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The migration of waders (Aves, Charadrii) in Greece

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Abstract – Waders (Charadrii) were counted weekly at six Greek wetlands during spring and autumn of the years 1996, 1997 and 1998 (161 counts in total). The aim of this research was to study the diversity, abundance and phenology of waders at the major coastal wetlands of Greece. Altogether 40 species were recorded. Among these, 15 were qualified as common migrants (present in all wetlands in both seasons), 16 as moderately common migrants (present in more than three wetlands but not in both seasons), 6 as rare migrants (between two and ten records during the study) and three as very rare (with just one record). The species diversity was very similar between the autumn (38 species) and spring migrations (37). However, the abundance of waders overall, was higher during the spring passage. The most abundant species during spring were the Ruff *Philomachus pugnax* followed by the Curlew Sandpiper *Calidris ferruginea* and the Dunlin *Calidris alpina.* During autumn the Redshank *Tringa totanus* followed by the Little Stint *Calidris minuta* and the Kentish Plover *Charadrius alexandrinus* were the most abundant species. The abundance of 16 species was much higher in spring while the abundance of nine was much higher in autumn, indicating that these species use different migration routes depending on the season. It is most probable that weather conditions affect the arrival and departure dates of migrating waders. The interannual differences regarding the abundance of migrating waders could probably also be explained by weather conditions. The understanding of the abundance of waders, their diversity and migration phenology contributes to the conservation and management of Greek coastal wetlands, which are much affected by habitat degradation and human disturbance.

INTRODUCTION

In Greece, 54 wader species (or shorebirds, order Charadriiformes, suborder Charadrii) have been recorded so far, including 12 considered as accidentals (Handrinos and Akriotis 1997). The majority is observed during migration and in winter. At least 10 species have been documented breeding regularly and three do so occasionally (Handrinos and Akriotis 1997). Eleven species that are experiencing various threats are included in the Red Data Book for Threatened Vertebrates of Greece (Handrinos 1992). Thirteen species are included in the Annex I of the EU Directive 79/409 (Bird Directive).

Greek wetlands, due to their geographical position along the Mediterranean - Black Sea flyway, are considered to be very important stop over sites for migrating waders on the way from their wintering grounds in Africa to their breeding areas in Scandinavia and Siberia (del Hoyo *et al.* 1996, Stroud *et al.* 2004). However, knowledge about wader populations of the Mediterranean-Black Sea flyway is limited in relation to the other flyways (Stroud *et al.* 2004). Research and published information concerning waders' migration in Greece, is likewise limited. A few, mainly short-term surveys have been carried out, especially during spring, in the wetlands of Macedonia, Thrace and western Greece (Engelmoer and Bloksma 1982, Goutner and Kazantzidis 1988, Meininger 1990, de Nobel 1995, Goutner *et al.* 2005).

Information about wader migration, distribution and populations is needed in order to support conservation activities. Coastal wetlands in Greece face many threats related to human activities such as urban development, fishery, recreation etc. These activities cause degradation or loss of habitats for birds, particularly waders (Zalidis and

Figure 1. The study areas.

Mantzavelas 1993, Hatzilacou 1999). Furthermore, the gradually expanding human presence in coastal wetlands brought about increased disturbance to birds, lowering the attractiveness of sites as stop over for refueling migrants.

This study was conducted within the framework of a program aiming to contribute to the conservation of one of the most threatened wader species in the World: the Slender-billed Curlew *Numenius tenuirostris* (Vangeluwe *et al.* 1999). In order to evaluate the characteristics of coastal Greek wetlands that are known to serve as a stop over for this threatened species we have studied the diversity, abundance and migration phenology of all wader species during both the autumn (outward) and spring (return) migration periods.

METHODS

The study was carried out at six of the largest coastal wetlands in Greece (Fig. 1) during the spring and autumn migration periods of the years 1996, 1997 and 1998. The wetlands were the Evros delta (area: 11,000 ha, coordinates: 40^0 47' N, 26^0 02' E), the Porto Lagos lagoon complex (5,600 ha, 40^0 59' N, 25^0 08' E), the Axios delta (8,000 ha, 40^0 31' N, 22^0 44' E), the Kalamas delta (1,350 ha, 39^0 32' N, 20^0 03' E), the Amvrakikos gulf (23,600 ha, 39^0 05' N, 20^0 50' E) and the Messolonghi lagoon (10,000 ha, 38^0 20' N', 21^0 16' E). All these wetlands are designated as Special Protected Areas (SPAs) according to the EU Directive 79/409 and as Important Bird Areas (Bourdakis and Vareltzidou 2000). Five of them are characterized as wetlands of International Importance in accordance to the Ramsar Convention (with the exclusion of the Kalamas delta). The study areas of Porto Lagos, Axios delta and Amvrakikos gulf are parts of wider wetland complexes (Zalidis and Mantzavelas 1994). In all study areas coastal habitats (sea shores, mud flats, and salt marshes) dominate. At the Axios and Evros deltas and at the Amvrakikos gulf freshwater habitats, natural or man made (such as marshes and ponds, rice fields and small shallow lakes) cover a considerable percentage of the wetland area (Zalidis and Mantzavelas 1994).

Using binoculars and telescopes, waders were counted weekly from the ground by one or two researchers operat-

ing in each study area. The same route was followed and the same area was covered in each survey. The study period extended from the end of March (13th or 14th week) until the middle of May (18th or 19th week) in spring, and from the end of August (33rd or 34th week) until the middle of October (39th or 40th week) in autumn. As far as possible, counts were conducted simultaneously in all six wetlands. The numbers of some small species (like plovers) may sometimes have been underestimated, and their presence may have occasionally been overlooked. This happened when mixed-species flocks were observed from a long distance and under unfavourable weather and/or light conditions.

