



Factors influencing passerine bird communities breeding in a changing marshland

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Abstract: Kis-Balaton is a large wetland in Western-Hungary with over 2000 ha of reed bed. The water level increased (> 40 cm) in 1992. The breeding passerine bird community was studied in this changing marshland, using line-transect data in a largely (west dike - WD), and a moderately (north dike - ND) modified part of the inundated area. Diversity increased at the ND shortly after inundation, but declined later. At the WD the diversity also declined but did not change immediately. The response of birds to the inundation was species-specific. At both sites the Savi's Warbler (*Locustella luscinioides*) declined after the inundation, the Reed Bunting (*Emberiza schoeniclus*) and the Sedge Warbler (*A. schoenobaenus*) declined only in the long term, after four years of the inundation. The Reed Warbler (*A. scirpaceus*) declined in the

seriously affected WD site, while increasing in the least influenced ND site. The only species with a continuously increasing population was the Great Reed Warbler (*A. arundinaceus*). Considering all passerine species, only five did not respond to inundation and all of them are non-wetland inhabitants. The results regarding community structure revealed that season and the changing vegetation due to inundation had a significant effect.

1 Introduction

Wetland research is very important in conservation biology, partly because wetlands are among the most threatened habitats on earth, and partly because wetlands are a good predictor of the environmental situation (IUCN 1993, HAWKE and JOSÉ 1996). The Kis-Balaton is one of the most important wetlands in Hungary and about half of the Hungarian avifauna (373 species, MAGYAR et al. 1998) can be observed there every year. In addition, many threatened species occur and breed in this marshland, like the Ferruginous Duck (*Aythya nyroca*), White-Tailed Eagle (*Haliaeetus albicilla*), and Spoonbill (*Platalea leucorodia*).

The fate of Kis-Balaton is similar to other wetlands in Europe. It was regulated, and most parts of it were drained out at the beginning of the century (BÁLDI et al. 1999). However, the main influx to Lake Balaton is River Zala, and the Kis-Balaton marshland can be seen as a filter of it. Since Lake Balaton is the most important recreational area in Hungary, its water quality is a key problem. There-

fore, to restore the water quality of Lake Balaton, a new reservoir was built in the 1980s and the historical marshland of Kis-Balaton was partly flooded in the 1990s.

Although the restoration was not for scientific purposes, it can be viewed as a large scale experiment to examine the effect of inundation on bird communities and species. The influence of increasing the water level for passerines is mediated by changes of the vegetation structure, which is a key factor in habitat selection of birds (CODY 1985, MOSKÁT et al. 1993).

The aim of the present paper is, based on ten years of observations, to show how the breeding passerine bird community changes after a sudden increase in the water level of this marshland, and to search for the main factors affecting community structure and composition.

2 Study area and methods

Kis-Balaton is at the SW end of Lake Balaton in Western Hungary (46°42' N, 17°21' E), covering 14.700 ha. It lies around the River Zala inlet into Lake Balaton. The vegetation was mainly *Phragmites australis*, *Typha* spp., *Carex* spp. Our study area was the NW part of the historical Kis-Balaton marshland (LŐRINCZ et al. 1990). We censused birds using the line transect method (more details on methodology: MOSKÁT & BÁLDI 1999), because the transect access was facilitated by dikes (but see RANNER & DVORAK 1994). We divided the 9 km long census route into two parts, the first site is on the west dike (WD) along areas, which were near the water influx, thus were seriously affected; the second site is on the north dike (ND) along the least affected part of the inundated areas (Fig. 1). Fieldwork was carried out from 1989–1998, except for the years 1992 and 1995. The number of censuses in a year varied from 1–8, but for the present study no more than 3 censuses per year, 1 in April and 2 in May, were considered.

We compared several community structure parameters, like species number (S), ln based SHANNON-WIENER diversity measure (H'), equitability ($E = H'/\ln S$), and abundance (number of individuals and density). We applied agglomerative cluster analysis based on the squared Euclidean measure and average linkage fusion strategy, stepwise multivariate discriminant analysis (MDA) and non-metric multidimensional scaling (NMDS) to reveal the structure of the data set. Observations were separated into three groups:

- 1) before inundation (1989–1991),
- 2) immediately after inundation (1993–1994) to investigate short term effects,
and
- 3) years after inundation for long-term effects (1996–1998).

