

# Year-round use of the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium, central Italy) by waterbirds

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**Abstract** – From 2007-2011, surveys were carried out to describe the presence of waterbirds in the Regional Nature Reserve of Nazzano, Tevere-Farfa. The key parameters of the community were analysed: richness, abundance, dominance, diversity, evenness and daily energy expenditure for each 15-day period in which counts were made. A census for all breeding species was also carried out. Forty-nine species were encountered, the most abundant of which was *Anas platyrhynchos*, *Fulica atra* and *Gallinula chloropus*. There was negative trend in the bird population for all species combined during the years of the study, probably caused by the worsening of the water conditions due to a decrease of aquatic macrophytes. Management actions proposed aimed at improving food availability and creating wetlands with different water levels.

**Key words:** waterbirds community, wetland, macrophytes, central Italy

## INTRODUCTION

The birdlife present in the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium) has been investigated several times, beginning in the mid-1970s (Di Carlo 1976, 1983, Gallo 1983a, b, Isotti 1995). In particular, the wintering waterbirds have been regularly monitored, as this area is also included in those regularly studied by the International Waterbird Census (IWC) which aims to record the presence of wintering waterbirds (Baccetti *et al.* 2002, Brunelli *et al.* 2009). The knowledge of the birdlife in the reserve has recently been updated by Angelici & Brunelli (2008). From 2007 the aquatic birdlife has been the subject of more in-depth studies to better define the qualitative and quantitative features of the populations during the different seasons (Angelici 2009).

The present study also follows this line of investigation, and was encouraged and funded by the Reserve's Administration, to identify potential critical issues for waterbirds and obtain useful information for application of appropriate management measures to improve ecological conditions of the area.

## STUDY AREAS

The study area of the present investigation was the Regional Nature Reserve of Nazzano, Tevere-Farfa, which was established by Regione Lazio in 1979, and lies in the SIC/ZPS area IT6030012 (Cattena *et al.* 2004).

The reserve covers 700 ha and is located along the River Tiber near the confluence with the smaller River Farfa, about 40 km north of Rome (42°12'N -12°3'E) at 30 m above sea level.

The main part of the reserve is represented by the artificial Lake Nazzano, formed after a dam was constructed to generate electricity in the mid-1950s.

The wetland, which covers an area of around 350 ha, contains vast beds of *Phragmites australis*, *Typha latifolia* and *T. angustifolia*; along the river banks there are damp woods of *Alnus glutinosa*, *Populus alba* and *Salix alba*. The remaining portion of the reserve is comprised in part of thermophilous deciduous forests of *Quercus cerris*, *Q. pubescens*, *Q. frainetto*, *Q. petraea* and *Fraxinus ornus*, and in part of grasslands of secondary origin.

## METHODS

The study spanned 5 years (January 2007 to December 2011), during which counts were taken every 15 days ( $\pm 1$ ), thus 24 counts for year (total: 120 surveys). Fifteen-min recording sessions were conducted from the same 10 spots located 300-500 m apart (mean  $\pm$  SD, 398  $\pm$  92.8). All spots were sampled on the same day. Surveys were conducted in days with good visibility and without rain.

We censused the individuals for all species of Anseriformes, Pelecaniformes, Ciconiiformes, Podicipediformes, Gruiformes and Charadriiformes; due to its occasional presence, *Croicocephalus ridibundus* was not included in the counts also to prevent introduction of biases because of their great and unmanageable numbers.

The limited surface of the study wetland and its elongated and narrow shape permitted an easy census of all individuals present in the area.

