

Bird communities in a restored Mediterranean wetland: a 10-year annotated checklist from the Geloi Plain (southern Sicily, Italy)

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ABSTRACT

This study presents a ten-year annotated checklist of the avifauna of the Geloi Plain (southern Sicily), with particular focus on the restored Geloi Wetland private reserve, based on standardized surveys conducted from 2016 to 2026. Bird data were collected through direct observations, breeding bird monitoring and winter waterbird counts carried out within the framework of the International Waterbird Census (IWC). A total of 194 species belonging to 20 orders and 53 families were recorded, including 117 non-passerines and 77 passerines, with confirmed breeding for 70 species. Species richness increased from 105 species recorded in 2016 to 194 in 2026, reflecting both the long-term monitoring and the progressive ecological recovery of restored wetland habitats. Winter waterbird communities showed a significant increase in both species richness and abundance following habitat restoration carried out between 2020 and 2022, which restored approximately 50–60 ha of wetland habitats. The abundance of several species showed marked increases after restoration, most notably including Common Teal (*Anas crecca*), Eurasian Coot (*Fulica atra*), Mallard (*Anas platyrhynchos*), Little Grebe (*Tachybaptus ruficollis*) and Black-winged Stilt (*Himantopus himantopus*). The regular occurrence and confirmed breeding of conservation-priority species, including European Roller (*Coracias garrulus*), Lesser Kestrel (*Falco naumanni*), Stone-curlew (*Burhinus oedipnemos*), Collared Pratincole (*Glareola pratincola*), Western Swamphe (*Porphyrio porphyrio*) and White Stork (*Ciconia ciconia*), further highlight the ecological importance of this restored wetland system within an intensively cultivated Mediterranean landscape.

KEY WORDS

Agroecosystems; avifauna checklist; breeding birds; biodiversity trends; conservation-priority species; habitat heterogeneity; Mediterranean flyway.

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INTRODUCTION

Mediterranean wetlands represent biodiversity hotspots and play a key ecological role for migratory, wintering and breeding birds along the Afro-Palearctic flyway (Perennou et al., 2012; Newton,

2008). These ecosystems act as critical stepping-stones for migratory birds moving between Africa and Europe, supporting a high diversity of waterbirds and terrestrial species throughout their annual cycle (Finlayson et al., 2018). Despite their ecological importance, Mediterranean wetlands have un-

dergone severe degradation during the last century as a consequence of land reclamation, agricultural intensification, hydrological alteration and increasing human pressure, resulting in widespread habitat loss and fragmentation across the basin (Perennou et al., 2012; Finlayson et al., 2018; Mediterranean Wetlands Observatory, 2018). Within Sicily, several wetlands have been investigated from an ornithological perspective, including the wetlands of the Simeto estuary and Lake Lentini (Ciaccio & Priolo, 1997), as well as other major wetland systems of the island (Iapichino & Massa, 1989; Corso, 2005; Massa et al., 2021; Surdo, 2025), highlighting their importance for migratory, wintering and breeding birds in the central Mediterranean. However, wetlands embedded within agricultural landscapes remain comparatively poorly documented, particularly where recent habitat restoration has modified local ecological conditions. Even relatively small wetlands can play a disproportionate ecological role within agricultural landscapes by providing feeding areas, breeding habitats and migratory stopover sites and may represent critical refuges for ecological connectivity in highly transformed landscapes. Wetland restoration is therefore increasingly recognised as a key strategy for recovering ecological functionality and enhancing biodiversity in human-modified landscapes (Zedler & Kercher, 2005; Finlayson et al., 2018). Annotated checklists provide an essential baseline for biodiversity assessment by documenting species composition, phenology and long-term changes in local communities, particularly in Mediterranean landscapes undergoing rapid environmental transformation (Blondel et al., 2010; Brichetti & Fracasso, 2018).

The Plain of Gela, located along the southern coast of Sicily, represents one of the largest coastal plains of the island and hosts a mosaic of agricultural areas, residual wetlands and coastal habitats. Due to its position along the central Mediterranean migratory routes, the area has long been recognised as important for birds, although historical ornithological records were often based on opportunistic observations and rarely provided standardized long-term data. In recent years, the Plain of Gela has been affected by conservation and habitat restoration initiatives within the Special Protection Area (SPA) ITA050012. These initiatives include projects promoted by public institutions and conserva-

tion organizations, such as the “Glareola” project and the LIFE programmes CHOONA and Net-ProNet, as well as initiatives developed within the *Observe – Nodi di Biodiversità Siciliana* project and through the support of private foundations including *Stiftung Pro Artenvielfalt* and the *Sicily Environment Fund* (Zafarana & Lutri, 2022). Significant environmental changes occurred between 2020 and 2022 following hydrological restoration and habitat enhancement measures that led to the creation and recovery of several wetland habitats within the study area (Zafarana et al., 2024). These changes provide an opportunity to evaluate how habitat restoration and landscape heterogeneity influence the structure and composition of bird communities in Mediterranean agricultural landscapes. Despite the ecological importance of the area and the growing number of conservation initiatives, an updated synthesis of the avifauna of the Geloi Plain based on long-term standardized monitoring is still lacking. The primary aim of this study is to provide an updated, annotated checklist of the avifauna of the Geloi Plain based on ten years of standardized monitoring (2016–2026). Furthermore, we use these data to evaluate the influence of recent wetland restoration on bird community composition and richness, and to assess the area’s conservation relevance based on species listed in Annex I of the EU Birds Directive and IUCN Red Lists, alongside long-term wintering waterbird trends derived from IWC data.

MATERIAL AND METHODS

Study area

This study was conducted in the Geloi Plain, a sector of the Gela Plain (southern Sicily, Italy), within the Special Protection Area (SPA) ITA050012. The study area encompasses approximately 40 km², centered on approximately 37.092° N, 14.337° E (Fig. 1). It includes a mosaic of agricultural landscapes, residual wetlands and rural habitats. For monitoring purposes, the area was subdivided into a 1 × 1 km grid ($n = 40$ cells), which served as the spatial sampling framework for both breeding and winter surveys. In recent years, the study area has undergone significant environmental changes following habitat restoration interventions

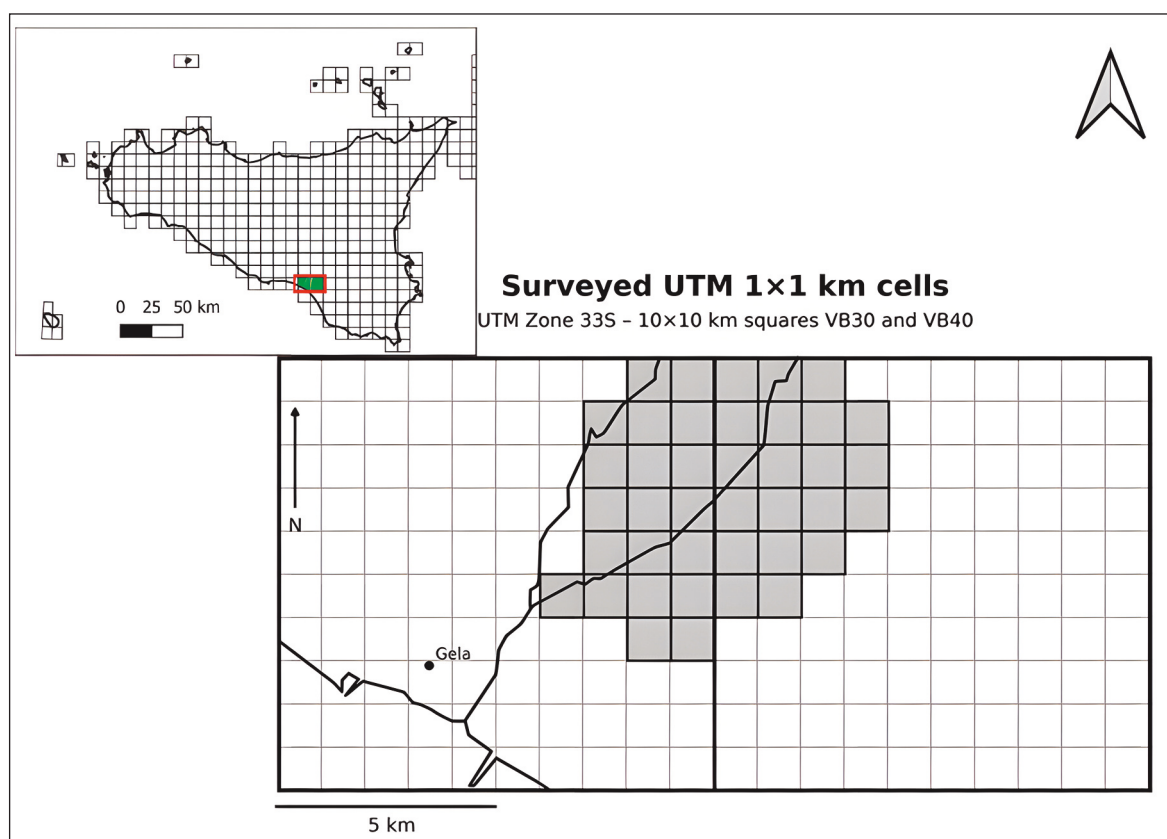


Figure 1. Geographic location of the study area in southern Sicily and surveyed UTM grid. The shaded squares represent the 1×1 km cells surveyed for breeding birds within the Geloi Plain.

carried out between 2020 and 2022 (Fig. 2), which led to the creation and recovery of several wetland habitats covering approximately 50–60 ha (in seven 1×1 km cells), with maximum water depths of about 1.8 m, within a private reserve (Zafarana et al., 2024).

Breeding bird surveys

Breeding bird communities were monitored between 2016 and 2026 using point counts conducted within the 1×1 km grid system described above. Each sampling cell contained at least one survey point located in a representative habitat. Point counts lasted 10 minutes and were conducted during the breeding season (April–June) under suitable weather conditions during the morning hours of peak bird activity. Each grid cell was visited twice during each breeding season in order to improve detection probability and confirm breeding presence. All birds seen or heard were recorded, with partic-

ular attention to behavioural evidence indicating breeding (e.g. territorial singing, nest building, feeding of young).

Winter bird surveys and waterbird monitoring

Winter bird communities were assessed through point counts conducted during January of each study year, using the same 1×1 km grid system adopted for breeding bird monitoring. Each grid cell was surveyed once during the winter monitoring period. Surveys were carried out during daylight hours and under suitable weather conditions (absence of strong wind or heavy precipitation). Waterbird populations were monitored annually through midwinter counts conducted within the framework of IWC coordinated by Wetlands International. Counts were carried out in January of each year between 2016 and 2026 following standard IWC protocol and focused on the main wetland habitats present within the study area. All individuals belonging to regu-

larly monitored waterbird families were counted using direct visual census techniques with binoculars and spotting scopes. Surveys were conducted from fixed observation points or by walking along wetland margins to ensure complete coverage of the surveyed habitats.

Phenological status and spatial frequency

For each recorded species, phenological status and spatial frequency of occurrence were determined based on the temporal distribution of observations during the study period (2016–2026). Phenological status was assigned using the following categories: B = breeding species (species showing confirmed or probable breeding during the breeding season); W = wintering species (regularly recorded during winter surveys); M = migrant species recorded mainly during migration periods. Species recorded throughout the year were considered resident. Spatial frequency was expressed as the percentage of occupied 1×1 km grid cells within the study area ($n = 40$). Two parameters were used: SO-B (%) = breeding spatial occupancy, calculated as the percentage of grid cells in which the species was recorded during the breeding season; SO-W (%) = winter spatial occupancy, calculated as the percentage of grid cells in which the species was recorded during winter surveys. Spatial frequency therefore represents a measure of spatial occupancy within the study area rather than abundance. Differences in species richness between grid cells including the Geloi Wetland restoration area and those belonging to the surrounding agricultural landscape were tested using a Mann–Whitney U test.

RESULTS

Composition of the avifauna

During the study period (2016–2026), a total of 194 bird species belonging to 20 orders and 53 families were recorded. Non-passerines accounted for 117 species (60.3%), while passerines represented 77 species (39.7%). The recorded avifauna corresponds to approximately 43.8% of the bird species recorded in Sicily, highlighting the importance of the study area within the southern Sicilian wetland network.

Conservation value of the avifauna

Of the 194 species recorded, 94 (48.5%) are included in the Annexes of the EU Birds Directive. In particular, 58 species (29.9%) are listed in Annex I, indicating a high proportion of conservation-priority species. In terms of European conservation concern (BirdLife International), 56 species (28.9%) belong to SPEC categories 1–3. Among these, 15 species (7.7% of the total) are classified as SPEC 1, 11 species (5.7%) as SPEC 2, and 30 species (15.5%) as SPEC 3 (Burfield et al., 2023).

Temporal changes in species richness

Species richness increased progressively during the study period. The number of recorded species rose from 105 in 2016 to 194 in 2026, indicating an increase in bird diversity over the ten-year monitoring period. Several wetland-associated species previously irregular or absent in the study area became regular winter visitors following wetland restoration implemented between 2020 and 2022.