The inundation occurred in November 1992.

The analyses were based on the census route section (WD vs. ND)/census time (Y/M) – species abundance matrix. We used the DIVORD program for the calculation of diversity indices and their statistical comparison (TÓTHMÉRÉSZ 1995, 1997). The PC-ORD software was used for non-metric scaling (MCCUNE & MEFFORD 1995), and the SPSS/PC+ program package for cluster and discriminant analyses (NORUSIS 1990).

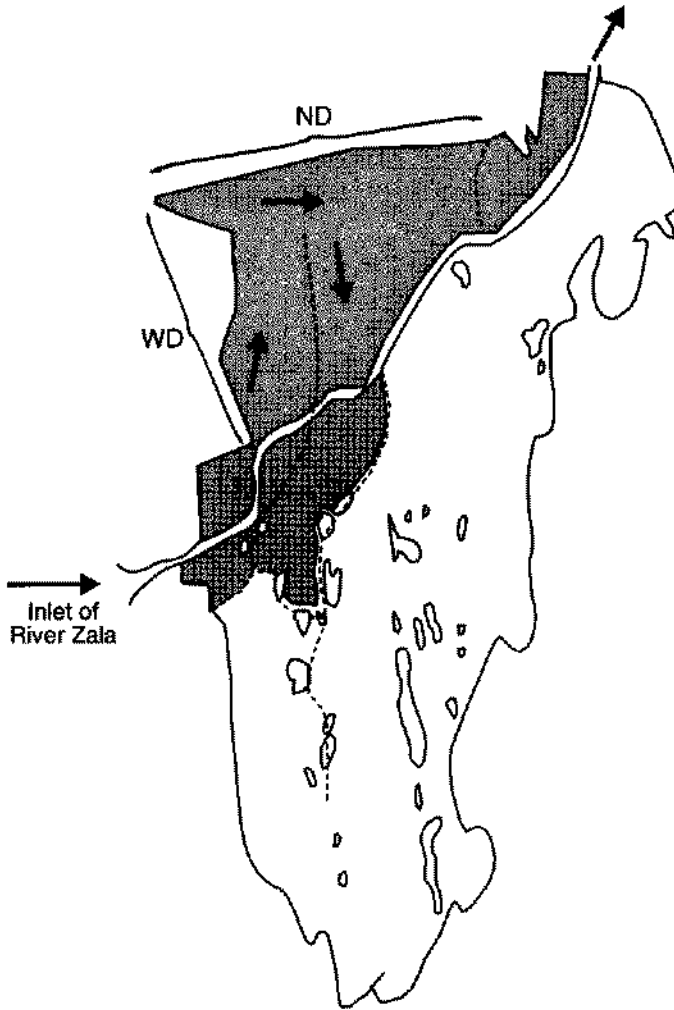


Fig. 1: Map of the Kis-Balaton Marshland. River Zala flows from the Kis-Balaton reservoir (not on the map) across the marshland. The embankment of the river was partly destroyed to inundate ca. 16 km² marshland (dark areas). The hatched lines indicate dikes. The direction of the water flow is shown by black arrows. WD: west dike study site, ND: north dike study site.

3 Results

3.1 Changes in the community structure parameters

The SHANNON-WIENER diversity measure showed different patterns between the two study sites. It increased significantly after the inundation at the ND, but did not change at the WD. Long term changes were also detected: the index declined to the pre-inundation level at the ND, but significantly decreased at the WD (Fig. 2).

