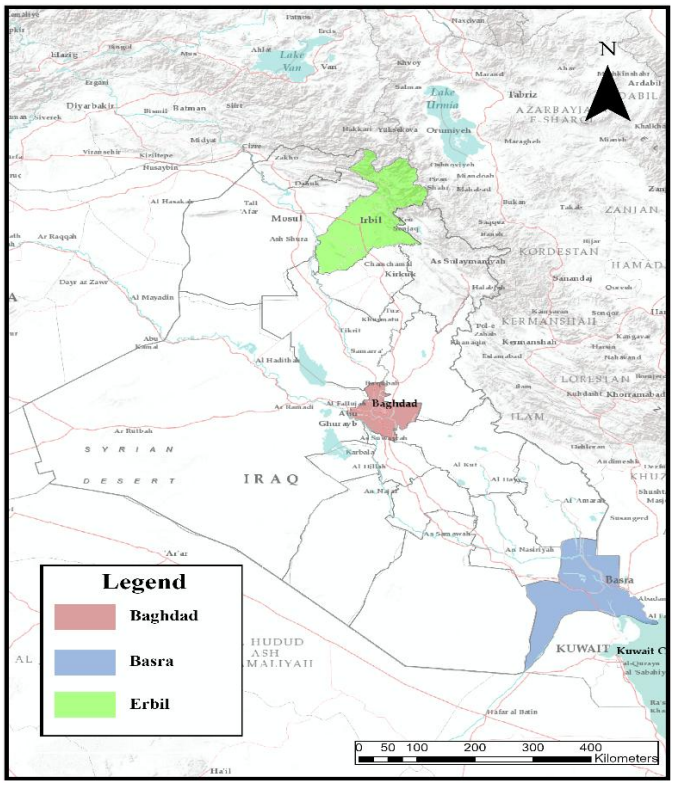
In Iraq, based on Salim *et al*. (2012), several introduced bird species have become established. These include the bank myna *Acridotheres ginginianus,* the common myna *Acridotheres tristis*, the Namaqua dove *Oena capensis*, and the rose-ringed parakeet *Psittacula krameri*. Therefore, understanding the impact associated with the introduced invasive birds is important for the implementation of appropriate management measures (Alshamlih *et al*., 2022). The aim of this study is: (i) to conduct a risk screening on selected non-native bird species in Iraq to improve knowledge on their potential impacts on the biodiversity and ecosystems of the country, and (ii) to compile a comprehensive list of non-native bird species introduced to Iraq.

MATERIALS AND METHODS

Study area and sampling sites: The sampling sites were located in three provinces: Baghdad in the central of Iraq, Basra in the south, and Erbil in the north. These provinces harbour the most important commercial centres in the country, consisting of local animal markets (Suq) for the trade of non-native species. Annually, these local wildlife markets exhibit several wild animals (Al-Sheikhly, 2011). At the same time, the ecology and biodiversity of these areas have a substantial impact on invasion success, with modification and continuous disruption of habitats by humans favouring the occupation by introduced species (Simberloff, 2013).

Of the **t**hree main animal markets surveyed (Map 1):

1- Suq Al–Gazel is located in Khulafa Street, Baghdad (33°20'17.2" N; 44°23'53.4" E) and is considered the biggest local animal market for selling and buying domestic and wild animals, hence representing a hotspot for several non-native species.
2- Basra old market is one of the oldest in the Basra Province (30°29'53.7"N; 47°48'49.3"E) and is popular with fisheries markets and bird stores.
3- Erbil animal market, named after the namesake city (36°11'13.1"N; 44°01'07.7"E), hosts many different caged wild animal species, including non-native species.



Map (1): Iraq map with study sites, including the first study site (Baghdad province), the second study site (Basra Province), and the third study site (Erbil Province).

Surveys were conducted at the three animal markets from November 2023 to November 2024. The time at which the surveys started was between 8:00 am and 1:00 pm at all sites and during all seasons. Non-native bird species were observed using direct visual observation methods of live birds in captivity (Salim *et al.*, 2021; Nolan *et al*., 2022). Photo documentation was made using a digital camera Nikon D7100 equipped with a 50-500mm F/4-6.3 AF zoom Lens.

