Sustainability and Biodiversity Conservation

Pet markets as facades for illicit wildlife trade: a case from Tehran, Iran

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Abstract

This study examines the dynamics of wildlife trade at the Khalij-e-Fars Bird Market in Tehran, Iran. We conducted seven surveys throughout the year in the market and observed 154 species, including 95 native and 59 non-native species, with native species comprising 80% of the trade. Birds were the most commonly traded group, with the European Goldfinch (*Carduelis carduelis*) and the African Grey Parrot (*Psittacus erithacus*) being the most frequently observed native and non-native species, respectively. Our findings highlight significant challenges related to species conservation, as a considerable portion of native species is experiencing population declines. These issues are exacerbated by regulatory gaps, with 70% of native species not listed under CITES. Additionally, non-native species often command higher prices due to rarity and consumer demand for exotic pets, which further fuels exploitation. The market's dynamics illustrate a complex interplay between supply, demand, and pricing, with seasonal patterns influencing trade activities. This study underscores the urgent need for enhanced regulatory frameworks, public awareness campaigns, and local community engagement to combat illegal wildlife trade in Iran. Future research should expand market surveys to obtain a better understanding of trade dynamics, thus informing strategic policy-making and improving enforcement mechanisms.
Keywords: Illegal Wildlife Trade, Pet Trade, Conservation, Marketplace, Songbird Crisis

Introduction

In Iran, illegal bird markets such as the Khalij-e-Fars Bird Market in Tehran are active, with both native and non-native species being sold for bushmeat and as pets, posing significant conservation challenges (Boroumand & Amiri, 2023; Mir Mohamad Tabar et al., 2024). This

local context mirrors broader global dynamics of the illegal wildlife trade (Van Uhm, 2016). mirrors broader global dynamics (Bush et al., 2014; Robinson & Sinovas, 2018). The illegal wildlife trade poses a threat to global biodiversity, impacting countless species and ecosystems worldwide (Van Uhm, 2016). This illicit activity involves the trafficking of wild animals such as wild cats, birds, reptiles, and other groups of animals, often for use as pets, decoration, luxury food, traditional medicine, and cultural rituals (Mozer & Prost, 2023). The global movement and interaction of traded species facilitate the spread of zoonotic diseases, posing further risks to public health (Cardoso et al., 2021; Nijman et al., 2024). E.g., raising the risk of well-known diseases such as bird flu, parrot fever, and Salmonella; local reports of wild-swan deaths and infections in pet birds and reptiles underscore this concern (Tamimi et al., 2014; Madani et al., 2011; Fallah Mehrabadi et al., 2019; Vascellari et al., 2007). The consequences of the wildlife trade are profound, undermining conservation efforts and destabilizing natural habitats (Chng & Eaton, 2016). Furthermore, the illegal wildlife trade is one of the most important ways to introduce and spread non-native species to an area via anthropogenic means (Cardoso et al., 2021). Farashi & Alizadeh-Noughani (2021) show that Middle Eastern countries face a high risk of biological invasion of pet reptiles, and Rezaeian et al. (2023) remark several examples in Iran as evidence, including all the non-native reptiles, Rhesus macaque (*Macaca mulatta*), plus four more mammals, Rose-ringed parakeet (*Alexandrinus krameri*), and five other birds that arrived and established in Iran through the illegal pet trade. One notable example is the Persian squirrel (*Sciurus anomalus*), which is native to the Zagros mountains, but it is introduced to the other parts of Iran via the pet trade and is currently known as an invasive species/pest for the local gardens of the Alborz area (Ghasempour et al., 2022). Also, as a case, the Red-eared Slider (*Trachemys scripta elegans*), widely introduced globally, has been recorded in several wetlands of Iran and is considered a potential competitor to the native turtle species (Mozaffari et al., 2020; Safaei-Mahroo et al., 2015). These exotic turtles are able to increase the mortality of native pond turtles by causing competitive displacements, hybridize with local turtles, impact aquatic food chains, and disturb water birds by basking in their nests (Farashi & Alizadeh-Noughani, 2021). Addressing these issues of illegal wildlife trade requires robust legal frameworks, stringent enforcement, and public awareness campaigns to reduce the demand for illegally sourced wildlife products (Shepherd & Magnus, 2004). Operating through both physical markets and online platforms, this trade frequently violates international and local wildlife conservation laws due to weak enforcement and inadequate legislation (Chng & Eaton, 2016; Nijman et al., 2019; Sardari et al., 2022b). These conditions have allowed the trade to thrive, leading to significant population declines among endangered species (e.g.,

