Breeding birds in a small wetland before a habitat restoration LIFE project (Mola Muti; Latium; central Italy): a field note

GIUSEPPE DODARO
Fondazione per lo Sviluppo Sostenibile, via Garigliano 61a, 00198 Rome, Italy; https://orcid.org/0000-0003-3735-5828; e-mail: dodaro@susdef.it

CORRADO BATTISTI
"Torre Flavia" LTER (Long Term Ecological Research) Station, Città Metropolitana di Roma, Servizio Aree protette - Parchi Regionali – Via Ribotta, 41 – 00144 Rome, Italy; https://orcid.org/0000-0002-2621-3659; e-mail: c.battisti@cittametropolitanaroma.it

Abstract

We reported the data obtained by a standardized sampling (quantitative mapping method) focused on breeding birds, carried out before the LIFE17 NAT/IT/000619 'GREENCHANGE' restoring project (pre-operam step) located in the 'Mola Muti': a small wetland patch (a. 10 ha) along the Ufente river (Latina, central Italy). We recorded 32 bird species (25 breeding) in the period March-July, 2021 (28.5 pairs, with a density of 7.29 pairs/ha). The diversity indices (Shannon-Wiener and evenness) were high, suggesting a low level of environmental stress. Data can be useful for a comparison after the wetland restoration, so as to verify the effectiveness of the restoration project.

Key words: Breeding birds, small wetland, habitat restoration, LIFE project, Latium.

Riassunto

Uccelli nidificanti in una piccola zona umida prima del ripristino dell'habitat LIFE progetto (Mola Muti; Lazio; Italia centrale): note di campo
Si riportano i dati ottenuti da un mappaggio standardizzato degli uccelli nidificanti in un frammento di ambiente umido ('Mola Muti'; fiume Ufente; Latina, Italia centrale) effettuato precedentemente all'avvio di un progetto di ripristino ambientale (LIFE17 NAT/IT/000619 GREENCHANGE - Green infrastructures for increasing biodiversity in Agro Pontino and Maltese rural areas). Sono state contattate 34 specie (24 nidificanti) nel periodo Marzo-Luglio 2021 (28.5 coppie nidificanti; densità: 7.29 coppie/ha). Gli indici di diversità (Shannon-Wiener ed evenness) sono relativamente elevati ed evidenziano una comunità ornitica complessa, sottoposta ad un basso livello di stress antropogeno. I dati ottenuti saranno utili per comparazioni *before-after*, così da verificare l'efficacia del progetto di ripristino ambientale.

Parole chiave: Uccelli nidificanti, piccola zona umida, ripristino habitat, progetto LIFE, Lazio.

Introduction

Remnant wetlands embedded in the land reclaimed landscape of Southern Latium (Agro Pontino; central Italy; Linoli, 2005) are only occasionally studied (e.g., Zerunian, 1984; Budoni & Ricci, 2020) yet they have a high ecological value and are home to flora and fauna species of conservation interest (Iberite & Pelliccioni, 2009; Abati *et al.*, 2010; Raimondi, 2014). For this reason, the LIFE17 NAT/IT/000619 'GREENCHANGE *Green infrastructures for increasing biodiversity in Agro Pontino and Maltese rural areas*' project - which has set itself the general objective to preserve biodiversity and enhance the ecological value of the agro-ecosystems of Agro Pontino – has implemented some restoration ecology projects which have created new wetlands in the rural matrix and improved the ecological functionality of some of the already existing ones. In order to verify the fully effectiveness of these actions, an in-depth ex ante monitoring was carried out on different environmental components and numerous taxon groups of fauna including breeding birds, - whose characteristics as indicators will allow us to obtain useful data to compare with similar data collected after the project (Hockings *et al.*, 2006; Battisti, 2018).

This short note reports the data obtained following a standardized sampling protocol (quantitative mapping method) focused on breeding birds, carried out before the beginning of the restoring project (pre-operam step) in a small wet ecosystem located at the sources of the Ufente river, the largest natural watercourse in the Agro Pontino.

