DOI: 10.17242/MVvK_3.49

PREFERENTIAL HABITAT OF AQUATIC BIRDS IN RESTORED WETLAND

F.A. Comín, J.A. Romero, O. Hernández, C. García

Department of Ecology, University of Barcelona, Diagonal 645, 08028 Barcelona. Spain.

ABSTRACT

Aquatic birds were counted in different experimental wetlands located in the Ebro Delta (NE Spain) every two hours for one day, every month from May to September in order to identify preferential habitats of waterfowl in wetlands restored from ricefields. Emergent, floating and submerged vegetation and macroinvertebrates were monitored together nutrient content in the sediments as characteristics defining the habitat status for bird utilization

The number of individuals of the different species observed (*Anas platyrhynchos*, *Gallinula chloropus*, *Fulica atra*, *Ixobrychus minutus*, *Himantopus himantopus*, *Bubulcus ibis*, *Ardea purpurea*) was, in general, higher during the early and late hours of the day than at midday.

A higher number of birds of the various species was observed in the wetlands on which *Typha* plants were the dominant vegetation compared to those where *Phragmites* were dominant. The number of birds was lower in the wetlands with short emergent vegetation (including ricefields) than in the wetlands with tall emergent vegetation.

Protection by tall emergent vegetation, open areas in the vegetation and relatively deep water are the major factors favouring the presence of waterbirds in the experimental wetlands.

INTRODUCTION

Habitat restoration is one of the main reasons for restoring wetlands (Mitsch and Gosselink, 1993). Different communities can be established in restored wetlands depending on the level of restoration achieved. Aquatic birds prefer a wetland based on their requirements for

food and/or environmental protection, and these two characteristics can change in a wetland during the process of restoration.

In those areas where most of the wetlands was lost, restoring wetlands can also be a way to restore the biological community. This is the case of many lakes and lagoons where the vegetated belt was reduced, usually because of agricultural and urban developments. Restoring the wetland belt would contribute to the restoration of the habitat used by many aquatic birds. Identifying the habitat preferences of the bird community may help us to understand the community structure and the value of the restored wetland as habitat for birds.

An experimental programme of wetland restoration for the enhancement of habitat and water quality has been developed in the belts of the Ebro Delta coastal lagoons for several years. This offers the opportunity to compare the ecological characteristics of wetlands at different stages of restoration. Among other objectives, the preferential habitat of aquatic birds was studied by comparing the use of restored wetland of different ages in the reed belt of a coastal lagoon, which is reported in this paper.

MATERIALS AND METHODS

The study area consists of five wetlands located in the vegetation belt of a coastal lagoon in the Delta of the Ebro River. The five wetlands are contiguous and have the same general climate. The wetlands are abandoned ricefields (cultivated for at least thirty years, until recently) which were allowed to evolve under the same hydrologic regime for several years. They are similar in area and in their morphometric characteristics (**Figure 1**). The time since the paddy fields were abandoned for rice cultivation and became natural wetlands until 1994 - the year of this study- is indicated in **Figure 1**, and will be called here the wetland age. They all receive freshwater from a common irrigation channel from mid April to the end of September. During the rest of the year there is no water inflow. The study was performed during the plant growing season of 1994. The water column was in all the cases between 5 and 20 cm depth, except in wetland 3b, where depth was between 20 and 40 cm because it had been excavated just after the last season as a ricefield.

