

Mid-winter counts of waders in the Senegal delta, West Africa, 1993-1997

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Although the delta of the Senegal river has long been known as a very important place for waterbirds, relatively little attention has been paid to waders wintering there. We present the results of the first series of thorough mid-winter counts carried out in January 1993-1997, concerning 41 species of waders. The status of Ruff *Philomachus pugnax* and Black-tailed Godwit *Limosa limosa*, which have been studied for a longer period, are discussed in more detail. Numbers of various species linked to mudflats and shallow lagunas varied greatly from one year to the other, the variations being only partly governed by the local availability of favourable habitats. The delta as a whole is of international importance for the conservation of six wader species: Black-winged Stilt *Himantopus himantopus*, Avocet *Recurvirostra avosetta*, Little Stint *Calidris minuta*, Ruff, Black-tailed Godwit and, in some years at least, Kentish Plover *Charadrius alexandrinus*. The most valuable areas for the conservation of waders are the Diawling national park in Mauritania, the national park of Djoudj, the lagunas near Saint-Louis -including the Guembeul reserve- and the artificially flooded area in northern Ndiel in Senegal.

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INTRODUCTION

Surveys of waterbirds in the Senegal delta were initiated at the end of the 1950s (Roux 1959) and have been conducted annually since 1972 (Roux *et al.* 1976). They mostly concentrated on the overwintering Anatidae (Triplet & Yésou 1997) but from the start it was apparent that the area was of importance for waders, particularly wintering Ruff *Philomachus pugnax* and Black-tailed Godwit *Limosa limosa* (Morel & Roux 1966). Nevertheless, few wader censuses were undertaken until the 1980s (Altenburg & van der Kamp 1986; Meininger 1989; Hötter & Dietrich 1991). From 1989 onwards, a team from Office National de la Chasse (ONC, French Ministry of Environment) visited the delta every January and collected new data on waders in co-operation with the national park services of Senegal and Mauritania. Initially aimed at Ruff and Black-tailed Godwit on the Senegalese side of the river (Trollet & Girard 1991; Trollet *et al.* 1992, 1995), the censuses covered all the species on both the Mauritanian and Senegalese parts of the delta from 1993 to 1997 (Trollet *et al.* 1993; Triplet & Yésou 1993, 1994a; Triplet *et al.* 1995, 1997; Yésou *et al.* 1996). The whole area was thus censused for five years in succession, allowing a better description of its value for waders in winter, and illustrating the annual variations in number which occur in the unpredictable Sahelian environment.

STUDY AREA AND METHODS

The delta of the Senegal river (15°44'-16°38'N; 15°35'-16°30'W) covers 200,000 ha in Senegal and 120,000 ha in Mauritania. Until the river was dammed, up to 180,000 ha were flooded every autumn after the rainy season. Large-scale hydraulic works began in the 1960s, including dykes on both banks of the river and a dam. Since 1992, the flooding of most parts of the delta is under human control through sluices, and

many wetlands have been turned into rice fields or sub-desert areas. A historical summary of the hydraulic works and a description of the remaining wetlands are given in Triplet & Yésou (1997).

The delta area has been divided into census units in the framework of the international waterfowl surveys co-ordinated by Wetlands International (previously IWRB). In Senegal, the main wetlands are the Parc National des Oiseaux du Djoudj (PNOD), the Trois-Marigots, parts of the Ndiel, the Djeuss valley, the surroundings of lake of Guier, the Nieti Yone river, and the lagunas near de Saint-Louis, including the Guembeul nature sanctuary (see Figure 1). The Parc National de la Langue de Barbarie, which consists mostly of sand dunes with difficult access to the seashore, was visited in 1997 only. Waders also occur in previously wet areas now converted into rice fields. Thus, they are mostly dry in January, particularly on the census units of Débi and Boundoum Kassac. These areas were covered as extensively as possible in 1994, 1995 and 1996.

In Mauritania, the main wetlands are the Parc National du Diawling, the ponds of Dioup and Keur Massène, and the laguna of Chott Boul. Waders can also occur in rice fields and smaller ponds along the dyke from Dioup to Rosso.