Data were extracted about recognized introduced non-native bird species by checking published abstracts, scientific articles, reports, books, book chapters, reports, as well as gray literature on non-native species in Iraq. Furthermore, browsing websites of science and Google Scholar databases using related keywords (’alien species‘ , ’invasive species‘ , ’birds ‘, ’Iraq‘) in English without a specific timespan (Stănescu *et al*., 2020).

Species with a documented history of causing harm to the environment by establishing new ranges outside their native habitat were identified using the Global Invasive Species Database (Faulkner *et al*., 2014; GISD, 2024) and the Centre for Agriculture and Biosciences International Invasive Species Compendium (CABI ISC). These databases provide

information on invasive species globally, including their native and introduced range and introduction pathways (Turbelin *et al*., 2017).

Risk screening: The four non-native bird species *A. ginginianus, A. tristis*, *O. capensis*, and *P. krameri* were screened for their potential invasiveness in Iraq. These species were selected according to the following characteristics: (i) establishment, i.e., already present and with self-sustainable populations in the risk assessment area (IMoE, 2018), and (ii) continuous trading, hence likely to be dispersed further in the risk assessment area in the future. The four screened alien bird species were found within the list of alien invasive species in Iraq (IMoE, 2018), the common myna *Acridotheres tristis*, the rose-ringed parakeet *Psittacula krameri*, the bank myna *Acridotheres ginginianus*, and the Namaqua dove (*Oena capensis*), which is listed within the 100 of the world's worst invasive alien species (Lowe *et al*., 2000; Thaker and Haba, 2022). Two alien bird species, the rose-ringed parakeet and the common myna, were listed in the GISD, while the other two birds were not included.

The TAS-ISK (Vilizzi *et al*., 2022b) was employed to evaluate the potential risk of invasiveness of the four non-native bird species in Iraq. This taxon-generic, multilingual decision-support tool meets the minimum standards for screening alien species under European Union Regulation No. 1143/2014 on the prevention and management of the introduction and spread of alien invasive species (European Union, 2014). The TAS-ISK consists of 55 questions: the first 49 comprise the Basic Risk Assessment (BRA) and address the Biogeography/Invasion History and Biology/Ecology of the screened species; the last six comprise the Climate Change Assessment (CCA) to predict how future climatic conditions might influence risks of introduction, establishment, dispersal, and impact (Vilizzi *et al*., 2022b).

For a valid screening, the assessor must respond to every question and provide a confidence level and a justification based on literature sources (Vilizzi *et al*., 2022a). The BRA score ranges from –20 to 68, and the BRA+CCA score ranges from –32 to 80. A score < 1 suggests a low risk of the species being or becoming invasive in the risk assessment area; a score ≥ 1 indicates a medium or high risk of invasiveness. Confidence levels in the responses to questions are ranked using a 1–4 scale (1 = low; 2 = medium; 3 = high; 4 = very high) and a confidence factor (CF), ranging from a minimum of 0.25 to a maximum of 1 is computed for BRA+CCA, BRA, and CCA (Vilizzi *et al*., 2022b). An empirical threshold to distinguish between medium and high-risk species was based on the evaluation of the BRA and the BRA+CCA risk scores due to the new utilization of this screening toolkit, which prevents computation of a calibrated threshold (Vilizzi *et al*., 2022b).

RESULTS AND DISCUSSION

Field surveys

Surveys conducted at Suq Al–Gazel wild animal trading market in Baghdad resulted in the observation of *A. tristis* and *P. krameri* (Pl. 1). These species were previously reported as established invasive species in the 6th National Report (IMoE, 2018) and are recognized as invasive globally (GISD, 2024). These birds were found in captivity to be sold live as

songbirds, as both can produce a sound that mimics that of humans. Both species were sold individually or in male–female pairs. The growth of international trade routes increases the likelihood of their introduction into new habitats, where these species may subsequently become established (Ahmad *et al*., 2021). Salim (1998) mentioned in his first observation of *A. tristis* in the wild in Basra Province in southern Iraq that *A. tristis* had established populations, mostly believed to be related to escapes from captivity. Similarly, the established populations of *P. krameri* in Iraq also originated from escapes (Salim *et al*., 2012). It is anticipated that increased trading of this non-native species across Iraq may eventually lead to an increase in the risks posed to the country's biodiversity and ecosystems.

Plate (1): Introduced invasive species into the Iraqi ecosystem through caged bird trading in Suq Al–Gazel market, resulting in a new population establishment in the wild as soon as it escapes from its cages; (A) common myna *Acridotheres tristis*, (B) Rose-ringed parakeet *Psittacula krameri*.