Breeding bird community

A total of 70 species were confirmed as breeding within the study area, representing 36.3% of the recorded avifauna and 25.2% of the bird species known to breed in Italy (Fig. 3). Among the 24 species classified as Endangered (EN) in Italy (Gustin et al., 2021), 6 species (25%) were recorded breeding in Geloi, while 7 of the 37 species classified as Vulnerable (VU) at the national level (18.9%) were also found breeding within the study area. Breeding bird richness ranged from 8 to 44 species per grid cell, with a mean of 24.2 ± 8.4 species across the 40 surveyed cells, reflecting the heterogeneous habitat mosaic of wetlands, agricultural landscapes, ruderal habitats and ecotonal environments. The highest richness values were recorded in cells 33N 440/4106 (44 species), 33N 441/4106 (41 species), and 33N 442/4105 (39 species). Wetland habitats supported regular breeding of species such as Mallard (*Anas platyrhynchos*), Little Grebe (*Tachybaptus ruficollis*) and Black-winged Stilt (*Himantopus himantopus*), while open farmland and steppe-like habitats hosted species of conservation interest including Stone-curlew (*Burhinus oedichnemus*), European

Roller (*Coracias garrulus*) and Lesser Kestrel (*Falco naumanni*). Breeding species richness was significantly higher in grid cells including the Geloi wetland private reserve (mean = 33.7 species, $n = 7$) than in the surrounding agricultural landscape (mean = 22.2 species, $n = 33$) (Mann–Whitney U test, $U = 210.5$, $p < 0.001$). The effect size was large (Cliff's $\delta = 0.82$), indicating that species richness in reserve cells was approximately 50% higher than in the surrounding agricultural landscape indicating a strong positive effect of wetland restoration on local bird diversity patterns.

Wintering and waterbird assemblages

Winter waterbird monitoring conducted within the framework of the International Waterbird Census revealed a clear increase in the abundance and regular occurrence of several wetland species. The increase in wintering Anatidae after 2020 coincides with the restoration of shallow wetland basins (2020–2022) and improved water availability within the Geloi Wetland restoration area. Species such as *Anas crecca*, *Fulica atra* and *Spatula clypeata* showed higher counts and more regular occurrence compared to earlier years. Wintering bird richness ranged from



Figure 2. Landscape transformation following wetland restoration in the Geloi Plain. Left: conditions in 2017 before restoration. Right: the same sites in 2023 after restoration works carried out between 2020 and 2022, with the creation of new wetland habitats.

7 to 63 species per grid cell (mean 17.4 ± 11.3), with the highest values in cells 33N 441/4106 (63 species) and 33N 440/4106 (55 species), both within the restoration area (Fig. 4). Richness was significantly higher in cells including the restoration area (mean = 35.4 species) than in the surrounding agricultural landscape (mean = 13.5 species) (Mann–Whitney U test, $U = 223$, $p < 0.0001$), with a very large effect size (Cliff's $\delta = 0.90$). Overall, wintering richness in reserve cells exceeded that of the surrounding landscape by more than 150%.

Species of conservation interest

The study area hosts several bird species of conservation and biogeographical relevance. Regular occurrences or breeding records were documented for species such as European Roller (*Coracias garrulus*), Lesser Kestrel (*Falco naumanni*), Stone-

curlew (*Burhinus oedicephalus*), Collared Pratincole (*Glareola pratincola*), Western Swamphen (*Porphyrio porphyrio*) and White Stork (*Ciconia ciconia*). The presence of these species highlights the ecological value of the Geloi Plain as a multifunctional habitat supporting both wetland birds and species associated with open agricultural landscapes. These species are typically associated with open Mediterranean farmland mosaics and temporary wetlands, habitats that have undergone significant decline in southern Europe due to agricultural intensification and land-use change.

Annotated checklist of species

The complete checklist of bird species recorded in the Geloi Plain during the study period is reported in Table 1. The checklist includes 58 species (29.9%) listed in Annex I of the EU Birds Directive.

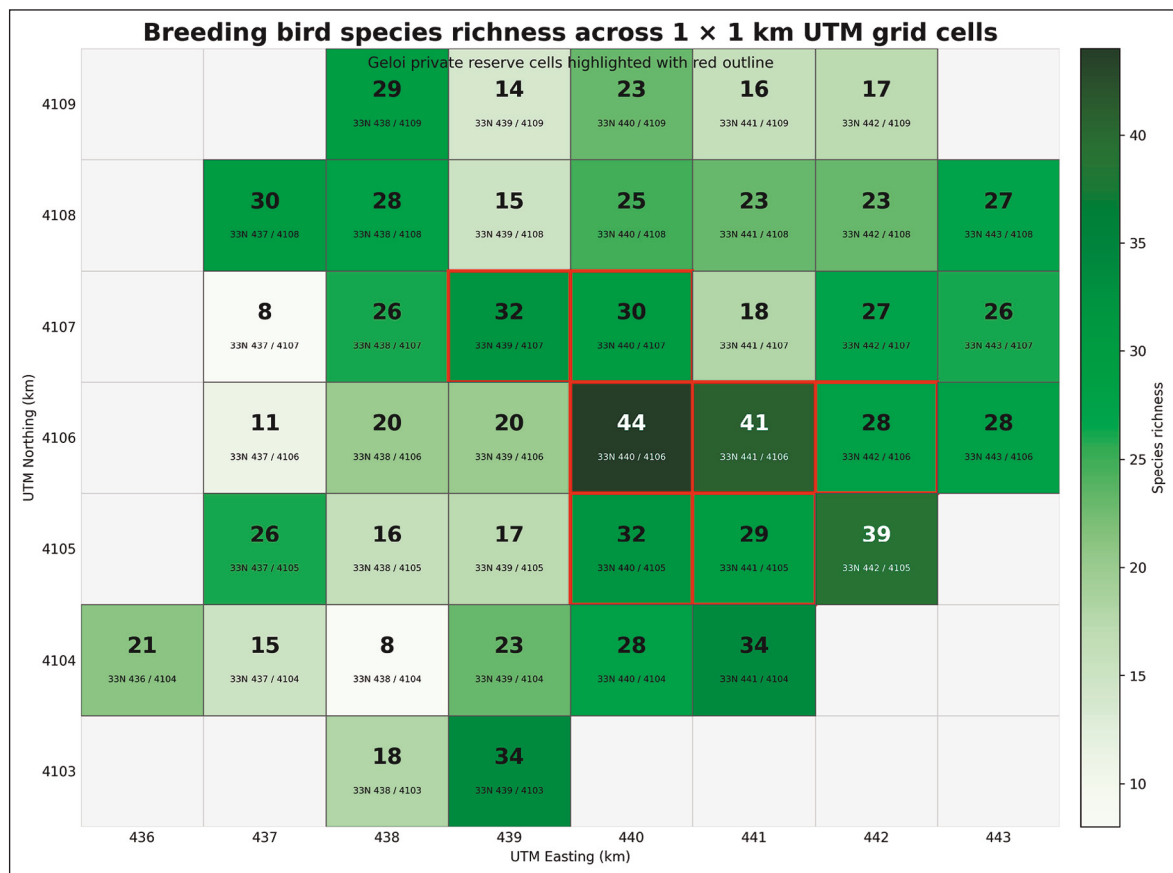


Figure 3. Spatial distribution of breeding bird species richness across the 1 × 1 km UTM grid in the Geloi sector of the Plain of Gela (southern Sicily). Numbers indicate the number of breeding species recorded in each grid cell. Grid cells (N=7) corresponding to the Geloi Wetland restoration area are outlined in red.

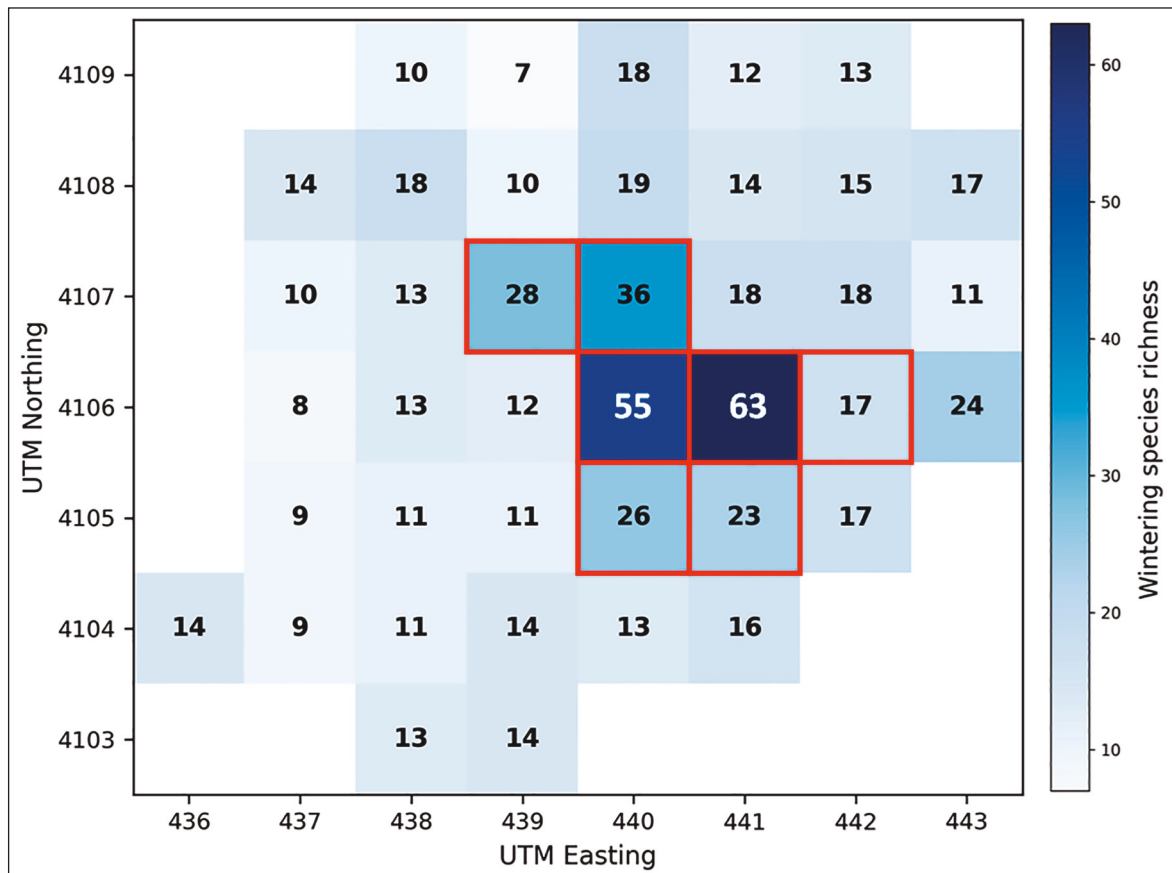


Figure 4. Spatial distribution of wintering bird species richness across the 1×1 km UTM grid in the Geloi sector of the Plain of Gela. Values indicate the number of wintering species recorded in each grid cell. Cells ($N = 7$) corresponding to the Geloi Wetland restoration private area are outlined in red.

The annotated list presented below focuses on taxa of particular faunistic or ecological interest. For each species, the current phenological status was defined on the basis of records collected during the most recent monitoring period (2021–2026), corresponding to the six seasonal cycles following wetland restoration. This status reflects the effective seasonal use of the study area under present environmental conditions. Phenological status is indicated using the following abbreviations: A = accidental; B = breeding species; irr. = irregular (recorded discontinuously, not in every year of the 2021–2026 monitoring period); M = migrant; R = resident; reg. = regular (recorded in the last 6 years of the monitoring period); W = wintering species. Roman numerals are used to indicate the month of observation. Under “Frequency”, spatial occupancy is expressed as the percentage of occupied 1×1 km grid cells within the study area ($n = 40$). Two pa-

rameters are used: SO-B (%) = breeding spatial occupancy, calculated as the percentage of grid cells in which the species was recorded during the breeding season; SO-W (%) = winter spatial occupancy, calculated as the percentage of grid cells in which the species was recorded during winter surveys. Spatial frequency therefore represents the proportion of surveyed grid cells occupied by a species and was used as a proxy of its spatial importance within the breeding and wintering bird communities. Based on spatial occupancy values, species were assigned to six occurrence categories: very common ($\geq 75\%$ of grid cells), common (50–74%), uncommon (25–49%), rare (10–24%), sporadic (5–9%) and accidental ($\sim 2.5\%$, one grid cell). This classification follows approaches commonly adopted in occupancy–frequency distributions and regional bird atlas studies (McGeoch & Gaston, 2002). Other abbreviations: ind. = individuals; max.

= maximum count; mean = mean annual number of individuals; juv. = juvenile. The systematic sequence and nomenclature follow the updated checklist of the Italian avifauna proposed by Baccetti et al. (2021), with additional updates derived from recent specialized literature when necessary. The checklist also includes selected historical records of faunistic relevance predating the standardized monitoring period.

Ordo GALLIFORMES
Familia PHASIANIDAE

Coturnix coturnix (Linnaeus, 1758) Fig. 5
Common Quail

Status: B, M reg., W reg. Frequency: common breeder (SO-B 60%; 24/40 grid cells) and rare wintering species (SO-W 18%; 7/40 grid cells). Breeds mainly in agricultural habitats, with an estimated population of at least 40–50 breeding pairs. Spring migration begins in early III and peaks in early IV, when daily counts may reach 30–45 individuals. Wintering individuals have been recorded since 2020 (max. 40–50 ind. in I.2026).

Alectoris graeca whitakeri Schiebel, 1934
Sicilian Rock Partridge

Status: R, B. Frequency: rare breeder (SO-B 13%; 5/40 grid cells). Resident species recorded in a limited number of sectors of the study area. Breeding was confirmed by observations of adults with broods during 2022–2025. Small groups (6–8 ind.) are occasionally observed moving between rocky slopes and quarry areas.

Alectoris rufa (Linnaeus, 1758)
Red-legged Partridge

Status: A. 1 ind. was recorded in the study area on 10.V.2014, most likely referring to birds released for hunting purposes.

