The Mediterranean Flyway: a network of wetlands for waterbirds

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Wetlands along the Mediterranean Flyway are especially used by waders during spring migration when moving north from African and Mediterranean wintering quarters. The WIWO Foundation has organised more than 40 studies in the Afro-Palaearctic region between 1980 and 1993, mainly during the spring period. Eleven WIWO studies have been carried out along the Mediterrranean Flyway in more than twenty wetlands. Two major natural wetland types can be found in this flyway: coastal lagoons and saline lakes. Water levels of both wetland types usually show annual and seasonal variation in rainfall or vary daily through variation in wind force and direction. Mudflats exposed regularly by wind action are known as windflats. Large windflat areas occur in the Sivash, Ukraine, which is an important staging site for Broad-billed Sandpiper *Limicola falcinellus*. Both numbers and species numbers of waterbirds were found to correlate significantly with wetland size. Two large wetlands - Kneiss, Gulf of Gabès, Tunisia and the Sivash, Ukraine - contained a larger number of waterbirds than expected for their size. This could be due to the presence of extensive tidal mudflats (Kneiss) and windflats (Sivash) with a high biomass of benthic fauna. In Lake Manzala a much lower number of waterbird species was found than expected for its size, which is possibly caused by its highly degraded state. These results suggest that wetland loss will directly lead to a decrease in number and number of species of waterbirds in the network of Mediterranean wetlands.

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Водно-болотные угодья на протяженности Средиземноморского пролетного пути используются в первую очередь во время весенней миграции куликами, следующими на север с мест зимовок, расположенных в Африке и в Средиземном море. Фондом "Рабочая группа международного изучения околоводных птиц и водно-болотных угодий" (WIWO) было организовано свыше 40 исследований в Афро-Палеарктическом регионе с 1980 по 1993 гг., преимущественно в весенний период. Фондом WIWO было проведено 11 исследований вдоль Средиземнорского пролетного пути свыше, чем в 20 водно-болотных угодьях. Встречаются на этом пролетном пути два главных типа естественных водно-болотных угодий : прибрежные лиманы и соленые озера. Уровни воды обоих типов угодий обычно показывают межгодовую и сезонную изменчивость в объеме осадков, или же варьируют ежедневно с изменениями в силе и направлении ветра. Грязевые отмели, регулярно обнажающиеся под действием ветра, известны под названием "ветряные отмели". Такие большие участки встречаются на Сиваше (Украина), который является важным местом остановки для грязовика *Limicola falcinellus*. Была найдена сильная корреляция между числом околоводных птиц и количеством видов с площадью водно-болотного угодья. В двух больших водно-болотных угодьях, Кнейс, залив Габес (Тунис) и Сиваш (Украина) было обнаружено большее количество околоводных птиц, чем можно было бы ожидать исходя из размера площади. Это, может быть, связано с присутствием обширных грязевых отмелей, обнажающихся во время отлива (Кнейс) и "ветряных отмелей" (Сиваш), а также с высокой биомассой придонной фауны. На озере Манзала было зарегистрировано гораздо меньшее количество околоводных птиц, чем можно было ожидать, исходя из площади, что, возможно, является следствием его сильно деградированного состояния. Эти результаты наводят на мысль о том, что утрата водно-болотных угодий поведет непосредственно к спаду численности околоводных птиц и уменьшению количества видов в сети средиземноморских ветландов.

Introduction

Waterbirds and wetlands have long attracted the attention of Dutch field ornithologists. The Foundation Working Group International Waterbird and Wetland Research (WIWO) stimulates this interest and supports international studies of waterbirds and wetlands initiatives by volunteers usually in co-operation with local counterparts. These studies have ranged from general surveys of breeding, migration and wintering areas of waterbirds to fundamental research of migration ecology and strategies of waders. More than 40

studies have been carried out within the Afro-Palaearctic region between 1980 and 1993 (WIWO 1994a,b). By reporting the results in reports and journals the data are distributed widely and also used for conservation and management of wetlands.