Besides *A. tristis* and *P. krameri*, a pair of *A. ginginianus* was also observed in Erbil animal market (Fig. 3). The seller of the pair mentioned that the source of these birds was from India. *A. ginginianus* is readily distinguished from *A. tristis* by the key morphological feature, especially by the orange orbital patch and a slate-grey body. This non-native species was also listed in the 6th National Report (IMoE, 2018). However, *A. ginginianus* was not listed as an invasive species in the Global Invasive Species Database. Abed and Salim (2019) mentioned

that the bank myna has been found in captivity many times from 2001 to 2017 at different animal markets across Iraq. Also, the species was observed in the wild many times, but the first confirmed record of this non-native species in Iraq was in 2017, close to the Diwaniya city area. Another confirmed record in the wild was in the Al-Majara dumpsite, 17 km to the southwest of Al-Nashwa Village in the Majnoon area, Basra Province, southern Iraq, by Al-Barazengy and Al-Sheikhly (2019), where two bank myna were foraging and perching repeatedly on a concrete bridge. Furthermore, the *A. ginginianus* has been observed in neighboring countries such as Iran, Kuwait, and Kingdom of Saudi Arabia, where most, if not all of the birds found in the wild were considered as escaped birds from the cages (Porter and Aspinall, 2010).

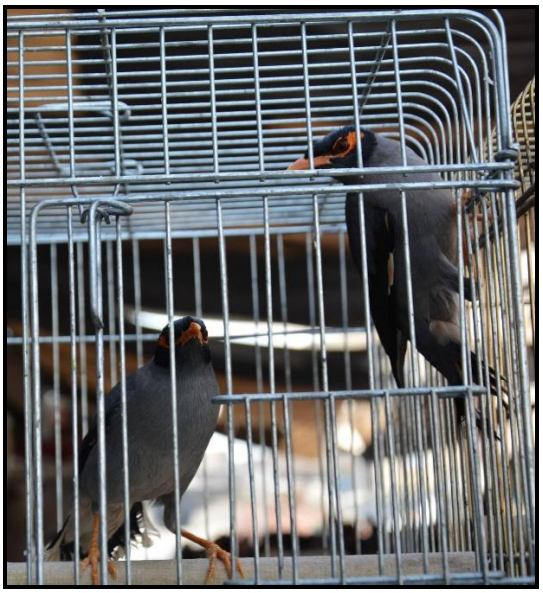


Plate (2): A Pair of non-native bank myna *Acridotheres ginginianus* caged in the Erbil animal market.

The results of the surveys done in Basra's old market were similar compared with the observation of the other two study sites (Baghdad and Erbil markets) in finding the same non-native bird species. The survey was limited to observing caged chicks of the non-native invasive myna species, where it is not possible to identify the exact type whether it is the *A. tristis* or *A. ginginianus*. The chicks were 5 in number and in the cage (Pl. 3). According to the seller, these chicks were caught from nests in the wild in Basra Province.

Plate (3): Five chicks of the non-native myna species caged in the Basra old market.

The literature search resulted in a few studies that guided the topic of alien invasive vertebrates and their potential biological impacts on biodiversity in Iraq. One of the articles concerning alien invasive species in Iraq was restricted to only one area in the Al-Dalmaj Protected Area (Salim *et al*., 2021); only single-species first records of alien invasive bird species articles were found. However, in Table (1), we gathered all mentioned alien vertebrates in the literature sources found in the wild of Iraq and then checked if these species were invasive globally or not by using the GISD (GISD, 2024) and the CABI ISC (Turbelin *et al*., 2017).

Table (1): The common name, scientific name, International Union for Conservation of Nature (IUCN) status, and status, with references for each alien species found in the literature in Iraq.