Ordo ANSERIFORMES
Familia ANATIDAE

Tadorna tadorna (Linnaeus, 1758)
Common Shelduck

Status: W reg., M reg. Frequency: sporadic wintering species (SO-W 5%; 2/40 grid cells; mean 4.18 ind./year). Regularly recorded during winter since 2019, with the earliest arrival on 19.XII.2019. Maximum count of 26 ind. on I.2020. Small wintering groups were also recorded in subsequent winters.

Aythya ferina (Linnaeus, 1758)
Common Pochard

Status: W irr., M irr. Frequency: sporadic wintering species (SO-W 5%; 2/40 grid cells; mean 0.64 ind./year). Occurrence appears related to water levels in the wetlands. First recorded on 24.XI.2021. Maximum count 4 ind. in I.2025.

Aythya nyroca (Güldenstädt, 1770)
Ferruginous Duck

Status: W reg., M reg. Frequency: sporadic wintering species (SO-W 5%; 2/40 grid cells; mean c. 2 ind./year). Regularly recorded since winter 2021–2022, with small groups occurring in restored wetlands. Maximum count 11 ind. in XII.2022. Wintering groups of 4–6 ind. were recorded from XII.2025 to I.2026, remaining until late III. Occasional records outside the winter period include a summer observation in VIII.2022.

Spatula clypeata (Linnaeus, 1758)
Northern Shoveler

Status: W reg., M reg. Frequency: sporadic wintering species (SO-W 5%; 2/40 grid cells; mean 34.18 ind./year). Regularly recorded in winter since 2021, showing a marked increase following wetland restoration from 20 ind. in I.2022 to a maximum of 130 ind. in I.2025. Early autumn arrivals were occasionally recorded from IX onwards.

Mareca strepera (Linnaeus, 1758)
Gadwall

Status: W reg., M reg. Frequency: accidental wintering species (SO-W 2.5%; 1/40 grid cells; mean 2.82 ind./year). First recorded on 30.XI.2021 (10 ind.). Small groups were subsequently recorded during several winters, with occasional

records in autumn (from X) and spring (4 ind. on III.2023).

Mareca penelope (Linnaeus, 1758)
Eurasian Wigeon

Status: W reg., M reg. Frequency: rare wintering species (SO-W 10%; 4/40 grid cells; mean 17.18 ind./year). Regularly recorded in winter since 2019–2020, increasing from 9 ind. in I.2020 to a maximum of 60 ind. in I.2026. Autumn arrivals typically occur in XI, with occasional early records in late VIII.

Anas platyrhynchos Linnaeus, 1758
Mallard

Status: R, B, W reg. Frequency: rare breeder (SO-B 15%; 6/40 grid cells) and uncommon wintering species (SO-W 35%; 14/40 grid cells; mean 45.45 ind./year). Breeding was first recorded in 2018–2020 with 1 pair; the breeding population increased after wetland restoration, reaching a max. of 8 breeding pairs in 2025. Winter numbers peaked at 202 ind. in I.2022. Summer flocks may reach 80–90 ind., including juv., indicating successful breeding and the presence of a small estimating population.

Anas acuta Linnaeus, 1758
Northern Pintail

Status: W reg., M reg. Frequency: sporadic wintering species (SO-W 5%; 2/40 grid cells; mean 3.45 ind./year). Recorded in small wintering groups since 2019. Maximum count 12 ind. in I.2022. Occasional spring records occur until late III. First autumn observations at IX.

Anas crecca Linnaeus, 1758
Common Teal

Status: W reg., M reg. Frequency: rare wintering species (SO-W 13%; 5/40 grid cells; mean 136.64 ind./year). Regular wintering species since 2020, with a marked increase after wetland restoration. Winter counts rose from 1 ind. in I.2020 to a peak of c. 500 ind. in I.2023. Large flocks continue to occur during winter, regularly recorded in recent years. Post-breeding arrivals may occur from late VIII.

Ordo PODICIPEDIFORMES
Familia PODICIPEDIDAE

Tachybaptus ruficollis (Pallas, 1764)
Little Grebe

Status: B reg., W reg., M reg. Frequency: sporadic breeder (SO-B 5%; 2/40 grid cells; mean 3.27 ind./year) and rare wintering species (SO-W 18%; 7/40 grid cells). *Tachybaptus ruficollis* is a species regularly recorded in restored wetlands. Wintering groups have been documented since 2021, with a maximum of 12 ind. in I.2023 and 8 ind. on 05.I.2026. Breeding has been recorded since 2022 with 1 pair, increasing to 5 pairs in 2025. The highest concentration was 14 ind. on 26.VIII.2022.

Ordo COLUMBIFORMES
Familia COLUMBIDAE

Columba oenas Linnaeus, 1758
Stock Dove

Status: W occ. Frequency: accidental wintering species (SO-W 2.5%; 1/40 grid cells). Single winter record involving 5 ind. observed from 04.I.2025 to 20.I.2025.

Streptopelia turtur (Linnaeus, 1758)
European Turtle-dove

Status: M reg., B. Frequency: common breeder (SO-B 55%; 22/40 grid cells). Regular breeding species in agricultural habitats. First spring arrivals generally occur in mid-IV (earliest record 13.IV.2023), with peak presence in late IV. The breeding population is estimated at 30–40 pairs in suitable habitats. Autumn migration occurs from late VIII to mid-IX, with the latest record on 01.X.2023.

Spilopelia senegalensis (Linnaeus, 1766)
Laughing Dove

Status: A. Single observation recorded on 11.X.2023. This record represents the first documented occurrence for the Plain of Gela and the first record for Italy (outside the known areas: Pantelleria and Mazara del Vallo) in 2023 (EBN Italia, 2023).

Ordo CAPRIMULGIFORMES
Familia APODIDAE

Apus apus (Linnaeus, 1758)
Common Swift

Status: M reg. Common migrant during spring passage. The earliest arrivals are generally recorded in late III (first observation 20.III.2022). Large migratory flocks regularly forage over the Geloi area, with peak numbers exceeding 1000 ind. on 23.III.2025. Groups of 200 ind. were observed on 08.IV.2019, while feeding flocks of 500-700 ind. were regularly recorded during IV–V. The species does not breed locally but frequently forages over the study area. The latest record was on 26.V.2024.

Ordo CUCULIFORMES
Familia CUCULIDAE

Clamator glandarius (Linnaeus, 1758) Fig. 6
Great Spotted Cuckoo

Status: M reg., B reg. First breeding recorded in VI.2018. The species parasitizes nests of *Pica pica* within the study area. Breeding was confirmed in 2021, when 2 juv. fledged from 2 different host nests, and again in 2024. Specimens were observed feeding on larvae of *Lasiocampa trifolii*. Spring arrival usually occurs in mid III (first seasonal record 02.III.2026). Specimens are generally present until mid VIII.

Ordo GRUIFORMES
Familia RALLIDAE

Rallus aquaticus Linnaeus, 1758
Water Rail

Status: R, B reg., W reg. Frequency: uncommon breeder (SO-B 25%; 10/40 grid cells) and rare wintering species (SO-W 20%; 8/40 grid cells; mean 1.82 ind./year). Regularly recorded in wetland habitats of the study area. The species is present throughout the year, with calling individuals recorded in autumn and winter (e.g. 31.X.2025).

Porzana porzana (Linnaeus, 1766)
Spotted Crake

Status: M occ. Single record on 25.III.2023 (A. Cortese, pers. comm.).

Porphyrio porphyrio (Linnaeus, 1758) Fig. 7
Purple Swamphen

Status: R, B reg., W reg. Frequency: rare breeder (SO-B 10%; 4/40 grid cells) and rare wintering species (SO-W 15%; 6/40 grid cells; mean 0.73 ind./year). Breeding population established after wetland restoration in 2023 with 1–2 pairs. The species is regularly observed in wetland habitats and may move along the Maroglio stream during dry periods.

Gallinula chloropus (Linnaeus, 1758)
Common Moorhen

Status: R, B reg. Frequency: uncommon breeder (SO-B 28%; 11/40 grid cells; mean 3.09 ind./year). Regular breeding species recorded in several wetlands of the study area. Breeding activity has been documented since 2016 through observations of juv. and breeding pairs. The breeding population increased in recent years, from 4–6 pairs in 2021 to an estimated 8–12 pairs in 2024–2025. Small wintering groups are occasionally recorded, including up to 10 ind. in I.2023.

Fulica atra Linnaeus, 1758
Eurasian Coot

Status: B reg., W reg., M reg. Frequency: uncommon breeder (SO-B 25%; 10/40 grid cells) and rare wintering species (SO-W 18%; 7/40 grid cells; mean 47.73 ind./year). Breeding has been recorded regularly since 2020, with nesting confirmed in 2023 with 2 pairs, increasing to 8–10 pairs by V.2025. Winter numbers increased following wetland restoration, with large flocks observed in several years. Max. counts included c. 150 ind. on 03.XII.2022 and c. 200 ind. on 01.I.2023.

Ordo GRUIFORMES
Familia GRUIDAE

Grus grus (Linnaeus, 1758)
Common Crane

Status: M reg., W irr. Frequency: sporadic win-



Figures 5, 6. Representative bird species recorded in the study area: Geloï Plain (southern Sicily, Italy).
Fig. 5: *Coturnix coturnix*. Fig. 6: *Clamator glandarius* courtship feeding. Photos by Andrea Cortese.

tering species (SO-W 5%; 2/40 grid cells; mean 1.09 ind./year). Observed mainly during migration periods (II–III). A flock of c. 80 ind. was recorded on 29.II.2020. A marked migratory passage occurred in II.2026, when more than 430 ind. were recorded over several consecutive days. Other migratory groups included 29 ind. on 01.IV.2023 and 8 ind. on 06.XI.2024. Two wintering events have been documented: 7 ind. from 08.XII.2017 to 09.I.2018 and 5 ind. in I.2026.

Ordo CICONIIFORMES
Familia CICONIIDAE

Ciconia ciconia (Linnaeus, 1758) Fig. 8
White Stork

Status: R, M reg., B reg., W reg. Frequency: rare breeder (SO-B 20%; 8/40 grid cells) and rare wintering species (SO-W 15%; 6/40 grid cells; mean 6.27 ind./year). The study area hosts an important portion of the White Stork population of the Plain of Gela, with 20–24 pairs representing c. 46% of the local population (Zafarana et al., 2020). Since 2023, breeding attempts have occurred on artificial wooden nesting platforms installed in the area. In 2024, 3 chicks were ringed but were later predated by stray shepherd dogs, while in 2025 3 juv. successfully fledged from one of the artificial nests. The species also winters regularly in small numbers, with a maximum of 11 ind. recorded in 2023 and up to 18 ind. observed on

12.I.2026. Breeding pairs usually occupy nests as early as I, whereas from IX to XII individuals may disperse to different areas of Sicily (Zafarana et al., 2019). Several individuals also frequent the TimpaZZo landfill, where plastics are used as nesting material and waste may be ingested (Zafarana, 2020a). Feeding ecology in the area was investigated by Surdo et al. (2022), who showed that the species follows an opportunistic insectivorous diet during the breeding and post-breeding periods.

Ordo PELECANIFORMES
Familia THRESKIORNITHIDAE

Threskiornis aethiopicus (Latham, 1790)
African Sacred Ibis

Status: A. First observations recorded in XII.2025 with 2 ind.

Plegadis falcinellus (Linnaeus, 1766) Fig. 9
Glossy Ibis

Status: M reg. Recorded regularly since 2019 during spring migration, usually between III and IV. Individuals and small groups are observed both during active migration and foraging in temporary and restored wetland habitats within the study area, where the species appears increasingly frequent. The earliest observation was on 03.III.2022 (1 ind.). The

largest group consisted of 6 ind. on 28.IV.2024 and 47 ind. on 10.IV.2026. Occasional late summer records include 2 first-year juv. on 25–26.VIII.2022. Familia ARDEIDAE

Botaurus stellaris (Linnaeus, 1758)
Eurasian Bittern

Status: M reg., W reg. Frequency: rare wintering species (SO-W 15%; 6/40 grid cells; mean 1.36 ind./year). Regular winter presence documented since 2019, typically involving 1–3 ind., with consistent records in I since 2020. Camera-trap footage frequently shows individuals hunting at dawn along mown fields and open tracks within the private reserve. The species is most frequently observed during spring migration from III to late IV. A recent record includes 1 ind. on 18.III.2025 and 1 ind. from 20.III.2026.

Nycticorax nycticorax (Linnaeus, 1758)
Black-crowned Night Heron

Status: M reg., B occ., W irr. Frequency: accidental breeder (SO-B 2.5%; 1/40 grid cells) and rare wintering species (SO-W 13%; 5/40 grid cells; mean 2.36 ind./year). Breeding was confirmed in 2023 with 1 pair (Rannisi et al., 2024).

Ardeola ralloides (Scopoli, 1769)
Squacco Heron

Status: M reg. Observed mainly during spring migration, particularly in IV. The largest group recorded consisted of 7 ind. on 13.IV.2024 and 4 ind. on 03.IV.2023. Additional records include small groups in IV.2020 and 1 ind. in V.2020. A breeding attempt was observed in V.2022 when a pair was seen building a nest on a *Tamarix* tree, although the attempt failed. Occasional late summer records were documented in VIII (03.VIII.2023; 03.VIII.2025).

Bubulcus ibis (Linnaeus, 1758)
Cattle Egret

Status: M reg., W reg. Frequency: common wintering species (SO-W 53%; 21/40 grid cells; mean 31.18 ind./year). Winter numbers regularly exceed several dozen individuals, with a maximum of 82 ind. in I.2023 and 65 ind. in I.2025. Spring migra-

tion occurs from late III to IV, with up to 55 ind. recorded on 19.IV.2024. Early post-breeding movements occur in VIII (e.g. 18 ind. on 15.VIII.2022), while the main wintering population usually arrives during the second half of October.

