Spatial and temporal dynamics in the habitat use by waterbirds in the coastal area of Friuli Venezia Giulia: a series of case studies

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Introduction
Birds can move either on long distances, during migrations, or on shorter distances. In this case, the movements are dispersive or periodical and are often performed on a circadian base. Short-distance moves include those carried out between feeding and resting grounds during wintering. They are an important portion of the total movements of a bird over an annual cycle. The analysis of these movements is crucial to better understand the biology and ecology of birds during the non-breeding season.

Wintering
Wintering and resting during migrations are very delicate periods for many waterbird species. Such periods can represent over 75% of a bird’s life (Hutto, 1998) and they can affect the reproductive success of individuals and on a global level the population trend, especially considering that many species tend to return to the same wintering grounds throughout the years (McKelvey & Smith, 1990; Hestbeck, 1993). The feeding resource plays a fundamental role in the choice of such areas (Berthold, 2003). It has been observed as a deficiency in the diet during wintering affects
i) moult ing period (Richardson & Kaminsky, 1992), with consequences on thermoregulation and time of migration;
ii) body weight;
iii) pair formation (Demarest et al., 1997);
iv) date of start of breeding (Dubovsky & Kaminsky, 1994).
The understanding of the distribution of the food resource is therefore crucial to understand bird population dynamics and choice of wintering grounds. Meanwhile, the presence of human activities such as fishing, hunting and recreational activities, can affect habitat use, as a function of the level of disturbance. Tamisier (1999), comparing Camargue in France and lake Ichkeul in Tunisia, highlights how different hunting regimes affect the use of the food resource up to 80% with visible consequences on population dynamics. The creation of protec-
ted areas, where conditions are kept as natural as possible, limits the level of human pressure on birds. However, they cannot always provide the ideal wintering conditions for all waterbird species. For instance in the case of dunlin, the numbers recorded in Friuli Venezia Giulia protected areas are only 1% of the wintering lagoonal population, although such a wader is of international importance for the Grado and Marano lagoon (Tab. 1).

Aims of the work
The aim of the work is to understand the spatial-temporal dynamics of wintering waterbirds, by analysing the following target species:

- Wigeon (Anas penelope);
- Eurasian Curlew (Numenius arquata);
- Grey Plover (Pluvialis squatarola);
- Dunlin (Calidris alpina).

Such dynamics will be analysed taking into account also the effect of factors such as human disturbance, food availability, presence of protected areas. In this way it will be possible to understand on the one hand the strategies of habitat use by the four species as a function of the different pressures. On the other, the best management models will be highlighted by the analysis of habitat use in the study area. These information can give important indications for the definition of management plans for SPAs according to the “Birds” directive 79/409/EC.

Study area
The study area is located between Tagliamento river (W) and Panzano bay (E). It includes the whole Grado and Marano lagoon and the reserves “Valle Cavanata” and “Foce dell’Isonzo” (Fig. 1). Grado and Marano lagoon is one of the most important resting and wintering sites for waterbirds in Adriatic and in Italy. It is of international value for 6 wintering species, and of national value for 26 (average 1996-2000, Baccetti et al., 2002).

Waterfowl: the Wigeon
It is a surface waterfowl species. It is herbivorous and feeds mainly on seagrasses. It is of hunting interest, as it is the most common wintering waterfowl species, with 34,757 individuals in 2005 (Census IWC-Region FVG). Grado and Marano lagoon is of international importance for this species (Fig. 2), as it hosts at least 1% of the total population (Siberia W/Europa NE/Mar Nero/Mediterraneo).

Strategies of habitat use by wigeon in the FVG wintering grounds
During the Eighties this species fed in fish farms and lagoons mainly during the night, whereas during the day it rested out at sea to avoid human disturbance (Parodi & Perco, 1988). Since 1993/94, after hunting was banned in Nat.Reg.Res Foce dell’Isonzo and hunting pressure decreased in general over the lagoon, the widgeon has been recorded feeding also during the day in the lagoon and in Foce Isonzo mudflats. This site is already occupied in September (Kravos et al., 2003). Since 1995/96, the diurnal presence in the lagoon and Foce Isonzo has progressively and significantly increased (Kravos et al., 2003). In all cases Marano lagoon is occupied later in the season (February-March).

