Monthly dynamics of waterbirds in the Orbetello lagoon (central Italy): preliminary results

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Abstract: the Orbetello lagoon, a protected wetland area of international importance according to Ramsar criteria, is subject to various human activities and facing ecological changes of anthropogenic origin, such as changes in water quality, with an increase in nutrient inputs over time, and in hydrological cycles, with the artificial raising of water levels in the spring-summer months. In 2024, a project based on monthly bird censuses was started in order to investigate how birds use the wetland throughout the year and the factors that influence their abundance and distribution within the lagoon. The censuses are carried out by 10 teams working simultaneously, counting birds in 26 pre-defined sectors. During the first year of the survey, 82 species of waterbirds were recorded, with the lowest monthly value in June (29) and the highest in January (52). The number of birds varied between a minimum of 1,681 in May and a maximum of 17,520 in February. Twelve species were dominant (relative abundance ≥ 5%) in at least one month; among these, the Greater Flamingo *Phoenicopterus roseus* was dominant in 11 months (with values even above 50%). Preliminary results from the first year of the study indicate that herbivore species (such as the Eurasian Coot *Fulica atra*) and shorebirds, particularly those present as transient migrants, are relatively poorly represented and that the functional diversity of the waterbird community at the site is reduced.
Keywords: waterbirds, annual cycle, Orbetello lagoon, wetlands.

Introduction

Since March 2024, a waterbird monitoring project has been underway in the Orbetello Lagoon, based on monthly censuses.
The site, of international importance under to the Ramsar Convention and included in the Natura 2000 network (SCA/SPA IT51A0026) and in the State and Regional Reserves (Fig. 1), hosts numerous migratory and sedentary species. [1], [2], [3]

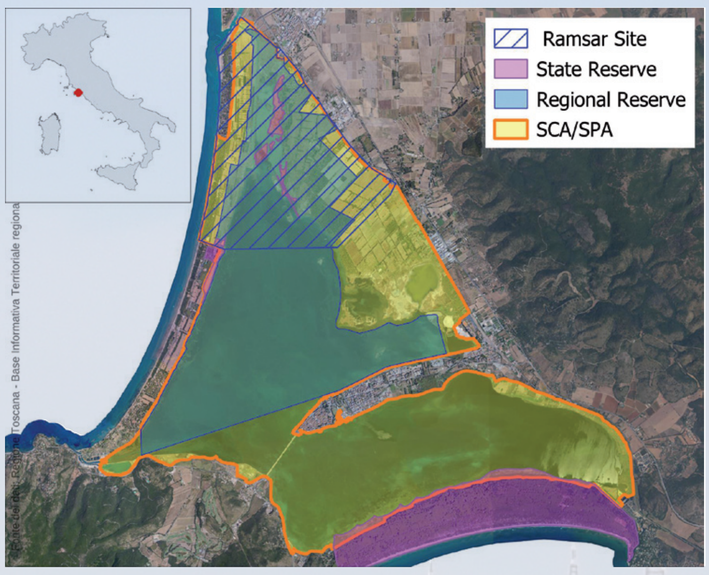


Figure 1 – Location of the Orbetello lagoon and boundaries of the protected areas.

Various anthropic pressures exerted over time on the lagoon and surrounding areas have led to various alterations of the site, including in particular:

1) eutrophication, caused by the introduction of agricultural, urban and aquaculture wastewater, with consequent alteration of aquatic phytocoenoses [4], [5], [6], [7];
2) the artificial raising of water levels in spring and summer by pumping sea water.

The monitoring aims to study how birds use this wetland throughout the year and the factors that influence their numbers and distribution.
In this work we present a preliminary analysis of the data collected during the first 15 months.

Study area and methods

The Orbetello Lagoon, covering an area of 27 km² and divided into two large bodies of water, is in fact more similar to a coastal lake [8], with an average depth of 1 metre and connections to the sea via channels. It is separated from the sea to the west and east by two strips of land, respectively the 'Tombolo della Giannella' and the 'Tombolo della Feniglia', while to the west, Monte Argentario is connected to the town of Orbetello by a dam (Fig. 1).
Due to the periodic pumping of seawater, the water level in the lagoon does not decrease during the spring and summer months, as is typical in Mediterranean environments (Fig. 2).