The East Atlantic Flyway (Piersma *et al.* 1987) was the major focus of the first series of WIWO projects. This flyway includes the migration and wintering range of waders breeding in the area ranging from north-east Canada to the Taimyr Peninsula. Major stopover sites are situated along the Atlantic coast of Europe and West Africa, the wintering areas range from Europe to southern Africa. It became increasingly clear, however, that some wader species, which are commonly migrating and staging in summer and autumn along the Atlantic shores of Europe, including the Wadden Sea, in spring migrate along a more eastern axis from the wintering areas in West Africa and the Mediterranean. The species, in which this so-called loop migration has been proven, are Ruff *Philomachus pugnax*, Curlew Sandpiper *Calidris ferruginea*, Little Stint *Calidris minuta*, and eastern populations of Dunlin *Calidris alpina* (Gromadzka 1989).

Since 1987 many expeditions have been organised to the Mediterranean and the Black Sea region to study this intercontinental network and the migration strategies of waders (de Goeij *et al.* 1992). Eleven projects have been carried out along the Mediterranean Flyway (Table 1, Figure 1) mainly during the spring period when waders return to northern breeding areas from wintering grounds in Africa and the Mediterranean.

The Mediterranean Flyway can be provisionally defined as the area between (and including) the breeding and wintering areas of waders using wetlands in the Mediterranean and Black Sea region as stopover, moulting and wintering sites (Piersma *et al.* 1987).

Wetland types of the Mediterranean Flyway

Along the Mediterranean Flyway two major, natural wetland types can be found, coastal lagoons and saline lakes. In the latter wetland type there is by definition no present or past influence of sea water (Hammer 1986), whilst sea water is always present within coastal lagoons. Examples of man-made wetlands are fish ponds (*e.g.* Maagan Mikhael, Israel, Table 1), salt pans and rice fields.
Most coastal lagoons in the Mediterranean and Black Sea region have little or no tidal range. Notable exceptions are Kneiss, Gulf of Gabès, Tunisia and coastal lagoons in the Northern Adriatic Sea, where the tidal difference can be up to two metres during spring tides, but only a few tens of centimetres during neap tides. Examples of coastal lagoons are the Sivash, Ukraine, and the Çukurova Deltas, Turkey (Table 1). Examples of saline lakes are Yay Gölü, Seyfe Gölü, and Eber Gölü (also known as playa lakes) in Turkey and Lac Kelbia and Lac Tunis (also known as sebkhets or sebkas) in Tunisia.

Despite the absence or limited influence of tidal differences, water levels can vary considerably from year to year by variation in rainfall, and from day to day or even from hour to hour by variation in wind direction. This effect is most obvious in large, shallow lagoons. In these places mudflats irregularly exposed by wind action have been named windflats (Kube 1994). Extensive windflats occur in the Sivash, Ukraine (Verkuil *et al.* 1993).
The salinity in coastal lagoons varies from hyposaline (brackish, often in winter and spring) to hypersaline (summer and autumn). Different saline lakes range from almost subsaline to hypersaline. This variation in salinity is mainly caused by rainfall in winter and evaporation in summer.
Compared with the rich, tidal mudflats along the East Atlantic Flyway the availability and diversity of food for waders in coastal lagoons, and on windflats in particular, is usually lower. There are mainly Dipteran larvae (Hammer 1986; Cronau 1988; Kube 1994; Szekély *et al.* 1992) and Brine Shrimps *Artemia salina* (Hammer 1986; Verkuil *et al.* 1993).