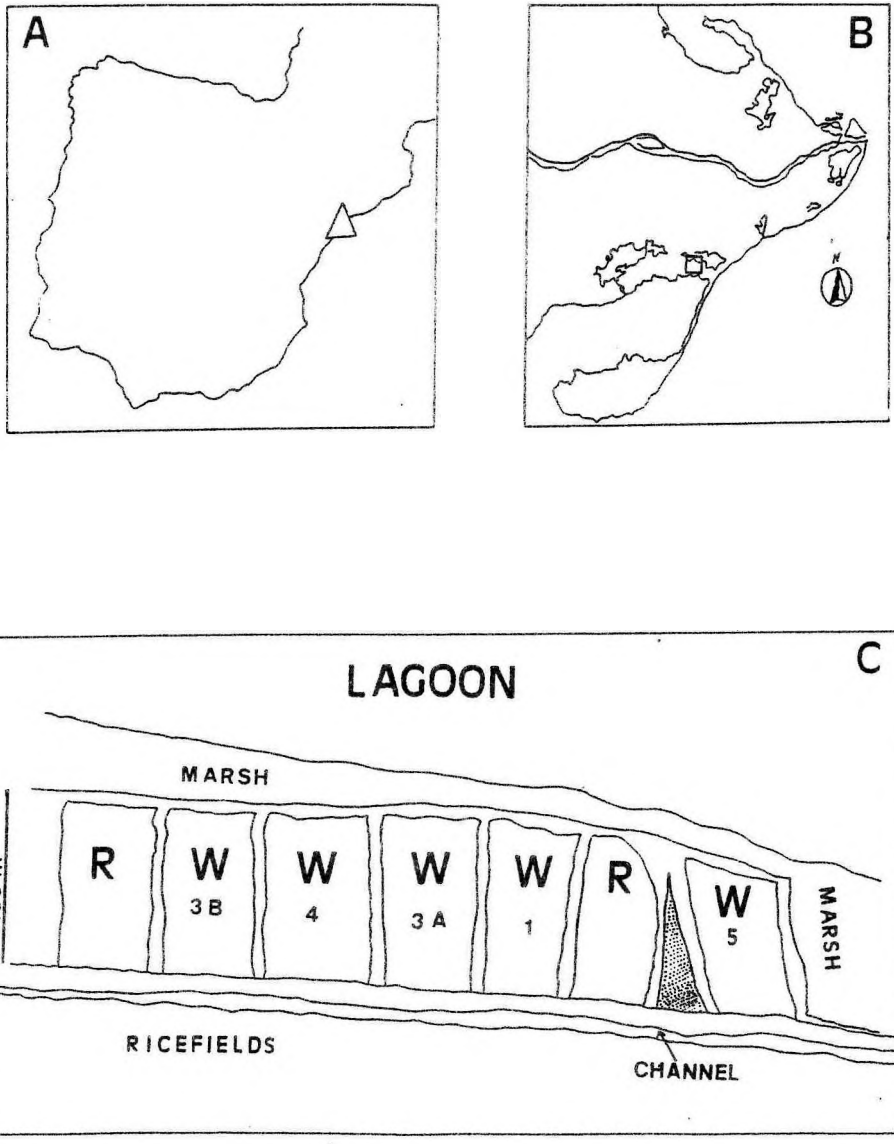


Figure 1: Study area. A) Location in NE. Spain. B) Location in the Delta of the Ebro River. C) Distribution of the wetlands. The numbers in the different areas indicate the number of years since they were abandoned as ricefields.

Aquatic birds in the different wetlands were counted monthly by walking carefully around every area and counting the birds identified by sight or sound. The count was repeated every two hours in every area during the light hours of the day. The maximum number of birds observed at any time during the day, which corresponded in most cases to the last and to the early hours of the day, is used as an estimate of the abundance of birds in the wetlands. As all the wetlands have similar areas, the numbers of birds per wetland can be used to compare bird abundance between wetlands. Observations in the different areas were recorded following a spatial sequence and taking care not to disturb the birds. The number of birds per wetland observed were lower than in other areas where colonial birds accumulate. However, these abundance are similar to those observed in other studies for birds living is similar environments (Acuna *et al.*, 1994, Lillie and Evrard, 1994).

The number of species (species richness) and the diversity index S-1/N (where S is the number of species and N the number of individuals) were used as indicators of the structure of the bird community. This index is appropriate in this context because of the low number of species and individuals in our data (Magurran, 1988). The minimum value of the index (minimum diversity) is 0 and the maximum value (maximum diversity) is 1.

Monthly samples of submerged invertebrates and macrophytes were collected with a plastic tube (ten cm diameter) from random places in the study areas. Macrophytes were collected from the space limited by the tube located in the wetland area. The invertebrate samples consisted of the animals collected within a closed plastic tube after it was towed for two meters submerged in the water. Several replicates in every wetland were obtained from random sites.

Monthly samples of emergent macrophytes were obtained from sampling quadrates (50 cm per 50 cm) placed at random in every wetland. Dry weight of plant material was determined after drying until constant weight at 70 °C.