For every spring there were five weekly counts in every study area except in 1997 when there were six counts. Altogether, 86 spring counts were conducted in all study areas during the three years (one survey in 1996, three in 1997 and one in 1998 were missed due to rainy weather). In autumn, five weekly counts were conducted at six study areas except in 1998 when there were six weekly counts in three wetlands and no counts in the Evros delta, Porto Lagos and the Amvrakikos gulf. The total autumn counts were 75 (two counts were missed in 1996 and one in 1997). Although the counts covered the largest part of the migration periods, for certain species (very early or very late migrants) this was not achieved.

An analysis of variance (ANOVA) procedure was used, on log-transformed data where necessary, to examine the factors affecting species abundance (differences among the years and weeks) and t-tests to compare the means of species abundance between the seasons. The Least Significance Difference test (LSD) was used to detect differences among the weeks of each year (Sokal and Rohlf 1981).

RESULTS

Altogether, 40 wader species were recorded in all six wetlands during the study period (Tab. 1, Annex I). Species were categorized according to their relative abundance in the study areas during the migration periods (Tab. 1) as follows. **Common migrants** observed in all wetlands, all the years and seasons, concern 15 species. **Moderately common migrants** observed in more than three wetlands, in all study years but not throughout the year, total 16 species. **Rare migrants** are species with between two and ten records during the entire study period. Six of the species are listed as rare migrants: Broad-billed Sandpiper *Limicola falcinellus* (ten records in three wetlands from one to 20 birds in each record), Spur-winged Plover *Hoplopterus spinosus* (seven records in two wetlands, from one to 16 birds each), Jack Snipe *Lymnocryptes minimus* (seven records in three wetlands from one to three birds each), Slender-billed Curlew *Numenius tenuirostris* (three records in two deltas with two birds each), Greater Sandplover *Charadrius leschenaulti* (three records in Messolonghi lagoon with one bird each), and Red-necked Phalarope *Phalaropus lobatus* (two records, in two wetlands with one and two birds respectively). Lastly, species with just one record in the study areas during the study were considered as **very rare migrants or accidentals**: Eurasian Dotterel *Charadrius morinellus* (one record in Amvrakikos Gulf with one bird), Caspian Plover *Charadrius asiaticus* (one record in Kalamas delta with 15 birds) and Great Snipe *Gallinago media* (one record with one bird in Amvrakikos Gulf).

The number of wader species observed varied between the years from 37 in 1996, and 34 in 1997 to 35 in 1988 (Tab. 2). Species richness was very similar in autumn (38 species) and in spring (37 species). The highest diversity of species was recorded during autumn, in two of the three study years (Tab. 2).

During spring the highest number of species was recorded in early April 1996 (at the 14th week, 34 species) and in mid April 1997 and 1998 (at the 15th and 16th weeks respectively with 31 and 29 species in each year respectively). The highest number of species in autumn was recorded in the middle of September (at the 38th week in 1996 and 1998, 31 and 29 species respectively as well as at the 37th week in 1997, 32 species). Although fewer wetlands were surveyed in 1998 the number of species recorded in total that year was similar to previous years indicating a probable broad front migration pattern by waders along the Balkans (Tab. 2).

Regarding the abundance of waders, the migration pattern observed in both seasons presents many similarities for all the study years. Two major influxes were recorded in the return migration every year with one or two weeks difference between them. The first one was recorded in early April, during the 14th (1997) or the 15th (1996 and 1998) week and the second in late April, during the 17th week (1996, 1997) or early May, during the 18th (1998) week (Fig. 2). In two of the three years the second peak was higher (Fig. 2). It should be mentioned that the difference between the abundance of waders in spring during the three study years was not significant ($F = 2.36$, $N = 15$, $p = 0.13$, an area with only two years of data was not included in the analysis). However, differences among the years were detected during only the 14th week ($F = 5.35$, $p = 0.033$, Fig. 2) and especially between 1997 and the other two years (LSD test: $p = 0.029$ and $p = 0.014$ for 1997-1996 and 1997-1998 respectively). In 1998 the abundance

Table 1. Species recorded during the three years of the study (1996-1998) in six Greek wetlands during spring and autumn migration periods, their status and the season when the mean numbers were higher (comparison between the seasons was made only for common and moderately common species). Species included in annex I of EU Bird Directive 79/409 are marked in bold.

	Species		Common	Moderately common	Rare	Very rare	Season *
1	*Haematopus ostralegus*	Oystercatcher	+				Spring
2	***Himantopus himantopus***	**Black-winged Stilt**		+			Spring
3	***Recuvirostra avosetta***	**Avocet**		+			?
4	***Burhinus oedicnemus***	**Stone Curlew**		+			Autumn
5	***Glareola pratincola***	**Collared Pratincole**	+				Spring
6	*Charadrius dubius*	Little Ringed Plover	+				Autumn
7	*Charadrius hiaticula*	Ringed Plover		+			Autumn
8	*Charadrius alexandrinus*	Kentish Plover	+				?
9	*Charadrius leschenaultii*	Greater Sandplover			+		
10	*Charadrius asiaticus*	Caspian Plover				+	
11	***Charadrius morinellus***	**Dotterel**				+	
12	***Pluvialis apricaria***	**Golden Plover**		+			Spring
13	*Pluvialis squatarola*	Grey Plover	+				=
14	***Hoplopterus spinosus***	**Spur-winged Plover**			+		
15	*Calidris canutus*	Knot		+			Spring
16	*Calidris alba*	Sanderling		+			Spring
17	*Calidris minuta*	Little Stint	+				Spring
18	*Calidris temminckii*	Temminck's Stint		+			Autumn
19	*Calidris ferruginea*	Curlew Sandpiper	+				Spring
20	*Calidris alpina*	Dunlin	+				Spring
21	*Vanellus vanellus*	Lapwing		+			Autumn
22	*Limicola falcinellus*	Broad-billed Sandpiper			+		
23	***Philomachus pugnax***	**Ruff**	+				Spring
24	*Lymnocryptes minimus*	Jack Snipe			+		
25	*Gallinago gallinago*	Snipe		+			Autumn
26	***Gallinago media***	**Great Snipe**				+	
27	***Phalaropus lobatus***	**Red-necked Phalarope**			+		
28	*Limosa limosa*	Black-tailed Godwit		+			Spring
29	***Limosa lapponica***	**Bar-tailed Godwit**		+			?
30	*Numenius phaeopus*	Whimbrel		+			Spring
31	***Numenius tenuirostris***	**Slender-billed Curlew**			+		
32	*Numenius arquata*	Curlew	+				Autumn
33	*Tringa erythropus*	Spotted Redshank		+			Spring
34	*Tringa totanus*	Redshank	+				Autumn
35	*Tringa stagnatilis*	Marsh Sandpiper	+				Spring
36	*Tringa nebularia*	Greenshank	+				Spring
37	*Tringa ochropus*	Green Sandpiper	+				=
38	***Tringa glareola***	**Wood Sandpiper**	+				=
39	*Actitis hypoleucos*	Common Sandpiper		+			Autumn
40	*Arenaria interpres*	Turnstone		+			Spring
	Total		**15**	**16**	**6**	**3**	