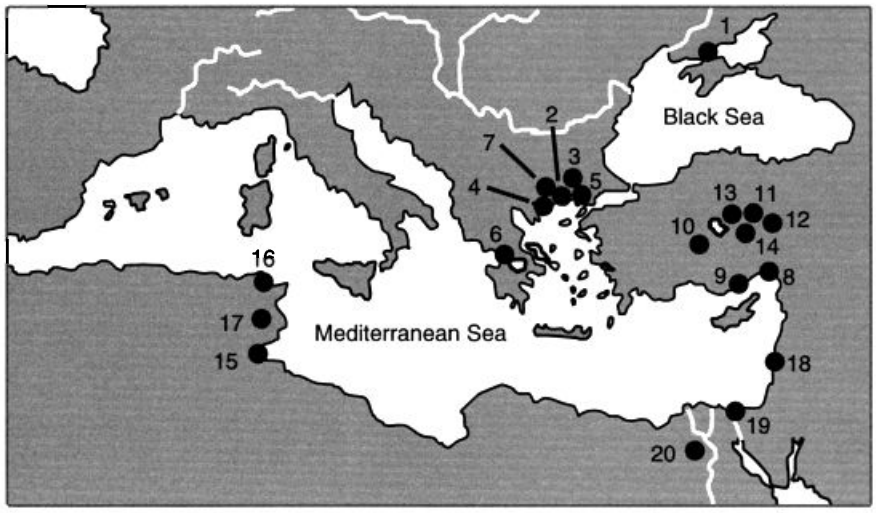

Figure 1. The location of major Mediterranean wetlands. Numbers refer to those sites named and listed in Table 1.

Table 1. Total number of waterbirds (grebes, cormorants, herons, ducks, flamingos, waders, gulls and terns) and total number of waders in twenty Mediterranean wetlands (site numbers relate to Figure 1). The estimates are based on maximum numbers counted between March and May during WIWO-projects between 1987 and 1993. Wetland type is based on the most characteristic habitat present. The reference indicates the source of the data.

Wetland	Country	Wetland type	Census year	Total waterbirds	Total waders	Source
1. Sivash	Ukraine	l,w	1992	700, 000	650, 000	van der Have *et al.* 1992
2. Porto Lagos	Greece	l	1987	36, 200	12, 500	Meininger 1990
3. Lake Vistonis	Greece	l	1990	31, 700	2,400	de Nobel 1995
4. Nestos delta	Greece	l	1987	11, 900	2,900	Meininger 1990
5. Evros delta	Greece	l	1987	11, 300	2,200	Kivit *et al.* 1994
6. Messolonghi	Greece	l	1990	19, 000	8,950	de Nobel 1995
7. Avdira	Greece	l	1987	3,300	2,700	Meininger 1990
8. Çukurova deltas	Turkey	l	1987	64, 900	37, 650	van der Have *et al.* 1988
9. Göksu delta	Turkey	l	1989	22, 400	3,300	van den Berk (*in prep.*)
10. Eber Gölü	Turkey	s	1988	20, 700	8,100	van Winden *et al.* 1989
11. Seyfe Gölü	Turkey	s	1988	12, 700	4,850	Schekkerman & van Roomen 1993
12. Tuzla Gölü	Turkey	s	1988	10, 600	4,600	Schekkerman & van Roomen 1993
13. Kulu Gölü	Turkey	s	1988	8,600	3,500	Schekkerman & van Roomen 1993
14. Yay Gölü	Turkey	s	1988	7,400	1,900	Schekkerman & van Roomen 1993
15. Kneiss	Tunesia	t	1990	311, 500	295, 900	Spiekman *et al.* 1993
16. Lac Tunis	Tunesia	l	1990	13, 500	5,700	Spiekman *et al.* 1993
17. Lac Kelbia	Tunesia	s	1990	8,100	5,800	Spiekman *et al.* 1993
18 .Maagan Mikhael	Israel	f	1989	26, 700	2,200	Keijl *et al.* 1992
19. Lake Manzala	Egypt	l	1990	85, 400	76, 200	Meininger & Atta 1994
20. Quarun Meer	Egypt	s	1990	8,100	1,800	Meininger 1990

Wetland types: t, tidal mudflats; w, windflats; l, coastal lagoon; s, saline lake; f, fish ponds

There are two notable exceptions: Kneiss, Gulf of Gabès, and the Sivash, Ukraine. Kneiss is virtually unique in the Mediterranean in having a large tidal range and the presence of extensive eelgrass Zostera beds. The macrozoobenthos is varied and includes bivalves, gastropods and annelid worms (van Dijk *et al.* 1986; Spiekman *et al.* 1993). The extensive, shallow lagoons of the Eastern Sivash nearest the inlet with the Sea of Azov also contain large eelgrass beds and a substantial biomass of bivalves and annelid worms, *Nereis diversicolor* in particular (van der Have *et al.* 1993; Verkuil *et al.* 1993). Windflats are variously exposed by changes in wind direction and force, providing an almost permanent supply of invertebrates for staging waders. Not surprisingly, both Sivash and Kneiss contain internationally important numbers of waders (Table 1, Chernichko *et al.* 1991; Spiekman *et al.* 1993). The Sivash and Kneiss are two of the few Mediterranean wetlands with substantial numbers of Curlew Sandpipers and Dunlins (de Goeij *et al.* 1992).