Total biomass and necromass (decaying non photosynthetic plant material) abundance are expressed as dry weight per area unit. Density of plants, number of emergent individuals per area unit, and stem height are also used to define the wetland vegetation. Abundance of other organisms is indicated as number of individuals.

The sediment of the wetlands was sampled with a plastic tube (5 cm diameter) from three different sites at random to analyze the carbon and nitrogen content by Automatic Analyzer and phosphorus by a colorimetric method (Grasshoff *et al.*, 1983) after digestion.

RESULTS

The highest number of birds was observed in wetland 3b, followed by wetlands 3a and 4. A decreasing trend in the number of birds in the different wetlands is observed during the plant growing season (**Figure 2**). After September either a very low number or an increasing trend is observed in the different wetlands.

In wetland 3b, 3a and 4 a higher number of species was also observed than in the other wetlands. These species were: *Gallinula chloropus, Ixobrychus minutus, Anas platyrhynchos, Ardea purpurea, Fulica atra, Bubulcus ibis, Tachybaptus ruficollis, Himantopus himantopus, Chlidonias hybrida, Larus rudibundus*.

The number of species observed in the wetlands and the diversity decrease over time during the period of study. Wetland 3b is also the area with the highest number of species and diversity observed during the period of the study. The lowest values of these two parameters corresponded to wetlands 5 and 1. A general trend of decreasing number of species and diversity was observed during the period of study

A general pattern of hourly variation of the abundance of birds in the wetlands was observed (**Figure 3**). These figures represent the monthly average (and the standard deviations) of the number of birds observed at the time of the day indicated on the horizontal axis. In spite of the high dispersion of data, it is clear from this figure that the birds showed a pattern of using the wetlands mostly in the early and late hours of the day. Very few birds were observed in the wetlands during the central hours of the day. Again, a higher number of birds were observed in wetlands 3b, 3a and 4 than in the other wetlands.

None of the different biological groups studied showed any pattern of variation of their abundance's related to that of the birds (**Figure 4**). Emergent macrophytes (mostly *Phragmites australis, Typha angustifolia, Scirpus maritimus*) showed a typical pattern of increasing their biomes as the growth season proceeded (**Figure 5**)