Material and methods

The study area (i.e., the project site; Sezze; Province of Latina; geographical coordinates: 41.482419 N; 13.085269 E) is approximately 10 ha large and includes two small wetlands: Lago Pani and Mola Muti. In the innermost area there is a dominant population of *Phragmites australis*, which leaves little space for typical species of hygrophilous flora including *Carex riparia* and the alien *Zantedeschia aethiopica*. The outermost areas are characterized by vegetation formations of little ecological value. On the north side there is a newly formed wood patch, dominated by *Ailanthus altissima* with sporadic examples of hygrophilous (e.g. *Ulmus minor, Populus* sp., *Salix* sp.) and thermophilic species, such as *Rhamnus alaternus* and *Pistacia lentiscus*. On the other sides there is a large population of *Arundo donax* interspersed with areas occupied by recoloni-

		Buffer			Project site		
Species	n	pa	D	fr	pa	D	fr
Anas platyrhynchos Linnaeus. 1758	5	1	0.105	0.016	1	0.256	0.035
Tachybaptus ruficollis (Pallas. 1764)	8	1	0.105	0.016	0.5	0.128	0.018
Streptopelia turtur (Linnaeus. 1758)	4	2	0.210	0.032	1	0.256	0.035
Streptopelia decaocto (Frivaldszky. 1838)	6	2.5	0.262	0.040	1	0.256	0.035
Cuculus canorus Linnaeus. 1758	2	0.5	0.052	0.008	0	0	0
Gallinula chloropus (Linnaeus. 1758)	18	4.5	0.472	**0.073**	3	0.767	**0.105**
Fulica atra Linnaeus. 1758	15	3	0.314	0.048	2	0.512	**0.070**
Alcedo atthis Linnaeus. 1758	8	1	0.105	0.016	0.5	0.128	0.018
Falco tinnunculus Linnaeus. 1758	3	0.5	0.052	0.008	0.5	0.128	0.018
Pica pica (Linnaeus. 1758)	4	0.5	0.052	0.008	0	0	0
Cyanistes caeruleus (Linnaeus. 1758)	3	2	0.210	0.032	1	0.256	0.035
Parus major Linnaeus. 1758	7	3	0.314	0.048	2	0.512	**0.070**
Cisticola juncidis (Rafinesque. 1810)	7	2	0.210	0.032	0.5	0.128	0.018
Acrocephalus scirpaceus (Hermann. 1804)	7	4	0.419	**0.065**	2	0.512	**0.070**
Cettia cetti (Temminck. 1820)	38	8	0.839	**0.129**	3.5	0.895	**0.123**
Aegithalos caudatus (Linnaeus. 1758)	4	1.5	0.157	0.024	0.5	0.128	0.018
Sylvia atricapilla (Linnaeus. 1758)	28	8	0.839	**0.129**	3.5	0.895	**0.123**
Curruca melanocephala (J. F. Gmelin. 1789)	8	2	0.210	0.032	1	0.256	0.035
Sylvia cantillans (Pallas. 1764)	1	0.5	0.052	0.008	0	0	0
Turdus merula Linnaeus. 1758	8	2.5	0.262	0.040	1.5	0.384	**0.053**
Luscinia megarhynchos C. L. Brehm. 1831	14	3.5	0.367	**0.056**	2.5	0.639	**0.088**
Passer italiae (Vieillot. 1817)	20	5	0.524	**0.081**	0	0	0
Motacilla alba Linnaeus. 1758	1	1	0.105	0.016	0	0	0
Serinus serinus (Linnaeus. 1766)	9	2.5	0.262	0.040	1	0.256	0.035
	228	62	6.499	1	28.5	7.289	1

Tab. 1. Breeding bird species in the study area (project area and 50 m buffer area; see Methods). The following metrics have been reported: number of individual contacts (n), number of estimated breeding pairs (pa), density (D: in pairs/ha), relative frequency (fr), both for the buffer area and for the specific area of project. In bold, the dominant species (fr>0.05).

zation of *Rubus ulmifolius.* Along the southern side, the edge of the wetlands is represented by the very first stretch of the Ufente river, which shows good water quality with the presence of hygrophilous species of conservation interest such as *Callitriche brutia.* Climate is termo-Mediterranean (Tomaselli *et al.*, 1973).

For the census of breeding birds in the project site and in the surrounding buffer (50 m in the neighbouring), the mapping census method was used (Bibby *et al.*, 2000; Sutherland, 2006) which allows for detailed fine-grained data (as number of breeding pairs and derived indices) for small areas (about 10 ha in size; see Bibby *et al.*, 2000; examples for wetlands of central Italy: Bernoni, 1984; Causarano & Battisti, 2009; Talbi *et al.*, 2021).