* The mean numbers were higher at indicated seasons (t test, $p < 0.05$). =: The difference in the mean numbers between the seasons was insignificant (t test, $p > 0.05$). ?: The numbers were higher in spring in one year and in autumn the other.

Table 2. The number of species recorded during the spring and autumn migration periods for the years 1996-1998 in six Greek coastal wetlands.

	Spring	Autumn	Total
1996	35	35	37
1997	33	34	34
1998	30	33	35
Total	**37**	**38**	**40**

of waders was lower compared to the previous years because only five wetlands were systematically surveyed.

The mean temperature at the study areas during spring 1997 was the lowest recorded among the three years of the study (13.9°C ± 5.03°C while in 1996 was 15.5°C ± 4.15°C and in 1998 17.0°C ± 2.69°C). Specifically, the lowest temperatures during the study (9.0°C ± 2.17°C) were recorded at the 14th week of 1997 and this was most likely the reason for the high concentration of birds during this week (Fig. 2).

The autumn migration pattern of waders was similar for all the years with one influx (Fig. 3). The highest number was recorded in mid September (the 37th week) of the years 1996 and 1997 and at the 39th week of 1998. In 1998 the number of waders was lower in relation to the previous years due to the fact that only three wetlands were systematically surveyed (Annex I). The numbers of waders did not differ in any of the autumns studied ($F = 0.207$, $N = 16$, $p = 0.816$, analysis was done among the three wetlands with data in all three years of the study period). Additionally, temperature differences during autumn at the study areas were negligible (the mean temperature of all study areas was 22.5°C ± 3.37°C, 22.6°C ± 2.45°C and 23.4°C ± 3.57°C for the years 1996, 1997 and 1998 respectively).

The most abundant species during spring migration was the Ruff *Philomachus pugnax* (peak 16,085 individuals in early April 1997) followed by the Curlew Sandpiper *Calidris ferruginea* (13,434 individuals in early May 1996) and the Dunlin *Calidris alpina* (12,440 individuals in April 1997, Fig. 3, Annex I). In autumn, the most abundant species was the Redshank *Tringa totanus* (peak 5,080 individuals) followed by the Little Stint *Calidris minuta* (3,074 individuals) and the Kentish Plover *Charadrius alexandrinus* (2,505 individuals, Annex I). The highest abundance for all these species was recorded in the middle of September 1997 (at the 37th week, Fig. 4).

The abundance of waders counted in autumn was much lower compared to what was recorded in the spring migration (Annex I). The sum of waders counted in autumn represents between 45.5% (1997) and 48.7% (1996) of the waders counted during the spring migration. Comparing the mean numbers of the most numerous species between the two seasons, the percentage in autumn ranged from 4.3% to 0.2% for the ruff, from 8.3% to 9.2% for the curlew sandpiper and from 39.4% to 18.4% for the dunlin for the years 1996 and 1997 respectively (for 1998 no comparison was made between the seasons). On the other hand, the numbers of redshanks were higher in their outward migration in relation to those recorded in the return migration. A percentage of 12.7% and 7.2% of the numbers recorded in autumn for the years 1996 and 1997 respectively was counted in spring. Overall, comparing the mean numbers for the 31 common and moderately common migrants, as specified above, between the two seasons, the numbers of 16 were higher in spring than in au-

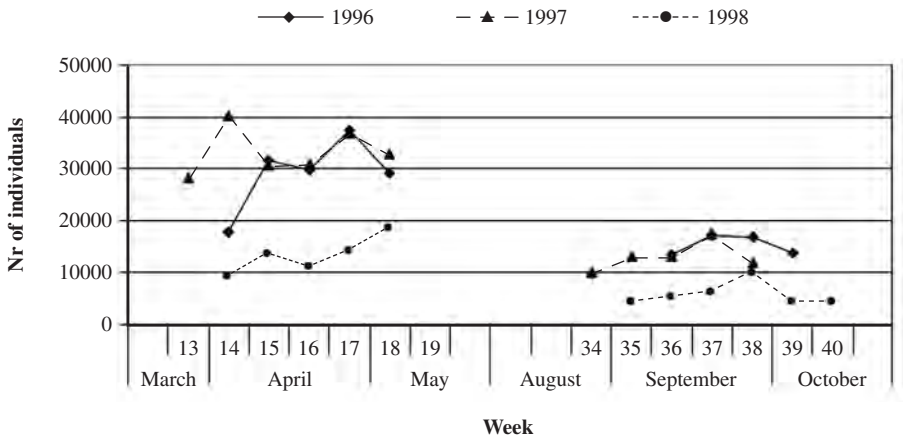

Figure 2. Evolution of the abundance of waders (all species combined) counted during spring and autumn migration periods for the years 1996 - 1998 in six Greek coastal wetlands.