tigers, leopards, and clouded leopards) and disrupting local ecosystems (Nijman et al., 2019). The dynamics of wildlife markets, particularly concerning high-value and threatened species, are influenced by complex socio-economic factors and regulatory challenges (Challender et al., 2015). Rare species often command higher prices in these markets due to their scarcity and the high demand for exotic and unique wildlife. For instance, in the avicultural markets, bird species such as the Macaw can sell for tens of thousands of dollars, significantly more than common species like Budgerigar, due to their rarity and desirability (Robinson, 2001). These inflated prices create a lucrative incentive for illegal activities, as weak enforcement and strategic market locations make wildlife trafficking a profitable enterprise, contributing to illicit income estimated at USD 320 billion annually (Robinson & Sinovas, 2018). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), tasked with regulating this trade, operates with a modest annual budget of USD 6 million, which is starkly inadequate compared to the vast scale of the global wildlife trade (Robinson & Sinovas, 2018). The stark imbalance between regulatory resources and the scale of wildlife trafficking highlights the urgent need for enhanced enforcement strategies and international cooperation (Narreddy & Shashidhar, 2024). This imbalance is particularly evident in regions such as the Middle East, where the trade in exotic wildlife continues to thrive despite regulatory efforts (Bush et al., 2014). In the Middle East, the illegal wildlife trade is closely linked with cultural traditions and economic interests, posing significant conservation challenges, particularly for bird populations (Ribeiro et al., 2019). Birds have historically been symbols of cultural heritage, with practices like falconry revered in the Persian Gulf, notably in the United Arab Emirates and other Arab states (Krawietz, 2016; Wakefield, 2012). Keeping birds of prey and songbirds, especially finches and larks, seems to be rooted in local traditions and may continue to drive demand for wild-caught individuals. Also, the demand in the neighboring countries can indirectly fuel the illegal taking of wild birds within Iran. In Iran, the trade in native wildlife, particularly birds, exacerbates conservation challenges due to limited research on illegal pet trade and exploitation. The Fereydunkenar International Wetland, for instance, is severely impacted by illegal bird hunting, which undermines conservation efforts and incentivizes continued poaching, as the captured birds are often sold in bird markets illegally for bushmeat (Mir Mohamad Tabar et al., 2024). Estimates suggest that 1.7 to 4.6 million birds from 413 species are illegally captured or killed annually in the Arabian Peninsula, including Iran and Iraq, many during their migratory journeys (Brochet et al., 2019). However, in Iran, not all markets focus on bushmeat; some are involved in selling animals as pets both in the physical and online marketplaces (Boroumand & Amiri, 2023; Sardari et al., 2022b). Physical

marketplaces, such as the Khalij-e-Fars Bird Market in Tehran, facilitate wildlife trafficking in Iran under various motivations, ranging from entertainment to economic gain (Boroumand & Amiri, 2023). Simultaneously, online platforms have emerged as significant facilitators of the wildlife trade, as documented by Sardari et al. (2022a; 2022b), highlighting the illegal sale of native Testudines and other protected species. This digital dimension underscores the regulatory challenges in monitoring such activities. This digital dimension underscores the regulatory challenges in monitoring such activities. Findings from both Badelu et al. (2025) and Sardari et al. (2022a) demonstrate that online platforms not only complement physical markets but may also surpass them in trade volume and present significant enforcement difficulties. Additionally, the illegal collection and trade of plants, such as orchids, pose significant conservation challenges in Iran. Up to 19 species and subspecies of orchids are harvested and traded from Iran to markets in Türkiye, Pakistan, and India, highlighting the broad biodiversity affected by illegal trade practices (Ghorbani et al., 2014). Despite the critical role of marketplaces in wildlife trade, no comprehensive study in Iran has surveyed open pet marketplaces to catalog wildlife species traded in these markets. This study aims to explore the dynamics of the Khalij-e-Fars Bird Market, examining the diversity of species traded. By focusing on both native and non-native species, this study seeks to provide a detailed snapshot of market dynamics, including species prevalence, legal and conservation statuses, spatial distribution within the market, and pricing variations.