In the 2021 breeding season (March-July), a number of periodic field surveys were carried out (n = 4: 22 March, 25 April, 6 June, 1 July; total sampling effort: 12 hours). During each survey, we walked on pre-established transects, representative of the project area, at a speed of approx. 1.5 km/h, in the early hours of the morning (7.30-10.30), when the singing activity is maximum for the greatest number of species (Bibby *et al.*, 2000). Therefore, we obtained direct or indirect records (song contacts) for the whole area reported on a 1:1,000 scale map (see Bibby *et al.*, 2000). Professional Leica 10x42 binoculars were used for field sampling. Data reported on the field maps were extracted in order to obtain 'species-specific maps', evidencing clusters of contacts ('territories') for each breeding species (limited to territorial species). For non-territorial species (e.g. *Passer* sp., *Corvus cornix, Pica pica, Streptopelia decaocto*, etc.) an estimate of the nesting pairs was obtained based both on the presence of nests and of the number of individuals observed in breeding activity. No data were obtained on species having crepuscular or nocturnal

activity, as Strigiformes and Caprimulgiformes. Individuals in 'high flight' (> 25 m), whose presence is most likely not directly attributable to the project area or the neighboring buffer, were not considered in the analyses.

For the taxonomic nomenclature (scientific name, descriptor and year of description) we referred to Baccetti *et al.* (2021). We considered the *Passer italiae* a good species (stable hybrid), as indicated by Hermansen *et al.* (2011). For the nomenclature of the domestic form of *Columba livia*, we referred to Battisti & Zapparoli (2011). Data analysis was carried out both at the species and community level. At the species level, the number of contacts (n), the number of territories (pairs, pa) and the density of breeding pairs (d = number of territories/ha, calculated both in the project site, 3.91 hectares, and in surrounding 50 m buffer zone, total area: 9.54 hectares) were obtained. For each species, the relative frequency (fr) of breeding pairs out of the total number in the area was also calculated. Species with fr>0.05 were considered dominant (Turček, 1956).

At the community level, the following parameters were obtained (both for the project area and for the buffer area): (i) number of breeding species (S); (ii) number of nesting pairs (pa); (iii) total density of breeding pairs (D, in n. pa/ha); (iv) Shannon-Wiener diversity index H' (Shannon & Weaver, 1963), calculated as $H' = -\Sigma frx(\ln fr)$. The relative frequencies (fr) were compared using the $\chi 2$ test (PAST 1.89 software; Hammer *et al.*, 2001), maintaining the significance level of p=0.05, as threshold (Dytham, 2011). We carried out a check for data reliability following Battisti *et al.* (2014). Finally, the species were included in the IUCN threat categories according to Rondinini *et al.*, 2022), indicating their occurrence in the Annex 1 of Directive 147/2009/EC (EU, 2009).

Results

In total, 252 individual records belonging to 34 bird species were obtained in the study period. Among them, 228 records were belonging to 24 species breeding in the buffer area for a total of 62 breeding pairs and a density of 6.5 pairs/ha (among these 19 species for a total of 28.5 pairs were considered breeding in the project area, with a density of 7.29 pairs/ha; Tab. 1).

metric	Buffer	Project site
Cp	62	28.5
D	6.499	7.289
S	25	20
H'	2.897	2.74
E	0.9	0.915

Tab. 2. Breeding bird community metrics, considering the buffer area and the project site. The following metrics have been reported: number of pairs estimated with clustering (Cp), total density (D: in pairs/ha); number of species (S), Shannon-Wiener diversity index (H'), evenness index (E).

In the buffer area, the species that showed a higher frequency (fr>0.05; dominant species) were (in progressive decreasing order of frequency): *Sylvia atricapilla*, *Cettia cetti*, *Passer italiae*, *Gallinula chloropus*, *Acrocephalus scirpaceus* and *Luscinia megarhynchos* (Tab. 1). *Fulica atra*, *Parus major*, *Turdus merula*. *Passer italiae*, appeared breeding outside the project site (Tab. 1). *Luscinia megarhynchos* and *Sylvia atricapilla* were significantly more frequent when compared to other species ($p<0.05$).

At community level, the area shows a high diversity of breeding birds in relation to its size: the diversity index is close to the value of 3 for both the buffer area (H'=2.897) and the project area (H' = 2.74) and a high evenness index (e = 0.9 for the buffer area and 0.915 for the project area; Tab. 2) suggests a low level of environmental stress (see Magurran, 2013). Among the recorded species, the following were included in threat categories (Rondinini *et al.*, 2022): 'Near Threatened': *Cuculus canorus, Alcedo atthis* and *Hirundo rustica*; 'Vulnerable': *Passer italiae* and *Remiz pendulinus*.