Materials and methods
The distribution of wigeons in the study area is given in figure 3. Data have been collected during 3 monthly transects. The values are given as an average presence of the species.
Results

Figure 4 shows the monthly trends in wigeon presence during the wintering season 2005/06. In September there is already a significant presence, whereas in April all the population has already moved to the breeding grounds. The highest values are recorded in January.

Figure 5 shows the monthly presences, considering distribution and abundance classes. The first individuals arrive in September and occupy Foce Isonzo area. From October the area of Noghera becomes important. This is a fish farm where waterfowl is artificially fed and hunting occurs once per week. These two areas have high number of wigeons also in November, December and January.

Meanwhile a general increase in numbers is recorded, and a wider distribution to cover the whole Grado lagoon. When the hunting season is closed at the end of January, and the food resource is likely to be depauperated, “Foce dell’Isonzo” shows a strong decrease in bird presence. The same occurs in Noghera. In February and March the westward areas are occupied, and in April all individuals have moved towards the breeding grounds.

From December to April, it is interesting to note a progressive movement of the population from east to west, that is from Grado to Marano lagoon.

Wigeon presence in Noghera

Noghera is the biggest fish farm of the lagoon. It has big water basins, that are particularly indicated for wigeons. It is also a hunting estate. Hunting is carried out once per week however, so the disturbance on wigeons is low. Furthermore, birds are artificially fed and this increases the presences in the area.

Density values shown in Figures 6 - 7 have been collected from dawn till dusk, every 30 minutes, at monthly intervals. It is apparent that wigeons are abundant in the fish farm at dawn, when the tide is high in the lagoon, whereas wigeons are less abundant in the afternoon, when tides are low and they go out to forage on the seagrass beds. The species density is however still high, as shown in Figure 7, due to the good environmental conditions of the fish farm. The low values of presence in January (Fig. 6 and 7) are related to the fact that on the day of monitoring an ice layer was covering the water basin.

The waders: curlew, grey plover and dunlin

The Eurasian curlew (3.262 individuals), the grey plover (3.722 individuals) and the dunlin (15.100 individuals) represent 92.8% of wintering waders in FVG Region (Census IWC-Region FVG, Jan 2005). They are not species of hunting interest. They feed on mudflats at low tide, especially eating benthic macroinvertebrates. At high tide they concentrate in roosts on saltmarshes or sandbanks. The Grado and Marano lagoon is of international importance for the dunlin and of national importance for curlew and grey plover (Fig. 8-10, Baccetti et al., 2002).

The activity of ringing has allowed to catch a good number of birds, using Mist net and Abberton methods (Tab. 2 e 3), and to mark them with radio-transmitters. Several individuals of the 3 wader species have thus been followed with radio-telemetry methods.

Materials and methods

All roosts in the lagoonal area has been monitored at monthly intervals. The monthly distribution of the 3 target species in the study area has been estimated for the wintering period 2005/06.

Radio-telemetry

This technique allows to locate and follow the movements of individually radio-marked birds, by detecting the radio signals emitted. In winter 2005/2006, 7 curlews and 5 grey plovers have been marked with radio-transmit-
ters PD-2 (weight 3.8 g, battery 6 months; Holohil Ltd.); 7 dunlins with radio-transmitters BD-2 (weight 1.4 g, battery 8 weeks; Holohil Ltd.). The three catching sites (Fig. 12) have been chosen in the proximity of important roosts (Fig. 11), located in the central-eastern part of the study area. The movements have been followed by a receiver SIKA and a directional antenna Yagi at 3 elements (Biotrack Ltd.). The activity was carried out between December 2005 and April 2006. Three monthly monitoring sessions have been carried out at different moon and tidal phases. During each session, 3 fix per individual per tidal cycle were collected. Hence, the individuals were contacted when they were roosting, while foraging and when they were roosting again. An average of 15 monitoring hours were carried out during each session (13-18).