Materials and methods

Study Area

The Khalij-e-Fars Bird Market[1] is located in Southwest Tehran and consists of four main sections: a two-story building (Zones 1 and 2), an L-shaped corridor with permanent booths (Zone 3), a courtyard (Zone 4), and a parking area (Zone 5). The market operates daily, with regular shopkeepers and vendors present in the main building and booths, while the courtyard and parking areas become active on Fridays, when vendor presence is significantly higher.

[1] Also known as ‘Azadegan Bird Bazaar’. On Google Maps it is named ‘Tehran Birds Market’.

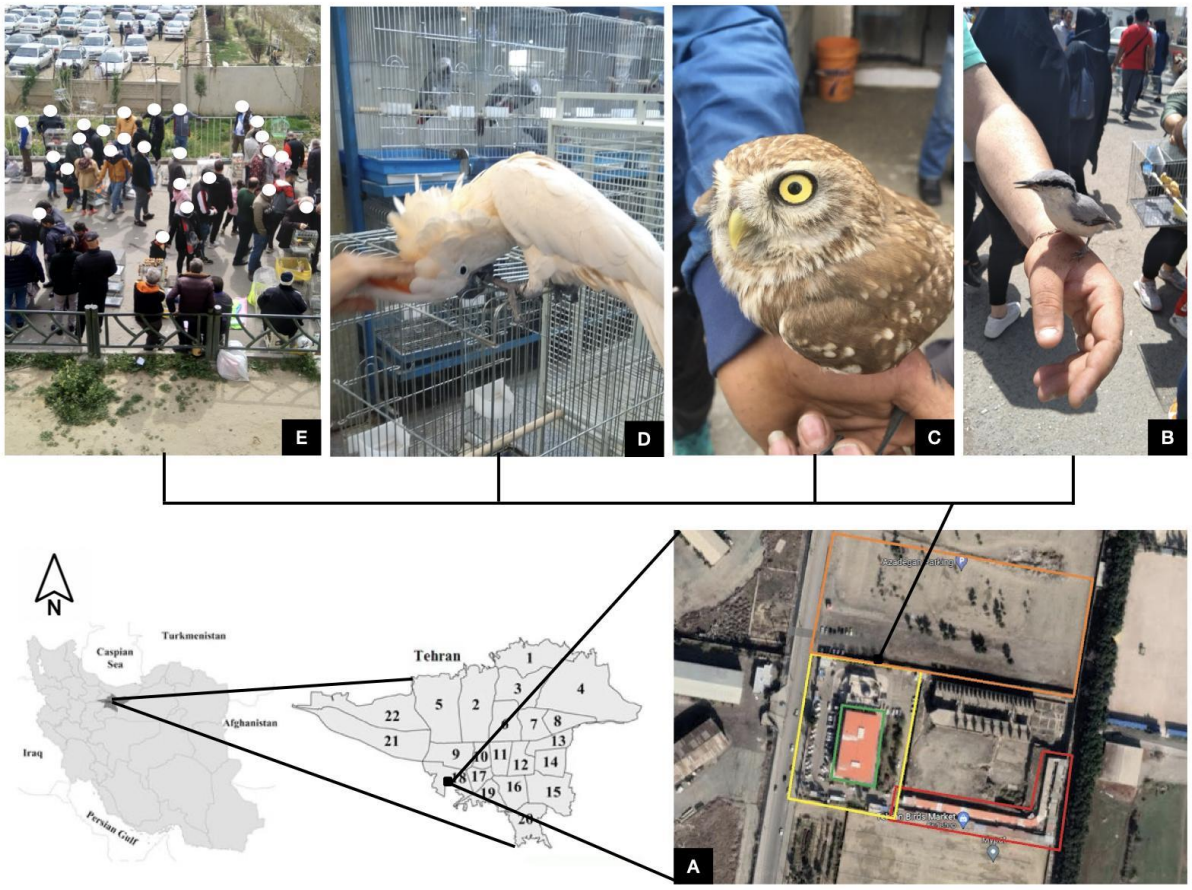

Figure 1. A) Google Maps image of the market with the outlined zones. Green (Zone 1 and Zone 2): the main building; Red (Zone 3): L-shaped corridor with booths; Yellow (Zone 4): the courtyard; Orange (Zone 5): the parking. B) *Sitta tephronota* for sale in Zone 4. C) *Athene noctua* for sale in zone 3. D) *Cacatua moluccensis* and *Psittacus erithacus* for sale in zone 1. E) The market's courtyard on Friday (Zone 4)