Discussion and conclusion

The breeding birds occurring in the Mola Muti and Lago Pani site shows mixed characteristics, typical of assemblages linked to heterogeneous landscape mosaics with the presence of wet ecosystems, with neighbouring Mediterranean scrub on limestone slopes, agricultural and synanthropic environments. We observed: (i) species strictly linked to wet habitats (*Phragmites australis* reedbeds, rushbeds, hygrophilous tree vegetation with *Populus* sp. e *Salix* sp.) and ecotones, as *Anas platyrhynchos*, *Tachybaptus ruficollis*, *Gallinula chloropus*, *Fulica atra*, *Cettia cetti*, *Acrocephalus scirpaceus*, *Alcedo atthis* (this last included in the Annex 1 - 147/2009/EC), (ii) species typical of crop-lands and agro-forestry environments (*Streptopelia turtur*, *Cuculus canorus*, *Falco tinnunculus*, *Pica pica*, *Cisticola juncidis*, etc.), (iii) warblers of Mediterranean shrubs (e.g., *Currura melanocephala* e *Sylvia cantillans*) and, finally, (iv) synanthropic species occurring in human-transformed and edge habitats (e.g., *Streptopelia decaocto*, *Passer italiae*, *Serinus serinus*). However, the guild of wet-related species is significant: 7 out of 20 species are linked to these habitats (35% in project area; 7 out of 25, i.e. 28% considering the buffer) and over 40 % of total records (n=99 out of a total of 229) were found to belong to species linked to these specific ecosystems (43,9% in project area; 36.3% in the buffer). The diversity indices are high and suggest a low level of environmental stress (high Shannon-Wiener diversity and evenness values) when compared to other wetlands of central Italy (Bernoni, 1984; Causarano and Battisti, 2009). These values could increase after the interventions aimed to restore the wet habitats. Considering non-breeding species, the local occurrence of *Motacilla cinerea* is of particular interest. The presence of this species indicates a good level of water quality (Larsen *et al.,* 2010).

The data collected can be compared with those that will be collected after the wetland restoration, so as to verify their effectiveness in terms of change in density and diversity of bre-

eding birds, as well as on the environmental state of the site, thanks to the role of indicator of these vertebrates (e.g., Hagy *et al.*, 2017; Almeida *et al.,* 2020: Battisti *et al.*, 2021).

Acknowledgments

The data was collected as part of the *Greenchange* project ('Green Infrastructure for increasing biodiversity in Agro Pontino and Maltese rural areas'; LIFE17 NAT/IT/000619). We thank Giovanni Mastrobuoni for helping us in the fieldwork and Antonio Romano for historical information regarding the study area.

References

Abati S., Castorina M., Iberite M., Minciardi M.R., Pelliccioni I., Spada C.D., 2010 - Utilizzo di macrofite come bioindicatori nello studio della vegetazione delle acque interne dell'Agro Pontino. Macrofite e Ambiente, Atti del XIX Congresso della Societa Italiana di Ecologia. 119-131

Almeida B.A., Sebastián-González E., dos Anjos L. & Green A. J., 2020 - Comparing the diversity and composition of waterbird functional traits between natural, restored, and artificial wetlands. *Freshwater Biology*, 65(12): 2196-2210.

Baccetti N., Fracasso N. & C.O.I., 2021 - CISO-COI Check-list of Italian birds – 2020. *Avocetta*, 45: 21-85.

Battisti C., 2018 - Unifying the trans-disciplinary arsenal of project management tools in a single logical framework: Further suggestion for IUCN project cycle development. *Journal for Nature Conservation*, 41: 63-72.

Battisti C., Dodaro G. & Franco D., 2014 - The data reliability in ecological research: a proposal for a quick self-assessment tool. *Natural History Sciences*, 1: 75–79.

Battisti C. & Zapparoli M., 2011 - Sulla nomenclatura delle popolazioni urbane di. *Columba livia*. *Avocetta*, 35: 23-29.

Battisti C., Cento M., Circosta A., Coppola M. & Muratore S., 2023 -. Resurrecting seasonal dynamics in waterbirds after wetland restoration: before-after monitoring highlights the role of a single dominant species. *Wetlands Ecology and Management*, 31(2): 203-211.