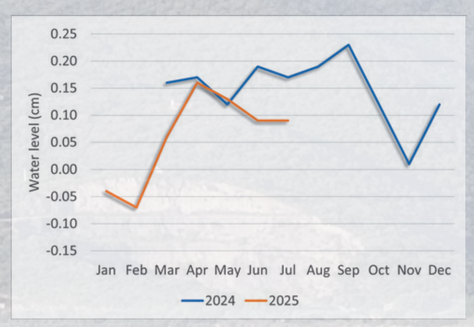


Figure 2 - Water level (relative to sea level) on census days.

The lagoon was divided into 26 predefined sectors based on their ecological characteristics and on the presence of salient landscape features.
Waterbirds [9] were censused approximately in the middle of each month by 10 teams of observers, equipped with both paper and digital maps (Fig. 3), who worked simultaneously.
In areas with poor visibility, a drone with 7x optical zoom was also used to minimise disturbance, subject to specific authorisation from the Region.

Results were summarized on either a monthly or annual basis. In the latter case, for months represented by two counts conducted in different years, the mean abundance per species was used.
Consuming biomass was estimated by summing the mean body mass of individuals of each species (as reported by Storchová [10]) raised to the power of 2/3, following the approach of Ng et al. [11].
Each species was assigned to a trophic category—phytophagous, invertebrate predator, piscivore, predator of other vertebrates, or omnivore—according to the classifications of Wilman et al. [12] and Storchová & Hořák [10]. For each species, monthly relative abundance (P) was calculated, with species considered dominant when P > 0.05 and subdominant when 0.05 < P < 0.2.

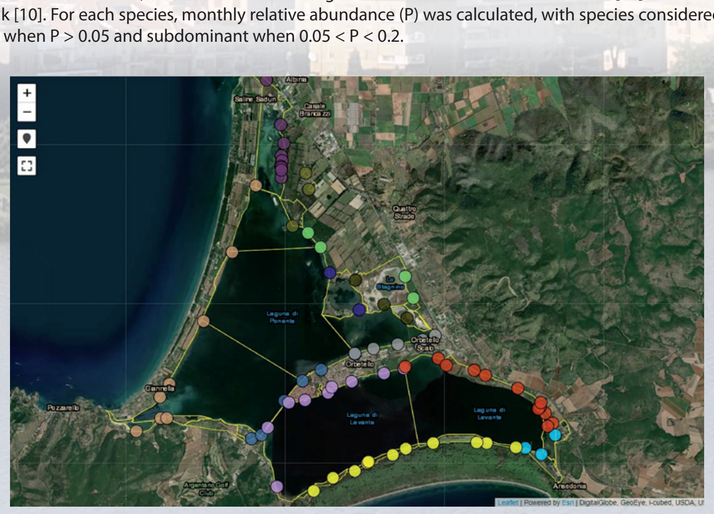


Figure 3- Online map, accessible by scanning a QR code, with indication of observation points in the Orbetello lagoon. By activating GPS on the smartphone, the observers will be able to see their position in real time and be guided, if necessary, to the chosen point via a link to "Google maps". In this way, even non-expert observers will be able to carry out their survey easily.

Results

To date, 85 species belonging to 15 families have been recorded (Fig. 4), with the *Scolopacidae* represented by the largest number of species (21) and the *Phoenicopteridae* by only one species, but with the largest number of individuals (38% on an annual basis).

The community has shown very similar monthly trends in both years, without significant variations linked to migration peaks, both in terms of the number of species and abundance, which are higher during the autumn-winter period (Fig. 5).

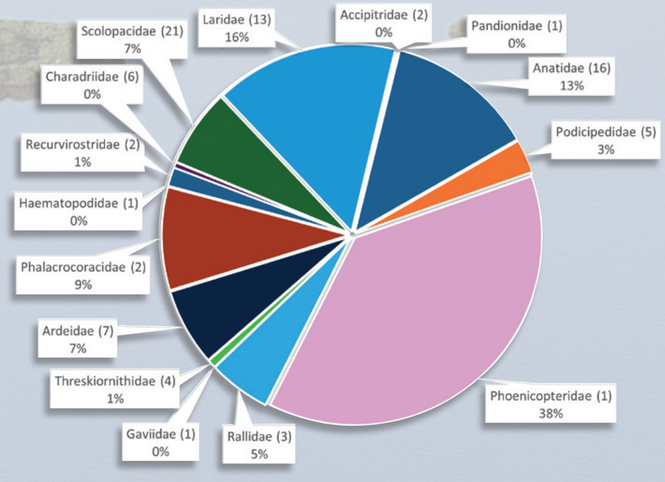
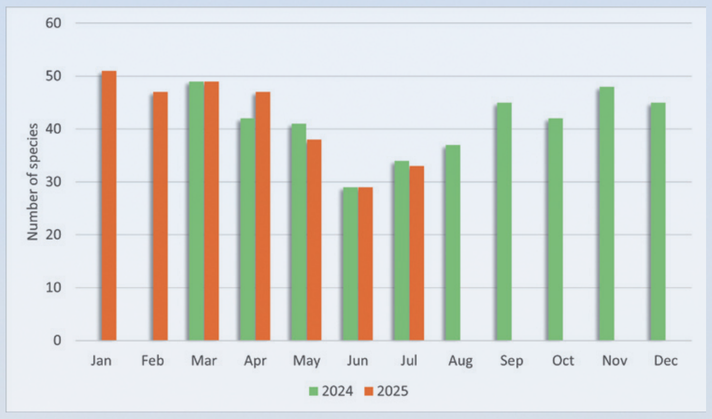