The surveys were carried out every year between 7 and 25 January, the PNOD usually being censused on 15 January. Most of the interesting sites for waders were visited at least once every season (Table 1), either by car, on foot or by boat according to the local conditions. Every bird seen was counted, since the widely dispersed species often occurred at low density. This census method can lead to underestimates, particularly for species widely dispersed in semi-open habitat



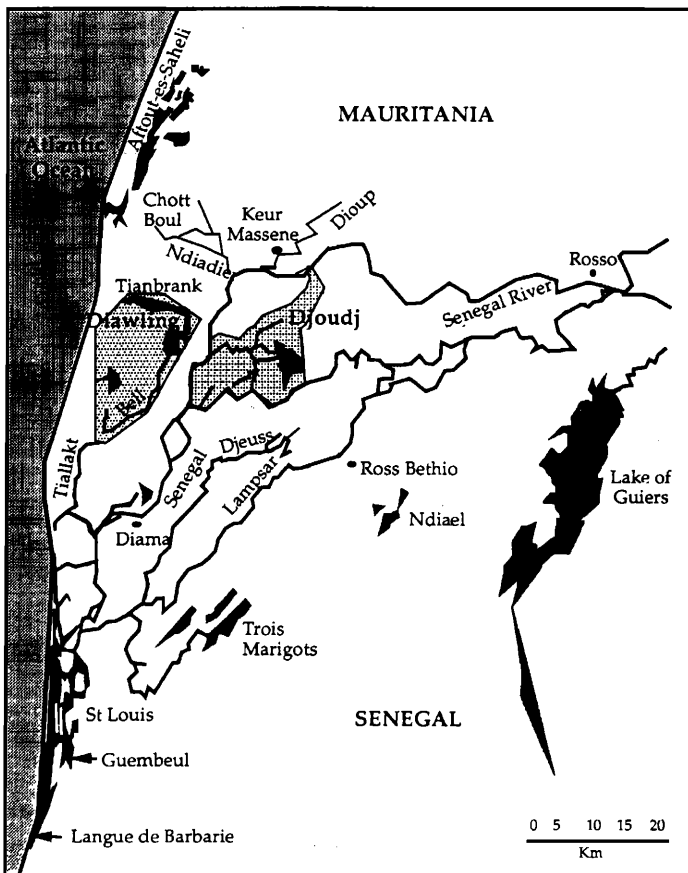


Figure 1. The Senegal delta, main localities, rivers and water bodies. Shaded areas: national parks.

RESULTS

This five-year survey gives the longest-lasting series of data available for wintering waders within the Sahel zone. Table 2 summarises this information and includes the estimates given by Meininger (1989) and Hötter & Dietrich (1991) for the winters 1987-1988 and 1988-1989. The latter report, however, is based on a November-December survey, when the wetlands are wetter than in January; thus some care is needed when comparing the results.

Black-winged Stilt *Himantopus himantopus*

Many localities within the delta must be considered of international importance for this species' conservation, as over 60 birds were usually found in most census units. The species' abundance, which seems to depend upon the water level, varied from 500 to over 1,000 birds in the delta. Rodwell *et al.* (1996) gave a maximum of 200 birds at PNOD, but a new record of 318 birds was set there on 15 January 1997. A bird wearing a French colour-ring combination was controlled at exactly the same spot in Diawling NP, Mauritania, in January 1993, 1995 and 1996 (Yésou *et al.* 1995 and unpub.). Meanwhile, this bird has been controlled on its breeding grounds in France.

Avocet *Recurvirostra avosetta*

Up to 7,200 Avocets were recorded in the lower delta, mostly at Guembeul and nearby, in December 1987-January 1988 (Meininger 1989) and 6,700 in November-December 1988 (Hötter & Dietrich 1991). Thus, the population seems to have

Table 1. Coverage of the Senegal delta for waders, January 1993-1997: main wetland areas and years when they were censused.