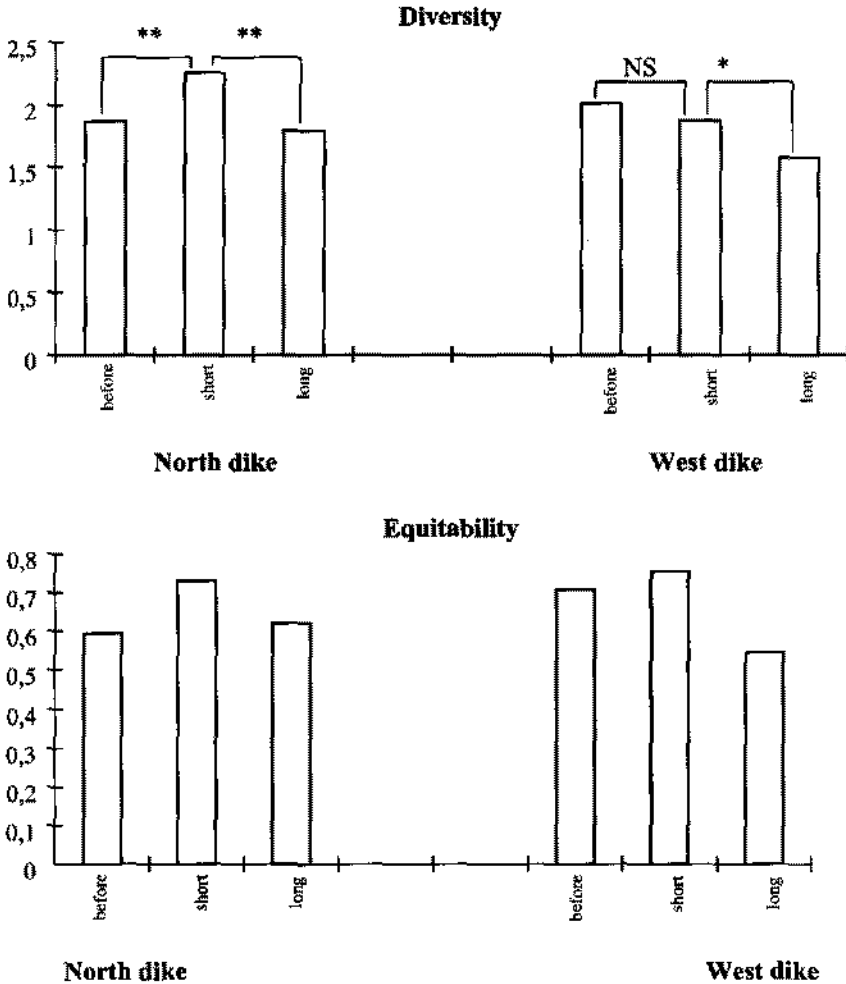


Fig. 2: SHANNON-WIENER diversity and equitability measures for both study sites and time period in relation to inundation (before: 1989–1991, short after: 1993–1994, and long after: 1996–1998).

Equitability showed a very similar pattern to that of the diversity index at the ND, but at the WD it increased after the inundation, then declined.

3.2 Changes in the community composition

The most pronounced pattern emerged in the community composition. First, the proportion of reed passerines dominated the community composition, more than 90 % of the observations in May belonged to them, but in April censuses migrant, mainly bush-living species represented even 60 % (Fig. 3).