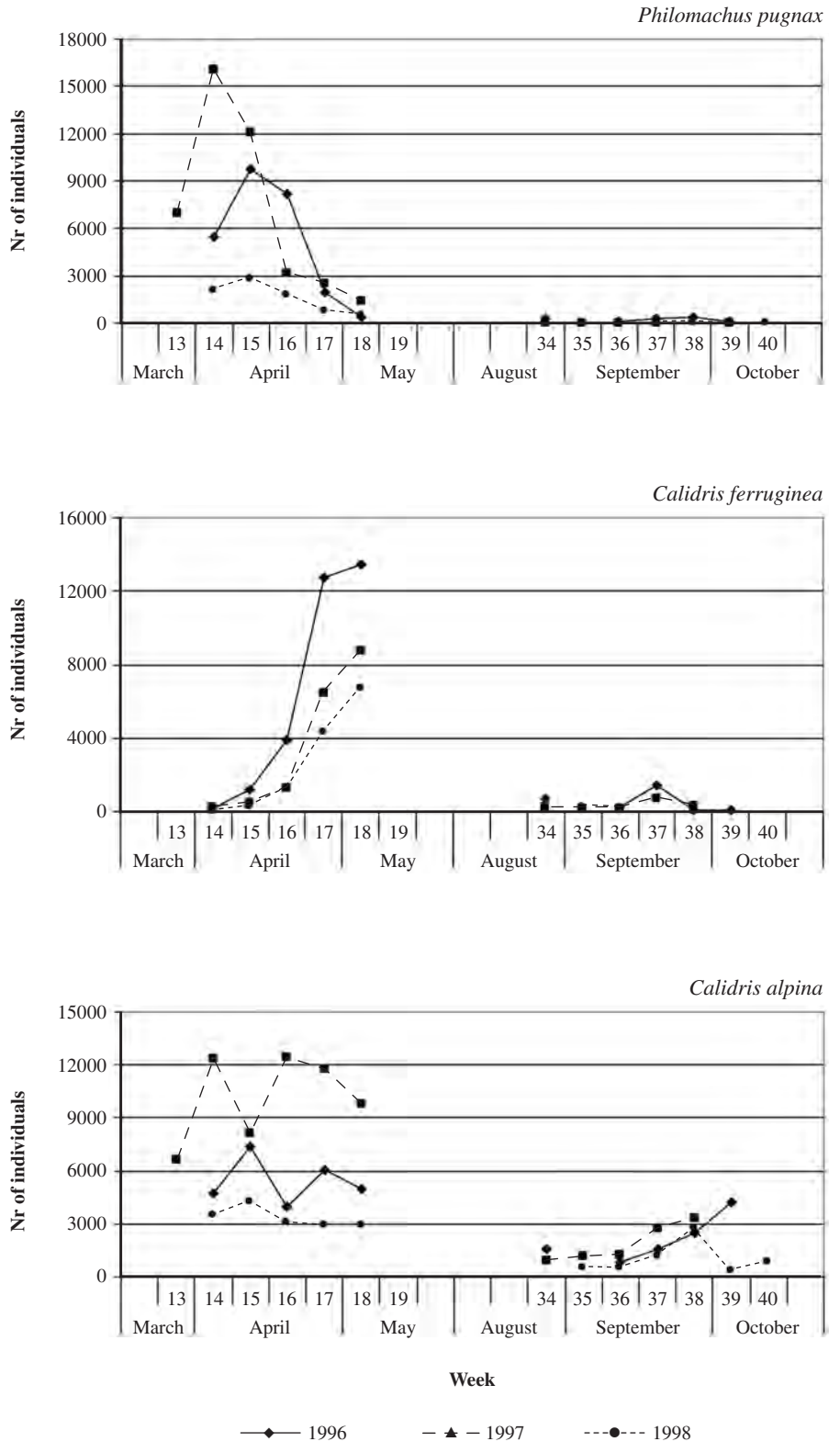

Figure 3. Evolution of the abundance of the three most numerous wader species counted during the spring migration periods for the years 1996-1998 in six Greek coastal wetlands.