Ordo CHARADRIIFORMES
Familia BURHINIDAE

Burhinus oedicephalus (Linnaeus, 1758) Fig. 10
Eurasian Stone Curlew

Status: R, B reg., W reg. Frequency: very common breeder (SO-B 78%; 31/40 grid cells) and uncommon wintering species (SO-W 43%; 17/40 grid cells; mean 20.18 ind./year). One of the most characteristic species of the agricultural habitats of the study area. An increase in breeding within the Geloi reserve has been documented since 2018, likely facilitated by habitat management practices, including the maintenance of firebreak lines, pre-breeding ploughing of selected fields and the marking of nests to avoid disturbance from vehicles and mowing. The breeding population currently estimated at 12–15 breeding pairs within Geloi reserve. Courtship and territorial behaviour begin early, with singing males recorded from III and pair formation observed as early as II. During winter the species forms aggregations in open fields and steppe-like habitats, with groups typically ranging from 20 to 40 ind. GPS tracking of 2 breeding pairs in 2020 (Grasso et al., in preparation) documented movements towards eastern sectors of the Plain of Gela during the non-breeding period, confirming that the species regularly overwinters within Sicily. During winter the members of each pair used different wintering areas, reuniting at the breeding territories from early II.

Familia RECURVIROSTRIDAE

Himantopus himantopus (Linnaeus, 1758)
Black-winged Stilt

Status: M reg., B reg. Frequency: rare breeder (SO-B 20%; 8/40 grid cells). Breeding species associated with restored wetlands. Small groups are usually recorded from early III, with the first individuals observed at the beginning of the breeding season. Breeding at Geloi reserve has been documented since

2022, with up to 6 breeding pairs and the presence of juv. already observed in VII. The local breeding population appears to have increased following the restoration of wetland habitats, with several pairs newly colonizing the restored basins. Subsequent breeding attempts were recorded in later years, including a pair with 3 chicks on 19.VII.2023. In 2024 several pairs were present in restored wetlands from early III, with groups of up to 8 ind. recorded in IV. Recent observations include a breeding pair recorded on 31.V.2025 and groups of up to 6 ind. in VI.2025.

Familia CHARADRIIDAE

Pluvialis apricaria (Linnaeus, 1758)

European Golden Plover

Status: M reg., W reg. Frequency: rare wintering species (SO-W 15%; 6/40 grid cells; mean 264.55 ind./year). Regular winter visitor in open agricultural fields of the study area. Large flocks are recorded during winter, with counts of 200 ind. in I.2019, 300 ind. in I.2020, 120 ind. in I.2021 and a peak of c. 700 ind. in I.2022. Subsequent winter counts included 190 ind. in I.2024, 240 ind. in I.2025 and 150 ind. in I.2026. The species usually arrives in XI and remains until



Figures 7–10. Representative bird species recorded in the study area: Geloi Plain (southern Sicily, Italy). Fig. 7: *Porphyrion porphyrio*. Fig. 8: *Ciconia ciconia* breeding at Geloi (June 2026). Fig. 9: *Plegadis falcinellus* during spring migration. Fig. 10: chick of *Burhinus oedipnemos* in an abandoned artichoke field. Photos by Andrea Cortese and Manuel Andrea Zafarana.

early III. It represents one of the most frequent prey species of *Falco peregrinus* Tunstall, 1771 in the study area.

Vanellus vanellus (Linnaeus, 1758)

Northern Lapwing

Status: M reg., W reg. Frequency: uncommon wintering species (SO-W 25%; 10/40 grid cells; mean 163.27 ind./year). Regular wintering species occur mainly in open agricultural fields, often in mixed flocks with *Pluvialis apricaria*. Large winter aggregations have been recorded in several years, including c. 400 ind. on 18.I.2020 and c. 250 ind. on 17.I.2022. Seasonal arrival generally occurs between late X and XI, with wintering flocks persisting until II. Additional winter counts include c. 150 ind. in I.2023, 58 ind. on 30.XI.2023 and 33 ind. on 27.XI.2024. Recent records include 180 ind. on 05.I.2026.

Familia SCOLOPACIDAE

Calidris temminckii (Leisler, 1812)

Temminck's Stint

Status: M reg., W irr. Recorded mainly in temporary wetlands during migration periods. Since 2021 the species has been recorded regularly during migration, particularly in spring. Winter records include single ind. observed on 01.I.2017, 27.XI.2019, 28.XII.2019 and 19.XI.2021. Additional observations occurred during spring migration in III.2022 and IV.2023, with occasional records in late summer and autumn (VIII–X). Small groups of up to 2–3 ind. were observed in I.2023.

Calidris melanotos (Vieillot, 1819)

Pectoral Sandpiper

Status: A. Single observation recorded on 14.X.2011 involving a first-year individual. This record represents the 5th documented occurrence for Sicily.

Gallinago gallinago (Linnaeus, 1758)

Common Snipe

Status: M reg., W reg. Frequency: uncommon

wintering species (SO-W 40%; 16/40 grid cells; mean 20.55 ind./year). Regular winter visitor in wetland habitats of the study area. Autumn arrival generally occurs in IX–X, with individuals remaining until IV. Winter flocks usually range from 10–40 ind., with a maximum of 47 ind. on 01.I.2020 and c. 50 ind. on I.2023. Additional winter counts include c. 90 ind. recorded in XII.2020. Spring records occasionally extend to late IV (e.g. 29.IV.2025).

Lymnocyptes minimus (Brünnich, 1764)

Jack Snipe

Status: M irr. Frequency: accidental species. Recorded on 2 occasions, both documented through camera traps: 1 ind. in X.2019 and 1 ind. on 24.IV.2022.

Familia GLAREOLIDAE

Glareola pratincola (Linnaeus, 1766) Fig. 11

Collared Pratincole

Status: M reg., B reg. Frequency: rare breeder (SO-B 20%; 8/40 grid cells). Summer breeding species associated with open agricultural habitats of the Plain of Gela. The local breeding population is estimated at c. 65–80 pairs, which frequently forage over the wetlands of the Geloi reserve from IV to VIII. Spring arrival usually occurs in early IV (earliest record 04.IV.2020). Large feeding flocks are regularly observed, including c. 60 ind. on 16.IV.2020 and c. 110 ind. on 19.VI.2020. Within the private reserve area, several habitat management actions were undertaken to prepare suitable breeding grounds; successful nesting within the restored area was finally recorded in 2025 with 1 breeding pair in a ploughed field. Post-breeding movements usually begin in early VIII, with occasional late observations such as a juv. recorded on 11.IX.2020. The species is also the focus of the LIPU “Glareola” project, which includes systematic monitoring of breeding colonies across the Plain of Gela and targeted conservation actions such as nest surveillance and collaboration with local farmers to prevent disturbance during the breeding season, highlighting both the conservation relevance and the vulnerability of the local population to environmental conditions and agricultural practices (Zafarana, 2020b).



Figure 11. Representative bird species recorded in the study area: Geloi Plain (southern Sicily, Italy). *Glareola pratincola*. Photo by Andrea Cortese.

Ordo STRIGIFORMES

Familia STRIGIDAE

Asio otus (Linnaeus, 1758)

Long-eared Owl

Status: R, B reg., W reg. Frequency: rare breeder (SO-B 15%; 6/40 grid cells). Resident species showing a recent increase in the study area. The first wintering individual was recorded in I.2020, followed by the observation of a juv. on 24.IV.2020. Breeding was confirmed in 2023–2024 with 6–10 nesting pairs and at least 8 fledglings recorded.

Asio flammeus (Pontoppidan, 1763)

Short-eared Owl

Status: M reg., W irr. Frequency: rare wintering species (SO-W 10%; 4/40 grid cells; mean 0.27 ind./year). Wintering individuals were recorded in I.2021, I.2024 and I.2026. Additional observations include 2 ind. during spring migration on II.2020 and on III.2026 and occasional single records during autumn migration (X–XI). Rare late spring observations were also documented (V.2016, V.2018).

Ordo ACCIPITRIFORMES

Familia PANDIONIDAE

Pandion haliaetus (Linnaeus, 1758)

Osprey

Status: M irr., W irr. Frequency: accidental wintering species (SO-W 2.5%; 1/40 grid cells; mean 0.18 ind./year). First recorded on 27.IX.2023, when 1 ind. was observed hunting at Acquittrino Isola. The same individual overwintered on I.2024. Additional observations include 1 juv. on 22.II.2025 and 1 ind. recorded in I.2026.

Familia ACCIPITRIDAE

Circaetus gallicus (J.F. Gmelin, 1788)

Short-toed Snake Eagle

Status: M reg., W reg. Frequency: rare wintering species (SO-W 23%; 9/40 grid cells; mean 1.73 ind./year). Observed mainly during migration periods in spring (III–IV) and autumn (X–XI). Wintering individuals are recorded regularly from 2018. Small groups may occur during migration, such as 8 ind. observed together on 24.X.2021. The species is occasionally observed hunting reptiles in the area, including a predation event on *Hierophis viridiflavus* on 21.IV.2021. Individuals have repeatedly been observed hunting on artificial rocky substrates created within the reserve as ecological niches for reptile fauna, highlighting the role of habitat management actions in increasing prey availability.

Aquila heliaca Savigny, 1809

Eastern Imperial Eagle

Status: M irr., W irr. Frequency: sporadic wintering species (SO-W 5%; 2/40 grid cells; mean 0.36 ind./year). Observed irregularly in the study area, mainly during winter. The first record involved a juv. overwintering individual on 04.I.2021. Additional observations include 1 ad. on 20.IX.2021, 2 ind. on 25.I.2022 and 1 ind. on 09.II.2022. More recent records include 1 ind. in I.2024 and a juv. observed in XII.2025.

Aquila fasciata Vieillot, 1822

Bonelli's Eagle

Status: R. Frequency: accidental breeder (SO-B 2.5%; 1/40 grid cells) and rare wintering species

(SO-W 18%; 7/40 grid cells). The species is frequently observed in the study area, particularly immature individuals dispersing from nearby territories. Since 2020 a territorial pair has been regularly present in the area. Telemetry data indicate that the satellite-tracked individual “Greta” used the area on 06.V.2018 (Di Vittorio, pers. comm.). Individuals of different age classes are regularly observed hunting over the area, preying mainly on *Columba palumbus*, *Lepus corsicanus*, *Erinaceus europaeus* and occasionally *Burhinus oedinenus*.

***Circus aeruginosus* (Linnaeus, 1758)**

Western Marsh Harrier

Status: M reg., W reg. Frequency: common wintering species (SO-W 55%; 22/40 grid cells; mean 4.55 ind./year). One of the most regularly observed raptors in the study area. Wintering individuals are recorded every year, with maxima of 10 ind. in I.2024 and I.2026. Spring migration peaks in IV, when 35–50 ind. may be observed during the pre-breeding passage. Autumn migration occurs mainly in IX–X, with a maximum of 32 ind. recorded on IX.2022. Small wintering groups (3–8 ind.) are regularly present in wetland habitats.

***Circus cyaneus* (Linnaeus, 1766)**

Hen Harrier

Status: M reg., W reg. Frequency: uncommon wintering species (SO-W 28%; 11/40 grid cells; mean 1.36 ind./year). Regular winter visitor in open agricultural habitats. Wintering numbers usually range from 1–3 ind., with a maximum of 3 ind. recorded in I.2025. Spring migration occurs mainly between II and IV, with small numbers recorded monthly (max 6 ind. on 21.IV.2024). Autumn passage is less frequent, usually involving single individuals observed from IX onwards.

***Circus macrourus* (S.G. Gmelin, 1770)**

Pallid Harrier

Status: M reg., W reg. Frequency: regular but rare wintering species (SO-W 15%; 6/40 grid cells; mean 0.73 ind./year). Wintering individuals have been recorded in several years, including records in I.2021 and I.2025, with up to 4 ind. wintering in I.2026. Observed mainly during migration periods,

with most records occurring in X–XI (max. 4 ind. on 17.X.2024). Spring migration occurs mainly in III–IV, with the earliest record on 08.III.2020.

***Circus pygargus* (Linnaeus, 1758)**

Montagu's Harrier

Status: M reg., W occ., B?. Frequency: accidental wintering species (SO-W 2.5%; 1/40 grid cells; mean 0.18 ind./year). Observed mainly between III and V during spring migration and again in late summer and autumn (VIII–X). Two wintering events have been documented (05.I.2019 and 28.I.2023). In 2022 a pair estivated in cereal fields and was suspected to breed, with a juv. observed in late summer. Small migratory groups may occur during passage, with peaks of 5–10 ind. recorded in IV.2021.

***Milvus milvus* (Linnaeus, 1758)**

Red Kite

Status: M irr., W occ. Frequency: accidental wintering species (SO-W 2.5%; 1/40 grid cells; mean 1.09 ind./year). First recorded on 22.XI.2020 with an immature individual. The species overwintered in the area in I.2021, regularly visiting a raptor feeding station. An additional observation involved 1 ind. recorded on 08.XI.2023.

***Milvus migrans* (Boddaert, 1783)**

Black Kite

Status: M reg., W irr. Frequency: sporadic wintering species (SO-W 5%; 2/40 grid cells; mean 0.27 ind./year). Regularly observed during migration and occasionally during summer months. Wintering was documented in I.2021 when 2 immature individuals remained in the area, likely attracted by an active raptor feeding station. Additional records include scattered observations between IV and IX in several years, indicating regular passage and occasional estivating individuals.