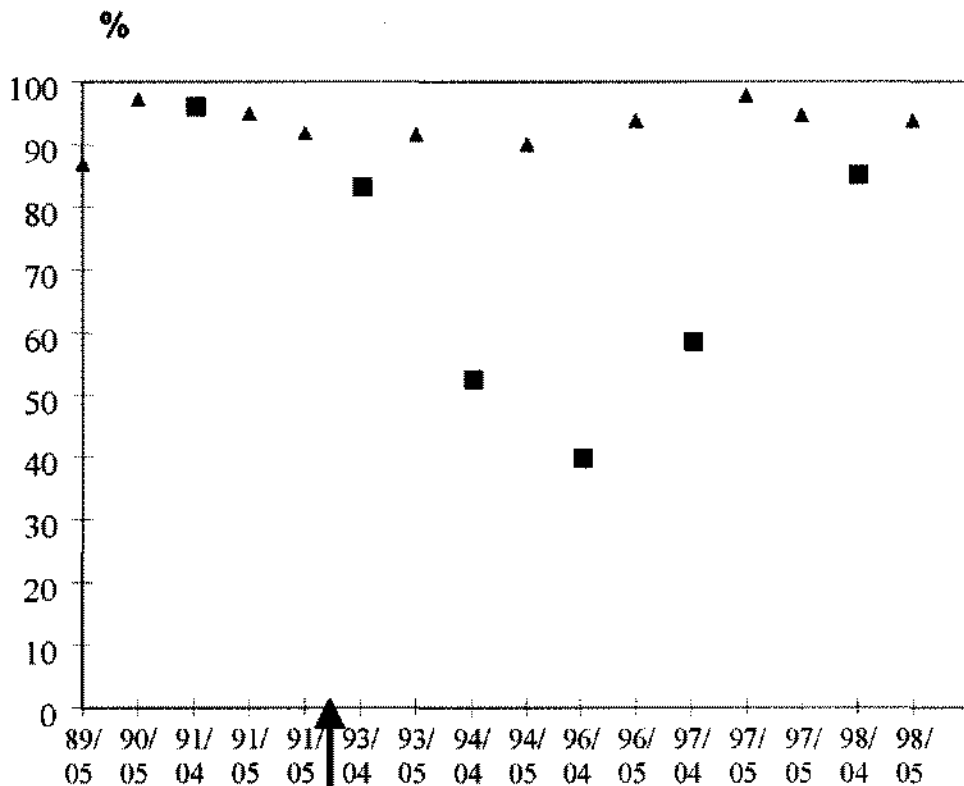


Fig. 3: The proportion of reed and other bird species in the censuses. In some years two censuses in May were included. Squares: censuses in April, triangles: censuses in May. (Black arrow indicates the inundation.)

Changes in the number of non-reed inhabitants correlated with the presence and size of the bushline along the dike-water interface. Second, the proportion of the five most common reed passerines showed considerable changes after inundation (Fig. 4). At both sites the Savi's Warbler (*Locustella luscinioides*) sharply declined after the inundation, the Reed Bunting (*Emberiza schoeniclus*) and the