SENEGAL	
• PN Djoudj, Djeuss valley, Ndiael (northern part), Niety Yone, Trois-Marigots, Diama, lagunas near Saint-Louis	1993-1997
• River edges near Saint-Louis	1993-1996
• Rice & sugar-cane fields and relic wetlands between Djoudj and Richard-Toll (incl. Débi and Boundoum-Kassac areas)	1994-1996
• Langue de Barbarie NP (in part)	1997
MAURITANIA	
• Diawling proper (part of Diawling NP), Bell, lakes Nter and Ntok, river edge near Diama eastward to Rosso	1993-1997
• Tiallakt, Kurumbam, Tombos, Tianbrank and Chott Boul	1995-1997
• Ponds at Dioup and Keur Massene	1995-1997
• Seashore	1996-1997

with aquatic vegetation where birds can be overlooked (*e.g.* Wood Sandpiper *Tringa glareola* and Common Snipe *Gallinago gallinago* for which the counts are far from complete; field experience can nevertheless help to propose some population estimates based on partial counts). Two species, Ruff and Black-tailed Godwit, were more efficiently censused at night roosts: once the roost sites were located, they were censused almost simultaneously. For both species, however, underestimates would have occurred if a roost had remained unnoticed.

decreased in a few years, as only 1,350-4,940 were censused in January 1993-1997, although it is difficult to compare counts carried out in different months. Variations in numbers are linked to the water level and salinity of large lagunas and lakes. Hötter *et al.* (1990) have shown that the birds progressively leave Guembeul and nearby lagunas (where they can reach high figures: 3,300 on 21 January 1990) as it dries up, and then either migrate northward or go to PNOD where numbers steadily increase in late January and February (up to 3,050 on 27 February 1990, Rodwell *et al.* 1996), possibly including



Table 2. January counts of the commoner wader species in the Senegal delta. Numbers in bold: over 1% of the bio-geographic population, a level from which the area is considered of international importance for the species' conservation (after Smit & Piersma 1989; Rose & Scott 1997). Data for 1987-1988 combine the estimates obtained in December 1987-January 1988 by Meininger (1989) and in November-December 1988 by Hötter & Dietrich (1991). nc = no count that year

species	1 %	1987-1988	1993	1994	1995	1996	1997
Black-winged Stilt	60	>1,024	450	313	1,137	1,023	1,039
Avocet	700	6,600-7,200	2,048	1,366	1,342	4,940	3,049
Senegal Thick-knee	-		68	63	172	313	nc
Pratincole	-		217	1,814	653	394	75
Little Ringed Plover	-		30	15	57	51	83
Ringed Plover	2,000	1,600	120	271	340	232	283
Kittlitz's Sandplover	-	65	34	68	127	20	69
Kentish Plover	700	>20-300	192	1,523	674	272	441
Grey Plover	1,500	150	17	210	32	7	58
Spur-winged Plover	-		nc	444	524	989	nc
Sanderling	1,000		nc	nc	92	259	260
Little Stint	2,100	5,000-10,000	4,034	2,578	316	1,626	4,388
Curlew Sandpiper	4,500	2,000-4,000	547	865	1,072	64	490
Dunlin	14,000	150-500	217	1054	288	73	348
Ruff	-		≥170,000	>32,072	>124,060	>38,150	≥135,929
Black-tailed Godwit	3,500	3,300-10,000	11,100	≥4,090	≥2,210	≥2,081	2,495
Spotted Redshank	1,200	1,200	41	21	12	100	113
Redshank	1,500		57	41	385	67	52
Marsh Sandpiper	-		89	255	397	39	99
Greenshank	-	450	65	80	144	117	239
Green Sandpiper	-		12	8	13	16	6
Wood Sandpiper	-		70	60	149	137	49
Common Sandpiper	-		27	25	71	68	68
Turnstone	300		4	2	29	40	4

migrant birds from more southerly wintering areas.

Senegal Thick-knee *Burhinus senegalensis*

The numbers recorded varied greatly, from 68 to 313 birds, at least in part as a result of the variable attention we paid to the species, which roost by day in small groups on river banks. The January population in the delta is not thought to be more than 500 individuals.

Collared Pratincole *Glareola pratincola*

Usually a few hundred recorded, mostly on rice fields and a limited number of wetlands (PNOD, Ndiael, Trois-Marigots). Over 1,800 were counted in January 1994 during an invasion of locust *Schistocerca gregaria*, including 1,650 roosting together at PNOD (Triplet & Yésou 1995). The previous winter maximum on this site was 600 on 1 January 1991 (M. Fouquet, ONC, pers. comm.).