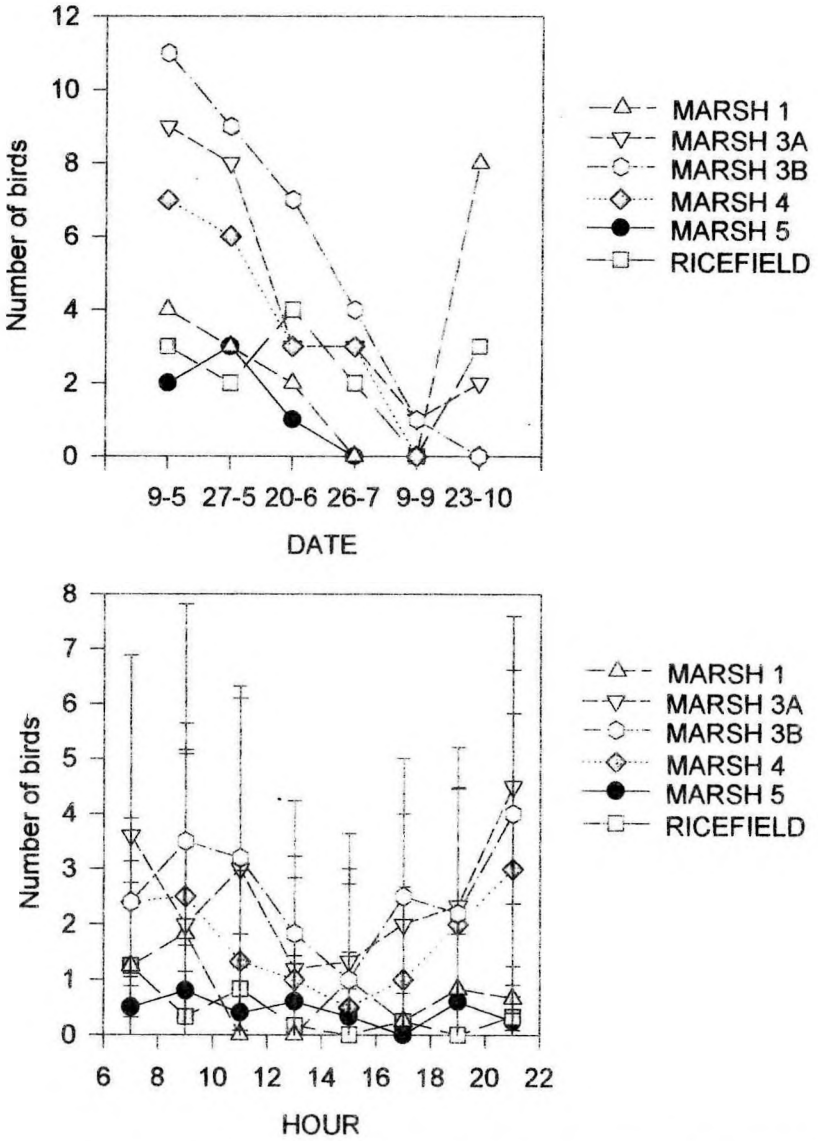


Figure 2: Above: Changes of the maximum number of aquatic birds per wetland counted during the daily observations carried out monthly during the plant growing season in the wetlands studied. Below: Average and standard deviation of the number of birds counted monthly at a given hour of the day of observation (horizontal axis).

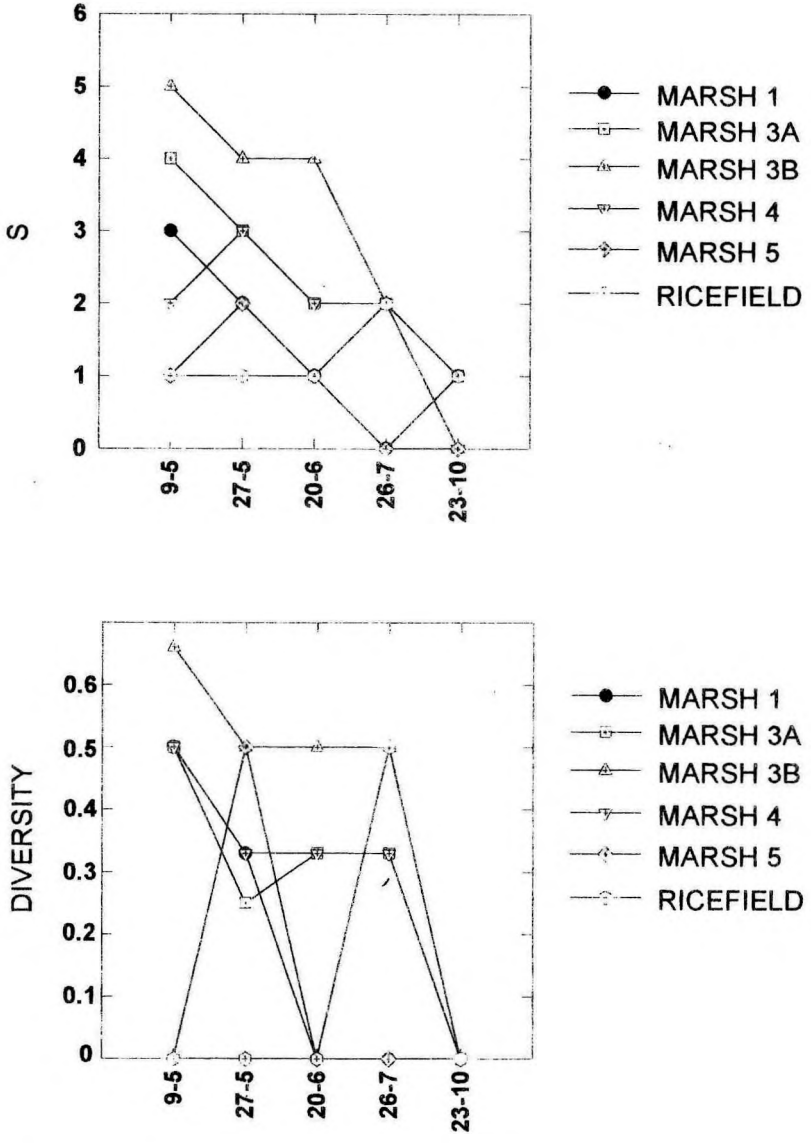


Figure 3: Number of species (above) and diversity (S-1/N, see explanation in the text) (below) in the different wetlands during the period of study.