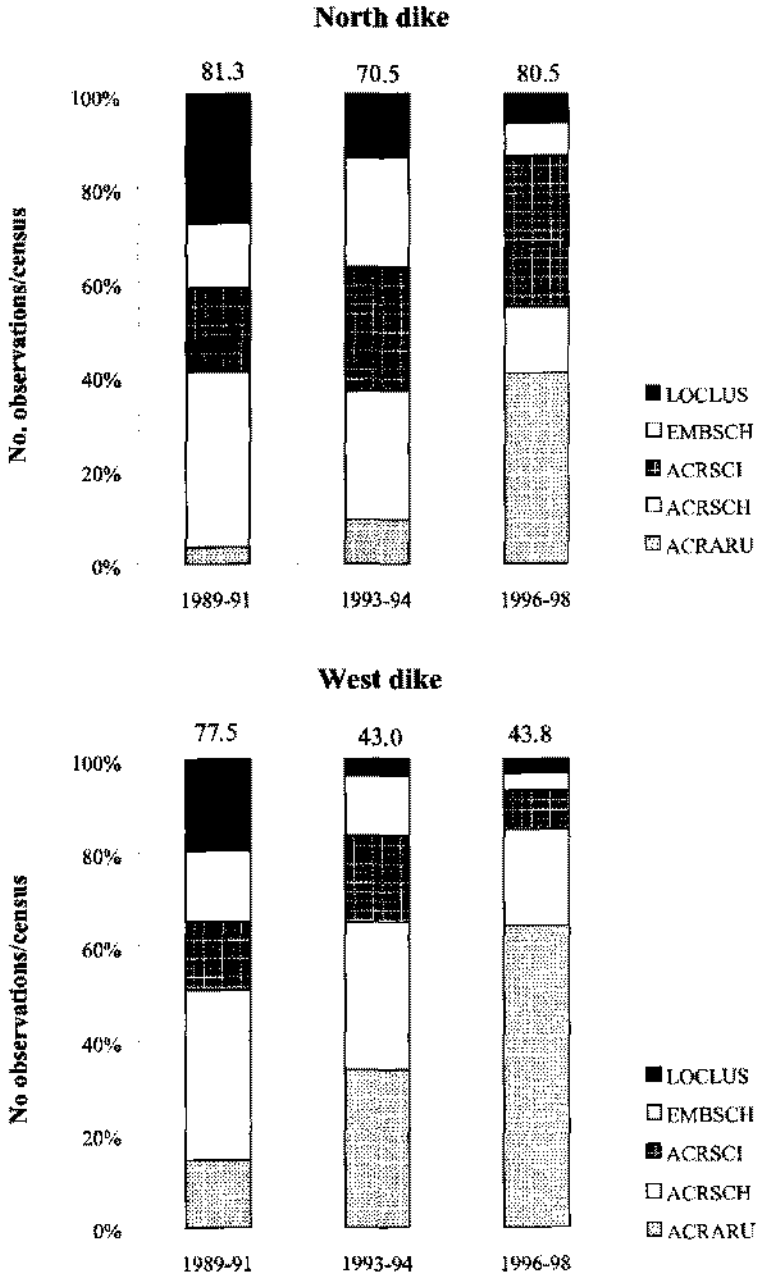


Fig. 4: Mean proportion/census of observed individuals of the five most common birds. The numbers above the columns represent the proportion of the five species to the total number of birds observed.

Sedge Warbler (*A. schoenobaenus*) seemed to decline only in the long term (after four years). However, the Reed Warbler (*A. scirpaceus*) declined in the seriously affected WD site, while increasing in the least influenced ND site. Only the Great Reed Warbler continuously increased in population size (*A. arundinaceus*).

3.3 Differences between areas and periods

The 32 sampling units (based on census date/dike section) of the matrix, were grouped into 5 classes by the cluster analysis (Fig. 5):

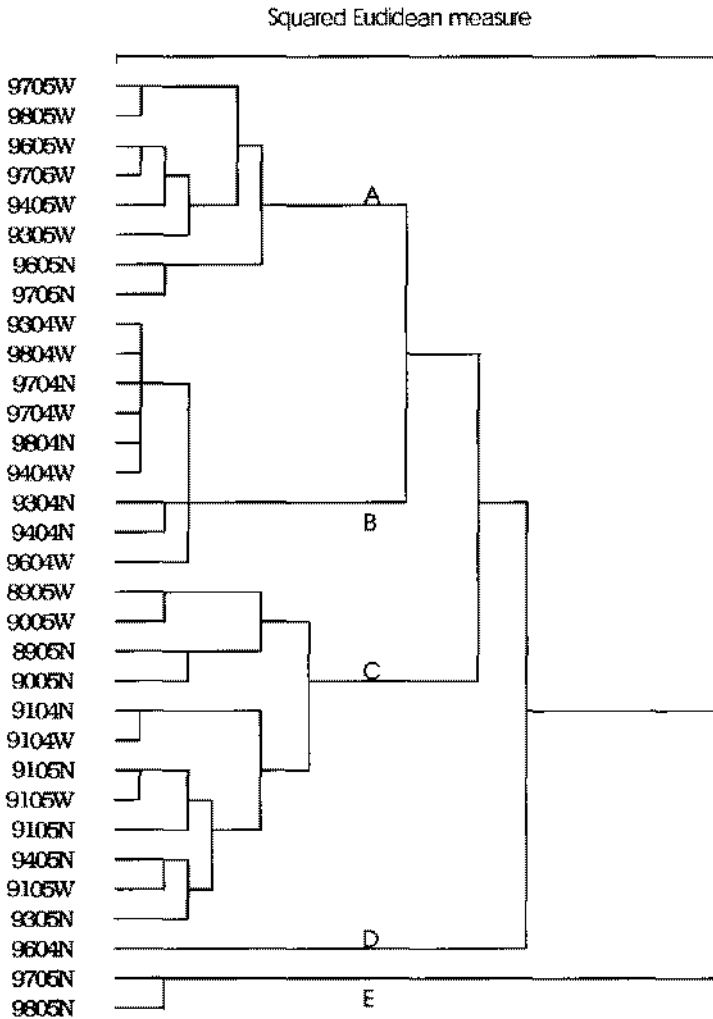


Fig. 5: Cluster dendrogram of the censuses (by site and date). W: west dike, N: north dike.

- A: May samples from the WD immediately and years after the inundation, and samples from the ND years after the inundation (except for 1998);
- B: April samples from both areas immediately and years after the inundation;
- C: April and May samples before the inundation and the May samples from the ND immediately after the inundation;
- D: only one April census belongs here;
- E: May samples of the ND years after the inundation.