Little Ringed Plover *Charadrius dubius*

Usually scattered in various habitats from coastal lagunas to village pools, and certainly under-recorded: the January population might be 300-500. Up to 58 birds at PNOD in January 1997 was an unusual concentration (previous local record number: 20 in April 1993, Rodwell *et al.* 1996).

Ringed Plover *Charadrius hiaticula*

Mostly occurs on lagunas, although also widely dispersed over various habitats including smallish ponds where a proportion remains unrecorded. The January population is likely to be in the range 300-500, which is far below the 1,500 estimated (1,097 counted) in November-December 1988 by Hötter & Dietrich (1991). It is not clear whether the wintering population has decreased dramatically, or whether the difference merely reflects a usual, seasonal, decrease from autumn to mid-winter, in line with the drying up of mudflats and other wetlands.

Kittlitz's Sandpiper *Charadrius pecuarius*

Widely scattered in usually low numbers, the 46 birds recorded in Ndiael and 45 at Diawling NP in January 1995 were unusually large concentrations. Possibly up to 200 birds were present throughout the whole delta. Fully-grown juveniles still showing down feathers on the crown were observed in mid-January 1995, indicating a laying date in November, *i.e.* one month later than that given by Morel & Morel (1990).

Kentish Plover *Charadrius alexandrinus*

Hötter & Dietrich (1991) counted 200 birds at Langue de Barbarie NP, which we did not survey. Outside this coastal dune, the species was recorded almost exclusively on the



shores of drying-up lagunas. This strong habitat preference allows a precise census of the species: the recorded year-to-year variations are a true phenomenon and may be linked to the availability of favourable habitat, both locally and on a larger geographic scale (since numbers can remain rather low in years with plenty of seemingly good habitat over the delta, as in January 1995). The 1994 record number included a group of 1,410 birds in northern Ndiael.

Grey Plover *Pluvialis squatarola*

Uncommon. The 210 birds observed in 1994, mostly in the lagunas south of Saint-Louis, were unusual for the area. Possibly regular at Langue de Barbarie, where 40 were seen in December 1988 (Hötker & Djétrich 1991) and 42 during a partial survey in January 1997.

Spur-winged Plover *Vanellus spinosus*

This species occurs in various habitats, including dry fields and tracks, although never far from water. Widely distributed at low density, it is difficult to census precisely and annual variations in number are almost impossible to interpret. We estimate the January population to be 600-1,200 birds. Juveniles which had just fledged and were not yet fully grown were seen on 8 January 1995, indicating that laying had taken place in November. This agrees with the species' protected breeding period (Morel & Morel 1990).

Sanderling *Calidris alba*

All the birds seen in 1995 were in Mauritania, but a few tens were counted on a small portion of beach south of Saint-Louis in 1996. Much higher numbers would surely be recorded if the beach was fully surveyed, as shown by the 1997 data which includes parts of both the Mauritanian beach and Langue de Barbarie NP (Triplet *et al.* 1997); in December 1988, 300 were counted at Langue de Barbarie (Hötker & Dietrich 1991).

Little Stint *Calidris minuta*

The Senegal delta usually supports internationally important numbers (3,000-5,000 birds) of this species, except in years when the water level is very high in some lagunas following exceptional flooding, as in January 1995 and 1996. Further to our data, Hötker & Dietrich (1991) counted 4,128 Little Stint over the delta in November-December 1988, while Hötker *et al.* (1990) counted 2,700 on 21 January 1990 at Guembeul alone.

Curlew Sandpiper *Calidris ferruginea*

With a maximum of 1,072 birds, the 1993-1997 numbers remained well below the high estimates of 1987-1988, although the latter were partly based on November-December counts and might then reflect the autumn passage better than the mid-winter situation. The record 1,080 birds in January 1990 at Guembeul (Hötker *et al.* 1990), which was only a partial count of the delta population, further illustrates the huge variations observed from one year to the next in the species abundance (Table 2). This variability has no obvious local

explanation. The birds frequent shallow lagunas, mostly around Saint-Louis: the overall area covered by the lagunas varies yearly according to flooding and evaporation, but this variation is far less marked than that shown in counts of Curlew Sandpiper.