Furthermore, the Sivash is the spring staging site for one-third of the Fenno-Scandian population of the Broad-billed Sandpiper *Limicola falcinellus*, and probably is the most important site for this species in the world (van Winden *et al.* 1993).

Biodiversity and conservation of Mediterranean wetlands

A comparison of numbers and the number of species of waterbirds in wetlands along the Mediterranean Flyway shows that the numerical and relative importance for biodiversity depends mainly on wetland area (Figures 1 and 2; de Goeij *et al.* 1991). Both numbers of waterbirds, including waders, and the number of waterbird species increase with wetland area. Both Kneiss and the Sivash contain more waterbirds, of which the majority are waders, than expected from the general relationship (Table 1, Figure 1). These high numbers of waders could be related to the high biomass of benthic fauna present in the tidal mudflats of Kneiss (Spiekman *et al.* 1993) and in the extensive windflats in the Sivash (Verkuil *et al.* 1993). Lake Manzala forms a clear outlier in the general species - wetland area relationship (Figure 2). The smaller number of waterbird species than expected could be explained by the highly degraded state of Lake Manzala combined with high hunting pressure (Meininger & Atta 1994). Both relationships imply clearly that every loss in wetland area will directly lead to a decrease in number and the number of species of waterbirds.

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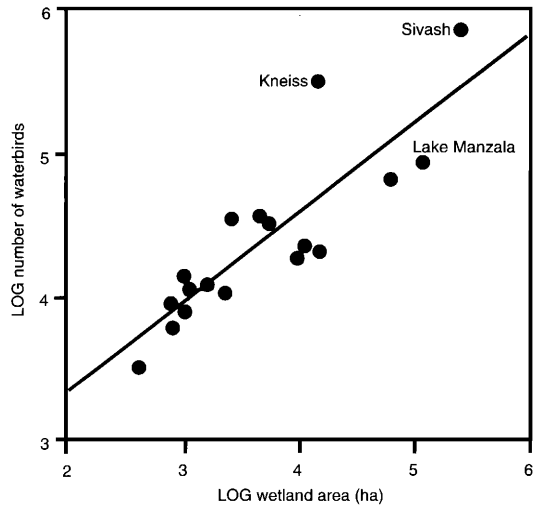

Figure 2. The relationship between numbers of waterbirds, based on maximum numbers counted in spring, and wetland size (in ha) in the Mediterranean (R^2=0.72, n=17, p<0.001).

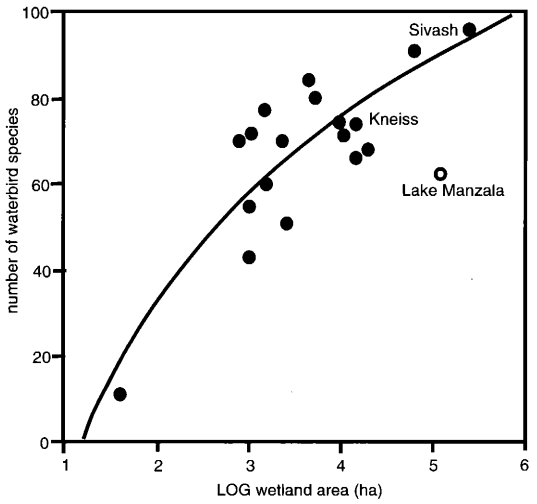

Figure 3. The relationship between the number of waterbird species, counted during WIWO-projects in spring, and wetland size (in ha) in the Mediterranean (R^2=0.72, n=18, p<0.001). Lake Manzala was excluded from the regression analysis, because of its highly degraded state.

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