HABITAT PREFERENCES OF ANATIDAE (Aves, Anseriformes) IN A MEDITERRANEAN PATCHY WETLAND (CENTRAL ITALY)

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Abstract

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The habitat preferences of a set of duck species (Anseriformes, Anatidae) occurring in a Mediterranean remnant wetland of central Italy were assessed in respect to four habitat types selected *a priori* (reed beds, flooded meadows, uncultivated fields, flooded pastures). We obtained 1392 records from five species. Wetland fragment studied appears a patchy mosaic of habitat differently utilized by the duck species. Mallard (*Anas platyrhynchos*) occurs more frequently in reed beds, garganey (*Anas querquedula*) in the flooded meadows, wigeon (*Anas penelope*), teal (*Anas crecca*), shoveler (*Anas clypeata*) in the flooded pastures. We evidenced two groups that appear different in regard to their specialization: species linked to flooded pastures (wigeon, teal, shoveler), more specialists, with lower niche breadth index (< 0.2) and species linked to reed beds and flooded meadows (mallard and garganey), with higher niche breadth values (> 0.4). Comparing the species belonging to the two groups, they show low values of niche overlap index. At local scale and around a yearly cycle, the presence of different habitat types induces a patchiness at local scale that may favour the presence of duck species with different ecology.

Key words: land cover use, remnant wetland, ducks, habitat types, heterogeneity, specialization

Introduction

Wetlands may host different habitat types due to their heterogeneity induced by anthropogenic and/or natural disturbances (Hobbs, Huenneke, 1992; Nichols et al., 1998; Austin, 2002; Tews et al., 2004; Boertmann, Ricet, 2006).

The role of wetlands as food, stop-over and breeding sites for waterfowls is widely known (e.g., Pöysä, 1983; BirdLife International, 2004; Connor, Gabor, 2006). Among waterflows, Anseriformes Anatidae (hereafter, ducks) are a group of species that are sen-

sitive to the environmental patchiness, utilizing differently the habitat types of a wetland mosaic (Austin, 2002; Nummy, Pöysä, 1995; Krapu et al., 2006). Duck species select often the available resources and the microhabitats in different ways throughout the wetlands, depending on their behaviour or spatial location for feeding and breeding (Austin, 2002; Paracuellos, 2006).

Despite a wide literature has been focused on ecology of duck species and other waterfowls, studies concerning their habitat preferences refer mainly to Northern Europe and Nearctic region (Nilsson, 1972; Pöysä, 1983; Rotella, Ratti, 1992; Krapu et al., 2006) and few data are available for the Mediterranean area. Lack of these data could generate implications in conservation and management strategies focused on these wetland-associated species (Elmberg et al., 2006).

The aim of this work is to analyze, around a yearly cycle, the habitat preferences of a set of duck species that occur in a patchy remnant wetland of central Italy, focusing on possible implications of these data for wetland management strategies.

Material and methods

Study area

We conducted the field research in the "Torre Flavia wetland" Natural Monument (Central Italy; 41°58' N; 12°03' E; hereafter, TFNM), a small protected wetland (40 ha) on the Tyrrhenian coast (Special Area of Conservation, according to the European Directive "Birds" 79/409/CEE). This area is a relict of a larger wetland, recently drained and transformed (Battisti, 2006).

At landscape scale (about 10-km wide), this area shows features of a remnant wetland fragment embedded in an agricultural and urbanized matrix. At the study scale (about 1-km wide), it shows a specific, semi-natural patchiness with water ponds and channels, reed beds (*Phragmites australis*), flooded meadows, dune and backdune areas, patches at *Carex hirta*, *Juncus acutus* and Cyperaceae (*Juncetalia maritimi* 92/43 European Directive habitat type).

In the wetland area, water is mainly of meteoric and of sea storm origin (meso-Mediterranean xeric region; Blasi, 1994). Water depth is seasonally variable in time and space (0–130 cm in reed beds; 0–40 cm in the pasture lands and in flooded meadows with *Carex hirta*, *Juncus acutus* and Cyperaceae). In the period July–September, wetland is drought (Battisti et al., 2006).

Inside the study area we selected four coarse-grained habitat types characterized by different water depth regime, vegetation cover and natural or human-induced disturbances (grazing by horses in pasture lands, mowing in reed beds and fields) for a total of 26.53 ha (about 65% of total size area of TFNM):

- reed beds (RE), corresponding to small size patches of *Phragmites australis* reed beds, periodically (every 2–3 years) mowed along the edges, with channels for fish farming (mullet fry belonging to three species: *Mugil cephalus, Liza ramada, Liza saliens*); water depth in channel is between 0 and 100 cm in October–June period (maximum in winter; Battisti, 2006) (6.79 ha; 26% of the study area);
- flooded meadows (FM), corresponding to patches at *Carex hirta*, *Juncus acutus* and Cyperaceae (*Juncetalia maritimi* habitat type); water depth is between 0 and 40 cm in November–June period (5.93 ha; 22%);
- uncultivated fields (UF): set-aside lands with a predominance of Cruciferae, Umbelliferae, Compositae, Graminaceae periodically mowed; water is present only occasionally (from meteoric precipitations; 9.20 ha; 35%);
- flooded pastures (FP), corresponding to flooded meadows (patches at *Carex hirta*, *Juncus acutus* and Cyperaceae; *Juncetalia maritimi* habitat type), grazed by horses; water depth is depth between 0 and 40 cm in November–April period (4.60 ha; 17%); no water occur in May–October period.