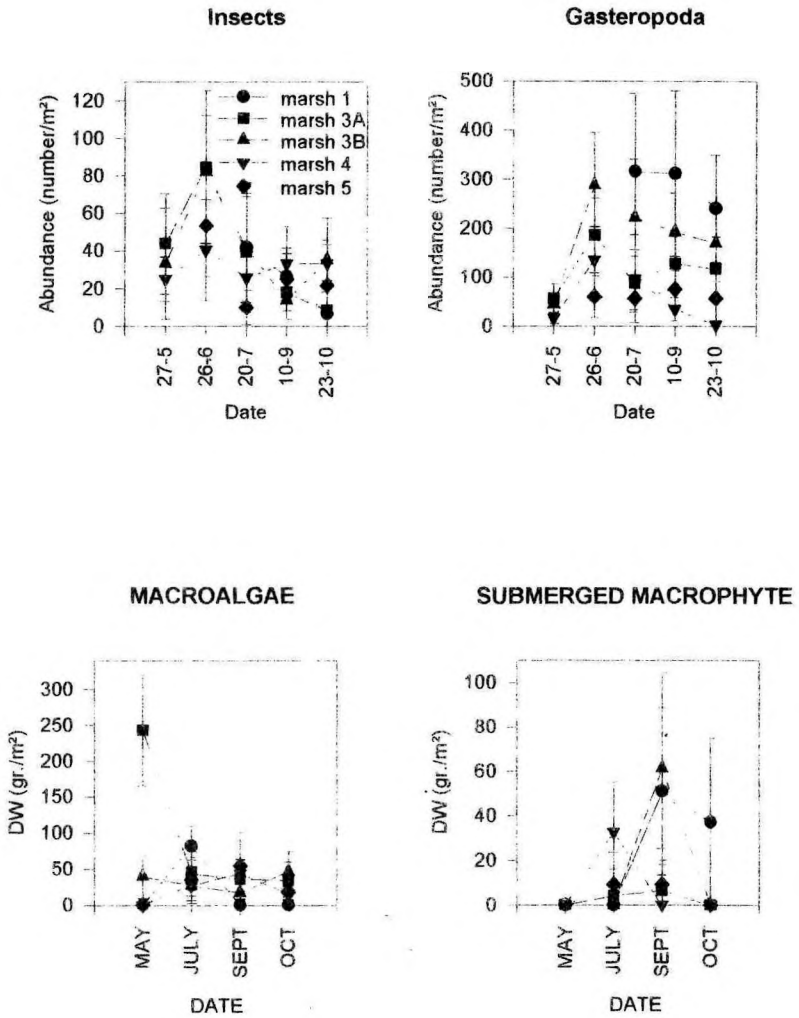


Figure 4: Changes of the abundance of different biological groups in the wetlands during the period of study.

Differences between wetlands are attributed to the age and species composition of the vegetation. In wetland 1, the emergent vegetation was dominated by *Echinochloa crus-galli* and short *Typha angustifolia*. The maximum height of the plants in this wetland was 40 cm at

the end of the growing season. Wetland 3 is dominated by *Scirpus maritimus* and *Typha angustifolia*. Wetland 4 is dominated by *Scirpus maritimus and Phragmites australis. Wetland 5 is almost exclusively occupied by P. australis.* In general, the older the wetland the higher the biomass reached during the growing season. This is also the case for the dry weight of decaying emergent macrophytes accumulated in the wetlands (**Figure 5**).

Differences between wetlands are also observed on the basis of the structure of the emergent vegetation. The highest biomass observed in the oldest wetland is due to a higher density and height of the stems than in the other wetlands (**Figure 6**).

The sediment characteristics of the wetlands showed a higher nutrient content, particularly clear for carbon and nitrogen content, as the wetlands' age increases (**Figure 7**).