Scientific name	Common name	IUCN status	Status	Reference
Acridotheres ginginianus (Latham, 1790)	bank myna	Least Concern	Non-Invasive	Al-Barazengy and Al-Sheikhly (2019)
Acridotheres tristis (Linnaeus, 1766)	common myna	Least Concern	Invasive	Salim (1998), Salim and Abed (2017)
Dendrocygna viduata Linnaeus, 1766	white-faced whistling duck	Least Concern	Non-Invasive	Salim *et al*. (2020)
Elanus caeruleus Desfontaines, 1789	black winged kite	Least Concern	Non-Invasive	Salim and Abed (2017), Abed and Salim (2018), Salim *et al*. (2021)
Euodice malabarica Linnaeus, 1758	Indian silverbill	Least Concern	Non-Invasive	IMoE (2018)
Gracupica contra Linnaeus, 1758	Asian pied starling	Least Concern	Non-Invasive	Abed and Salim (2019)

Oena capensis Linnaeus, 1766	Namaqua dove	Least Concern	Non-Invasive	Salim (2008), Salim *et al*. (2012), Salim and Abed (2017), Salim *et al*. (2021)
Psittacula eupatria (Linnaeus, 1766)	Alexandrian parakeet	Near Threatened	Invasive	Abed *et al*. (2020)
Psittacula krameri (Scopoli, 1769)	rose-ringed Parakeet	Least Concern	Invasive	Salim *et al*. (2012)
Spilopelia senegalensis Linnaeus, 1766	laughing dove	Least Concern	Invasive	Salim *et al*. (2021))

Risk screening

Acridotheres ginginianus was ranked as carrying a medium risk of invasiveness (Tab. 2). Lack of evidence for adverse impacts caused by this species in its introduced range likely resulted in its lowest score in the *Invasive elsewhere* section relative to the other three screened species. However, an undesirable trait of *A. ginginianus* is its harbouring of parasites and consequent potential transmission of diseases to humans, as in the case of the chewing lice *Menacanthus eurysternus* (Khan *et al*., 2009; Naz *et al*., 2016; Tariq *et al*., 2024). Based on the Köppen-Geiger classification system, the climate of the species' native range (India, Nepal, Pakistan, and Bangladesh: Al-Barazengy and Al-Sheikhly, 2019) indicates similarity for both the BWh and BSh zones, but less so for the Csa zone in the north. Under predicted future climate conditions, based on professional judgment of wildlife experts, the species' risks of dispersal within the risk assessment area are likely to increase with consequent higher magnitude of future potential impacts on biodiversity, ecosystem structure and function, as well as ecosystem services and related socio-economic factors.

Acridotheres tristis achieved the highest BRA and BRA+CCA scores of all screened species and was ranked as high risk (Tab. 2). This species is known to be invasive outside its native range. In Mauritius, where *A. tristis* species has been present since 1762 (Witt *et al*., 2021), it exerts adverse impacts on agriculture and the ecosystem, and socio-economic services, including predation on the skink *Gongylomorphus bojerii fontenayi*, which is endemic and endangered (Bissessur and Vincent Florens, 2018). In Kingdom of Saudi Arabia, *A. tristis* has a high adverse impact on agriculture as a result of its omnivorous feeding on field crops and invertebrates (Alshamlih *et al*., 2022). Similar to other invasive species, the aggressive behaviour of *A. tristis* allows it to outcompete native and migratory birds for resources in urban wetland ecosystems (Yam *et al*., 2015). The occurrence of *A. tristis* in popular tourist sites has resulted in adverse impacts on biodiversity with broad economic consequences (Orabi *et al*., 2024). *Acridotheres tristis* is a generalist species known for its adaptability and wide distributional range, which enables it to act as a reservoir and transmitter of a variety of diseases that, in turn, can affect both native wildlife and humans (Orabi *et al*., 2024). The species' behaviour and mode of existence reduce habitat quality for native species as a result of its aggressiveness toward nests, eggs, and chicks of native birds, leading to a reduction in their reproductive success (Grarock *et al*., 2012). Based on the Köppen-Geiger classification system, considering the climate of the species' native range

(India and central–southern Asia) (Feare and Craig, 2010), the BSh zone of the risk assessment area resulted in a medium climate match, while the BWh zone is considered less ideal. On the other hand, the Csa zone in northern Iraq has seasonal similarities to parts of the species' native range. Based on wildlife expert opinion, *A. tristis* scored the highest of all screened species in the *Climate change* section, indicating a higher likelihood of future potential impacts on biodiversity, ecosystem structure and function, as well as ecosystem services and related socio-economic factors. An increase in the risks of dispersal within the risk assessment area was also predicted.