Surveys and Data Collection

To conduct our surveys, we categorized the main building into the first (Zone 1) and second floors (Zone 2), each with shops lining both sides. An L-shaped corridor with booths on either side, located in the southeastern part of the main building, is designated Zone 3. A courtyard encircles the main building, and the market's parking area (north of the marketplace) is designated as Zone 4 and 5, respectively (See Figure 1). To ensure comprehensive data collection reflecting the market's dynamics, we conducted our initial survey on Thursday, March 10th, 2022, and subsequently focused on Fridays, when vendor activity significantly increased (See Figure 2). During seven surveys, we began with the first zone and concluded with the fifth. We focused on the native and non-native species and recorded their names, the approximate number of individuals for sale, price, IUCN Red List of Threatened Species rank, population trend, CITES rank, and the location of the shop/vendor within the market. We excluded domesticated species and those commonly bred in captivity, including Budgerigars,

Cockatiels, Green-cheeked parakeets, Canaries, Society finches, Zebra finches, Star finches, and domestic pets and farm animals, to focus exclusively on wild species. It was challenging to distinguish adults and chicks of *Melanocorypha calandra* and *M. bimaculata*. So, we labeled most of them as *Melanocorypha sp.* We also faced issues identifying a few more avian specimens and only managed to identify them to their genera, including *Argya sp.* (either *A. altirostris* or *A. caudata*), juvenile *Falco Sp.* (either *F. tinnunculus* or *F. naumanni*), and *Phylloscopus Sp.* (See Table S1). To ensure data quality and protect privacy, we did not collect personal information or record the names of vendors or shopkeepers. We conducted the surveys as casual visitors using a non-interacting, observer-only protocol and recorded only publicly visible information on wild species offered for sale. We encountered no resistance to observing stalls or taking notes; however, photography was generally prohibited, and images were taken only when permission was explicitly granted.

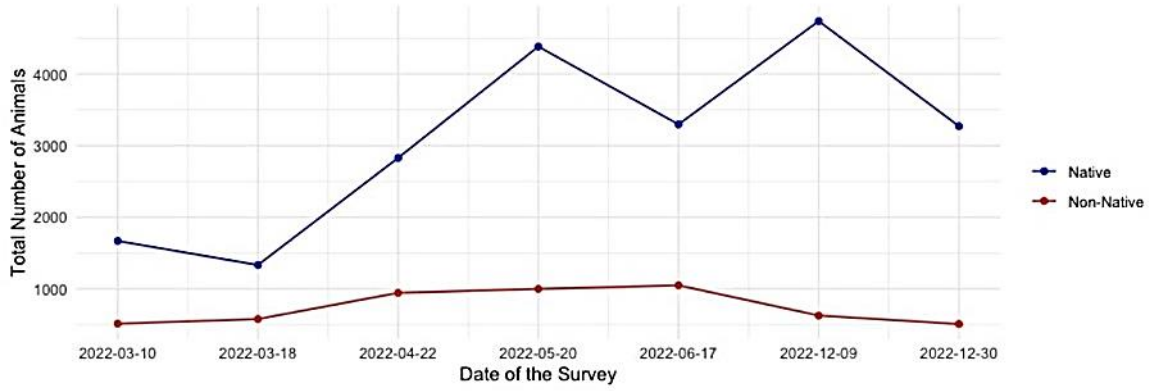

Figure 2. The date of the surveys and the number of animals seen in each survey

Statistical Analysis

The prices of the native (n=359, df=358) and non-native (n=340, df=339) species were not normally distributed as indicated by the Shapiro-Wilk test (W = 0.61355, p-value < 2.2e-16 for native; W = 0.6363, p-value < 2.2e-16 for non-native, respectively). Given the non-normality of the data, we used the Mann-Whitney U test to compare price distributions between the two groups. This test assumes that the distributions have similar shapes. To evaluate this assumption, we conducted a two-sample Kolmogorov–Smirnov (K-S) test, which revealed a significant difference in the shape of the distributions (D = 0.856, p-value < 2.2e-16). As a result, the Mann-Whitney U test should be interpreted as identifying a general distributional difference between native and non-native species prices, rather than a simple shift in medians.