DISCUSSION

All the results from this study indicate that wetland 3b (a 3-year-old wetland with a 20-40 cm water column) contained the highest number of birds and the highest structure of the bird community compared to the other wetlands during the growing season of the vegetation. Wetland 3a (a 3-year-old wetland with a 5-20 cm water column) follows wetland 3b in bird abundance and community structure and it is also outstanding compared to the other wetlands. Wetland 4 occupies an intermediate position between wetlands 3 and wetlands 5 and 1 with respect to the presence of birds. Clearly, wetlands 5 and 1 contained the lowest number of birds and their bird community structures were the lowest, as indicated by the species richness and diversity indexes.

Wetland 3b appeared to be more attractive to birds. In this wetland, the water was deeper, the plants were less dense and taller than in the other wetlands. These characteristics are related to the possibility of living in a protected environment and, at the same time, allow birds to hide and move more freely than in the other wetlands. These characteristics favor the preferential selection of this wetland by the birds. Wetlands with very dense vegetation - e.g., wetland 5 - present difficulties for birds to move within the wetland. On the other hand, wetlands with low plants - e.g., wetland 1 - do not offer as much protection for the birds as wetlands with taller plants.

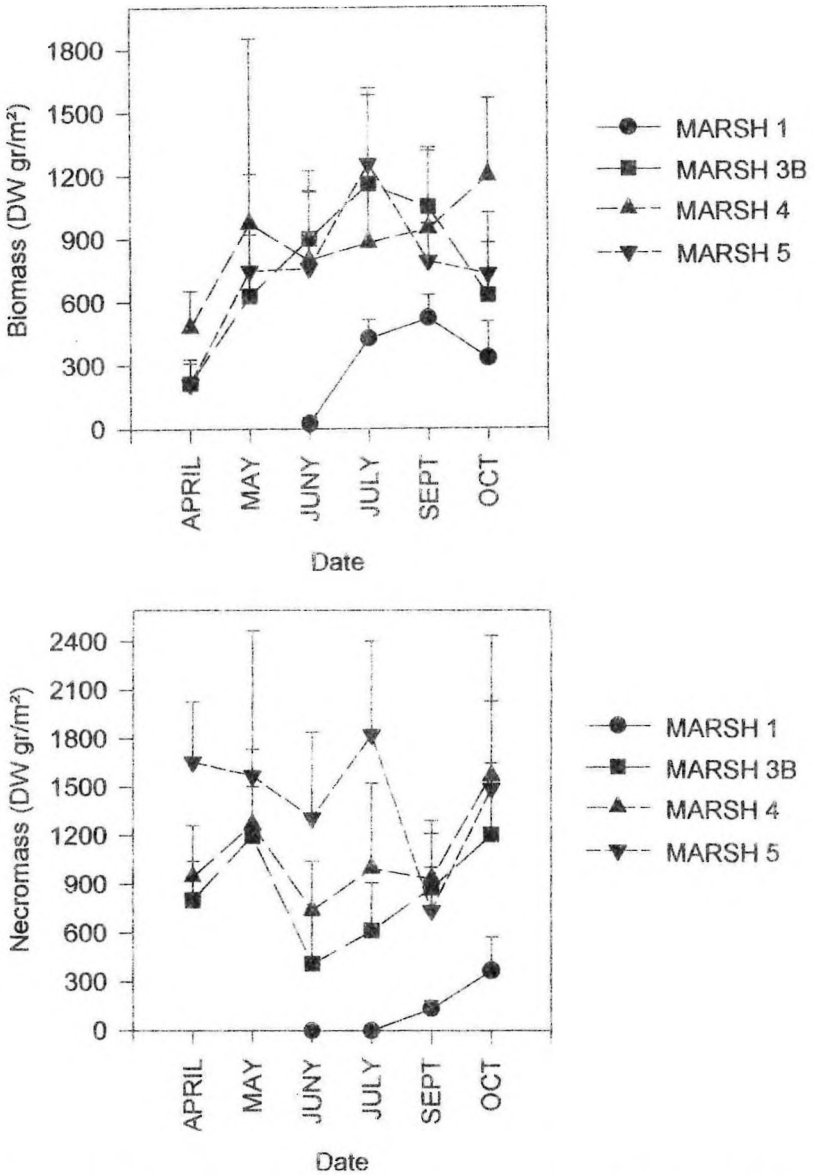


Figure 5: Dry weight of the live (a) and decaying (b) emergent macrophytes in the wetlands studied during the growing season.