Figure 4 – Annual composition of the waterbird community: for each family, the number of species detected is shown in parentheses, along with the total number of individuals recorded, expressed as a percentage and also represented graphically.



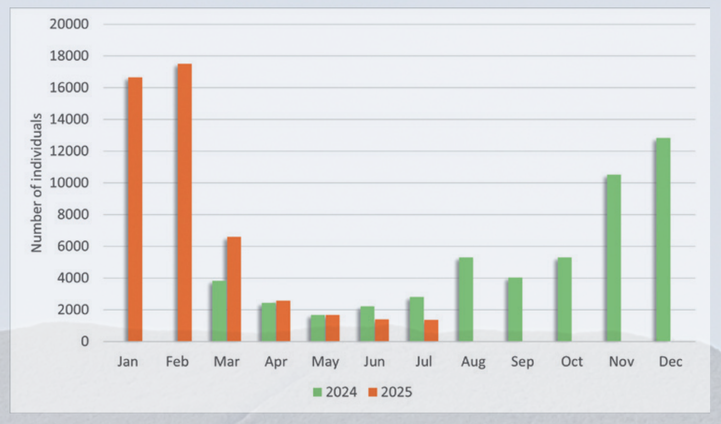


Figure 5 – Number of species (top) and individuals (down) per month.

During the year, phytophagous birds represent an appreciable percentage of the biomass only in the winter months; it is predominantly composed of invertebrate and ichthyophagous predators (Fig. 6).

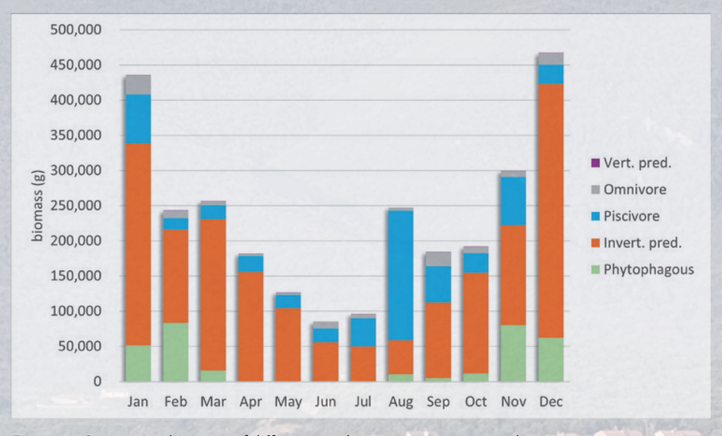


Figure 6 - Consuming biomass of different trophic categories per month.

Thirteen species reached dominance levels, while ten attained sub-dominance in at least one month (Table 1). The flamingo was the most abundant species throughout the year, often comprising about half of the total population and consistently exceeding a dominance index of 0.20. Only the yellow-legged gull recorded comparable values in August, following a large-scale fish die-off. Most of the dominant or sub-dominant species were invertebrate predators or piscivores; among phytophagous species, only the teal and the coot met these thresholds. Among shorebirds, only the black-winged stilt and the dunlin reached dominance, while three additional species attained sub-dominance.
Within the lagoon (Fig. 7), sectors with marginal areas—characterized by salt marshes and mudflats emerging during periods of less flooding—are particularly important for waterfowl and shorebirds (*Haematopodidae*, *Charadriidae*, *Recurvirostridae*, and *Scolopacidae*).
In contrast, herons (*Ardeidae*) frequent all habitat types, while cormorants (*Phalacrocoracidae*), flamingos (*Phoenicopteridae*), and grebes (*Podicipedidae*) are more frequently observed in open waters.