Results

We recorded 26,753 individuals from 154 species (95 native, 59 non-native). Approximately 80% were native (n = 21,346), and about 20% were non-native (n = 522). Birds dominated in both species and abundance (131 species; 26,561 individuals). The European Goldfinch (*Carduelis carduelis*) was the most frequently observed native species (n = 5,340), and the African gray parrot (*Psittacus erithacus*) was the most frequent non-native bird (n = 1,580). In Iran, Eastern and Western complexes of the European Goldfinch occur; both were present in the market. Mammals were also traded (112 individuals: 102 native, 10 non-native), with Persian squirrel (*Sciurus anomalus*, n = 71) and Rhesus macaque (*Macaca mulatta*, n = 9) the most observed. Reptile and amphibian richness was low: we did not observe amphibians for sale, and reptiles were limited to 15 native and 1 non-native species (70 individuals: 68 native, 2 non-native). The Greek tortoise (*Testudo graeca*, n = 23) was the most observed native reptile; the Green iguana (*Iguana iguana*, n = 2) was the only non-native reptile. We also recorded two scorpion species, the Zagros Montena scorpion (*Hottentotta zagrosensis*) and the Arabian fat-tailed scorpion (*Androctonus crassicauda*), with 10 native individuals in total. See Figure 3 for counts by group.

	Native		Non-native	
Taxon	**Number of Species**	**Number of Individuals**	**Number of Species**	**Number of Individuals**
Birds	75	21346	56	5215
Mammals	3	102	2	10
Reptiles	15	68	1	2
Arachnids	2	10	0	0
Total	**95**	**21526**	**59**	**5227**

Figure 3. Number of species and individuals seen at the marketplace for native and non-native species

Among native species (n = 95), 92.63% of species were Least Concern (e.g., *Turdus merula*, *Carduelis carduelis*); 3.16% of species were not listed by IUCN; 2.11% of species were Near Threatened (e.g., *Emys orbicularis*, *Naja oxiana*); 1.00% of species was Vulnerable (*Testudo graeca*); and 1.00% of species was Data Deficient (*Eublepharis angramainyu*). Among non-native species (n = 59), 76.27% of species were Least Concern (e.g., *Eclectus roratus*, *Ara ararauna*); 11.86% of species were Near Threatened (e.g., *Amazona aestiva*, *Cacatua goffiniana*); 8.47% of species were Endangered (e.g., *Psittacus erithacus*, *Aratinga solstitialis*); and 3.39% of species were Vulnerable (e.g., *Cacatua moluccensis*, *Pionites leucogaster*). The IUCN Red List of Threatened Species global population trends showed that, among native

species (n = 95), 38.95% of species were stable (e.g., *Athene noctua*, *Spalerosophis diadema*); 30.53% were decreasing (e.g., *Sciurus anomalus*, *Pyrrhocorax pyrrhocorax*); 12.63% were increasing (e.g., *Fringilla coelebs*, *Parus major*); and 17.90% were unknown/unspecified/unidentified or not listed by IUCN. Among non-native species (n = 59), 55.93% were decreasing (e.g., *Psittacus timneh*, *Crithagra mozambica*); 25.42% were stable (e.g., *Pionites melanocephalus*, *Pseudeos fuscata*); 15.25% were increasing (e.g., *Eolophus roseicapilla*, *Gracupica contra*); and 3.39% were unknown (e.g., *Iguana iguana*, *Macaca mulatta*). Based on CITES listings, among native species (n = 95), around 70.53% were not listed (e.g., *Pycnonotus leucotis*, *Alectoris chukar*); 14.47% were in Appendix II (e.g., *Athene noctua*, *Falco naumanni*); 13.68% were in Appendix III (e.g., *Erithacus rubecula*, *Galerida cristata*); 0% were in Appendix I; and 1.05% were unknown due to genus-level identification (*Melanocorypha* sp.). Among non-native species, 66.10% were in Appendix II (e.g., *Aratinga solstitialis*, *Cacatua galerita*); 22.03% were not listed (e.g., *Crithagra mozambica*, *Procyon lotor*); 10.17% were in Appendix I (e.g., *Cyanoramphus novaezelandiae*, *Cacatua moluccensis*); and 1.69% were in Appendix III (*Pavo cristatus*). For native animals, Zone 3 contained the highest proportion, with 71.59% of the individuals. Zone 4 followed with around 21.83%. Additionally, Zone 2, Zone 1, and Zone 5 accounted for about 3.5%, 2.52%, and 0.55% of the native animals, respectively. In contrast, non-native species showed a different pattern. Zone 2 held the majority with 56.88% of the non-native individuals, followed by Zone 1 with 33.54%. Zone 3, Zone 4, and Zone 5 had about 7.82%, 1.7% and 0.06% of non-native individuals, respectively. The Mann-Whitney U test results indicate a significant statistical difference between the prices of native and non-native species in the market ($W = 5529.5$, p-value < 2.2e-16). Given the differing shapes of the distributions, this result reflects a general distributional difference, with non-native species generally priced higher than native ones. The effect size, calculated using the rank-biserial correlation, was large ($r = 0.787$), suggesting a strong tendency for higher pricing among non-native species, consistent with stochastic dominance. The effect size, measured by rank-biserial correlation, was large ($r = 0.787$), indicating a substantial difference in pricing between the two groups. Additionally, among our observed animals, the highest number of native individuals was recorded on December 9, 2022 (n=4,740), while the peak for non-native individuals was on June 17, 2022 (n=1,050).