Reliability of the groups generated by the cluster analysis was evaluated by NMDS. The parallel use of both classification and ordination procedures was necessary to check whether the results are robust or not (PODANI 1994). The neighbouring points of the NMDS space were grouped into 5 groups (Fig. 6):

- 1: all but one April census;
- 2: only one April census;
- 3: May censuses before the inundation at the ND and WD, and censuses from the ND immediately after the inundation;
- 4: May censuses from the WD immediately after the inundation, and the ND years after the inundation;
- 5: May censuses from the WD after the inundation on the long term.

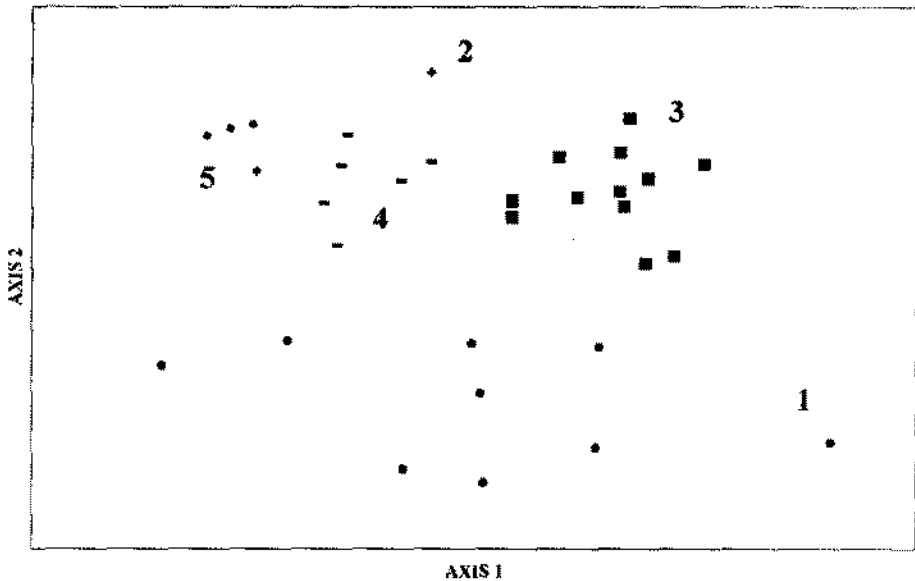


Fig. 6: Non-metric multidimensional scaling of the censuses (by site and date).

The five groups of the cluster analysis, and the five groups of the NMDS largely overlap:

Character	cluster analysis	NMDS
April censuses from both sites	B (partly C and D, which is only one census)	1 (+ 2, which is only one census)
After inundation, without significant changes	C	3
Immediate impact of inundation is significant	A	4
Long term impact of inundation is significant	A	5

I applied multivariate discriminant analysis (MDA) for the 17 most common passerines (where $N > 10$). Six different groups were created, using April and May, and before inundation, immediately, and years after inundation as separators:

- 1: 2 April censuses before inundation,
- 2: 4 April censuses immediately after inundation,
- 3: 6 April censuses years after inundation,
- 4: 8 May censuses before inundation,
- 5: 4 May censuses immediately after inundation,
- 6: 8 May censuses years after inundation.

The classification indicated that 96,8 % of the cases were correctly classified, which indicates very clear separation among the six groups.

3.4 Changes in species and abundances

We applied F statistics to test the null-hypothesis of similar group averages of a given variable (species) of the MDA. We found 12 species with significantly different group averages (Table 1) and 5 species with no differences.

Thus, the Bluethroat (*Luscinia svecica*), White Wagtail (*Motacilla alba*), Tree Sparrow (*Passer montanus*), Chiffchaff (*Phylloscopus collybita*) and the Blackcap (*Sylvia atricapilla*) did not show a response to the inundation or to the census time (April vs. May). The latter four species are not, or not strictly related to reed beds and sedges, thus the missing response to reed bed changes on their abundances are not surprising. The similar group averages for the Bluethroat are not expected but may be due to the low number of observations of this species.

Table 1: Testing for similarities in the group averages for each species. The groups were created for the MDA (see text). Only the 17 most common species were included ($N > 10$).