To study the structure of the bird community, the following parameters and indices were used:

- Richness (S): the number of species surveyed;
- Abundance (A): the number of individuals per species;
- Dominance ( $\pi_i$ ): where  $\pi_i = n/n_1$  - i.e. ratio between the number of individuals of each species ( $n$ ) and total number of individuals that comprise the community ( $n_1$ ); a species is considered to be dominant if  $\pi_i \geq 0.050$  (Turcek 1956);
- Diversity (H): where  $H = - \sum \pi_i \ln \pi_i$  (Shannon & Weaver 1963);
- Evenness (J): where  $J = H/\ln S$  (Lloyd & Ghelardi 1964, Pielou 1966);
- Daily Energy Expenditure (DEE): where  $DEE = 11.87 M^{0.608}$ , and  $M$  is the mass (g) of the species (Walsberg 1980); to determine biomass, the average weight obtained by Brichetti & Fracasso (2003, 2004, 2006) was used;
- Trophic structure: trophic structure of community was obtained by means of DEE values of each species (Casini *et al.* 1992). The species were subdivided in four trophic categories (omnivores, herbivores, piscivores and invertebrate predators) based on their diet composition Cramp & Simmons (1977, 1983). The trend of wintering species has been defined by means of the midwinter counts within IWC project.

For all the surveyed species a complete census of breeding pairs was carried out by searching nests. The censuses of breeding species were carried out from February to July by means of weekly surveys during which we checked the entirely study area. We considered breeding pairs only those with active nests (incubating adults and

nests with eggs or chicks). The number of breeding pairs of *Rallus aquaticus*, was estimated by locating territories from their calls.

## RESULTS

**Richness.** During the 5-year study, we recorded the presence of 49 species (Tab. 1). An overall negative trend was recorded, as 45 species were found in 2007, whereas 37 were found in 2010 and 2011 (average 39.8; SD = 3.35). The richness in species fluctuated from one season to another, with higher values during the spring and autumn migration periods, and generally lower values during the summer months (Fig. 1).

**Abundance.** Abundance of individuals ranged from 1485, counted in February 2008, and a minimum of 294, counted in May 2011. This parameter shows a bimodal yearly distribution, with higher values during winter and lower values during summer when almost exclusively breeding species are present. Again, the data collected during the entire period of this study showed a temporal negative trend (Fig. 2).

**Dominance.** Eleven species were dominant to some degree, and of these only *Anas platyrhynchos* and *Fulica atra* were always found to be dominant every year. *Gallinula chloropus* was dominant in 87% of the total surveys. *Bubulcus ibis*, although present occasionally until 2009, turned out to be a dominant species in the last three years of the study, whereas, on the other hand, *Podiceps auritus* was no longer be dominant in the last two years (Tab. 2).

**Diversity and evenness.** Each year, Diversity Index was characterized by two peaks, one in March-April and the other in October-November, during the spring and autumn migrations. The lowest values were recorded during winter, when only the wintering species were present, and in summer, when only the breeding species were present (Fig. 3). The evenness parameter showed no obvious fluctuations or patterns and was constant throughout the years (Fig. 3).

**Daily Energy Expenditure and trophic structure.** DEE Index values were highest between November and March, when wintering and migrating species were present, whereas the lowest values were recorded between April and August, when migrants were scarce and mainly breeding species were present (Fig. 4). The trophic structure was characterized primarily by the presence of omnivores, the

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**Table 1.** Species recorded at the Regional Nature Reserve of Nazzano, Tevere-Farfa and number of surveys per year during which each species was recorded.