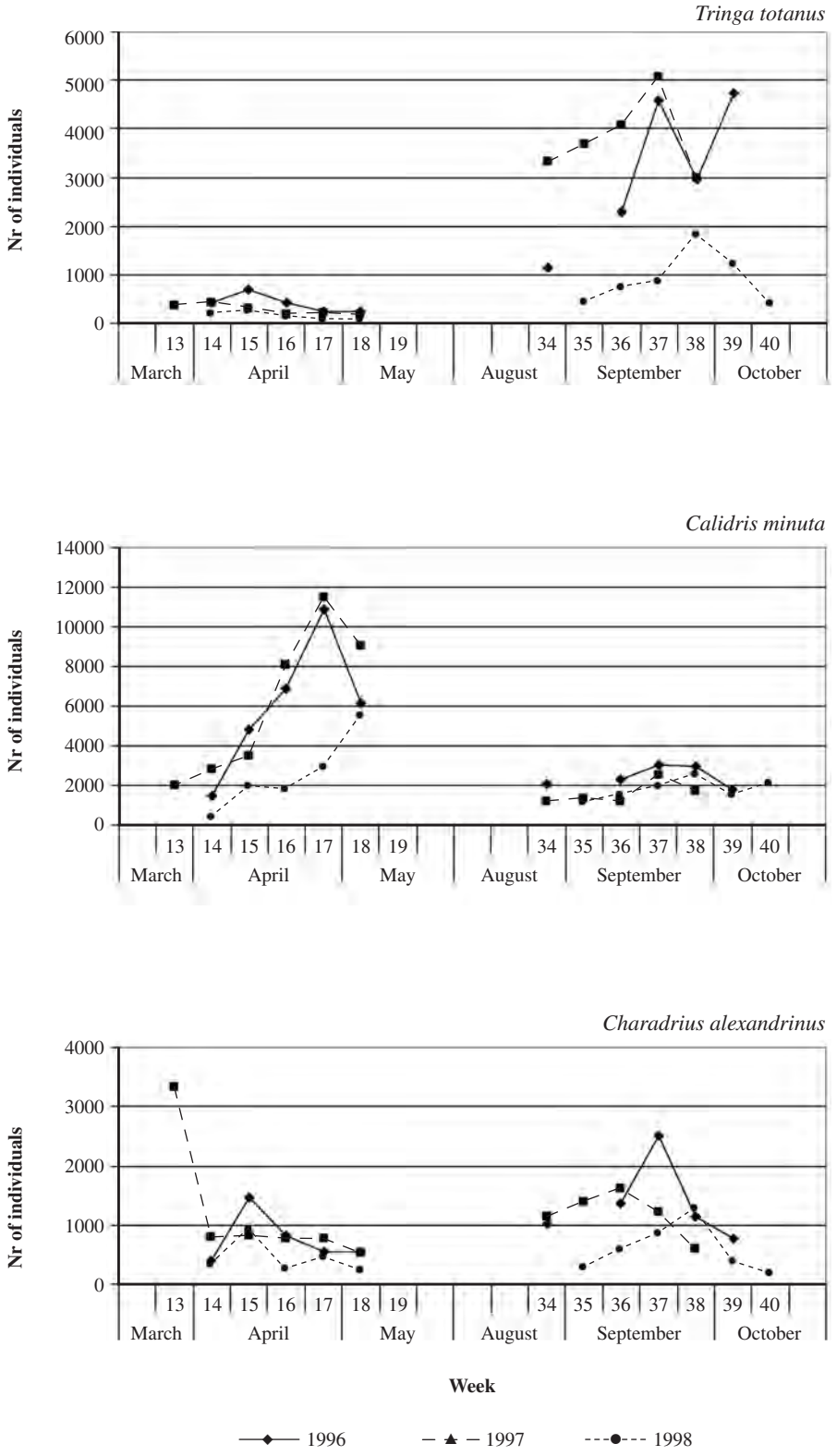

Figure 4. Evolution of the abundance of the three most numerous wader species counted during the autumn migration periods for the years 1996-1998 in six Greek coastal wetlands.

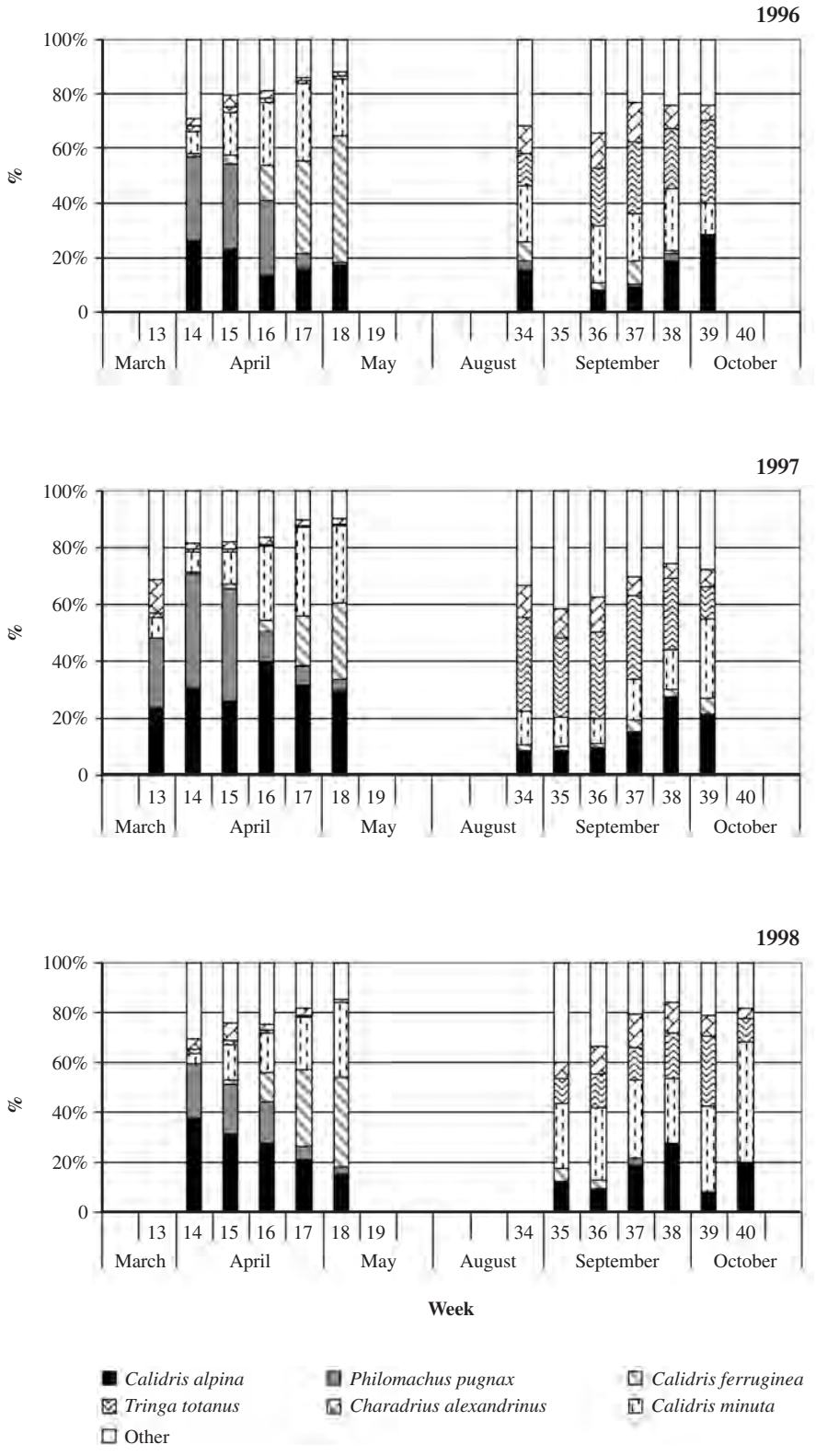

Figure 5. The participation (%) of the six most abundant species of the total number of waders counted during the spring and autumn migration periods for the years 1996-1998 in six Greek coastal wetlands.

tumn, whereas the numbers of nine species were higher in autumn. Three species were present in similar numbers in both seasons and the numbers of the other three species were higher in spring in one year and in autumn the other (Tab. 1, Annex I).