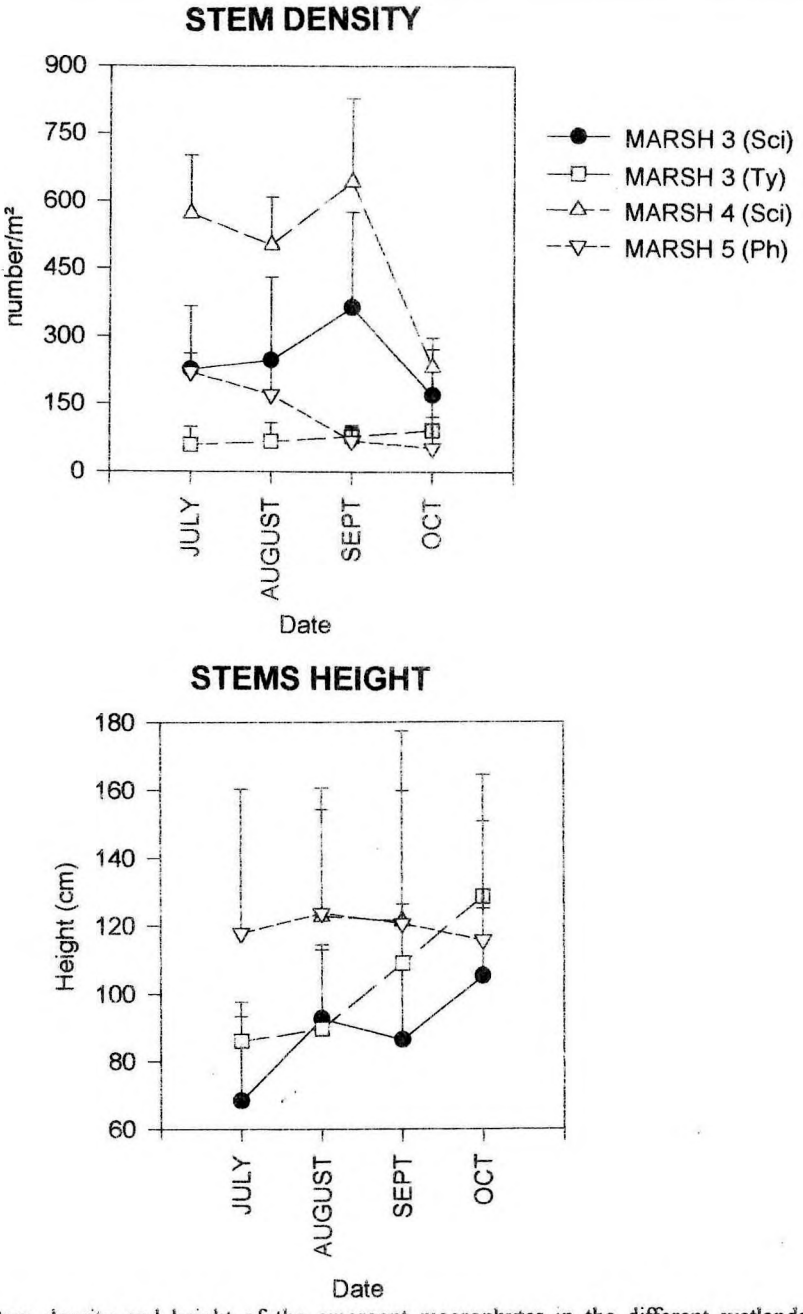
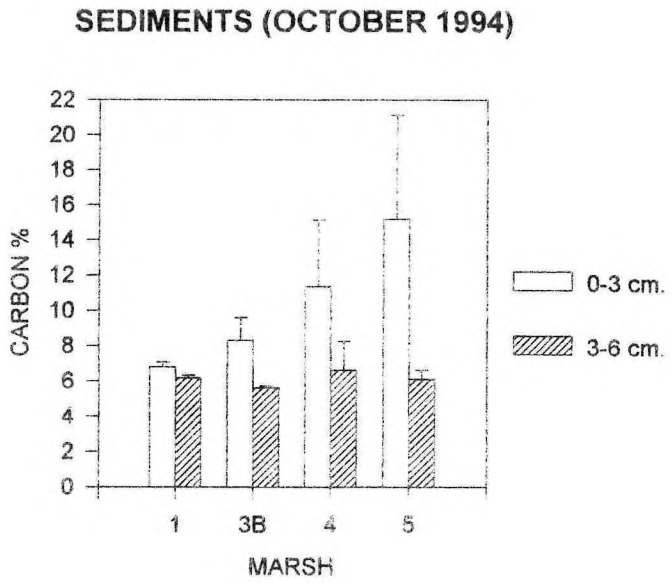


Figure 6: Stem density and height of the emergent macrophytes in the different wetlands during the growing season.