Species	2007	2008	2009	2010	2011
1 <i>Cygnus olor</i>	10	6	16	4	0
2 <i>Anser anser</i>	1	0	0	0	0
3 <i>Tadorna tadorna</i>	1	0	0	0	0
4 <i>Anas penelope</i>	18	12	7	7	7
5 <i>Anas strepera</i>	17	11	4	4	5
6 <i>Anas crecca</i>	24	24	24	24	24
7 <i>Anas platyrhynchos</i>	24	24	24	24	24
8 <i>Anas acuta</i>	7	7	4	5	5
9 <i>Anas querquedula</i>	7	6	1	2	2
10 <i>Anas clypeata</i>	9	10	9	8	9
11 <i>Aythya ferina</i>	24	24	24	24	24
12 <i>Aythya nyroca</i>	6	6	2	2	3
13 <i>Aythya fuligula</i>	18	9	2	6	6
14 <i>Aythya marila</i>	1	0	0	0	0
15 <i>Phalacrocorax carbo</i>	24	24	24	24	24
16 <i>Botaurus stellaris</i>	6	8	2	2	4
17 <i>Ixobrychus minutus</i>	1	7	8	5	5
18 <i>Nycticorax nycticorax</i>	0	15	9	3	5
19 <i>Ardeola ralloides</i>	0	0	0	0	2
20 <i>Bubulcus ibis</i>	12	12	10	15	16
21 <i>Egretta garzetta</i>	22	24	24	24	24
22 <i>Casmerodius alba</i>	21	23	23	22	23
23 <i>Ardea cinerea</i>	24	24	24	24	24
24 <i>Ardea purpurea</i>	11	7	1	4	4
25 <i>Ciconia ciconia</i>	1	0	0	0	0
26 <i>Threskiornis aethiopicus</i>	0	8	0	0	0
27 <i>Platalea leucordia</i>	6	5	6	2	0
28 <i>Tachybaptus ruficollis</i>	24	24	24	24	24
29 <i>Podiceps cristatus</i>	24	24	24	24	24
30 <i>Podiceps nigricollis</i>	2	7	2	0	0
31 <i>Rallus aquaticus</i>	24	24	24	24	24
32 <i>Gallinula chloropus</i>	24	24	24	24	24
33 <i>Fulica atra</i>	24	24	24	24	24
34 <i>Grus grus</i>	2	2	0	0	1
35 <i>Himantopus himantopus</i>	5	7	2	2	3
36 <i>Recurvirostra avosetta</i>	3	6	6	1	2
37 <i>Vanellus vanellus</i>	6	10	4	4	4
38 <i>Philomachus pugnax</i>	3	4	4	0	0
39 <i>Gallinago gallinago</i>	17	24	22	19	18
40 <i>Limosa limosa</i>	4	0	0	0	0
41 <i>Actitis hypoleucos</i>	16	16	15	13	13
42 <i>Tringa ochropus</i>	14	4	0	1	3
43 <i>Tringa erythropus</i>	4	4	3	0	0
44 <i>Tringa nabularia</i>	5	14	7	3	5
45 <i>Tringa stagnatilis</i>	5	12	5	4	5
46 <i>Tringa glareola</i>	4	0	0	1	1
47 <i>Tringa totanus</i>	1	7	5	1	1
48 <i>Larus fuscus</i>	0	0	2	0	0
49 <i>Larus michahellis</i>	24	24	24	24	24
<b>Total</b>	<b>45</b>	<b>41</b>	<b>39</b>	<b>37</b>	<b>37</b>

**Table 2.** Number of surveys per year during which each species was dominant. Percentage (%) of the dominance occurrences are reported out of a total of 120 surveys.

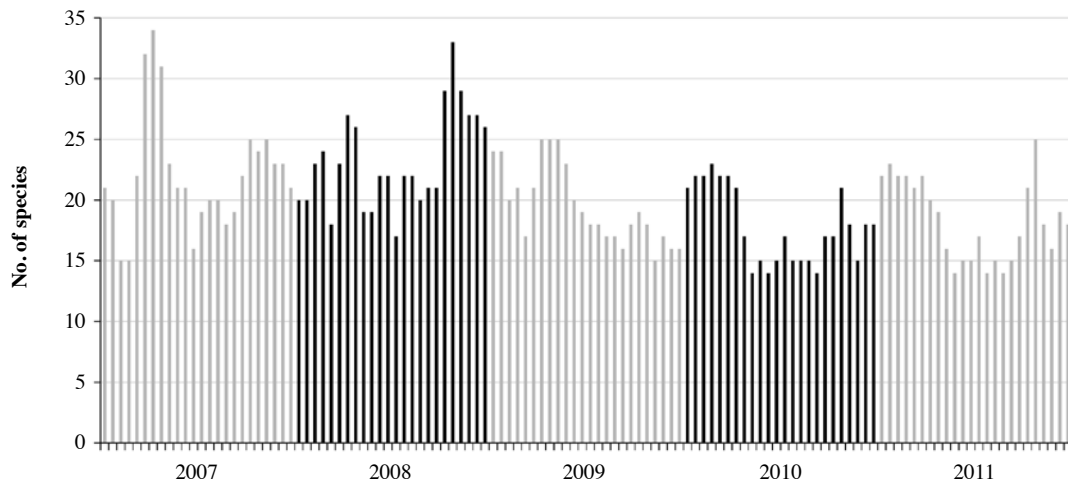
Species	2007	2008	2009	2010	2011	Total	%
<i>Phalacrocorax carbo</i>	4	1	0	0	2	7	5.8
<i>Bubulcus ibis</i>	0	0	2	11	12	25	20.8
<i>Podiceps cristatus</i>	10	15	14	0	0	39	32.5
<i>Ardea cinerea</i>	3	2	12	14	14	45	37.5
<i>Larus michahellis</i>	0	10	4	14	18	46	38.3
<i>Aythya ferina</i>	11	10	9	9	8	47	39.2
<i>Tachybaptus ruficollis</i>	14	14	12	11	4	55	45.8
<i>Anas crecca</i>	18	12	12	11	12	65	54.2
<i>Gallinula chloropus</i>	16	17	24	23	24	104	86.7
<i>Anas platyrhynchos</i>	24	24	24	24	24	120	100.0
<i>Fulica atra</i>	24	24	24	24	24	120	100.0