Oena capensis achieved the lowest BRA and BRA+CCA scores, and was ranked as medium risk (Tab. 2). Lack of evidence of impacts in its introduced range resulted in the species' low score in the *Invasive elsewhere* section. *Oena capensis* is naturalized in the Middle East following its northward expansion since 1980 (Jennings, 2000). This expansion was likely related to the presence of green lands and farms within Saudi Arabia that provide suitable shelter and food sources and have facilitated the species' movement northward. In the Gaza Strip (Palestine), *O. capensis* mostly occurs in menageries, pet shops, and live animal markets, and has been reported to reproduce freely in captivity (Abd Rabou and Abd Rabou 2019). Similar findings were reported from Lebanon, where a few individuals of this species were seen in the wild and thought to be possible escapees from cages (Ramadan-Jaradi and Ramadan-Jaradi, 2012). However, the Namaqua dove, despite the lack of any observation during the field surveys in targeted markets, was evaluated as a problematic invasive species that could potentially affect the ecosystem based on Al-Rammahi and Mohammad (2022). The current study used the Köppen-Geiger classification system to match the climate of the bird's native range which is the Afrotropical region (Alshamlih *et al*., 2022), and the risk assessment area theoretically, results revealed that The Namaqua Dove's natural range overlaps well with Iraq's climate, particularly in the central and southern desert regions (BWh, BSh), making it a suitable habitat. Under predicted climate conditions, the likelihood of dispersal by *O. capensis* within the risk assessment area is likely to increase, whereas the magnitude of future potential impacts on biodiversity, ecosystem structure or function, ecosystem services, and related socio-economic factors would remain unchanged.

Psittacula krameri achieved the second-highest scores amongst the four screened species and was ranked as high risk (Tab. 2). The rose-ringed Parakeet scored 16.5 in the Biogeography/Historical section of the TAS-ISK questionnaire, whereas in the Biology/Ecology section, it achieved only 8.0 points. The high score in the *Invasive elsewhere* section is a result of the species' being introduced in 47 countries, where it is widely spread and successful (Calzada Preston and Pruett-Jones, 2021). The aggressive behavior of *P. krameri* for nesting site competition has led to a decline of threatened colonies of the bat *Nyctalus lasiopterus* and of the threatened lesser kestrel *Falco naumanni* (Hernández-Brito *et al*., 2022). This species has a high negative impact on different agricultural crops such as fruits and orchids, which is attributed to its feeding habits as a generalist feeder (Abd Rabou, 2022). *Psittacula krameri* can have adverse socio-economic impacts as in the case of vineyards (Butler, 2021), its presence was found to decrease considerably the feeding rates of indigenous birds (Peck *et al*., 2014), and acts as a host to many pathogens, such as *Chlamydia*

psittaci, the Avian Influenza Virus, the Newcastle disease virus, and *Escherichia coli* (López *et al*., 2023). Its high reproductive flexibility, large clutch size, high survival rate of juveniles and adults, generalist foraging strategy, and popularity as a pet have enabled *P. krameri* to become the most widely spread parrot in the world (Rocha, 2020). Given the bird's native range in tropical and subtropical parts of Africa and Asia (Butler, 2005), both the BSh and BWh zones of Iraq align with its habitat requirements. When accounting for climate change, a higher magnitude of future potential impacts is expected for this species on biodiversity, ecosystem structure and function, and on ecosystem services, along with an increase in the risks of dispersal within the risk assessment area.

Table (2): Scoring outputs of the non-native bird species evaluated with TAS-ISK for Iraq.

Section/category	*A. ginginianus*	*A. tristis*	*O. capensis*	*P. krameri*
A - Biogeography/Historical	3.0	21.0	3.0	16.5
1.Domestication/Cultivation	2.0	2.0	0.0	2.0
2.Climate, distribution, and introduction risk	1.0	1.0	1.0	1.0
3. Invasive elsewhere	0.0	18.0	2.0	13.5
B- Biology/Ecology	10.0	16.0	0.0	*8.0*
4.Undesirable (or persistence) traits	7.0	9.0	2.0	8.0
5.Resource exploitation	5.0	5.0	0.0	0.0
6. Reproduction	2.0	3.0	1.0	2.0
7. Dispersal mechanisms	−2.0	−2.0	−2.0	−3.0
8.Tolerance attributes	−2.0	1.0	−1.0	1.0
BRA Score	**13.0**	**37.0**	**3.0**	**24.5**
C - Climate change				
9 . Climate change	6.0	8.0	2.0	6.0
BRA+CCA Score	**19.0**	**45.0**	**5.0**	**30.5**
BRA	0.89	0.89	0.88	0.90
CCA	0.79	0.83	0.79	0.83
BRA+CCA	0.88	0.88	0.87	0.89
Commercial sector	6	18	4	12
Environmental sector	8	15	1	9
Species or population nuisance traits	9	16	4	13