Sampling design and data collection

The transect method with direct-count was used to study the ducks in TFNM (Jarvinen, Vàisännen, 1973; Bibby et al., 2000). There are evidences that this method is the more suitable for application in studies carried out in every season (e.g., Blondel, 1969). Moreover, the direct-count method inside a transect provides an overall estimate and localization of the individuals and populations in the wetlands (Paracuellos, 2006). Since the birds included in this study are all medium-large in size, easily detected and that the landscape structure is characterized from open habitats or from patchy reed beds entirely covered from the observer, it was assumed that none of the species sampled in this study presented important differences of detection and that the direct counts had a high level of accuracy (see Bibby et al., 2000).

From 5 January to 23 December 2005 we conducted 23 transects in the TFNM study area (4,140 minutes of sampling effort), with an approximately two times/month frequency (all the months except November with only one sampling). Transect was approximately 3,500 m long.

Data were collected by one observer (E.R.), who surveyed as much of the transect as possible during a 3-h daily survey period (07.00 h–10.00 h a.m.), walking with constant speed (1.5 km/h). During each survey, the observer recorded the occurrences of all adult individuals seen belonging to duck species and reported the data on a 1:2,000 map. The habitat use of each individual sampled was visually estimated in relation to four selected habitat types and reported on the map. Flying individuals and *juveniles* were not sampled (see Bibby et al., 2000). We refer to entire set of values around the year, not subdividing data seasonally. Therefore, the results of this study do not imply intra-seasonal differences among habitat types.

Samples were taken under favourable environmental conditions (without rain and strong wind). Observer used a binocular 10x42 Leica BN.

Habitat preferences

We calculated the abundance (i.e., number of individuals recorded; n) and frequency (ratio number of individuals/total; fr) of each duck species in each of selected land use/cover habitat types.

For each species, we obtain the following indices:

– Feinsinger niche breadth index (Feinsinger et al., 1981), as:

$$PS = 1\text{-}0{,}5 \sum |p_i - q_i|$$

to evaluate the ability to use the resources in comparison to their availability (an index of habitat preference). In the index, p_i is the proportion of the utilized resource (i.e., the frequency of records in everyone of the four habitat types) and q_i the proportion of the available resource (i.e., the frequency of each land habitat type on total study area). The index varies from 0 (extreme specialist for that specific resource) to 1 (extreme generalist).

– a simple niche overlap index (Krebs, 1989), as:

$$Oi = \sum (p_{j1} p_{j2} / a_j),$$

where p_{j1} and p_{j2} are the relative frequencies, respectively, of the species 1 and 2 recorded among the habitat type j and a_j is the relative frequency of the available habitat type j.

Differences between relative frequencies were tested for significance using the Z statistic (Zar, 1984). We performed all statistical analyses using SPSS version 13.0 (SPSS Inc., 2003). We assumed an alpha level of 5% and 1%.

Results

A total of 1392 records relative to five duck species were obtained during the 2005 yearly period in the TFNM study area. No individual has been sampled in uncultivated fields (Table 1).

T a b l e 1. Abundance (n) and relative frequency (fr) of duck species (Anseriformes, Anatidae) in the four selected land use/cover habitat types in Torre Flavia wetland Natural Monument (central Italy), in the 2005 yearly cycle. N = total abundance. Among brackets, the frequency on the total; RE = reed beds; FM = flooded meadows; UF = uncultivated fields; FP = flooded pastures.

	Land use/cover habitat types								
	RE		FM		UF		FP		
Species	n	fr	n	fr	n	fr	n	fr	N
Anas platyrhynchos	321	0.96	151	0.72	0	0.00	14	0.02	486 (34.91)
Anas penelope	0	0.00	0	0.00	0	0.00	77	0.09	77 (5.53)
Anas crecca	0	0.00	15	0.07	0	0.00	720	0.85	735 (52.80)
Anas querquedula	15	0.04	44	0.21	0	0.00	0	0.00	59 (4.24)
Anas clypeata	0	0.00	0	0.00	0	0.00	35	0.04	35 (2.51)
Total	336	100	210	100	0	-	846	100	1392

Mallard was significantly more frequent in reed beds as compared to flooded meadows and to flooded pastures; and in flooded meadows as compared to flooded pastures (Table 2). Teal, absent in reed beds, was significantly more frequent in flooded pastures as compared to flooded meadows (Table 2). Garganey, absent in flooded pastures, was significantly more frequent in flooded meadows as compared to reed beds (Table 2).