Discussion

The investigation into the wildlife trade at the Khalij-e-Fars Bird Market in Iran provides an in-depth view of national wildlife-trade dynamics and situates them alongside global patterns.

Our study highlights several significant findings and parallels with international trends, emphasizing the urgent need for comprehensive management strategies to curb illegal wildlife trade in Iran. We find that native species dominate the market, comprising about 80% of the species observed. Similarly, Banjade et al. (2020) reported a high prevalence of native species in local markets in the Lao People's Democratic Republic, with distinct seasonal patterns influencing trade dynamics. Although many of the traded species are classified as Least Concern by the IUCN, the observation that about 30% of native species are experiencing global population declines raises serious concerns about the sustainability of the trade. This pattern is consistent with global evidence that wildlife trade contributes to population declines (Morton et al., 2021). In their meta-analysis, Morton et al. quantified the impact of wildlife trade on species abundance by comparing traded sites with unexploited control sites and found an average reduction in species abundance of 61.6%, with local extirpations observed in 16.4% of cases. Taken together, these findings underscore the unsustainable nature of current practices and highlight the urgent need for strengthened governance, including effective implementation of international agreements such as CITES, alongside robust national regulations. A significant portion of the native species trade remains unregulated by CITES, with 70.53% of native species not listed. This regulatory gap could lead to overexploitation, highlighting the need for national and international bodies to reconsider species protection criteria. Panter et al. (2019) emphasize the importance of aligning protection status with regional conservation needs. Unregulated trade of non-CITES species is a major driver of biodiversity loss, as Whitehead (2020) highlighted. Coordinated enforcement efforts, particularly during peak trading periods, as demonstrated by Holden et al. (2019), could effectively reduce illegal trade practices. The market's trade dynamics reflect a complex interplay of supply and demand that shapes outcomes for both native and non-native species. Price differences between these categories can steer buyer preferences and, in turn, exploitation pressure. Non-native species often command higher prices because of perceived rarity and exotic appeal (Robinson, 2001; Vall-llosera & Cassey, 2017). In international pet markets, rare and visually attractive birds fetch premium prices, although values can drop rapidly when oversupply occurs (Robinson, 2001). Likewise, willingness to pay tends to increase with perceived rarity, inflating prices for scarce taxa (Vall-llosera & Cassey, 2017). This preference for rarity can drive overexploitation as rarer species become even more sought after. Preferences for exotic, non-native species reinforce this pattern, often raising prices and intensifying pressure on wild populations (Krishna et al., 2019). Conversely, the relative affordability of native species, driven by their abundance and accessibility, can lead to higher exploitation (Krishna et al., 2019). These