Table 1 – Species dominance values exceeding the threshold of 0.05 (in green) or 0.02 (in yellow) in at least one month; values above 0.20 are shown in dark green.

	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Great Crested Grebe *Podiceps cristatus*	2024			0.03	0.01	0.01	0.01	0.00	0.02	0.02	0.01	0.01	0.03
	2025	0.01	0.01	0.01	0.01	0.00	0.00	0.01					
Black-necked Grebe *Podiceps nigricollis*	2024			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	2025	0.02	0.01	0.02	0.03	0.00	0.00	0.00					
Great Cormorant *Phalacrocorax carbo*	2024			0.17	0.05	0.02	0.01	0.05	0.03	0.07	0.11	0.15	0.11
	2025	0.08	0.08	0.04	0.05	0.05	0.02	0.04					
Western Cattle Egret *Bubulcus ibis*	2024			0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2025	0.00	0.00	0.00	0.00	0.04	0.04	0.03					
Little Egret *Egretta garzetta*	2024			0.02	0.05	0.09	0.09	0.09	0.11	0.10	0.03	0.01	0.01
	2025	0.01	0.01	0.02	0.04	0.09	0.08	0.11					
Grey Heron *Ardea cinerea*	2024			0.06	0.08	0.11	0.11	0.07	0.05	0.08	0.03	0.03	0.02
	2025	0.02	0.02	0.02	0.05	0.09	0.06	0.06					
Eurasian Spoonbill *Platalea leucorodia*	2024			0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.01	0.00
	2025	0.01	0.00	0.00	0.00	0.01	0.01	0.00					
Greater flamingo *Phoenicopterus roseus*	2024			0.17	0.29	0.27	0.36	0.08	0.01	0.22	0.53	0.28	0.49
	2025	0.44	0.47	0.49	0.26	0.22	0.27	0.03					
Common Shelduck *Tadorna tadorna*	2024			0.05	0.06	0.09	0.04	0.02	0.00	0.00	0.00	0.01	0.01
	2025	0.02	0.03	0.03	0.07	0.09	0.10	0.01					
Eurasian Wigeon *Mareca penelope*	2024			0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02
	2025	0.01	0.01	0.00	0.00	0.00	0.00	0.00					
Green-winged Teal *Anas crecca*	2024			0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.05
	2025	0.07	0.08	0.06	0.00	0.00	0.00	0.00					
Mallard *Anas platyrhynchos*	2024			0.01	0.01	0.02	0.07	0.05	0.02	0.05	0.02	0.01	0.02
	2025	0.02	0.01	0.01	0.02	0.05	0.06	0.11					
Northern Shoveler *Spatula clypeata*	2024			0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.02
	2025	0.02	0.02	0.02	0.01	0.00	0.00	0.00					
Common coot *Fulica atra*	2024			0.07	0.02	0.01	0.00	0.02	0.03	0.03	0.03	0.09	0.05
	2025	0.07	0.05	0.04	0.02	0.02	0.02	0.01					
Black-winged Stilt *Himantopus himantopus*	2024			0.00	0.05	0.07	0.05	0.07	0.03	0.00	0.00	0.00	0.00
	2025	0.00	0.00	0.00	0.05	0.05	0.10	0.06					
Dunlin *Calidris alpina*	2024			0.06	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.06	0.03
	2025	0.03	0.03	0.03	0.02	0.00	0.00	0.00					
Ruff *Calidris pugnax*	2024			0.00	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	2025	0.00	0.00	0.03	0.00	0.00	0.00	0.00					
Common Redshank *Tringa totanus*	2024			0.02	0.01	0.00	0.01	0.04	0.03	0.04	0.03	0.02	0.01
	2025	0.01	0.01	0.00	0.01	0.00	0.01	0.04					
Common Greenshank *Tringa nebularia*	2024			0.01	0.03	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
	2025	0.00	0.00	0.01	0.02	0.00	0.00	0.01					
Black-headed Gull *Larus ridibundus*	2024			0.05	0.03	0.00	0.01	0.16	0.15	0.12	0.03	0.10	0.03
	2025	0.05	0.08	0.03	0.06	0.01	0.02	0.18					
Slender-billed Gull *Larus genei*	2024			0.01	0.00	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00
	2025	0.00	0.00	0.00	0.00	0.01	0.00	0.00					
European Herring Gull *Larus michahellis*	2024			0.09	0.11	0.18	0.15	0.24	0.46	0.13	0.03	0.03	0.02
	2025	0.04	0.03	0.09	0.12	0.17	0.11	0.20					
Common Tern *Sterna hirundo*	2024			0.00	0.05	0.03	0.04	0.04	0.01	0.00	0.00	0.00	0.00
	2025	0.00	0.00	0.00	0.03	0.05	0.06	0.05					

Figure 7 – Percentage distribution of selected groups in the main environmental types characterising the individual survey sectors.