CONCLUSIONS

The findings of this study underscore the threat posed by some non-native bird species to Iraq's biodiversity and ecosystems. This study identified the *A. tristis* and *P. krameri* as high-risk species and *A. ginginianus* and *O. capensis* as medium-risk. These four bird species, which may further spread throughout the country primarily through wildlife trade, have the potential to spread widely and establish themselves in diverse habitats across Iraq, including urban, rural, and wetland environments disrupting native ecosystems, outcompeting indigenous species, and exacerbating socio-economic challenges under future climate conditions. The outcomes of this study highlights the need for immediate and concrete policy interventions. These should include regulating wildlife trade and bird markets, collaborating with the Iraqi Ministry of Environment on monitoring and enforcement mechanisms, and

launching public awareness campaigns to educate the public on the ecological dangers posed by invasive birds to mitigate the potential impacts of these non-native species and emphasize the importance of incorporating climate change predictions into risk assessment frameworks, allowing for proactive management strategies. Additionally, a comprehensive monitoring program is essential to track the distribution and population dynamics of these four species throughout the country. It is also critical to acknowledge the laughing dove *Spilopelia senegalensis* as a non-native invasive species in Iraq, given its documented establishment and it should be incorporated into future risk assessments and management strategies. Drawing from regional examples, such as Saudi Arabia's efforts to control the spread of the common myna, can inform the feasibility and design of effective control programs in Iraq.

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CONFLICT OF INTEREST STATMENT

"The authors declare no conflict of interest".

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تقييم المخاطر المحتملة لتأثيرات أربعة أنواع من الطيور غير المحلية على التنوع البيولوجي في العراق

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الخلاصة

تشكل انواع الطيور الغريبة الغازية تهديدًا كبيرًا للتنوع البيولوجي والأنظمة البيئية في جميع أنحاء العالم. في العراق، تزايدت هذه الأنواع، مما قد يؤدي إلى تحديات بيئية مختلفة. تهدف هذه الدراسة إلى تقييم التأثيرات البيولوجية المحتملة لأنواع الطيور الغريبة الغازية على التنوع البيولوجي في العراق وتوقع التأثيرات المستقبلية في ظل تغيرات المناخ.

أُجريت ملاحظات ميدانية للمدة من تشرين الثاني 2023 إلى تشرين الثاني 2024، اذ تركزت على أربعة أنواع من الطيور الغريبة الموجودة في أسواق الحياة البرية في جميع أنحاء العراق. شمل موقع الدراسة محافظات بغداد وأربيل والبصرة، التي تحتوي على مراكز تجارية وأكبر الأسواق المحلية لتجارة الأنواع الغريبة المختلفة. في هذه الدراسة، تم اختيار الأنواع المستهدفة بعد بحث مكثف في الدراسات المعنية بالأنواع الغازية المستقرة في العراق.

باستخدام مجموعة أدوات تقييم غزو الأنواع الحيوانية الأرضية (TAS-ISK)، قامت الدراسة بتقييم غزو هذه الأنواع. بالإضافة إلى ذلك، تم تجميع قائمة شاملة بأنواع الطيور الغريبة في العراق من خلال مراجعة أدبية موسعة. لأول مرة، تم تقييم مينا الضفاف *Acridotheres ginginianus* Latham, 1790، المينا الشائعة *Acridotheres* Linnaeus,

(1766) tristis، اليمام طويل الذنب *Oena capensis* (Linnaeus, 1766) ، و الببغاء ذو الحلقة الوردية (الدّرة الهندية) (*Psittacula krameri* (Scopoli, 1769).

كشفت النتائج أن المينا الشائعة والببغاء ذو الحلقة الوردية يشكلان تهديدًا كبيرًا للتنوع البيولوجي، بينما تُعتبر مينا الضفاف واليمام طويل الذنب تهديدات متوسطة. تُبرز هذه النتائج الحاجة إلى تضمين هذه الأنواع في خطط صنع القرار والادارة للتخفيف من تأثيرها على التنوع البيولوجي في العراق.