most common being *Anas platyrhynchos* and *Aythya ferina*; herbivores, *Fulica atra*; piscivores, *Phalacrocorax carbo*, *Ardea cinerea* and *Podiceps auritus*; and invertebrate predators, *Bubulcus ibis* and *Tachybaptus ruficollis*. The seasonal pattern is similar for all trophic categories (Fig. 5).

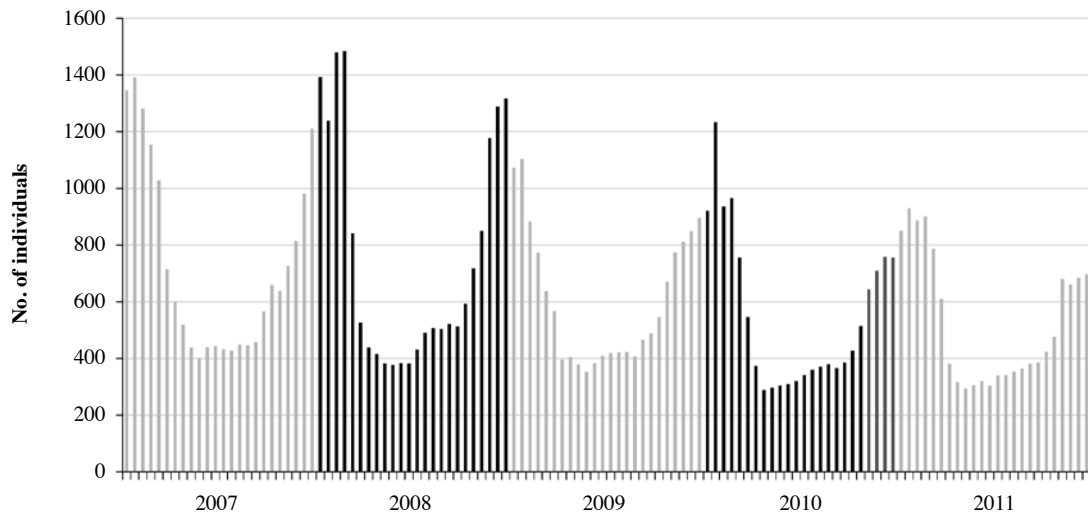
**Wintering species.** Data collected during the second half of January during the IWC (International Waterbird Census) resulted in 26 species recorded (Tab. 2). During the five years of the study, the number of recorded species fluctuated, whereas the number of wintering individuals tended to diminish (Fig 6). This is largely due to the evident decrease in *Aythya ferina*, as well as the less obvious decrease in *Anas crecca*, *Anas platyrhynchos* and *Fulica atra*; on the other hand, as previously mentioned, the population of *Bubulcus ibis* increased steadily (Tab. 3). During two winter months (i.e. between 1 December and 31 January), *Anas querquedula* and *Aythya nyroca* were also recorded occasionally.