Comparisons among utilized and available relative frequencies in different habitat types showed that: mallard occurs more frequently in the reed beds and avoided the flooded pastures; wigeon occurs more frequently in the flooded pastures; teal occurs more frequently in the flooded pastures and avoided the flooded meadows; garganey occurs more frequently in the flooded meadows; shoveler occurs more frequently in the flooded pastures (Table 3).

T a b l e 2. Comparisons between relative species frequencies (proportion of land use/cover habitat type utilized: p_i) of each species in selected land use/cover habitat types; N = number of records; Z statistic (probability level: ** = $p < 0,01$). RE = reed beds; FM = flooded meadows; FP = flooded pastures. Species present only in one land use/cover habitat type are not reported.

Species	p_i		N	Z
Anas platyrhynchos	RE 0.66	FM 0.31	486	10.853**
	RE 0.66	FP 0.02	486	20.993**
	FM 0.31	FP 0.02	486	12.093**
Anas crecca	FM 0.02	FP 0.98	735	36.755**
Anas querquedula	RE 0.25	FM 0.75	59	5.247**

T a b l e 3. Comparison between proportion of land use/cover habitat type utilized (p_i) and available (q_i; see Methods) in Torre Flavia wetland Natural Monument. Z = test value; Z statistic (probability level: ** = $p < 0.01$; * = $p < 0.05$). RE = reed beds; FM = flooded meadows; FP = flooded pastures.

Species	Habitat type	p_i	q_i	Z
Anas platyrhynchos	RE	0.66	0.26	4.006**
	FM	0.31	0.22	0.774
	FP	0.02	0.17	4.007**
Anas penelope	FP	1	0.17	8.754**
Anas crecca	FM	0.02	0.22	5.684**
	FP	0.98	0.17	18.749**
Anas querquedula	RE	0.25	0.26	0.168
	FM	0.75	0.22	4.392**
Anas clypeata	FP	1	0.17	6.478**

T a b l e 4. Feinsinger niche breadth index (PS) for the duck species in Torre Flavia wetland Natural Monument.

Species	**PS**
Anas platyrhynchos	0.51
Anas penelope	0.17
Anas crecca	0.19
Anas querquedula	0.47
Anas clypeata	0.17

T a b l e 5. Niche overlap index among species in Torre Flavia wetland Natural Monument.

	Anas platyrhynchos	*Anas penelope*	*Anas crecca*	*Anas querquedula*
Anas penelope	0.118			
Anas crecca	0.143	5.765		
Anas querquedula	1.691	5.882	0.068	
Anas clypeata	0.118	5.882	5.765	5.882

Mallard and garganey showed the higher values of the niche breadth index (> 0.4); wigeon, teal, shoveler showed the lower values (< 0.2; Table 4). Wigeon, garganey and shoveler showed, among them, the higher values (> 5) of niche overlap index. Teal showed high values of overlapping with wigeon and shoveler; mallard low values with all four (Table 5).

Discussion

Wetland remnants studied appear a patchy mosaic of habitat types differently preferred from the set of duck species.

Species differ in number and frequency of habitat types utilized as compared to their availability. Mallard occurs more frequently in reed beds and shows the higher value of niche breadth index. This duck is known as a generalist and edge species, foraging on emergent vegetation in reed beds and in flooded meadows (Rotella, Ratti, 1992; Krapu et al., 1997; Krapu et al., 2006; Steen et al., 2006). Garganey occurs more frequently in the flooded meadows and shows a high breadth index (> 0.4). This species prefers edge areas of open shallow water with rich submerged vegetation (Pöysä, 1983), diffused features in Mediterranean flooded meadows. Teal, shoveler and wigeon appear more specialized (low niche breadth index), with the last two species strictly linked to flooded pastures. These species prefer open shallow water areas with rich submerged vegetation, where forage on sub-emergent and emergent vegetation (Pöysä, 1983; Holm, Clausen, 2006). In this sense, flooded pastures appear locally the more suitable habitat for these species also in respect to flooded meadows where vegetation (*Juncus* sp. and *Carex* sp.) covers a high proportion of the surface and watered areas are scarce.

We evidenced two groups of species that appear different in regard to their specialization. Three species linked to flooded pastures (wigeon, teal, and shoveler), more specialized (lower niche breadth index), and two species (mallard and garganey), linked to reed beds and flooded meadows, with higher niche breadth values. Comparing species belonging to the two groups, we observed low values of niche overlap index.

In our study area, availability of reed beds, flooded pastures and meadows is due to the local regimes of water depth and specific disturbances (e.g. horse grazing, mowing; Battisti et al., 2004; Battisti, 2006), that induce a complex patchy pattern at local scale. Therefore, despite at landscape scale many others factors may operate (Krapu et al., 1997; Cowardin et al., 1998), at local scale the habitat heterogeneity (i.e. availability of different disturbance-induced habitat types) may favour the presence of duck species with different ecology (Isola et al., 2000; Bancroft et al., 2002; Holm, Clausen, 2006; Johnson et al., 2007).

Management strategies focused on these species should consider these conclusions. In this sense, further research are requested to assess the role of specific variables linked to water depth and disturbance regimes to explain the observed habitat preferences of duck species in Mediterranean wetland remnants.

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