Discussion

Preliminary analysis of the available results indicates that the waterbird community of the Orbetello Lagoon is imbalanced. This is evidenced by particularly high dominance values for a single species (the flamingo), reduced numbers of phytophagous birds, and an absence of obvious peaks linked to the migratory passage of many species. Although there are no quantitative data on the composition of the bird community throughout the year, the reduction in phytophagous species, particularly the common coot, and the increase in flamingos are well documented by the long series of winter data from the IWC project ([2]; COT Database), while the reduced presence of migratory birds contrasts with past anecdotal observations for this site or current observations at others (COT Database). The rarefaction of aquatic macrophytes, linked to eutrophication, seems to be the main cause of the reduction in phytophagous species, while the high relative abundance of flamingos, despite being part of a generally positive trend in the Mediterranean population, could reflect a significant imbalance in the hydrocoenosis. The alteration of hydrological cycles, with the continuous flooding of marginal areas in spring and summer, changes their ecological characteristics, increasing salinity and reducing opportunities for many species that need emerging mud banks or shallow waters in which to search for seeds, plants and invertebrates to rest and stay.

References

[1] Calchetti L., Cianchi F., Giannella C., 1987. L'avifauna nella Laguna di Orbetello (GR). Picus, Anno 13°, N°2 Agosto.
[2] Arcamone E., Dall'Antonia P., Puglisi L., 2007. Lo svernamento degli uccelli acquatici in Toscana. 1984-2006. Edizioni Regione Toscana.
[3] Puglisi L., Arcamone E., Franchini M., Giunchi D., Meschini E., Sacchetti A., Vanni L., Vezzani A., 2023. Atlante degli Uccelli nidificanti e svernanti in Toscana. 2. Distribuzione, Abbondanza, conservazione. Tipografia del Consiglio regionale della Toscana. Firenze.
[4] Giannella C., Velasco A., 2016. Una vita con le mani nell'acqua. Tipografia Baraldini, Modena.
[5] Lenzi M., Salvatori R., 1986. Eutrofizzazione, distrofie e produzione ittica nella Laguna di Orbetello.
[6] Lenzi M., Palmieri R., Porrello S., 2003. Restoration of the eutrophic Orbetello lagoon (Tyrrhenian Sea, Italy): water quality management. Marine Pollution Bulletin 46 (2003) 1540–1548.
[7] Lenzi M., Leporatti Persiano M., D'Agostino A., 2024. Growth tests of Gongolaria barbata (*Ochrophyta Sargassaceae*), a native species producing pleustophitic blooms in a hypertrophic Mediterranean lagoon. J Aquac Mar Biol 13: 71–78.
[8] Grazioli E., Anselmi S., Biagiotti I., Mancini E., Leporatti Persiano M., Di Dio S., Gentiloni P., Cerioni S., Renzi M., 2025. Ecosystem Services in the Orbetello Lagoon: Estimate of Value and Possible Effects Due to Global Change. Oceans 2025, 6, 14.
[9] Zenatello M., Baccetti N., Borghesi F., 2014. Risultati dei censimenti degli uccelli acquatici svernanti in Italia. Distribuzione, stima e trend delle popolazioni nel 2001-10. ISPRA, Serie Rapporti, 206/2014.
[10] Storchová L., Hořák D., 2018. Life-history characteristics of European birds. Global Ecology and Biogeography 27: 400–406.
[11] Ng W. H., Fink D., La Sorte F. A., Auer T., Hochachka W. M., Johnston A., Dokter A. M., 2022. Continental-scale biomass redistribution by migratory birds in response to seasonal variation in productivity. Global Ecology and Biogeography 31: 727–739.
[12] Wilman H., Belmaker J., Simpson J., de la Rosa C., Rivadeneira M. M., Jetz W., 2014. EltonTraits 1.0: Species-level foraging attributes of the world's birds and mammals. Ecology 95: 2027–2027.
[13] Focardi S., Mariottini M., Renzi M., Perra G., Focardi S., 2009. Anthropogenic impacts on the Orbetello lagoon ecosystem. Toxicology and Industrial Health 2009; 25: 365–371.

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