**Breeding species.** Eight species of waterbirds were found to breed (Tab. 4). During the spring and summer months, the presence of territorial pairs of both *Anas crecca* and *Aythya ferina* were also quite regular but breeding was never proved.

**Migratory species.** Twenty exclusively migratory or erratic species were recorded (Tab. 5). Of these, nine can be considered regular (present in 4 or 5 years), four irregular (2-3 years) and seven occasional (1 year). These species have been recorded a few times, from a minimum of once for *Anser anser* and *Tadorna tadorna* (2007), to up to 14 times for *Tringa ochropus* (2007) and *T. nebularia* (2008) (Tab. 1).



**Figure 1.** Numbers of the species recorded for each of the census counts occurred every 15 days during the 5-year study period at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium).



**Figure 2.** Numbers of the individuals recorded for each of the census counts occurred every 15 days during the 5-year study period at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium) and for all the species indicated in Tab. 1.

**DISCUSSION**

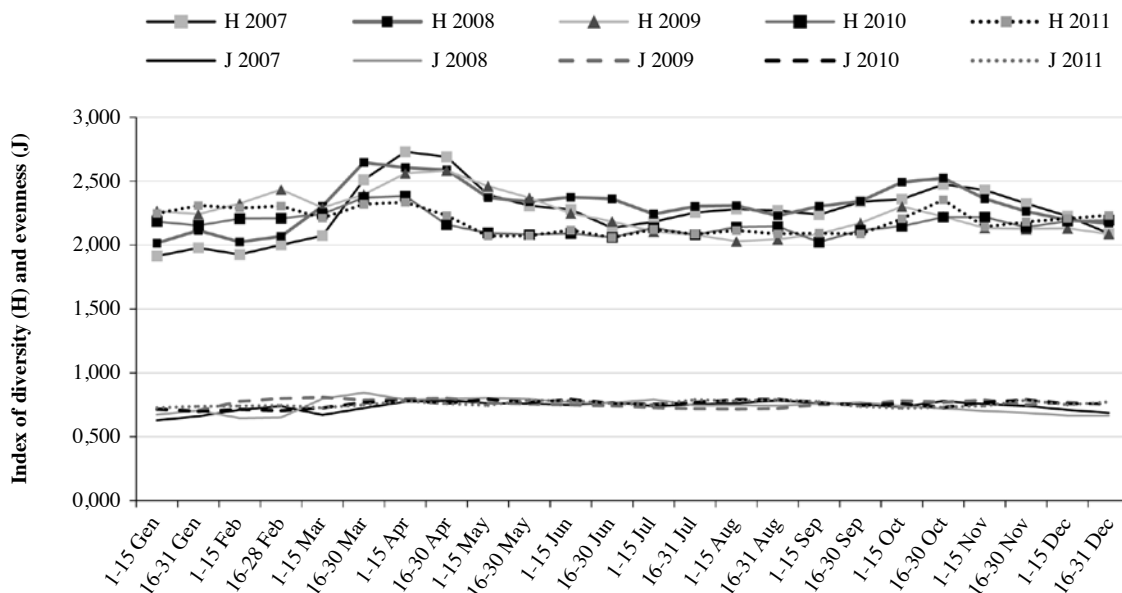
The Regional Nature Reserve of Nazzano has always played an important role at a regional level, especially as suitable habitat for waterbirds during winter, despite being characterized by widely fluctuating numbers of birds present (Brunelli *et al.* 2009).

At a regional level, data collected over the same period by the IWC confirms a negative trend for *Aythya ferina*, whilst there is more uncertainty regarding the fluctuations of both *Anas crecca* and *Anas platyrhynchos*; a positive