Species	F	P	significance
<i>Motacilla alba</i>	0.857	0.523	NS
<i>Erithacus rubecula</i>	3.038	0.027	*
<i>Luscinia svecica</i>	1.079	0.395	NS
<i>Locustella naevia</i>	3.120	0.025	*
<i>L. luscinoides</i>	14.45	0.000	***
<i>Acrocephalus melanopogon</i>	3.461	0.016	*
<i>A. schoenobaenus</i>	21.55	0.000	***
<i>A. palustris</i>	3.068	0.026	*
<i>A. scirpaceus</i>	3.055	0.028	*
<i>A. arundinaceus</i>	20.57	0.000	***
<i>Sylvia atricapilla</i>	1.970	0.117	NS
<i>Phylloscopus collybita</i>	1.043	0.414	NS
<i>P. trochilus</i>	4.236	0.006	**
<i>Panurus biarmicus</i>	3.857	0.01	**
<i>Lanius collurio</i>	2.657	0.046	*
<i>Passer montanus</i>	0.0405	0.841	NS
<i>Emberiza schoeniclus</i>	3.444	0.016	*

The NMDS of the 17 most common passerines ($N > 10$) resulted in a clearly interpretable graph (Fig. 7): the first group contains the migrant species, common mainly in April, the second is a mixture of three species with different requirements, the third are reed birds, the fourth contains two meadow preferring species. Three species do not belong to either of the groups, however, their position is clear: the Moustached Warbler is a reed bed passerine breeding earliest, and its position in the NMDS space is between reed and "April" birds. The Marsh Warbler, a close relative of the Reed and Sedge Warbler, is a less specialised reed inhabitant and is situated between the reed and the meadow birds. The Bearded Tit is between the reed birds and the second group, which contains species with different requirements. This could be a consequence of the small sample sizes for these species.

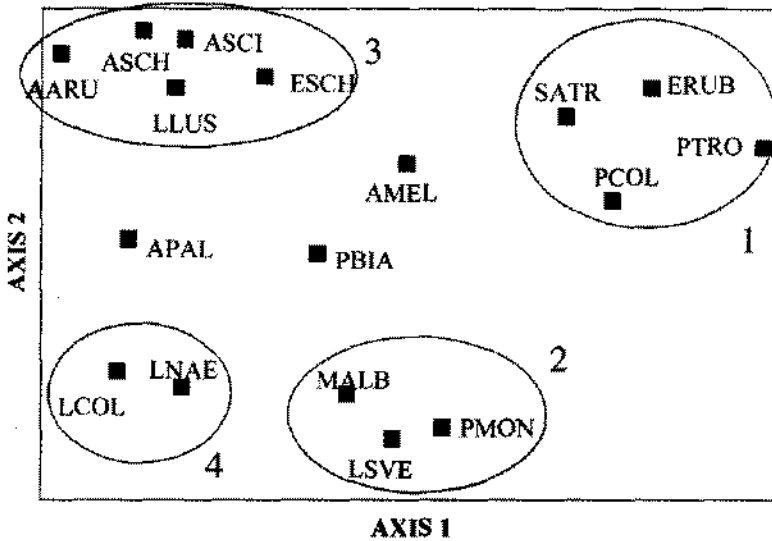


Fig. 7: Non-metric multidimensional scaling of the 17 most common species.

3.5 Nest predation experiments

Nest predation is probably the most important factor influencing life history and community organisation in birds (e.g., RICKLEFS 1969, MARTIN 1988, 1995). We placed 110 artificial open ground nests with a chicken egg in the grassy dike sides at 8 locations within the marshland. Below we give a short summary of the paper by BÁLDI (1999). The predation rate was very high, ca. 80 % after one day, although there were significant differences between locations (G-test of homogeneity with WILLIAMS' correction (FOWLER & COHEN 1995): $G_{\text{corr}} = 46.073$; $DF = 7$; $P < 0.01$). This variation was not a result of the edge effect, or water level, and vegetation beside the dikes (BÁLDI 1999). There was a weak effect of disturbance, the least disturbed locations had higher predation rates. Finally, we suspect that the local predator community is responsible for the variation in predation rates, although there is no direct evidence for it. A similar conclusion was made by several other authors. For example RÖNKÄ & KOIVULA (1997) found that the predation of artificial wader nests depended not on location, but on distances to its main predators, the Common Gull (*Larus canus*) colony.