Results

European Curlew
The percentage of collected fixes was 94.7%, against an expected value of 100% assuming the permanence of individuals in the study area. This means that marked individuals were highly localized during wintering. The comparison of figure 1 and 11 suggests that such individuals have spent the whole wintering period inside a reserve, or close by. Assuming that the spatial dynamics are analogous for all wintering curlews, it is apparent that individuals roosting in the central-western area of the lagoon are farther from the reserves, and are therefore potentially subject to higher disturbance levels.

Table 4 shows how the presence of curlews in a roost exclude the presence of grey plovers and dunlins. Indeed, the latter tend to roost on bare sandbanks along the littoral belt (Fig. 16 and 17), whereas the curlew prefers saltmarshes with halophytic vegetation and has a wider roost distribution (Fig. 11). A strong association between grey plover and dunlin is apparent (Spearman correlation, N = 26, Rs = 0.73, P < 0.0001), and the proportion of individual numbers of the two species tend to be of 1:10 (Fig. 13).

Grey Plover and Dunlin
Figures 14 and 15 shows the monthly variations of individual numbers for the two species. The values are rather low in October and then they increase, to abruptly decrease in February and then rise again. Figures 16 and 17 confirm this tendency (in number of roost and/or in number of individuals per roost). With regard to telemetry, the fix (Fig. 18-19) are less homogeneous around the catching sites, if compared with the results for curlews. Indeed, the fix cover only 24.1% of the expected fix for the dunlin and 34% of the expected fix for the grey plover. This may indicate that the marked individuals have partially wintered out of the study area. Such hypothesis seems to be confirmed by two experimental monitoring sessions carried out in February (population decrease in the study area) in Venice Lagoon (100 km from Grado and Marano lagoon), where 2 signals of dunlin and 1 of grey plover were recorded (Fig. 20). Furthermore, the signals of a grey plover and a dunlin, that had temporary disappeared, reappeared after a few weeks in the study area.

Conclusions
With regard to waterfowl, the results obtained show that the wigeon significantly responds to specific pressures and to different conditions of the wintering grounds. Overlapping different informative layers is therefore important, as this provides a comprehensive view of the habitat use of this species. Of particular relevance is the distribution of seagrasses (habitat of community interest according to dir ‘Habitats’ 92/43/EC, Annex I - Habitat). They represent the main food source for wigeons, thus knowing their distribution will give indications on
the potential feeding grounds and on their use. This part of the project is currently in progress. The monitoring activity will give indications on distribution, abundance and temporal dynamics of the species. Furthermore, radiotelemetry will give indications on the movements between different wintering grounds and different groups, together with indications on the movements carried out to reach different feeding and resting grounds. The quantification of hunting activity will suggest levels of hunting pressure, and effects on wigeons’ distribution and behavioural dynamics. All these information will allow to prepare management plans aimed at safeguarding and sustainably using the “resource” wigeon, which is the most abundant waterfowl species wintering in Grado and Marano lagoon.

With regard to waders, the results have highlighted a differential distribution and habitat use of different species during wintering. Indeed, the curlew is strongly localized, whereas grey plovers and dunlins are highly mobile. It is still not clear if the whole curlew population is localized however, or if it is a peculiarity of individuals that winter in the easternmost part of the study area, which is a natural reserve. The application of telemetry to individuals caught in the western part of the lagoon will give a better understanding of the wintering dynamics of the curlew in FVG Region. Also, it may help assessing the importance of protected areas in affecting the wintering modalities of such a species. In the case of grey plovers and dunlins, it is still to clarify if the movements recorded are part of migratory patterns, or if they are part of a strategy of resource use which implies long-distance movements between different wintering feeding grounds. Indeed, the wintering grounds could be the whole Northern Adriatic wetlands, rather than the mere Grado and Marano lagoon. Again, telemetry on more individuals will give more exhaustive information.

It is therefore of the utmost importance to continue this type of studies, as they can give precious hints for the integrated management of the eco-ethological components of the different species present in the area. Indeed, a better knowledge of the elements to be conserved lead to the creation of more efficient management plans.