***Buteo rufinus* (Cretzschmar, 1829)**

Long-legged Buzzard

Status: M irr., W irr. Observed sporadically in the study area, mainly during spring migration. Individuals were recorded between IV and VI in several years, including 1 bird present from late IV to

early VI.2020. Additional records include 1 ind. observed on 25.X.2025 and another on 14.I.2026. A North African subspecies *Buteo rufinus cirtensis* was observed between 09.IV and 22.IV.2021.

Ordo BUCEROTIFORMES
Familia UPUIDAE

Upupa epops Linnaeus, 1758
Common Hoopoe

Status: R, M reg., B reg., W reg. Frequency: rare breeder (SO-B 13%; 5/40 grid cells) and rare wintering species (SO-W 23%; 9/40 grid cells). Regular migrant and winter visitor in agricultural habitats of the study area, with wintering numbers usually reaching up to 10-15 ind. per year. Breeding has been confirmed, with nests located in ruins, cavities of abandoned buildings and holes in sandstone walls. The species is commonly recorded during post-breeding movements, particularly in VIII when small groups of 3-6 ind. may gather. Individuals are frequently observed feeding on larvae of the Pine Processionary Moth (*Thaumetopoea pityocampa*), suggesting opportunistic exploitation of locally abundant insect outbreaks.

Familia CORACIIDAE

Coracias garrulus Linnaeus, 1758 Fig. 12
European Roller

Status: M reg., B reg. Frequency: rare breeder (SO-B 13%; 5/40 grid cells). Summer breeding species associated with open agricultural habitats. In the Geloi reserve the species had disappeared after the last nesting site (a ruin used for breeding) was demolished in 2014. Following conservation actions, including the installation of nest boxes and habitat management, the species returned to breed in the area. Breeding was confirmed in several years, with a pair successfully nesting in 2020 and fledglings observed in VII.2020. The breeding population increased in recent years, reaching up to 6 breeding pairs in 2023-2024. Several nests are located in natural cavities and nest boxes installed in the study area. Post-breeding gatherings are regularly observed in late summer, when numerous fledged juveniles concentrate in the Geloi reserve to forage before migration; groups of up to 16 ind. were recorded in 2022. Occasional predation events by *Falco peregrinus* have also been documented.

Ordo FALCONIFORMES
Familia FALCONIDAE

Falco naumanni Fleischer, 1818
Lesser Kestrel

Status: M reg., B reg., W irr. Frequency: uncommon breeder (SO-B 25%; 10/40 grid cells). Important breeding species in the study area, with an estimated population of 70-85 breeding pairs. Spring arrival generally occurs in III, with the species remaining until IX. Post-breeding roosts on tall isolated trees may include 170-210 ind. Breeding occurs mainly in buildings and artificial nesting structures installed in the area, including nest boxes placed on the Geloi Visitor Center and nearby structures. Several breeding pairs and juveniles have been recorded in recent years, confirming the stability of the local colony. In 2025 a 6 ha area within the reserve was restored to natural conditions and artificial rocky substrates were created to increase trophic niches for the species. Following these habitat management actions, the presence of juveniles in the area increased markedly, with a c. 700% increase compared to summer 2024, when the area had been previously burned and ploughed. Occasional winter records involve small groups of up to 3-7 ind. since 2024. Several juveniles are preyed upon by *Rattus norvegicus*. The species frequently preys on the ocellated skink (*Chalcides ocellatus*).

Falco columbarius Linnaeus, 1758
Merlin

Status: M reg., W reg. Frequency: rare wintering species (SO-W 23%; 9/40 grid cells; mean 1.18 ind./year). Regular winter visitor in open agricultural habitats of the study area. Individuals are usually recorded between X and III, with scattered observations during migration and winter. Most records involve single ind., although up to 3 ind. were recorded in I.2026. Occasional spring records occur until IV (e.g. 1 ind. observed between 02.IV and 10.IV.2025). The species feeds mainly on *Alauda arvensis*.

Falco cherrug J.E. Gray, 1834
Saker Falcon

Status: M irr., W irr. Frequency: sporadic wintering species (SO-W 5%; 2/40 grid cells; mean

0.18 ind./year). First recorded on 04.XII.2020, when an immature ind. was observed feeding in open farmland; the bird remained in the area until I.2021. Additional observations include single ind. recorded in XI.2022 and XII.2023. A second wintering event was documented in I.2026 with 1 ind.

Ordo PASSERIFORMES
Familia LANIIDAE

Lanius excubitor algeriensis Lesson, 1839
Great Grey Shrike

Status: A. A single ind. was observed from 09.VIII to 05.IX in the same area. The bird used dry branches of *Tamarix* spp. as “larders”, impaling numerous prey including Orthoptera, Hymenoptera and Sicilian Pine Vole (*Microtus nebrodensis*) (Arena et al., 2019).

Lanius senator Linnaeus, 1758
Woodchat Shrike

Status: M reg., B reg. Frequency: uncommon breeder (SO-B 40%; 16/40 grid cells). Regular summer breeder in open agricultural habitats and shrublands, with an estimated population of 16–20 breeding pairs. The species is usually recorded between mid III and early IX. Breeding evidence includes pairs with juv. recorded in several years (e.g. 3 juv. on 23.VI.2018 and 3 fledglings on 24.VI.2025). The subspecies *L. s. badius* has also been recorded in the study area. Breeding activity is regularly documented through observations of adults carrying food and recently fledged juv. Individuals frequently use spontaneous hedgerows formed by *Vachellia karoo* to impale prey.

Familia REMIZIDAE

Remiz pendulinus (Linnaeus, 1758)
Eurasian Penduline Tit

Status: R, B reg., W reg. Frequency: rare breeder (SO-B 23%; 9/40 grid cells). Localized breeding species associated with wetlands and *Tamarix* stands. Breeding was confirmed in 2020 with a nest containing 6 chicks. During nest construction, ind. were observed using plant fibres and fragments of cocoons of the Pine Processionary Moth (*Thaumetopoea pityocampa*) as lining material for the nest.

Familia ALAUDIDAE

Melanocorypha calandra (Linnaeus, 1766)
Calandra Lark

Status: B irr., W irr. Frequency: sporadic breeder (SO-B 8%; 3/40 grid cells) and sporadic wintering species (SO-W 5%; 2/40 grid cells). Localized species recorded mainly in open steppe-like agricultural habitats. Small winter groups have been documented in several years, while breeding behaviour was observed in 2020 when singing males and territorial pairs were recorded.

Calandrella brachydactyla (Leisler, 1814)
Greater Short-toed Lark

Status: M reg., B reg. Frequency: common breeder (SO-B 50%; 20/40 grid cells). Common summer breeder in open agricultural and steppe habitats. First arrivals usually occur between III and IV, with the species remaining until early IX. The breeding population is estimated at c. 30-40 pairs in the study area.

Lullula arborea (Linnaeus, 1758)
Woodlark

Status: R. Frequency: sporadic breeder (SO-B 5%; 2/40 grid cells). Very localized species recorded mainly in scattered wooded patches and shrub habitats. Observations usually involve single ind. or small groups.

Alauda arvensis Linnaeus, 1758
Eurasian Skylark

Status: M reg., W reg. Frequency: common wintering species (SO-W 53%; 21/40 grid cells). Common winter visitor in open agricultural fields. Large winter flocks are regularly recorded, with max of c. 350-400 ind. in I.2020. The establishment of a protected fenced area within the Geloi reserve has contributed to reducing illegal hunting pressure, as some fields regularly used by the species are now inaccessible to potential hunting activities. Autumn arrival usually occurs in X–XI, with wintering groups persisting until IV. Occasional singing individuals have been recorded in spring.

Familia CISTICOLIDAE

Cisticola juncidis (Rafinesque, 1810)
Zitting Cisticola

Status: R. Frequency: very common breeder (SO-B 100%; 40/40 grid cells). A notable observation was recorded in VII.2019 when 1 ind. was found trapped in the web of the orb-weaving spider - *Argiope trifasciata* (Forskål, 1775) - representing an unusual case of accidental bird entrapment by a large spider.

Familia HIRUNDINIDAE

Cecropis daurica rufula (Temminck, 1835)
Red-rumped Swallow

Status: M reg., B irr. Regular migrant recorded mainly during the post-breeding migration period. The species occurs in small groups during spring passage, while larger concentrations are observed from VIII to IX. Post-breeding flocks may reach 40–60 ind., with peaks of up to 60–80 ind./day recorded during migration (Surdo et al., 2024). Occasional breeding has been documented at localized sites within the study area.

Familia SYLVIIDAE

Sylvia conspicillata Temminck, 1820
Spectacled Warbler

Status: M reg., B reg. Frequency: uncommon breeder (SO-B 33%; 13/40 grid cells). Regular summer breeder in shrub habitats and steppe-like environments. Spring arrival generally occurs in III, with singing males and territorial behaviour recorded soon after arrival. Breeding activity has been documented in several years through observations of nests under construction, courtship behaviour and recently fledged juv. The species is widely distributed across the study area during the breeding season.

Familia MUSCICAPIDAE

Cyanecula svecica (Linnaeus, 1758) Fig. 13
Bluethroat

Status: M reg., W reg. Frequency: rare wintering species (SO-W 13%; 5/40 grid cells). Regularly recorded during autumn migration and winter, mainly between X and III. It is usually observed in small numbers (3–5 ind./year) in wetland habitats close to artichoke fields. Several winter records involve single ind. recorded between XI and I, with occasional spring observations extending into III.

Oenanthe oenanthe (Linnaeus, 1758) Fig. 14
Northern Wheatear

Status: M reg., B reg. Frequency: common breeder (SO-B 58%; 23/40 grid cells). Common



Figures 12, 13. Representative bird species recorded in the study area: Geloi Plain (southern Sicily, Italy).
Fig. 12: *Coracias garrulus* (photo by Manuel Zafarana). Fig. 13: *Cyanecula svecica* (photo by Andrea Cortese).

summer breeder in open agricultural and steppe-like habitats. Spring arrival usually occurs in III, with the earliest individuals recorded in mid III (e.g. 18.III.2020; 18.III.2021). The breeding population is estimated at c. 25–35 pairs in the study area, with fledged juv. regularly observed between VI and VII. Artificial ground refuges have been installed to support nesting, and breeding pairs have been observed using drainage pipes and other artificial structures. Post-breeding movements occur mainly between VIII and IX, when small groups of up to 10–15 ind. may gather in recently ploughed fields.

Oenanthe isabellina (Temminck, 1829) Fig. 15
Isabelline Wheatear

Status: M irr. Rare migrant recorded occasionally during early spring. The first record involved 1 ind. observed on 18.III.2020. Additional observations include 2 ind. on 27.III.2022 and 1 ind. recorded on 04.III and 18.III.2025.

Familia MOTACILLIDAE

Anthus cervinus (Pallas, 1811)
Red-throated Pipit

Status: M reg., W reg. Frequency: uncommon wintering species (SO-W 30%; 12/40 grid cells). Regular winter visitor in open agricultural habitats and wetland edges, in accordance with recent studies documenting regular wintering of the species in Sicily (Surdo et al., 2023). Wintering numbers usually range between 8 and 12 ind. annually, with a maximum of 23 ind. recorded on 12.I.2024. The species is typically present between X and III, with occasional spring migration records extending into IV (e.g. up to 6 ind. on 09.IV.2025). Autumn arrival generally occurs in late X–XI.

Anthus richardi Vieillot, 1818
Richard's Pipit

Status: M occ, W occ. Frequency: accidental wintering species (SO-W 2.5%; 1/40 grid cells). It is very rare species in the study area. The first record involved 1 ind. observed on 09.VIII.2019. A second event occurred in winter 2025–2026, when 2 ind. were present from X.2025 until mid III.2026.



Figure 14. Representative bird species recorded in the study area: Geloi Plain (southern Sicily, Italy). Photo by Manuel Andrea Zafarana.

Anthus campestris (Linnaeus, 1758) Fig. 16
Tawny Pipit

Status: M reg., B reg. Frequency: rare breeder (SO-B 18%; 7/40 grid cells). Localized breeder associated with open steppe-like agricultural habitats. Breeding has been confirmed continuously since 2020, with at least 3 pairs recorded in the study area. Juveniles are regularly observed between VII and VIII, indicating successful breeding. The species is mainly recorded between IV and IX, with small groups observed during the breeding period (e.g. up to 7 ind. on 04.IV.2020). Occasional records outside the breeding season have been documented, including observations in I.2021.

Familia EMBERIZIDAE

Emberiza schoeniclus (Linnaeus, 1758)
Reed Bunting

Status: M reg., W reg. Frequency: rare wintering species (SO-W 15%; 6/40 grid cells). Regular winter visitor associated with reedbeds and wetland edges. Observations occur mainly between X and II, with occasional records in early spring. Wintering groups (4–15 ind.) are typically recorded in wetland habitats, especially within restored reedbeds of *Phragmites australis* and adjacent *Tamarix* stands.



Figures 15, 16. Representative bird species recorded in the study area: Geloi Plain (southern Sicily, Italy).
Fig. 15: *Oenanthe isabellina*. Fig. 16: *Anthus campestris*. Photos by Andrea Cortese.