The participation of the six most numerous species of the total number of waders varied during the migration period according to species and season. During early spring the Dunlin and the Ruff were present at high percentages while later, the Little Stint and the Curlew Sandpiper were dominant. In autumn, the percentages of Redshanks were higher in early October whereas, does not appear to be any specific trend for any other species. Overall, the percentages of the six most common species in spring ranged from 70.8% to 88.4% in 1996, from 68.6% to 90.0% in 1997 and from 69.1% to 85.5% in 1998 (Fig. 5). In autumn, the percentages were also very high ranging from 65.3% to 76.7% in 1996, from 58.5% to 74.2% in 1997 and from 60.1% to 84.2% in 1998 (Fig. 5).

DISCUSSION

The two distinct peaks in the pattern of the spring migration of waders in Greece seem to reflect the passage of different species. The first one, in early April, coincides with the passage of Ruffs, which for a short period is the most numerous species in spring. The second peak, at the end of April, coincides with the passage of Curlew Sandpiper and Little Stint populations. In autumn, there is a unimodal pattern with the peak in late September that coincides primarily with the passage of Redshank and Kentish Plover populations including both, the juveniles and the adults.

The diversity of wader species recorded in six Greek coastal wetlands during migration periods was similar to that found in the wetlands around Sofia, Bulgaria (40 species, Nankinov *et al*. 1998) and in the Bourgas wetland complex, in eastern Bulgaria (46 species, Dimitrov *et al.* 2005). However, the numbers of birds recorded in Greek wetlands were much higher for almost all species compared to those in the two Bulgarian regions with a few exceptions (e.g. the numbers of Avocets *Recurvirostra avosetta* in the Bourgas wetland complex were either similar to or higher than those recorded in some Greek wetlands). Regarding numbers, our study substantiates the importance of the Greek wetlands as a migratory stopover for waders. Peak day counts in spring ranged from 37,567 to 40,140 for all wader species combined (in 1996 and 1997 respectively), in all study areas (Annex I). Since we do not know how long the birds stay in the areas, we cannot determine precisely the populations of wader species that use the Greek wetlands during spring or autumn migration. However, more than 1% of the European, eastern Mediterranean - Black Sea breeding populations of at least eight species (including the globally threatened slender-billed curlew) stops at Greek wetlands for refueling at least during return migration (Vangeluwe *et al.* 1999, Delany and Scott 2002, Stroud *et al.* 2004). These species are the Redshank, Curlew Sandpiper, Avocet, Kentish Plover, Spotted Redshank *Tringa erythropus*, Little Stint and Black-tailed Godwit *Limosa limosa*.

More waders pass across Greece during spring rather than during autumn. The same pattern was recorded in Bulgarian wetlands where the numbers recorded in autumn were 14.5% of those recorded in spring (Nankinov *et al.* 1998). Apparently, the birds do not use the same migration routes in the two migration periods as they follow a more direct route from their wintering places in Africa taking a short cut to their breeding grounds in Siberia and Scandinavia in spring (Mediterranean-Black Sea flyway) and a longer one in autumn, from the breeding to wintering areas (del Hoyo *et al.* 1996, van de Kam *et al*. 2004). Ringing recoveries corroborates this loop migration. During the spring migration periods of 1996-2005, 3,238 Curlew Sandpipers were ringed in the Evros delta. Eight out of 32 recoveries of these birds were located during autumn along the east Atlantic flyway with one in Finland, three in Poland, two in Germany and two in Atlantic Spain. Recoveries during spring were located along the Mediterranean - Black Sea flyway with two in Tunisia, seven in Italy and six in Ukraine (Akriotis and Handrinos 2004). Additionally, one more was found wintering in Senegal and one which was ringed in autumn in Spain was recovered in Greece during spring (Akriotis and Handrinos 2004). It seems that, at least this species migrates to Africa probably following a longer route from the breeding areas along the East Atlantic flyway.

Although many aspects of migration are still vague, the most probable explanations for the loop migration pattern is the food availability and the weather, especially wind conditions that allows birds to reach breeding (or resting) grounds easily and quickly (Shuford *et al.* 1998, Berthold 2001). During the autumn migration period most of the shallow wetlands in Greece are dry after a long, hot summer, thus unsuitable as a stop-over for waders. This probably explains the low number of waders observed in autumn in the eastern Mediterranean. Conversely, the Greek wetlands are usually flooded during spring offering important refueling opportunities to spring migrating waders on their way to their breeding grounds (Vangeluwe and Bulteau 1999). Similar migration patterns of waders have

been recorded elsewhere in America (Hicklin 1987, Hayes and Fox 1991, Gratto-Trevor and Dickson 1994, Shuford *et al.* 1998), Asia (Ge *et al*. 2006), Europe (del Hoyo *et al.* 1996) and the western Pacific Ocean (Stinson *et al.* 1997) where wetland conditions and food availability appear to likewise constitute the main reasons.