Dunlin *Calidris alpina*

For this species too, the yearly variations are difficult to explain as they do not fit obvious changes in habitat. The record number of January 1994 was mostly due to 924 individuals in the lagunas around Saint-Louis.

Ruff *Philomachus pugnax*

Morel & Roux (1973) considered that up to 500,000 birds were using the delta in the late 1950s-early 1970s; indeed Roux (1973) proposed that the total figure reached one million in February 1972. This must be treated with some caution, however, in view of the huge overestimate given by the same author for another large wader also frequenting the delta rice fields in large groups, Black-tailed Godwit (Roux 1959, see below). More recently, the population overwintering in the delta was estimated at up to 200,000 individuals in 1984-1988 (OAG Münster 1996), then 180,000 in January 1991 and 200,000 in January 1992 (Trolliet *et al.* 1992). The latter authors thought that only one night roost occurred in the delta, at PNOD, although they acknowledged the possibility of a second roost near Richard-Toll. In 1993, a roost totalling 75,000 birds was found in northern Ndiael, while 95,000 were counted at the PNOD roost, hence a grand total marginally lower than that of the previous years (Trolliet *et al.* 1993). At the same time, about 45,000 birds were roosting by day on the Mauritanian bank, mostly near Dioup (Triplet & Yésou 1993). It was not certain whether these birds moved to the PNOD roost, or stayed in Mauritania where night roosts sometimes occur (O. Hamerlynck, IUCN, pers. comm.). Thus, the estimate given by Trolliet *et al.* (1993) for January 1993 must be corrected to 170,000-215,000.

In 1995, we found 108,000 Ruffs at PNOD; no bird was roosting at Ndiael by night, but a roost was suspected on the nearby Ross-Béthio ponds, that we were not able to reach. Good coverage was achieved in 1997: no night roost occurred in Mauritania and Ndiael, while the Ross-Béthio ponds were used as a pre-roost by birds *en route* to PNOD where just over 134,000 birds were counted. The total number for that year was 50,000 to 80,000 birds less than in 1992-1993. Small roosts might have escaped attention (particularly near Boundoum, Y. Capitaine, pers. comm.), but this does not explain why so many birds were missing. It is unclear whether the species was simply less numerous in the delta or whether the birds now disperse over a larger area in order to take advantage of new rice fields which have recently appeared upstream following the hydraulic improvements. They may then concentrate in the lower delta as the season progresses (e.g. c. 200,000 birds were counted in February 1996 at PNOD : O. Girard, ONC, pers. comm.).



The Ruff is the most studied wader species in the delta. Its feeding behaviour and energy demand were addressed by Tréca (1983, 1990, 1992, 1993, 1994) and in far less detail by Trolliet (1996), its sex-ratio by Trolliet (1992) and Tréca (1997) who obtained rather similar results (respectively 1:2.25 and 1:1.85 in January) and members of OAG Münster (1996, see also Melter & Sauvage 1997) who also found a sex-ratio of 1:1.85 in 'winter' (actually November-March, precise date of capture not given for most of their sample).

Black-tailed Godwit *Limosa limosa*

Roux (1959) claimed hundreds of thousands Black-tailed Godwit overwintering in the delta. Such numbers were never found again and, according to the known size and trends of the world population (Cramp & Simmons 1983; Altenburg *et al.* 1985), must be considered to be huge overestimates. Numbers reached 17,000-20,000 birds on various occasions in the 1970s, but only 4,000-5,000 in 1973 and 1974 (Tréca 1984); then Altenburg & van der Kamp (1985) recorded only 3,300 birds during a thorough survey of the area in October 1983. This led Tréca (1992) to consider that Black-tailed Godwit was disappearing as a wintering species in the delta. Analysing a more complete set of data, Trolliet *et al.* (1995) showed that Tréca's comment exaggerated the situation and, comparing the record number of 19,690 birds in January 1976 to the 11,100 they found in January 1993, their paper suggested that the species' status had not changed significantly over the long term.