DISCUSSION

Effects of wetland restoration on wintering waterbird dynamics

The analysis of IWC data collected between 2016 and 2026 clearly highlights the positive effect of wetland restoration measures implemented in the study area between 2020 and 2022. Comparison between the pre- and post-restoration phases reveals a marked shift in the dynamics of wintering waterbird communities: species previously occasional or scarce showed a rapid and consistent response following the increase in wetland surface area and the improved hydrological stability. The rise in mean annual abundance and maximum counts recorded for several Anatidae species suggests a substantial increase in the carrying capacity of the site (Fig. 17) consistent with widely documented responses of waterbird communities to habitat restoration in Mediterranean wetlands (Froneman et al., 2001; Zedler & Kercher, 2005; Kingsford et al., 2010). Wader species such as Northern Lapwing (*Vanellus vanellus*) and European Golden Plover (*Pluvialis apricaria*) also benefited from the presence of muddy substrates and shallow flooded surfaces, key conditions for winter foraging and resting. These results are consistent with previous studies showing that habitat heterogeneity and hydrological stability are key factors

determining waterbird abundance and diversity in restored wetlands (Sebastián-González & Green, 2014). Overall, the creation and management of permanent and temporary wetlands transformed a landscape previously characterized by strong hydrological variability into a more functional wetland system capable of supporting stable wintering populations, confirming that even relatively small wetland restoration initiatives (≈50–60 ha) can produce rapid and measurable biodiversity responses in Mediterranean agricultural landscapes.

Ecological role of Geloi Wetland for bird communities

Beyond wintering waterbirds, the Geloi Wetland reserve currently performs a multifunctional ecological role within the wider landscape of the Gela Plain, providing suitable habitats for several ecological guilds of bird species. Mediterranean agricultural landscapes characterised by a mosaic of wetlands, semi-natural habitats and extensive farmland are known to support high levels of avian diversity, particularly when habitat heterogeneity is maintained (Donald et al., 2001; Benton et al., 2003). Wetlands and ecotonal environments are known to support high avian diversity by increasing habitat heterogeneity and resource availability (Ma et al., 2010; Finlayson et al., 2018). In this context, the significantly higher bird species richness recorded in grid

cells including the Geloi Wetland restoration area further highlights the ecological importance of wetland habitats embedded within the agricultural landscape of the Plain of Gela. This pattern likely reflects the positive effects of recent habitat restoration and management actions, which have increased habitat heterogeneity and resource availability for both breeding and wintering bird communities. The area serves as an important post-breeding foraging site for Red-rumped Swallow *Cecropis daurica rufula*, hosting regular aggregations of individuals engaged in intensive aerial foraging. Such concentrations likely support the accumulation of energy reserves required for the subsequent migration towards African wintering grounds, highlighting the role of productive foraging habitats in facilitating long-distance migration (Newton, 2008; Surdo et al., 2024). Similarly, the area is regularly used as a wintering site by Red-throated Pipit *Anthus cervinus*, which occurs mainly in association with temporarily flooded saline grasslands and Mediterranean halophytic habitats. These environments represent ecologically valuable but increasingly threatened habitats across the Mediterranean basin due to land-use changes, hydrological alteration and coastal development (Médail & Quézel, 1999; Cox et al., 2006; Surdo et al., 2023). The site also supports breeding populations of conservation-priority species including Stone-curlew *Burhinus oediconemus*, Black-winged Stilt *Himantopus himantopus* and Collared Pratincole *Glareola pratincola*. These species are typically associated with open landscapes characterised by sparse vegetation and low disturbance levels, conditions that can still be maintained within traditional agricultural systems and semi-natural steppe habitats (Tucker & Heath, 1994; BirdLife International, 2021). The higher breeding species richness observed within the reserve likely reflects the greater habitat heterogeneity and the presence of restored wetland habitats. The surrounding agricultural matrix further enhances the ecological functionality of the area. Extensive cereal crops, fallow lands and lightly grazed habitats provide suitable feeding grounds for large wintering flocks of plovers and lapwings and support a diverse raptor assemblage, including several species of harriers (*Circus aeruginosus*, *C. cyaneus*, *C. macrourus* and *C. pygargus*). Such predator assemblages are often indicative of landscapes with relatively intact trophic networks and adequate prey availability (Sergio et al., 2008). Overall, the coexistence of wet-

lands, open agricultural habitats and semi-natural vegetation patches within the Geloi Plain creates a structurally heterogeneous landscape capable of supporting a diverse bird community throughout the annual cycle. This landscape complexity likely underlies the high species richness recorded in the study area and highlights the importance of the Geloi Wetland system as a key habitat for both breeding and wintering birds within the agricultural matrix of southern Sicily. Wetland restoration led to a clear functional shift in the wintering bird community, from wader-dominated assemblages associated with open, temporary habitats to communities dominated by Anatidae and Rallidae, reflecting increased habitat stability and structural complexity (Fig. 17).

Biogeographical relevance and stepping-stone function

The wetlands of the Gela Plain represent an important ecological node within the network of coastal and inland wetlands used by migratory birds crossing Sicily, which lies along one of the main Europe–Africa migratory routes (Harrison, 2016; Newton, 2008). In fragmented landscapes, small but functional wetlands play a crucial role in maintaining connectivity among migratory stopover sites (Taylor et al., 1993; Levey et al., 2005; Mitchell et al., 2013). The observations reported in this study suggest that the Geloi wetlands contribute to this connectivity network by offering a combination of shallow water bodies, temporary flooded areas and open agricultural habitats capable of supporting a diverse assemblage of migratory and wintering species. This role is especially relevant in the Mediterranean region, where coastal wetlands have undergone extensive degradation and loss over the past decades as a consequence of land reclamation, urbanisation and agricultural intensification (Perennou et al., 2012). In this context, the Geloi wetlands represent an example of how relatively small restoration initiatives can contribute to strengthening the network of Mediterranean wetlands used by migratory birds. By increasing habitat availability and improving ecological conditions for feeding and resting, these restored habitats may enhance the resilience of migratory systems in a region where environmental pressures and climate change are progressively altering habitat distribution and availability.

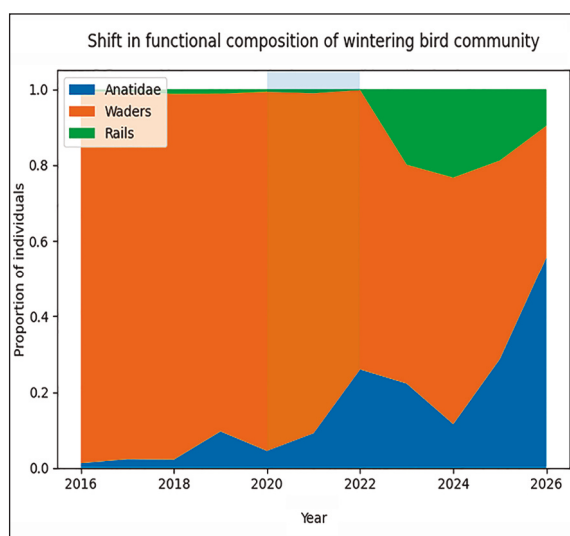


Figure 17. Changes in functional composition of the wintering bird community from 2016 to 2026. Values represent the proportion of individuals belonging to major ecological groups (Anatidae, waders, and rails). The shaded area (2020–2022) indicates the period of wetland restoration. A marked shift from wader-dominated assemblages to communities increasingly dominated by waterfowl and rails is evident after restoration.

Conservation implications and management perspectives

The high proportion of Annex I species (29.9%) and species of European conservation concern (SPEC categories: 28.9%) further confirms the importance of the Geloi wetlands as a key site for bird conservation within an agricultural landscape. The rapid response of several waterbird species following the restoration of wetland habitats demonstrates the effectiveness of relatively small-scale ecological interventions in improving habitat suitability and increasing the ecological functionality of degraded landscapes. In Mediterranean regions, where wetlands have historically undergone extensive drainage and land conversion, restoration and management initiatives represent a key strategy for reversing biodiversity loss and enhancing ecosystem resilience (Zedler & Kercher, 2005; Perennou et al., 2012). The Geloi Wetland provides a clear example of how the recovery of shallow-water habitats, combined with appropriate management practices, can rapidly increase the attractiveness of a site for both migratory and wintering bird species. The conservation value of the area is further enhanced by the

coexistence of wetlands with extensive agricultural habitats, which together create a heterogeneous landscape capable of supporting multiple ecological guilds. Numerous studies have shown that low-intensity farming systems and structurally diverse agricultural landscapes can significantly contribute to maintaining bird diversity, particularly in Mediterranean environments where traditional agroecosystems play an important ecological role (Benton et al., 2003; Tschardt et al., 2005).

In the Geloi Plain, fallow fields, cereal crops and semi-natural grasslands provide important feeding areas for raptors and steppe-associated species, complementing the trophic resources offered by the wetland habitats. Despite these positive developments, several potential threats may still affect the long-term conservation of the area. Illegal hunting, off-road vehicle traffic and unregulated land-use changes remain among the most relevant disturbance factors that may negatively influence bird communities by altering habitat structure or increasing disturbance levels. In Mediterranean wetlands, such pressures are frequently associated with declining habitat quality and reduced suitability for sensitive species (Mediterranean Wetlands Observatory, 2018). For these reasons, the continued implementation of active habitat management and monitoring programmes appears essential to ensure the persistence of the ecological functions currently provided by the Geloi wetlands. Conservation strategies should prioritise the maintenance of hydrological conditions favourable to waterbirds, the protection of breeding habitats for species of conservation concern and the promotion of wildlife-friendly agricultural practices within the surrounding landscape. More broadly, the Geloi experience demonstrates how integrating habitat restoration with sustainable land-use management represents an effective approach for biodiversity conservation in Mediterranean agricultural landscapes.

CONCLUSIONS

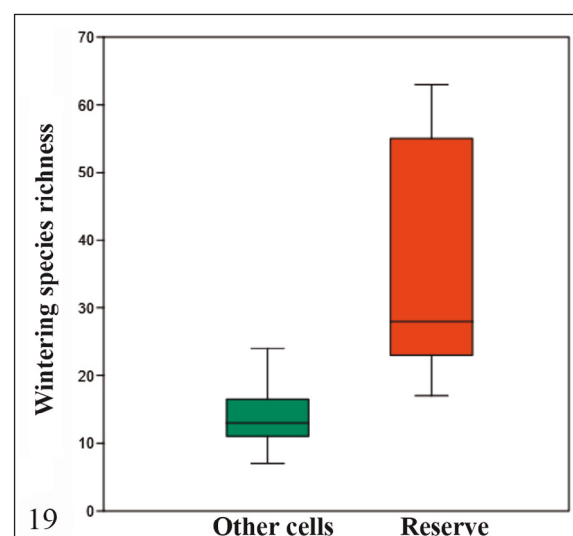
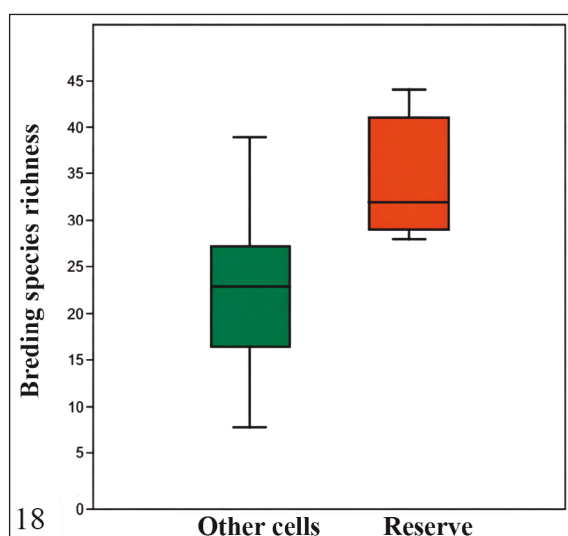
The results of this study highlight the growing ecological importance of the Geloi sector within the Gela Plain as a key site for bird conservation in southern Sicily. In the study area, 194 bird species

were recorded, corresponding to 43.8% of the bird species observed in Sicily (Massa et al., 2021). The restoration of wetland habitats carried out between 2020 and 2022 has significantly increased the capacity of the area to support wintering and migratory waterbirds, leading to rapid increases in both species occurrence and population size. At the same time, the coexistence of wetlands, traditional agricultural habitats and semi-natural areas supports a diverse bird community that includes breeding species of conservation concern, regular wintering waterbirds and several rare or occasional migrants. The results clearly show that environmental restoration interventions produced a significant increase in species richness both during the breeding season and during wintering. For breeding birds, restored cells have a median of 32 species compared to 23 for non-restored cells, with a large effect (Cliff's $\delta = 0.82$) (Fig. 18). This suggests that restoration has increased structural heterogeneity and the availability of suitable nesting habitats, favouring a greater number of territorial species. The effect is even more marked in winter, where the median increases from 13 to 28 species and the effect size reaches very high values (Cliff's $\delta = 0.90$) (Fig. 19). Within the broader Mediterranean context, the Geloï wetlands represent an important functional node along the Central Mediterranean migratory flyway, contributing to ecological connectivity among stopover sites. At the landscape scale, the area also plays a strategic role within the Natura 2000

network of the Gulf of Gela, acting as a connecting element between the Biviere di Gela Lake, the Spinasanta marshes, the cork-oak forests of Sughereta di Niscemi and Bosco Santo Pietro, and the coastal dune systems. Within this landscape framework, the Geloï wetlands function as a key stepping-stone habitat linking these major Natura 2000 sites and reinforcing one of the most important ecological corridors for biodiversity conservation in southern Sicily.

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Figures 18, 19. Comparison of breeding and wintering species richness between grid cells including the Geloï Wetland restoration area and the surrounding agricultural landscape. Fig. 18: Boxplots show median, interquartile range and extreme values of breeding species richness. Fig. 19: Boxplots show median, interquartile range and extreme values for wintering bird communities.