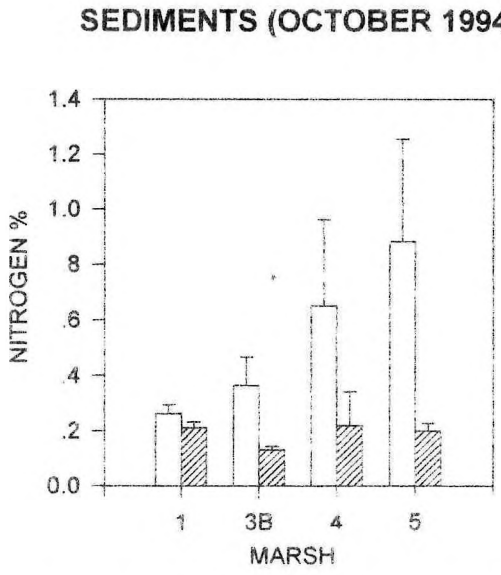


Figure 7: Some characteristics of the sediment in the wetlands at the time indicated in the figure.

The facts that the number of birds varies during the day, with a trend to stay in the wetlands at night, and the lack of apparent relationship of the number of birds to the abundance of other biological groups, which could be potential food for the birds, indicates that these birds used these wetlands mostly as a refuge during the early and late hours of the day and to rest at night. For this reason, a wetland with relatively tall and not excessively dense emergent plant population is attractive for a bird because it provides more quietness, security and it is more comfortable than a wetland with very low or too dense plants. One additional aspect is the fact that wetlands 3 are dominated by tall *Typha* and, because of this, a relatively high amount of decaying plants which, while accumulating in the wetland, form small mounts of soft material, which is used by the birds to rest and to form nesting areas. This is not possible either in wetlands dominated by *Scirpus* or *Phragmites* - wetlands 4 and 5 - because of the morphology of their leaves or in wetlands dominated by short *Typha*, because of the size of their leaves.

It is interesting to note that the data obtained for the ricefield give to it a close position to wetlands 5 and 1 in the preference of the birds. Ricefields, after the plants emerge from the water- have intermediate characteristics from the points of view considered here - water column depth, height and density of the emergent plants - in comparison with the range of wetlands considered, but closer to wetland 1 than to wetlands 3. As ricefields have been claimed to play an important role as alternative habitats for birds in the surroundings of natural areas (Fasola and Ruiz, *in press*), it is interesting to note that this is a forced alternative. Our results show that birds prefer natural habitats to rest in. The use of ricefields may be linked to the greater accessibility of food compared to other environments, as has been mentioned elsewhere (Ferrer and Martinez, 1987).

If a 2-year-old wetland had been available during this study the gradient of bird preferences shown here might have been shown complete. That is to say, the characteristics of the plant populations in wetland 2 would be intermediate between those of wetlands 1 and 3 and, consequently, the bird community characteristics in wetland 2 would be intermediate between those of wetlands 5 and 1 and those of wetlands 4 and 3. From the results presented here, a general conclusion can be proposed: wetland restoration plans for this particular area should aim to maintain zones of vegetation on the lakeshore at an intermediate successional

stage, if the major objective is to favour waterbird populations in some way. The heterogeneous environment (from the point of view of vegetation structure) created in natural conditions on the shores of many coastal lagoons may provide areas of the characteristics mentioned here as preferential habitat for the birds observed in our study.

ACKNOWLEDGMENTS

This work is part of a research programme supported by CICYT (AM92-0480). Thanks are also given to Generalitat de Catalunya-Parc Natural Delta de l'Ebre for the logistic assistance.

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