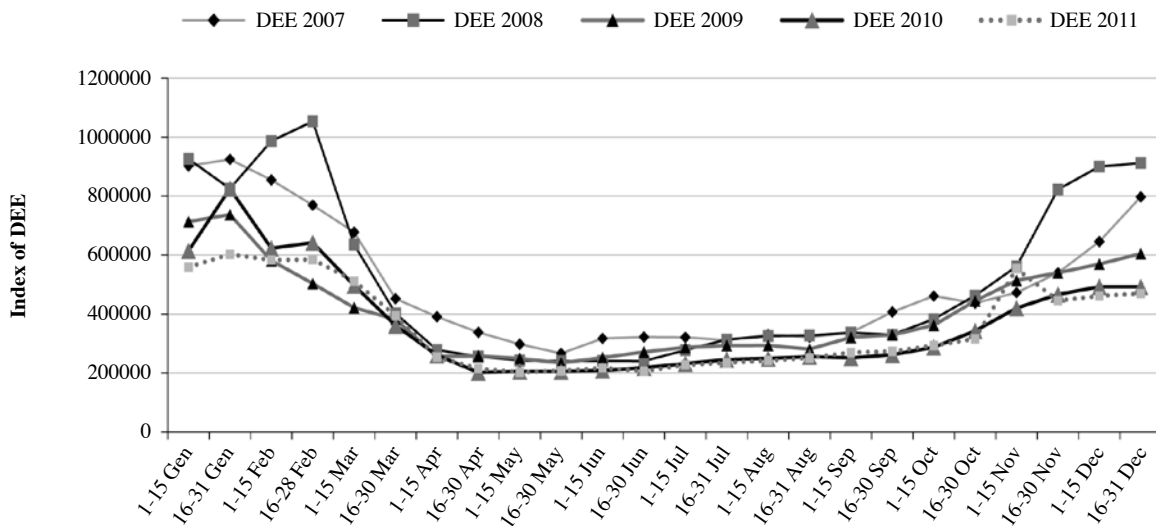
trend has instead been observed for both *Bubulcus ibis* and *Fulica atra* (Brunelli *et al.* 2009).

Overall the area resulted of limited importance for breeding species, both in qualitative and quantitative terms. At a regional level, however, it is worth noting the first breeding records of *Ardea cinerea* and *Rallus aquaticus* in Latium (Brunelli *et al.* 2011). Migratory birds usually remained at the reserve for a short time, probably due to the limited extension of the suitable areas (i.e., muddy areas with shallow water) that almost all species share to feed (Cramp & Simmons 1977, 1983).

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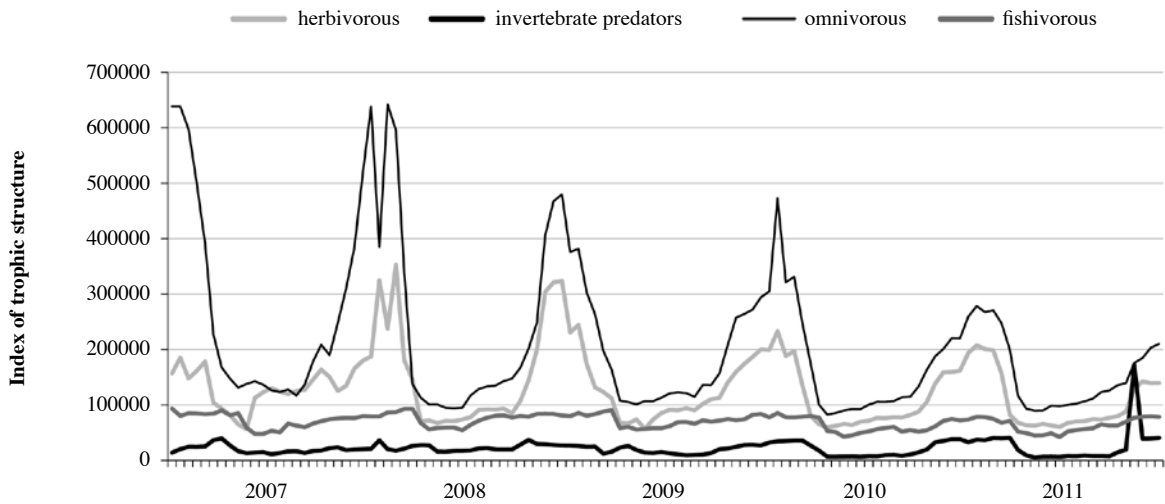
**Figure 3.** Trends of Diversity (H) and Evenness (J) resulted for the 5-year census at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium).