We paid special attention to this species in 1994-1997. Almost no bird was found returning to the roost in Ndiel where Trolliet *et al.* (1995) counted most of their birds in 1993: the godwits concentrated in PNOD where they roosted in inaccessible places and hence were difficult to census accurately. This possibly led to underestimates in some years, although it is very unlikely that the true numbers reached 5,000 in either 1995 or 1996, and only 2,500 were found in 1997 when a more complete census was carried out.

Thus Black-tailed Godwit clearly continue to regularly overwinter in the Senegal delta in reasonable numbers, contrary to Tréca's (1992) claims. The concentrations even reached international importance in some recent years. Their abundance, however, is not constant. High numbers occurred in the late 1970s, when the species benefited from very favourable foraging conditions in under-managed rice fields where the godwits feed preferentially (Tréca 1984, 1992 and 1994), although they also forage on wetlands in groups of up to ca. 2,000 (pers. obs.). High numbers can still occur as observed in 1993, but it seems that usually no more than 3,000-5,000 birds overwinter in the delta. Such variable figures had already been obtained in the early 1970s and during the only two thorough surveys of the 1980s (only 3,300 in October 1983, as quoted above, but 7,700 in November-December 1988: Hötter & Dietrich 1991, not quoted by Trolliet *et al.* 1995), indicating that important year to year variability in

numbers is not a recent phenomenon.

None of the following species was numerous: Spotted Redshank *Tringa erythropus*, Redshank *T. totanus*, Marsh Sandpiper *T. stagnatilis*, Greenshank *T. nebularia*, Green Sandpiper *T. ochropus*, Wood Sandpiper *T. glareola*, and Common Sandpiper *Actitis hypoleucos*. The scattered distribution of Wood and Green Sandpipers, which favour vegetated wetlands, meant that they were easily overlooked, thus reducing the value of the census data: the mid-winter population of Wood Sandpiper may be over 500, while Green Sandpiper is obviously scarcer.

The larger species mostly occur in open habitats, lagunas and large ponds, where they are not likely to be missed. Thus the year to year variations in their recorded numbers must reflect a true phenomenon. Meininger (1989) estimated that 250-1,000 Greenshanks and 100-1,000 Spotted Redshanks overwintered in the delta, on the basis of data obtained by Altenburg & Van der Kamp (1986) in October-November 1983, then 1,160 Spotted Redshanks were counted in mid-December 1988 (Hötter & Dietrich 1991): although high numbers can occur during autumn passage and early winter, the upper value of Meininger's estimates cannot hold for mid-winter populations in the light of the information collected in 1993-1997 (Table 2). Some species exhibit strong territorial, agonistic behaviour, such as Marsh Sandpiper (Hötter 1990), which may limit the number present at some localities. Up to 438 Marsh Sandpiper, however, were noted at PNOD on 15 January 1995 (Triplet *et al.* 1995), breaking the local daily record of 50 given by Rodwell *et al.* (1996).

Turnstone *Arenaria interpres*

Always found in small numbers in the coastal part of the delta, including the banks of inhabited islands at Saint-Louis, and easily overlooked. Larger numbers might occur at Langue de Barbarie NP.

Species recorded in low numbers :

- **Painted Snipe *Rostratula benghalensis***: considered as particularly common around Richard-Toll (Morel & Morel 1990), this easily overlooked species was rarely recorded, with a maximum mid-winter count of 9 in 1996, although up to 17 have been mist-netted on a single day at PNOD (Rodwell *et al.* 1996).
- **Eurasian Oystercatcher *Haematopus ostralegus*** : one at Saint-Louis lagunas in January 1997 is the only record.
- **Stone Curlew *Burhinus oedipnemus*** : not recorded during the mid-winter counts, but one was with Senegal Thick-knees at PNOD on 12 December 1991 (Rodwell *et al.* 1996).
- **Spotted Dikkop *Burhinus capensis*** : one at PNOD, 14 December 1991 to 11 January 1992 (Rodwell *et al.* 1996), 2 near Nieta Yone in January 1995 (Triplet *et al.* 1995).
- **Cream-coloured Courser *Cursorius cursor*** : widespread



but never abundant (up to 17 together near PNOD, Rodwell *et al.* 1996), it often occurs far from the wetlands and its abundance is greatly underestimated in mid-winter counts (*e.g.* among over 20 seen in January 1994, only five were on wetland census units). Its winter breeding was observed near Trois-Marigots in January 1994 (Triplet & Yésou 1994b).