economic dynamics shape market behavior, pulling traders and consumers toward more accessible native taxa. Studies by McNamara et al. (2016) and Krishna et al. (2019) show how supply-driven dynamics and consumer preferences can exacerbate population declines, especially for high-value species. Krishna et al. (2019) examined bird markets in Sumatra and found that preferences for rarity drive overexploitation: buyers pay more for rare birds, incentivizing further capture from dwindling populations, and because supply is inelastic, higher prices do not bring more birds to market. Similarly, McNamara et al. (2016) document pressures on marine species, where rarity-driven price increases intensify fishing and push species toward extinction. In our case, the European Goldfinch, the most frequently traded native species, may face localized declines despite its global Least Concern status; further research is needed to assess trade impacts and subspecies-level conservation challenges in Iran. Additionally, non-native species such as the African Grey Parrot pose global conservation concerns due to high market value in Iran and declining populations within their native range, despite CITES regulations. Together, demand for rarity and constrained supply create a feedback loop that accelerates population decline (the anthropogenic Allee effect), where rarity itself increases value and desirability, further endangering species (Siriwat et al., 2019).

Public awareness is essential for addressing the wildlife trade. Targeted education can shift consumer choices by explaining the ecological roles of traded species and the long-term costs of their decline (Veríssimo & Glikman, 2020). Demand can also be reduced by discouraging the purchase of wildlife as pets (Moorhouse et al., 2017). Finally, involving local communities and market stakeholders, especially shop owners, in community-science and simple monitoring programs can improve conservation outcomes and support more sustainable interactions with wildlife (Oskarsson, 2014). Building on these patterns, several practical steps are available to the Department of Environment (DOE) in urban wildlife markets: routine, unannounced inspections and license checks; publicly available vendor-facing lists of protected/non-tradable taxa aligned with national law and CITES; joint operations with police and customs; simple reporting hotlines; and inspector training in species identification and legislation. Coordinated monitoring and targeted operations have deterred open sales of protected species in other Asian markets (Chng & Eaton, 2016; Nijman et al., 2019). Coupling enforcement with demand reduction can maximize impact (Holden et al., 2019; Challender et al., 2015), and consumer-information campaigns can shift purchasing behavior (Veríssimo & Glikman, 2020; Moorhouse et al., 2017). In Iran, similar needs have been noted for urban bird markets (Boroumand & Amiri, 2023; Mir Mohamad Tabar et al., 2024). Addressing regulatory blind spots for non-CITES native taxa and improving trade-data systems would also strengthen

oversight (Robinson & Sinovas, 2018; Panter et al., 2019; Ribeiro et al., 2019). The study encountered several notable limitations that affected the accuracy of the data collection process. First, the absence of shopkeepers at key times created significant challenges in recording prices for various wildlife species. Without the ability to directly engage with sellers, the researchers had to rely on indirect methods, which often led to incomplete or inconsistent pricing data. Second, local regulations and concerns over privacy severely restricted the ability to photograph animals being sold, particularly those of high conservation concern. This limitation not only hampered efforts to visually document the species being traded but also made it difficult to verify species identification based solely on verbal descriptions. Third, the research team faced considerable obstacles in accessing backrooms and other concealed areas of shops, where illegal animals were likely to be hidden. These spaces, often off-limits to outsiders, are suspected to house a significant portion of the illicit wildlife trade. As a result, the data collected may underrepresent the true scale of illegal activities. Together, these challenges highlight the pressing need for more innovative and ethically sound methods to gather comprehensive data on the wildlife trade, ensuring a more accurate assessment of its scope and impact.

Conclusion

In conclusion, our findings from the Khalij-e-Fars Bird Market call for a comprehensive assessment of how wildlife trade is managed in Iran, particularly in the capital, from a regulatory and community engagement perspective. The observed trade dynamics highlight significant challenges and opportunities for improving conservation outcomes through more informed policy-making, enhanced enforcement strategies, and increased public education and engagement. We suggest more active supervision by the Department of Environment (DOE) that could implement more active supervision by introducing stricter regulations on wildlife trading, including the establishment of regular market inspections, clearer guidelines on species protection status, and collaboration with law enforcement agencies to reduce illegal trade. Finally, expanded research on market drivers is necessary to gain a better understanding of the factors influencing trade dynamics. This research could help improve market competitiveness by shedding light on patterns of demand, supply, prices, and consumer preferences. This information could enable policymakers and conservation bodies to design more effective strategies for managing legal markets and promoting sustainable trade.

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