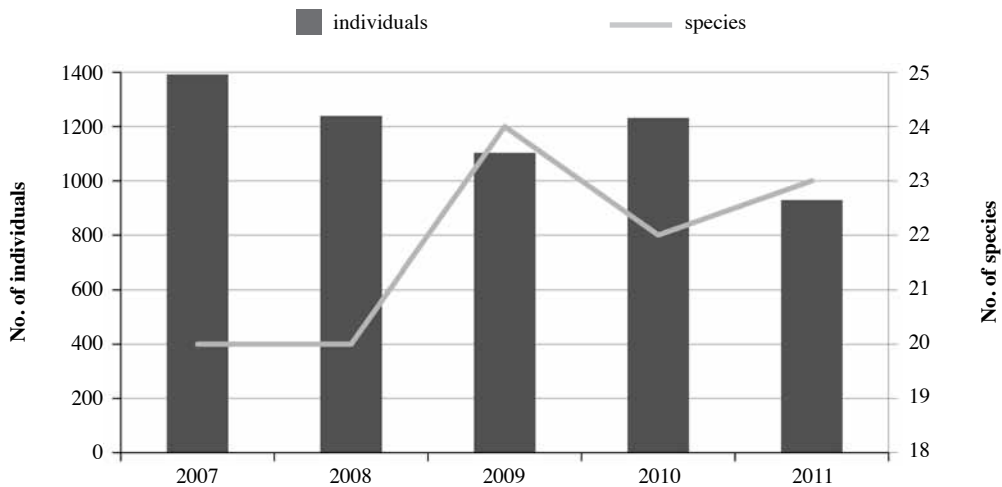
**Figure 4.** Trend of the Daily Energy Expenditure index resulted after the 5-year census at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium).

The present study revealed an overall negative trend in the numbers of individuals of each species recorded over the five years for the entire waterbird community in all seasons, possibly due to the dynamics of the bird populations on a larger scale and also to the changing conditions of the trophic capacity of the area, as previously hypothesized (Angelici & Brunelli 2008, Brunelli & Sorace

2008). Further support for this hypothesis is the disappearance of aquatic macrophytes between 2007 and 2010 where the River Farfa merges with the River Tiber, possibly caused by increased nitrogen compounds and micro-particles in suspension that, in turn, increase the water turbidity and promote the development of algae, with consequent oxygen and light decrease below the threshold nec-



**Figure 5.** Trend of the index of trophic structure of the species recorded at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium) across the 5-year study.



**Figure 6.** Number of wintering individuals and species counted during the second half of January each study year at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium).

essary for the macrophytes growth (Izzi 2011). In fact, the macrophytes are an important component for waterbirds as they represent a primary food source for some species (eg. *Fulica atra*), provide both shelter for invertebrates, main diet items for different Anatidae species (eg. *Aythya ferina*), and materials for nests (eg. *Podiceps cristatus*). It is therefore plausible that decrement or disappearance of macrophytes may have a negative impact on the waterbird community (Schmieder *et al.* 2006, Hanson *et al.* 2010).

Our results suggest that urgent management intervention is necessary to improve the trophic capabilities of the area. In particular, we believe that the causes that led to

the near disappearance of aquatic macrophytes (see for example the aerial photos in Izzi 2011, p. 110) should be identified and removed. Another desirable action would be to create new wetlands with shallow waters of different depths, which would be ideal resting and feeding areas for the birds, as it has been proved a successful action in other areas (cf. Marchesi & Tinarelli 2007).

In conclusion, the area is affected by the typical problems of all wetlands, in particular those of artificial origin (Finlayson 1992, Montemaggiore 1996) such as unnatural variation of water levels, accumulation of sediments and deterioration in water quality.

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**Table 3.** Total counts conducted in the second half of January of each year at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium).