Scientific name	English name	Italian name	Birds Dir. Annex	SPEC (1-3, NS)	IUCN (GL/EU/IT)	Phenology
GALLIFORMES PHASIANIDAE						
<i>Coturnix coturnix</i>	Common Quail	Quaglia	Ann. IIb	3	LC/NT/DD	B M W reg
<i>Alectoris graeca whitakeri</i>	Sicilian Rock Partridge	Coturnice siciliana	Ann. I	1	NA/NA/VU	R
<i>Alectoris rufa</i>	Red-legged Partridge	Pernice rossa	Ann. IIa/IIIa	1	NT/NT/DD	A
ANSERIFORMES ANATIDAE						
<i>Tadorna tadorna</i>	Common Shelduck	Volpoca	-	NS	LC/LC/VU	M W reg
<i>Tadorna ferruginea</i>	Ruddy Shelduck	Casarca	Ann. I	NS	LC/LC/NA	M W occ
<i>Aythya ferina</i>	Common Pochard	Moriglione	Ann. IIa/IIIb	1	VU/VU/VU	M W irr
<i>Aythya nyroca</i>	Ferruginous Duck	Moretta tabaccata	Ann. I	1	NT/LC/EN	M W reg
<i>Spatula querquedula</i>	Garganey	Marzaiola	Ann. IIa	3	LC/LC/VU	M reg
<i>Spatula clypeata</i>	Northern Shoveler	Mestolone	Ann. IIa/IIIb	3	LC/LC/VU	M W reg
<i>Mareca strepera</i>	Gadwall	Canapiglia	Ann. IIa	NS	LC/LC/NT	M W reg
<i>Mareca penelope</i>	Eurasian Wigeon	Fischione	Ann. IIa/IIIb	NS	LC/LC/NA	M W reg
<i>Anas platyrhynchos</i>	Mallard	Germano reale	Ann. IIa/IIIa	3	LC/LC/LC	R B M W reg
<i>Anas acuta</i>	Northern Pintail	Codone	Ann. IIa/IIIb	3	LC/VU/NA	M W reg
<i>Anas crecca</i>	Common Teal	Alzavola	Ann. IIa/IIIb	NS	LC/LC/EN	M W reg
PODICIPEDIFORMES PODICIPEDIDAE						
<i>Tachybaptus ruficollis</i>	Little Grebe	Tuffetto	-	NS	LC/LC/LC	B M W reg
<i>Podiceps nigricollis</i>	Black-necked Grebe	Svasso piccolo	-	3	LC/VU/NA	M irr, W occ
PHOENICOPTERIFORMES PHOENICOPTERIDAE						
<i>Phoenicopterus roseus</i>	Greater Flamingo	Fenicottero	-	NS	LC/LC/LC	M W occ
COLUMBIFORMES COLUMBIDAE						
<i>Columba livia</i> var. <i>domestica</i>	Rock Dove	Piccione domestico	Ann. IIa	NS	LC/LC/DD	R
<i>Columba oenas</i>	Stock Dove	Colombella	Ann. IIb	NS	LC/LC/DD	W occ
<i>Columba palumbus</i>	Wood Pigeon	Colombaccio	Ann. IIIa	NS	LC/LC/LC	B M W reg
<i>Streptopelia turtur</i>	European Turtle-dove	Tortora selvatica	Ann. IIb	1	VU/VU/LC	B M reg
<i>Streptopelia decaocto</i>	Eurasian Collared-dove	Tortora dal collare	Ann. IIb	NS	LC/LC/LC	R
<i>Spilopelia senegalensis</i>	Laughing Dove	Tortora delle palme	-	NS	LC/LC/NA	A
CAPRIMULGIFORMES CAPRIMULGIDAE						
<i>Caprimulgus europaeus</i>	European Nightjar	Succiacapre	Ann. I	NS	LC/LC/LC	B occ, M reg

APODIDAE						
<i>Tachymarptis melba</i>	Alpine Swift	Rondone maggiore	-	NS	LC/LC/LC	M reg
<i>Apus apus</i>	Common Swift	Rondone comune	-	3	LC/NT/LC	M reg
CUCULIFORMES CUCULIDAE						
<i>Clamator glandarius</i>	Great Spotted Cuckoo	Cuculo dal ciuffo	-	3	LC/VU/EN	B M reg
<i>Cuculus canorus</i>	Common Cuckoo	Cuculo	-	NS	LC/LC/NT	M reg, B occ
GRUIFORMES RALLIDAE						
<i>Rallus aquaticus</i>	Water Rail	Porciglione	Ann. IIb	NS	LC/LC/LC	R B W reg
<i>Porzana porzana</i>	Spotted Crake	Voltolino	Ann. I	2	LC/LC/CR	M occ
<i>Zapornia parva</i>	Little Crake	Schiribilla	Ann. I	NS	LC/LC/CR	M occ
<i>Porphyrio porphyrio</i>	Purple Swamphen	Pollo sultano	Ann. I	NS	LC/LC/NT	R B W reg
<i>Gallinula chloropus</i>	Common Moorhen	Gallinella d'acqua	Ann. IIb	NS	LC/LC/LC	R B reg
<i>Fulica atra</i>	Eurasian Coot	Folaga	Ann. IIa/IIIb	3	LC/LC/LC	B M W reg
GRUIDAE						
<i>Grus grus</i>	Common Crane	Gru	Ann. I	NS	LC/LC/RE	M reg, W irr
CICONIIFORMES CICONIIDAE						
<i>Ciconia nigra</i>	Black Stork	Cicogna nera	Ann. I	NS	LC/LC/EN	M irr, W occ
<i>Ciconia ciconia</i>	White Stork	Cicogna bianca	Ann. I	NS	LC/LC/LC	R B M W reg
PELECANIFORMES THRESKIORNITHIDAE						
<i>Platalea leucorodia</i>	Eurasian Spoonbill	Spatola	Ann. I	NS	LC/LC/NT	M irr, W occ
<i>Threskiornis aethiopicus</i>	African Sacred Ibis	Ibis sacro	-	-	LC/NA/NA	A
<i>Plegadis falcinellus</i>	Glossy Ibis	Mignattaio	Ann. I	NS	LC/LC/VU	M reg
ARDEIDAE						
<i>Botaurus stellaris</i>	Eurasian Bittern	Tarabuso	Ann. I	NS	LC/LC/EN	M W reg
<i>Ixobrychus minutus</i>	Common Little Bittern	Tarabusino	Ann. I	NS	LC/LC/VU	M irr
<i>Nycticorax nycticorax</i>	Black-crowned Night-heron	Nitticora	Ann. I	NS	LC/LC/LC	M reg, B W irr
<i>Ardeola ralloides</i>	Squacco Heron	Sgarza ciuffetto	Ann. I	NS	LC/LC/NT	M reg
<i>Bubulcus ibis</i>	Cattle Heron	Airone guardabuoi	-	NS	LC/LC/LC	M W reg
<i>Ardea cinerea</i>	Grey Heron	Airone cenerino	-	NS	LC/LC/LC	M W reg
<i>Ardea purpurea</i>	Purple Heron	Airone rosso	Ann. I	NS	LC/LC/LC	M reg
<i>Ardea alba</i>	Great Egret	Airone bianco maggiore	Ann. I	NS	LC/LC/NT	M W reg
<i>Egretta garzetta</i>	Little Egret	Garzetta	Ann. I	NS	LC/LC/LC	M W reg

SULIFORMES PHALACROCORACIDAE						
<i>Phalacrocorax carbo</i>	Great Cormorant	Cormorano	-	NS	LC/LC/LC	M reg, W irr
CHARADRIIFORMES BURHINIDAE						
<i>Burhinus oedicnemus</i>	Eurasian Stone-curlew	Occhione	Ann. I	3	LC/LC/LC	R B M W reg
RECURVIROSTRIDAE						
<i>Recurvirostra avosetta</i>	Pied Avocet	Avocetta	Ann. I	NS	LC/LC/LC	M W irr
<i>Himantopus himantopus</i>	Black-winged Stilt	Cavaliere d'Italia	Ann. I	NS	LC/LC/LC	B M reg
CHARADRIIDAE						
<i>Pluvialis apricaria</i>	European Golden Plover	Piviere dorato	Ann. I/Ib/IIIb	NS	LC/LC/NA	M W reg
<i>Charadrius hiaticula</i>	Common Ringed Plover	Corriere grosso	-	NS	LC/LC/NA	M irr, W occ
<i>Charadrius dubius</i>	Little Ringed Plover	Corriere piccolo	-	NS	LC/LC/LC	M reg, W occ
<i>Vanellus vanellus</i>	Lapwing	Pavoncella	Ann. Ib	1	NT/VU/LC	M W reg
SCOLOPACIDAE						
<i>Numenius phaeopus</i>	Eurasian Whimbrel	Chiurlo piccolo	Ann. Ib	NS	LC/LC/NA	M occ
<i>Numenius arquata</i>	Eurasian Curlew	Chiurlo maggiore	Ann. Ib	1	NT/NT/NA	M W reg
<i>Limosa limosa</i>	Black-tailed Godwit	Pittima reale	Ann. Ib	1	NT/NT/EN	M reg
<i>Calidris pugnax</i>	Ruff	Combattente	Ann. I/Ib	2	LC/NT/NA	M reg, W irr
<i>Calidris ferruginea</i>	Curlew Sandpiper	Piovanello comune	-	1	VU/VU/NA	M irr
<i>Calidris temminckii</i>	Temminck's Stint	Gambecchio nano	-	3	LC/LC/NA	M reg, W irr
<i>Calidris alpina</i>	Dunlin	Piovanello pancianera	-	3	NT/LC/NA	M reg, W irr
<i>Calidris minuta</i>	Little Stint	Gambecchio comune	-	NS	LC/LC/NA	M reg, W irr
<i>Calidris melanotos</i>	Pectoral Sandpiper	Piovanello pettorale	-	-	LC/NA/NA	A
<i>Gallinago gallinago</i>	Common Snipe	Beccaccino	Ann. IIa/IIIb	3	LC/VU/NA	M W reg
<i>Lymnocyrtus minimus</i>	Jack Snipe	Frullino	Ann. IIa/IIIb	3	LC/LC/NA	M irr
<i>Actitis hypoleucos</i>	Common Sandpiper	Piro piro piccolo	-	NS	LC/LC/NT	M irr
<i>Tringa ochropus</i>	Green Sandpiper	Piro piro culbianco	-	NS	LC/LC/NA	M W reg
<i>Tringa erythropus</i>	Spotted Redshank	Totano moro	Ann. Ib	3	LC/LC/NA	M W reg
<i>Tringa nebularia</i>	Common Greenshank	Pantana	Ann. Ib	NS	LC/LC/NA	M W reg
<i>Tringa totanus</i>	Common Redshank	Pettegola	Ann. Ib	2	LC/VU/LC	M W reg
<i>Tringa glareola</i>	Wood Sandpiper	Piro piro boschereccio	Ann. I	NS	LC/LC/NA	M W irr
<i>Tringa stagnatilis</i>	Marsh Sandpiper	Albastrello	-	NS	LC/LC/NA	M occ

GLAREOLIDAE						
<i>Glareola pratincola</i>	Collared Pratincole	Pernice di mare	Ann. I	NS	LC/LC/EN	B M reg
LARIDAE						
<i>Larus ridibundus</i>	Black-headed Gull	Gabbiano comune	Ann. IIb	2	LC/LC/LC	M irr, W occ
<i>Larus michahellis</i>	Yellow-legged Gull	Gabbiano reale	-	NS	LC/LC/LC	M W reg
<i>Gelochelidon nilotica</i>	Gull-billed Tern	Sterna zampenere	Ann. I	NS	LC/LC/NT	M occ
<i>Chlidonias hybrida</i>	Whiskered Tern	Mignattino piombato	Ann. I	NS	LC/LC/VU	M occ
STRIGIFORMES TYTONIDAE						
<i>Tyto alba</i>	Barn Owl	Barbagianni	-	NS	LC/LC/LC	R
STRIGIDAE						
<i>Athene noctua</i>	Little Owl	Civetta	-	NS	LC/LC/LC	R
<i>Otus scops</i>	Eurasian Scops Owl	Assiolo	-	NS	LC/LC/LC	B M reg, W irr
<i>Asio otus</i>	Long-eared Owl	Gufo comune	-	NS	LC/LC/LC	R B M W reg
<i>Asio flammeus</i>	Short-eared Owl	Gufo di palude	Ann. I	NS	LC/LC/NA	M reg, W irr
ACCIPITRIFORMES PANDIONIDAE						
<i>Pandion haliaetus</i>	Osprey	Falco pescatore	Ann. I	NS	LC/LC/CR	M W irr
ACCIPITRIDAE						
<i>Pernis apivorus</i>	European Honey-buzzard	Falco pecchiaiolo	Ann. I	NS	LC/LC/LC	M reg
<i>Neophron percnopterus</i>	Egyptian Vulture	Capovaccaio	Ann. I	1	EN/VU/CR	M occ
<i>Circaetus gallicus</i>	Short-toed Snake-Eagle	Biancone	Ann. I	NS	LC/LC/LC	M W reg
<i>Clanga pomarina</i>	Lesser Spotted Eagle	Aquila anatraia minore	Ann. I	NS	LC/LC/NA	M occ
<i>Aquila heliaca</i>	Eastern Imperial Eagle	Aquila imperiale	Ann. I	1	VU/LC/NA	M W irr
<i>Aquila fasciata</i>	Bonelli's Eagle	Aquila di Bonelli	Ann. I	3	LC/LC/EN	R
<i>Hieraaetus pennatus</i>	Booted Eagle	Aquila minore	Ann. I	NS	LC/LC/NA	M W reg
<i>Circus aeruginosus</i>	Western Marsh Harrier	Falco di palude	Ann. I	NS	LC/LC/VU	M W reg
<i>Circus cyaneus</i>	Hen Harrier	Albanella reale	Ann. I	3	LC/LC/NA	M W reg
<i>Circus macrourus</i>	Pallid Harrier	Albanella pallida	Ann. I	1	NT/LC/NA	M W reg
<i>Circus pygargus</i>	Montagu's Harrier	Albanella minore	Ann. I	NS	LC/LC/VU	B ?, M reg, W occ
<i>Accipiter nisus</i>	Eurasian Sparrowhawk	Sparviere	-	NS	LC/LC/LC	M W reg
<i>Milvus milvus</i>	Red Kite	Nibbio reale	Ann. I	NS	LC/LC/VU	M W occ
<i>Milvus migrans</i>	Black Kite	Nibbio bruno	Ann. I	NS	LC/LC/LC	M reg, W irr