On the other hand, the higher numbers of Redshank and Kentish Plover recorded in autumn in relation to the spring migration period are due to the fact that these species breed in all study wetlands. The same pattern was also recorded in the Black Sea, as both species breed in high numbers along Ukrainian coasts (Kube *et al*. 1998). The breeding population of the Redshank in Greece is estimated at 400-800 pairs and of the Kentish Plover at 1000-2000 pairs (Birdlife International 2004). So, many of the birds (including many juveniles) counted in autumn originate from this breeding population. Furthermore, according to ringing recoveries in Greece, many Redshanks in autumn originate from northeastern countries such as Belarus and Ukraine where their breeding population is among the highest in Europe (Akriotis and Handrinos 2004, Birdlife International 2004).

Weather conditions may temporarily influence the migration of waders. The large number of waders recorded in early spring and specifically at the 14th week in 1997 was quite possibly the result of the low temperatures that occurred during that week in Greece impending the birds' northward flight. Specific local weather conditions, such as the low air temperature, influence especially the return migration of birds reducing migratory activity or interrupting migration (Beason 1978, Berthold 2001, Elkins 2004).

The most numerous species (Ruff, Curlew Sandpiper, Dunlin), at least in spring, were abundant in all study areas indicating a massive influx of these species and at the same time exhibiting a common pattern of seasonal occurrence in coastal Greek wetlands, which has previously been documented (Goutner *et al.* 2005). Most likely this is due to the location of these wetlands along the eastern Mediterranean migration flyway.

Differences in population numbers between the seasons were also recorded in the Bulgarian wetlands. However, species like the Redshank (the most numerous in autumn in the Greek wetlands) was also numerous in the Bourgas wetland complex during the same period but not in the wetlands around Sofia where it was most numerous in spring, indicating probably that different pathways are probably followed by this species.

The Greek wetlands, due to their position (among the first stop over sites after the east Mediterranean crossing) appear to be refueling areas of high importance, especially for the long distance migrants during the spring migration and should thus be of conservation priority as spring migration is the critical time of year for the tropical winterers that breed in the north (van der Kam *et al.* 2004). The maintenance of shallow mudflats along the coastal areas and limiting disturbance from various human activities in all the study wetlands should take precedence. On the other hand, man-made habitats such as rice fields found in certain study areas (e.g. Axios delta) are valuable for the migrating waders providing foraging areas especially in spring. The value of these coastal agricultural fields for the migrating waders has been documented elsewhere (Rottenborn 1996, Shuford *et al.* 1998). For this reason, agricultural practices in rice fields and the extensive use of insecticides and pesticides need serious reconsideration (Albanis *et al.* 1996). Further research is also needed to understand the value of inland wetlands for migrating waders, the factors affecting the distribution of waders in different habitats within the wetlands and the relation of the wader numbers to wetland complexity. However, the conservation of migrants is an international issue and depends on cooperative conservation activities among the countries. It is imperative to provide initiatives and promote joint actions among neighboring countries for the best possible conservation of waders. Moreover, additional ringing efforts would provide us with further information on the movements of waders revealing more significant details about the Mediterranean-Black Sea flyway as well as the origin and routes of migrants to and from the Greek wetlands.

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Annex I. Mean ± standard deviation and the maximum number (in parenthesis) of wader species recorded during the spring and autumn migration periods in six coastal wetlands in Greece during the years 1996, 1997 and 1998.

Species		Season					
		Spring			Autumn		
	years	**1996**	**1997**	**1998**	**1996**	**1997**	**1998***
1	*Haematopus ostralegus*	150 ± 47	108 ± 39	139 ± 32	82 ± 4	84 ± 28	17 ± 4
	Oystercatcher	(216)	(166)	(172)	(168)	(114)	(22)
2	*Himantopus himantopus*	692 ± 171	498 ± 135	468 ± 185	159 ± 168	142 ± 170	80 ± 84
	Black-winged Stilt	(893)	(704)	(614)	(384)	(427)	(283)
3	*Recuvirostra avosetta*	391 ± 163	895 ± 371	493 ± 182	579 ± 273	700 ± 138	252 ± 49
	Avocet	(581)	(1402)	(740)	(1,052)	(805)	(310)
4	*Burhinus oedicnemus*	11 ± 5	18 ± 11	6 ± 3	41 ± 35	45 ± 28	6 ± 15
	Stone Culrew	(15)	(23)	(8)	(86)	(75)	(36)
5	*Glareola pratincola*	91 ± 77	92 ± 76	41 ± 29	9 ± 10	33 ± 16	1 ± 2
	Collared Pratincole	(165)	(202)	(63)	(25)	(43)	(5)
6	*Charadrius dubius*	73 ± 96	19 ± 18	25 ± 14	81 ± 136	32 ± 20	10 ± 7
	Little Ringed Plover	(233)	(53)	(50)	(325)	(56)	(20)
7	*Charadrius hiaticula*	27 ± 31	16 ± 20	19 ± 23	40 ± 42	111 ± 42	2 ± 3
	Ringed Plover	(72)	(50)	(47)	(104)	(179)	(7)
8	*Charadrius alexandrinus*	759 ± 422	1,167 ± 1,061	434 ± 287	1,358 ± 677	1,193 ± 374	586 ± 406
	Kentish Plover	(1,464)	(3,323)	(923)	(2,505)	(1,613)	(1,255)
9	*Charadrius leschenaultii*		(1)**			(1)	(1)
	Greater Sandplover						
10	*Charadrius asiaticus*				(15)		
	Caspian Plover						
11	*Charadrius morinellus*					(1)	
	Dotterel						
12	*Pluvialis apricaria*	139 ± 156	0	0	53 ± 48	1 ± 1	0
	Golden plover	(350)			(133)	(3)	
13	*Pluvialis squatarola*	433 ± 105	456 ± 104	370 ± 54	333 ± 179	624 ± 374	181 ± 96
	Grey Plover	(555)	(590)	(433)	(537)	(1,159)	(362)
14	*Hoplopterus spinosus*	(3)	(16)	(28)			
	Spur-winged Plover						
15	*Calidris canutus*	20 ± 18	13 ± 15	10 ± 9	1 ± 1	5 ± 3	0
	Knot	(46)	(40)	(25)	(1)	(8)	(2)
16	*Calidris alba*	197 ± 193	131 ± 118	64 ± 35	37 ± 2	15 ± 14	0
	Sanderling	(525)	(333)	(123)	(56)	(45)	(1)
17	*Calidris minuta*	6,051 ± 3,414	6,149 ± 3,878	2,495 ± 1,912	2,430 ± 570	1,574 ± 571	1,771 ± 512
	Little Stint	(10,889)	(11,466)	(5,508)	(3,074)	(2,529)	(2,555)
18	*Calidris temminckii*	3 ± 6	1 ± 2	0	20 ± 42	1 ± 1	1 ± 1
	Temminck's Stint	(14)	(3)		(106)	(2)	(2)
19	*Calidris ferruginea*	6,281 ± 6,361	3,441 ± 3,895	2,504 ± 2,901	521 ± 584	317 ± 217	68 ± 100
	Curlew Sandpiper	(13,434)	(8,745)	(6,695)	(1,455)	(698)	(211)
20	*Calidris alpina*	5,414 ± 1,313	10,175 ± 2,428	3,310 ± 571	2,131 ± 1,294	1,871 ± 1,100	1,006 ± 896
	Dunlin	(7,359)	(12,440)	(4,243)	(4,196)	(3,352)	(2,733)
21	*Vanellus vanellus*	6 ± 2	4 ± 2	8 ± 3	3 ± 4	19 ± 21	7 ± 8
	Lapwing	(8)	(6)	(10)	(11)	(51)	(16)
22	*Limicola falcinellus*	(14)			(19)	(19)	(5)
	Broad-billed Sandpiper						
23	*Philomachus pugnax*	5,142 ± 3,989	7,017 ± 5,905	1,558 ± 919	220 ± 144	12 ± 19	50 ± 78
	Ruff	(9,785)	(16,085)	(2,745)	(375)	(45)	(208)