Species	2007	2008	2009	2010	2011	Mean	SD
<i>Cygnus olor</i>	0	0	0	1	0	0.2	0.4
<i>Anas penelope</i>	7	38	22	18	12	19.4	11.9
<i>Anas strepera</i>	11	6	2	0	7	5.2	4.3
<i>Anas crecca</i>	253	128	126	169	156	166.4	51.8
<i>Anas platyrhynchos</i>	230	186	168	210	146	188.0	33.2
<i>Anas acuta</i>	0	0	2	4	3	1.8	1.8
<i>Anas clypeata</i>	0	17	18	22	15	14.4	8.4
<i>Aythya ferina</i>	429	217	225	285	77	246.6	127.3
<i>Aythya fuligula</i>	5	6	2	2	2	3.4	1.9
<i>Phalacrocorax carbo</i>	38	34	29	31	31	32.6	3.5
<i>Botaurus stellaris</i>	1	0	1	0	1	0.6	0.5
<i>Nycticorax nycticorax</i>	0	0	1	0	0	0.2	0.4
<i>Bubulcus ibis</i>	3	34	30	58	67	38.4	25.2
<i>Egretta garzetta</i>	1	2	4	3	2	2.4	1.1
<i>Casmerodius alba</i>	0	2	3	3	3	2.2	1.3
<i>Ardea cinerea</i>	18	11	17	24	18	17.6	4.6
<i>Tachybaptus ruficollis</i>	30	41	25	22	14	26.4	10.0
<i>Podiceps cristatus</i>	16	28	32	22	21	23.8	6.3
<i>Podiceps nigricollis</i>	1	0	2	0	0	0.6	0.9
<i>Rallus aquaticus</i>	18	8	11	7	5	9.8	5.1
<i>Gallinula chloropus</i>	39	43	58	45	47	46.4	7.1
<i>Fulica atra</i>	220	389	287	279	246	284.2	64.4
<i>Vanellus vanellus</i>	8	18	5	4	9	8.8	5.5
<i>Gallinago gallinago</i>	16	13	7	4	7	9.4	4.9
<i>Actitis hypoleucos</i>	0	0	0	1	1	0.4	0.5
<i>Larus michahellis</i>	48	18	26	18	39	29.8	13.3
<b>Total of individuals</b>	<b>1392</b>	<b>1239</b>	<b>1103</b>	<b>1232</b>	<b>929</b>	<b>1179.0</b>	<b>173.2</b>
<b>Total of species</b>	<b>20</b>	<b>20</b>	<b>24</b>	<b>22</b>	<b>23</b>	<b>21.8</b>	<b>1.8</b>

**Table 4.** Number of the pairs breeding at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium) during the 5-year study period.

Species	2008	2009	2010	2011
<i>Anas platyrhynchos</i>	27	28	35	32
<i>Ardea cinerea</i>	2	8	6	4
<i>Tachybaptus ruficollis</i>	4	3	2	2
<i>Podiceps cristatus</i>	11	7	3	2
<i>Rallus aquaticus</i> *	-	-	-	10-12
<i>Gallinula chloropus</i>	10	11	7	7
<i>Fulica atra</i>	13	14	12	11
<i>Larus michahellis</i>	0	2	1	0

\* Estimate based on call detection across the study area.

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**Table 5.** Number of years during which the following migratory species were recorded at the Regional Nature Reserve of Nazzano, Tevere-Farfa (Latium) and the maximum number of individuals counted.

Species	no. of years	maximum no. of individuals counted
<i>Anser anser</i>	1	5
<i>Tadorna tadorna</i>	1	1
<i>Ixobrychus minutus</i>	5	3
<i>Ardeola ralloides</i>	1	1
<i>Ardea purpurea</i>	5	2
<i>Ciconia ciconia</i>	1	1
<i>Threskiornis aethiopicus</i>	1	1
<i>Platalea leucordia</i>	4	3
<i>Grus grus</i>	3	1
<i>Himantopus himantopus</i>	5	12
<i>Recurvirostra avosetta</i>	5	6
<i>Philomachus pugnax</i>	3	4
<i>Limosa limosa</i>	1	3
<i>Tringa ochropus</i>	4	8
<i>Tringa erythropus</i>	3	7
<i>Tringa nabularia</i>	5	6
<i>Tringa stagnatilis</i>	5	4
<i>Tringa glareola</i>	3	2
<i>Tringa totanus</i>	5	6
<i>Larus fuscus</i>	1	2

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