4 Discussion

4.1 Effects of census time

Time of the census within a given year (April or May) is an important factor affecting passerine bird community at the Kis-Balaton marshland. The reason is that in April a lot of bird species appear in the reed, which are not related to reed habitats. Seasonal changes in the habitat selection of species are well known (MØLLER 1984, MOSKÁT et al. 1993), and reed beds are very important for non-reed birds outside the breeding season (e.g., BÖCK 1979). The most common species in April were the Moustached Warbler (*Acrocephalus melanopogon*), Chiffchaff, Blackcap, Robin, and the Willow Warbler (*Phylloscopus trochilus*). The first species is the earliest breeding reed passerine in Hungary, the other species use reed beds during migration (HARASZTHY 1998). Hence, two consecutive censuses are useful in Central-European marshlands (MOSKÁT & BÁLDI 1999): one census in April to detect migrants and early breeders, and one in May to census reed birds just when they occupy territories and are still easily detectable.

4.2 Effects of inundation and habitat selection by birds

Both census sites harboured similar bird communities before the inundation. After water level increases the species diversity increased first but later decreased. Species abundance decreased continuously. The effect was immediate at the WD site, which is the most affected part of the inundated area. Abundance decreased to ca. 50 % of the pre-inundation value on the long term. Both diversity and abundance increased at the least affected site (the ND) immediately after inundation, as a possible consequence of the colonisation of birds from the deteriorated habitats at WD. As inundation proceeded, the ND site became more and more affected, thus bird communities became similar at both sites, as in the pre-inundated censuses. The diversity measures of the two areas support this pattern: there was no significant difference between the two areas before ($t = 1.705$, $DF = 635$, NS), and 4 years after ($t = 1.895$, $DF = 343$, NS) the inundation, but there was significant difference immediately after the inundation ($t = 3.218$, $DF = 225$, $P < 0.01$).

The effects of inundation were also among the most important factors influencing bird communities. Both community structure and community composition changed significantly. The compositional changes seem to be related to the modification of vegetation. For example the grass/sedge layer of the reed bed disappeared from the inundated area, and the density of reed decreased. Consequently, species requiring dense vegetation for nesting, e.g., the Sedge and Savi's Warbler and the Reed Bunting seriously declined in the inundated part. The Savi's Warbler seemed to be the most sensitive species, since its population declined immediately, while the two other species showed a slower decrease in

their abundance. However, the inundation proceeded and the changes became more and more obvious, the differences between the WD and the ND data largely disappeared.

The changes in species abundance seem to be related to their habitat requirements. Species adapted to pure reed stands (LEISLER, 1975 and LEISLER et al., 1989) like the Great Reed and Reed Warblers increase while the other three species which prefer more herbaceous vegetation decrease.

4.3 Nest predation

Nest predation can be studied relatively easily using artificial nests. We investigated the possible changes of this process in the marshland experimentally using this method. Our preliminary results did not provide any clear evidence that inundation and its vegetational or structural changes can explain differences between predation rates at the 8 sites. More intensive experiments with passerine nests in the reed bed are needed to investigate whether nest predation is also effected.

5 Conclusions

Besides the seasonal effects, the organisation of the reed passerine bird communities breeding in the Kis-Balaton marshland were mainly influenced by the changing vegetation, at least during the study period. The inundation process appears to still be influencing bird communities. For example, the abundance of the Great Reed Warbler is still increasing whereas Sedge Warblers are decreasing. Thus, further compositional changes can be expected. In line with this, there are other points to consider, for example the spatial pattern of reed bed. The edge effect is significantly affecting the occurrence and abundance of reed bed birds (BÁLDI & KISBENEDEK 1999, MOSKÁT & BÁLDI 1999). Management (BÁLDI & MOSKÁT 1995), biotic interactions (MOSKÁT et al. 1992, MOSKÁT & HONZA 2000) and food availability (HOI et al. 1995) have also strong effects on the organisation of avian communities.

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