continued

Species		Season					
		Spring			Autumn		
	years	**1996**	**1997**	**1998**	**1996**	**1997**	**1998***
24	*Lymnocryptes minimus*	(9)			(2)		
	Jack Snipe						
25	*Gallinago gallinago*	5 ± 8	3 ± 6	1 ± 1	112 ± 66	27 ± 21	35 ± 25
	Snipe	(13)	(13)	(2)	(188)	(58)	(78)
26	*Gallinago media*	(1)					
	Great Snipe						
27	*Phalaropus lobatus*				(2)		(1)
	Red-necked Phalarope						
28	*Limosa limosa*	234 ± 244	1,279 ± 1,439	34 ± 31	70 ± 47	23 ± 17	85 ± 93
	Black-tailed Codwit	(640)	(3,859)	(83)	(122)	(50)	(264)
29	*Limosa lapponica*	5 ± 5	26 ± 34	10 ± 7	5 ± 8	2 ± 2	0
	Bar-tailed Codwit	(13)	(74)	(17)	(20)	(4)	1 ± 1
30	*Numenius phaeopus*	34 ± 20	110 ± 159	29 ± 12	3 ± 2	1 ± 1	(2)
	Whimbrel	(58)	(418)	(49)	(8)	(1)	
31	*Numenius tenuirostris*		(4)				
	Slender-billed Curlew						
32	*Numenius arquata*	282 ± 28	438 ± 219	336 ± 133	791 ± 379	854 ± 182	310 ± 72
	Curlew	(319)	(653)	(561)	(1,200)	(1,061)	(345)
33	*Tringa erythropus*	749 ± 232	472 ± 134	216 ± 167	58 ± 78	623 ± 740	46 ± 63
	Spotted Redshank	(1,004)	(628)	(244)	(212)	(1,830)	(160)
34	*Tringa totanus*	400 ± 181	275 ± 107	134 ± 81	3,145 ± 1,525	3,822 ± 812	902 ± 538
	Redshank	(686)	(432)	(240)	(4,731)	(5,080)	(1,816)
35	*Tringa stagnatilis*	326 ± 282	98 ± 94	39 ± 43	78 ± 61	28 ± 20	33 ± 31
	Marsh Sandpiper	(728)	(233)	(97)	(163)	(59)	(69)
36	*Tringa nebularia*	316 ± 194	199 ± 143	69 ± 33	223 ± 137	126 ± 47	42 ± 14
	Greenshank	(525)	(414)	(107)	(466)	(159)	(56)
37	*Tringa ochropus*	13 ± 14	8 ± 8	17 ±14	14 ± 7	8 ± 9	5 ± 6
	Green Sandpiper	(37)	(27)	(35)	(25)	(25)	(15)
38	*Tringa glareola*	869 ± 607	619 ± 369	319 ± 101	698 ± 594	924 ± 581	219 ± 177
	Wood Sandpiper	(1,775)	(1,239)	(479)	(1,293)	(1,261)	(366)
39	*Actitis hypoleucos*	24 ± 14	6 ± 5	9 ± 7	21 ± 19	4 ± 7	0
	Common Sandpiper	(35)	(11)	(15)	(56)	(16)	(1)
40	*Arenaria interpres*	65 ± 90	45 ± 55	16 ± 18	13 ± 15	14 ± 16	3 ± 4
	Turnstone	(221)	(130)	(46)	(30)	(36)	(12)
	Total	**29,218 ± 7,143 (37,567)**	**33286 ± 4,451 (40,140)**	**14,111 ± 3,528 (18,997)**	**14,242 ± 2,921 (17,026)**	**15,146 ± 4,252 (21,546)**	**5,719 ± 2,224 (9,957)**

* In autumn 1998 three study areas were not included in the analysis.
** Only the highest numbers are given for the "Rare" and the "Very rare" species.


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