Bernoni M., 1984 - Il metodo del mappaggio in una zona umida del Lazio: le Vasche di Maccarese. *Rivista italiana di Ornitologia*, 54(3-4), 235-243.

Budoni A. & Ricci L., 2020 - Green and blue infrastructures as the structure of a bioregion: The case of the Pontina bioregion. *WIT Transactions on Ecology and the Environment*, 249: 179-190.

Causarano F. & Battisti C., 2009 - Effect of seasonal water level decrease on a sensitive bird assemblage in a Mediterranean wetland. *Rendiconti Lincei*, 20: 211-218.

Dytham C., 2011 - Choosing and using statistics: a biologist's guide. John Wiley & Sons, New York.

EU (European Commission), 2009. Habitat Directive. (https://www.mite.gov.it/sites/default/files/archivio/allegati/rete_natura_2000/Direttiva_uccelli_2009.pdf).

Hagy H.M., Hine C.S., Horath M.M., Yetter A.P., Smith R.V. & Stafford J.D., 2017 - Waterbird response indicates floodplain wetland restoration. *Hydrobiologia*, 804: 119-137.

Hammer Ø., Harper D.A.T. & Ryan, P.D., 2001 - PAST-palaeontological statistics, ver. 1.89. *Palaeontologia Electronica*, 4(1): 1-9.

Hermansen J.S., Sæther S.A., Elgvin T.O., Borge T., Hjelle E. & Sætre G.-P., 2011 - Hybrid speciation in sparrows I: phenotypic intermediacy, genetic admixture and barriers to gene flow. *Molecular Ecology*, 20: 3812–3822.

Hockings M., Stolton S., Leverington F. & Courrau J., 2006 - Evaluating effectiveness: A framework for assessing management effectiveness of protected areas (2nd ed.). *Gland, Switzerland and Cambridge, UK: IUCN.*

Iberite M., Pelliccioni I., 2009 – La flora delle acque interne dell'Agro Pontino (Lazio Meridionale): indagini preliminari. Ann. Bot. (Roma), n.s., 9, suppl.: 155-164

Larsen S., Sorace A. & Mancini L., 2010 - Riparian bird communities as indicators of human impacts along Mediterranean streams. *Environmental Management*, 45(2): 261-273.

Linoli A., 2005 - Twenty-six centuries of reclamation and agricultural improvement on the Pontine marshes. In: Ohleg, C., Ed., Integrated Land and Water Resources Management in History, *Schriften der Deutschen Wasserhistorischen Gesellschaft (DWhG) Sonderband 2,* pp. 27-56.

Magurran A.E., 2013 - Measuring biological diversity. John Wiley & Sons, New York.

Raimondi S., 2014 - Natural values, coastal and marine ecosystems of the Circeo National Park: conservation priorities. *Biodiversity Journal*, 5(2): 147-150.

Rondinini, C., Battistoni, A., Teofili, C. (compilatori). 2022 Lista Rossa IUCN dei vertebrati italiani 2022 Comitato Italiano IUCN e Ministero dell'Ambiente e della Sicurezza Energetica, Roma.

Shannon C.E. & Weaver W., 1963 - Mathematical theory of communication. *University of Illinois Press. Urbana, Illinois.*

Talbi A., Battisti C., Samraoui B., Laïd T. & Samraoui F., 2021 - Wetland monitoring using wintering rallids (Gruiformes): Point counts provides reliable estimates when compared to time-expensive census method. *Vie et milieu - Life and environment*, 71: 1-6

Tomaselli R., Balduzzi A. & Filippello S., 1973 - Carta bioclimatica d'Italia. *Ministero Agricoltura e Foreste, Collana Verde n. 33. Rome, Italy.*

Turček F.J., 1956 - Zur Frage der Dominanz in Vogelpopulationen. *Waldhygiene*, 8: 249–257.

Zerunian S., 1984 - I Pesci del Fiume Amaseno e dei corsi d'acqua della Pianura Pontina (Lazio). *Quad. Ist. Idrobiol. Acquacolt. Brunelli,* 4: 26-67.

Zerunian S. & Leone M. (Eds), 1996 - Monitoraggio delle acque interne e Carta ittica della Provincia di Latina: i bacini campione del Fiume Amaseno e del Lago di Fondi. *Amministrazione Provinciale di Latina*