<i>Buteo buteo</i>	Eurasian Buzzard	Poiana	-	NS	LC/LC/LC	B M W reg
<i>Buteo rufinus</i>	Long-legged Buzzard	Poiana codabianca	Ann. I	NS	LC/LC/NA	M W irr
BUCEROTIFORMES UPUPIDAE						
<i>Upupa epops</i>	Common Hoopoe	Upupa	-	NS	LC/LC/LC	R B M W reg
CORACIIFORMES MEROPIDAE						
<i>Merops apiaster</i>	European Bee-eater	Gruccione	-	NS	LC/LC/NT	B M reg
CORACIIDAE						
<i>Coracias garrulus</i>	European Roller	Ghiandaia marina	Ann. I	2	LC/LC/LC	B M reg
ALCEDINIDAE						
<i>Alcedo atthis</i>	Common Kingfisher	Martin pescatore	Ann. I	NS	LC/LC/NT	M reg, W irr
PICIDAE						
<i>Jynx torquilla</i>	Eurasian Wryneck	Torcicollo	-	NS	LC/LC/EN	B M reg, W occ
FALCONIFORMES FALCONIDAE						
<i>Falco naumanni</i>	Lesser Kestrel	Grillaio	Ann. I	3	LC/LC/LC	B M reg, W irr
<i>Falco tinnunculus</i>	Common Kestrel	Gheppio	-	3	LC/LC/LC	R
<i>Falco vespertinus</i>	Red-footed Falcon	Falco cuculo	Ann. I	1	VU/VU/VU	M reg
<i>Falco columbarius</i>	Merlin	Smeriglio	Ann. I	3	LC/VU/NA	M W reg
<i>Falco subbuteo</i>	Eurasian Hobby	Lodolaio	-	NS	LC/LC/LC	M irr
<i>Falco biarmicus</i>	Lanner Falcon	Lanario	Ann. I	3	LC/EN/EN	A
<i>Falco cherrug</i>	Saker Falcon	Sacro	Ann. I	1	EN/EN/NA	M W irr
<i>Falco peregrinus</i>	Peregrine Falcon	Falco pellegrino	Ann. I	NS	LC/LC/LC	M W reg
PSITTACIFORMES PSITTACIDAE						
<i>Psittacula krameri</i>	Rose-ringed Parakeet	Parrocchetto dal collare	-	-	LC/NA/NA	A
PASSERIFORMES ORIOLIDAE						
<i>Oriolus oriolus</i>	Eurasian Golden Oriole	Rigogolo	-	NS	LC/LC/LC	M reg
LANIIDAE						
<i>Lanius excubitor algeriensis</i>	Great Grey Shrike	Averla maggiore algerina	-	-	LC/LC/NA	A
<i>Lanius senator</i>	Woodchat Shrike	Averla capirossa	-	1	NT/NT/EN	B M reg
CORVIDAE						
<i>Garrulus glandarius</i>	Eurasian Jay	Ghiandaia	Ann. IIb	NS	LC/LC/LC	R
<i>Pica pica</i>	Eurasian Magpie	Gazza	Ann. IIb	NS	LC/LC/LC	R
<i>Corvus monedula</i>	Eurasian Jackdaw	Taccola	Ann. IIb	NS	LC/LC/LC	R

<i>Corvus corax</i>	Common Raven	Corvo imperiale	-	NS	LC/LC/LC	R
<i>Corvus cornix</i>	Hooded Crow	Cornacchia grigia	Ann. IIb	NS	LC/LC/LC	R
PARIDAE						
<i>Cyanistes caeruleus</i>	Eurasian Blue Tit	Cinciarella	-	NS	LC/LC/LC	R
<i>Parus major</i>	Great Tit	Cinciallegria	-	NS	LC/LC/LC	R
REMIZIDAE						
<i>Remiz pendulinus</i>	Eurasian Penduline-tit	Pendolino	-	NS	LC/LC/VU	R B M W reg
ALAUDIDAE						
<i>Melanocorypha calandra</i>	Calandra Lark	Calandra	Ann. I	3	LC/LC/VU	B M W irr
<i>Calandrella brachydactyla</i>	Greater Short-toed Lark	Calandrella	Ann. I	3	LC/LC/LC	B M reg
<i>Lullula arborea</i>	Woodlark	Tottavilla	Ann. I	NS	LC/LC/LC	R
<i>Alauda arvensis</i>	Eurasian Skylark	Allodola	Ann. IIb	3	LC/LC/VU	M W reg
<i>Galerida cristata</i>	Crested Lark	Cappellaccia	-	3	LC/LC/LC	R
CISTICOLIDAE						
<i>Cisticola juncidis</i>	Zitting Cisticola	Beccamoschino	-	NS	LC/LC/LC	R
ACROCEPHALIDAE						
<i>Hippolais icterina</i>	Icterine Warbler	Canapino maggiore	-	NS	LC/LC/NA	M irr
<i>Acrocephalus schoenobaenus</i>	Sedge Warbler	Forapaglie comune	-	NS	LC/LC/CR	M reg
<i>Acrocephalus scirpaceus</i>	Common Reed-warbler	Cannaiola comune	-	NS	LC/LC/LC	B M reg
<i>Acrocephalus arundinaceus</i>	Great Reed-warbler	Cannareccione	-	NS	LC/LC/NT	B M reg
LOCUSTELLIDAE						
<i>Locustella luscinioides</i>	Savi's Warbler	Salciaiola	-	NS	LC/LC/EN	M occ
HIRUNDINIDAE						
<i>Delichon urbicum</i>	Northern House Martin	Balestruccio	-	2	LC/LC/NT	M reg
<i>Cecropis daurica rufula</i>	Red-rumped Swallow	Rondine rossiccia	-	NS	LC/LC/VU	B irr, M reg
<i>Hirundo rustica</i>	Barn Swallow	Rondine	-	3	LC/LC/NT	B M reg
<i>Riparia riparia</i>	Collared Sand Martin	Topino	-	NS	LC/LC/VU	M reg
PHYLLOSCOPIDAE						
<i>Phylloscopus sibilatrix</i>	Wood Warbler	Lui verde	-	2	LC/LC/LC	M reg
<i>Phylloscopus trochilus</i>	Willow Warbler	Lui grosso	-	3	LC/LC/NA	M reg
<i>Phylloscopus collybita</i>	Common Chiffchaff	Lui piccolo	-	NS	LC/LC/LC	M W reg
SCOTOCERCIDAE						
<i>Cettia cetti</i>	Cetti's Warbler	Usignolo di fiume	-	NS	LC/LC/LC	R

SYLVIIDAE						
<i>Sylvia atricapilla</i>	Eurasian Blackcap	Capinera	-	NS	LC/LC/LC	B M W reg
<i>Sylvia borin</i>	Garden Warbler	Beccafico	-	NS	LC/LC/EN	M reg
<i>Sylvia melanocephala</i>	Sardinian Warbler	Occhiocotto	-	NS	LC/LC/LC	R
<i>Sylvia cantillans</i>	Subalpine Warbler	Sterpazzolina	-	NS	LC/LC/LC	B M reg
<i>Sylvia communis</i>	Common Whitethroat	Sterpazzola	-	NS	LC/LC/LC	M reg
<i>Sylvia conspicillata</i>	Spectacled Warbler	Sterpazzola della Sardegna	-	NS	LC/LC/LC	B M reg
CERTHIIDAE						
<i>Certhia brachydactyla</i>	Short-toed Treecreeper	Rampichino comune	-	NS	LC/LC/LC	R
STURNIDAE						
<i>Sturnus vulgaris</i>	Common Starling	Storno comune	Ann. IIb	NS	LC/LC/LC	M W reg
<i>Sturnus unicolor</i>	Spotless Starling	Storno nero	-	NS	LC/LC/LC	R
TURDIDAE						
<i>Turdus philomelos</i>	Song Thrush	Tordo bottaccio	Ann. IIb	NS	LC/LC/LC	M W reg
<i>Turdus merula</i>	Eurasian Blackbird	Merlo	Ann. IIb	NS	LC/LC/LC	R
MUSCICAPIDAE						
<i>Muscicapa striata</i>	Spotted Flycatcher	Pigliamosche	-	NS	LC/LC/LC	M reg
<i>Erithacus rubecula</i>	European Robin	Pettiorosso	-	NS	LC/LC/LC	M W reg
<i>Cyanecula svecica</i>	Bluethroat	Pettazzurro	Ann. I	NS	LC/LC/NA	M W reg
<i>Luscinia megarhynchos</i>	Common Nightingale	Usignolo	-	NS	LC/LC/LC	M reg
<i>Ficedula hypoleuca</i>	European Pied Flycatcher	Balia nera	-	2	LC/LC/NA	M reg
<i>Ficedula albicollis</i>	Collared Flycatcher	Balia dal collare	Ann. I	NS	LC/LC/LC	M reg
<i>Phoenicurus ochruros</i>	Black Redstart	Codiroso spazzacamino	-	NS	LC/LC/LC	M W reg
<i>Phoenicurus phoenicurus</i>	Common Redstart	Codiroso comune	-	NS	LC/LC/LC	M reg
<i>Monticola solitarius</i>	Blue Rock-thrush	Passero solitario	-	NS	LC/LC/NT	R M W reg
<i>Saxicola rubetra</i>	Whinchat	Stiaccino	-	NS	LC/LC/VU	M reg
<i>Saxicola torquatus rubicola</i>	Common Stonechat	Saltimpalo comune	-	NS	LC/LC/EN	R B M W reg
<i>Oenanthe oenanthe</i>	Northern Wheatear	Culbianco	-	NS	LC/LC/LC	M B reg
<i>Oenanthe isabellina</i>	Isabelline Wheatear	Culbianco isabellino	-	NS	LC/LC/NA	M irr
<i>Oenanthe hispanica</i>	Black-eared Wheatear	Monachella	-	2	LC/LC/DD	M reg
PRUNELLIDAE						

<i>Prunella modularis</i>	Dunnock	<i>Passera scopaiola</i>	-	2	LC/LC/NT	M W occ
PASSERIDAE						
<i>Passer italiae</i>	Italian Sparrow	<i>Passera d'Italia</i>	-	NS	VU/VU/VU	R
<i>Passer montanus</i>	Eurasian Tree Sparrow	<i>Passera mattugia</i>	-	3	LC/LC/NT	R
<i>Petronia petronia</i>	Rock Sparrow	<i>Passera lagia</i>	-	NS	LC/LC/LC	R
MOTACILLIDAE						
<i>Anthus trivialis</i>	Tree Pipit	<i>Prispolone</i>	-	3	LC/LC/LC	M reg
<i>Anthus cervinus</i>	Red-throated Pipit	<i>Pispola golarossa</i>	-	NS	LC/LC/NA	M W reg
<i>Anthus pratensis</i>	Meadow Pipit	<i>Pispola</i>	-	2	LC/LC/NA	M W reg
<i>Anthus richardi</i>	Richard's Pipit	<i>Calandro maggiore</i>	-	-	LC/NA/NA	W irr
<i>Anthus campestris</i>	Tawny Pipit	<i>Calandro</i>	Ann. I	NS	LC/LC/VU	B reg, W occ
<i>Motacilla flava</i>	Western Yellow Wagtail	<i>Cutrettola</i>	-	3	LC/LC/NT	M reg
<i>Motacilla cinerea</i>	Grey Wagtail	<i>Ballerina gialla</i>	-	NS	LC/LC/LC	M reg, W occ
<i>Motacilla alba</i>	White Wagtail	<i>Ballerina bianca</i>	-	NS	LC/LC/LC	M W reg
FRINGILLIDAE						
<i>Fringilla coelebs</i>	Common Chaffinch	<i>Fringuello</i>	-	NS	LC/LC/LC	M W reg
<i>Coccothraustes coccothraustes</i>	Hawfinch	<i>Frosone</i>	-	NS	LC/LC/LC	W occ
<i>Chloris chloris</i>	European Greenfinch	<i>Verdone</i>	-	NS	LC/LC/VU	B M W reg
<i>Linaria cannabina</i>	Common Linnet	<i>Fanello</i>	-	NS	LC/LC/NT	R M W reg
<i>Carduelis carduelis</i>	European Goldfinch	<i>Cardellino</i>	-	NS	LC/LC/NT	R M W reg
<i>Serinus serinus</i>	European Serin	<i>Verzellino</i>	-	NS	LC/LC/LC	R
<i>Spinus spinus</i>	Eurasian Siskin	<i>Lucherino</i>	-	NS	LC/LC/LC	M W irr
EMBERIZIDAE						
<i>Emberiza calandra</i>	Corn Bunting	<i>Strillozzo</i>	-	NS	LC/LC/LC	R
<i>Emberiza cirrus</i>	Cirl Bunting	<i>Zigolo nero</i>	-	NS	LC/LC/LC	R
<i>Emberiza schoeniclus</i>	Reed Bunting	<i>Migliarino di palude</i>	-	NS	LC/LC/CR	M W reg

Table 1. The complete checklist of bird species recorded in the Geloi Plain (Sicily, Italy) during the study period

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