- **Temminck's Courser** *Cursorius temminckii* : recorded only in 1995 (two at Trois-Marigots, five near the lake of Guier, three at Diawling NP). It may breed, at least occasionally, at Diawling NP (O. Hamerlynck, IUCN, pers. com.).
- **Golden Plover** *Pluvialis apricaria* : two records at PNOD in December 1973 and February 1974 (Morel & Morel 1990) were followed by three birds on 24 November 1991 (Rodwell *et al.* 1996), then two in January 1994 and one in January 1995.
- **Black-headed Plover** *Vanellus tectus* : one on 29 January 1992 at PNOD (Rodwell *et al.* 1996), then two records in January 1994 (four birds) and one individual in 1995, at Trois-Marigots and Richard-Toll.
- **Senegal Wattled Plover** *Vanellus senegallus* : observed annually in small numbers (up to 16 birds in January 1995).
- **Northern Lapwing** *Vanellus vanellus* : following records in 1971 (one in May) and 1974 (6 on 30 January, Morel & Morel 1990), one was seen on 17-19 January 1987, one on 12th January 1992, and one from 27 November 1992 to 27th March 1993, with two on 17 December and 28 February (Rodwell *et al.* 1996, Girard *et al.* 1992, O. Girard, ONC, pers. comm.).
- **Knot** *Calidris canutus* : irregular in very small numbers (usually lone birds).
- **Temminck's Stint** *Calidris temminckii* : a few birds occur in the delta in winter, as already mentioned by Morel & Morel (1990); we did not find more than three individuals in any given year, but five were recorded at PNOD on 1st February 1992 (Rodwell *et al.* 1996).
- **Jack Snipe** *Lymnocyrtus minimus* : Morel & Morel (1990) recorded many contacts from late January into March near Richard-Toll. Ringing at PNOD showed that it occurred in small numbers until late January, becoming more frequent on passage in February to mid-March, with a record 12 on 1st February 1987 (Rodwell *et al.* 1996). One at PNOD on 15th January 1996 (T. Dodman, WI, pers. comm.) is the only record during the mid-winter counts, 1989-1997.
- **Common Snipe** *Gallinago gallinago* : mostly found around small ponds and channels surrounded by high herbaceous vegetation, this species is very difficult to census and only 2 - 12 individuals were counted each year [surprisingly, the 20 birds on 15 January 1991 at PNOD quoted by Rodwell *et al.* (1996) did not appear in the detailed census report for that year], which represent only a smallish proportion of the birds present.
- **Bar-tailed Godwit** *Limosa lapponica* : uncommon, maximum six birds together at Chott Boul in January 1995, in contrast with the 'small concentrations' claimed by Morel & Morel (1990) in the delta area.

- **Whimbrel** *Numenius phaeopus* : although Morel & Morel (1990) quoted that the species overwintered in the delta, no more than four birds were seen in any recent years. It must be stressed that the mangroves, a typical winter habitat for this species, have not been fully censused.
- **Eurasian Curlew** *Numenius arquata* : one or two birds every January.

DISCUSSION

We are fully aware that our five-year survey, although offering the only multi-year set of wader data for any large wetland in the Sahel zone, gives only a snapshot of the situation in a changing delta. It is of interest that this snapshot occurred when the Senegal delta had just been drastically modified by gigantic hydraulic works. Unfortunately, it is not possible to say whether or not these hydraulic works affected the waders. Previous estimates given for 'wintering' populations of various species (particularly Avocet, Ringed Plover and some *Calidris* and *Tringa* species) were much higher than recent counts (Meininger 1989; Hötter & Dietrich 1991). The former estimates, however, were largely based on surveys carried out in October-December, when many waders are still moving southward; also, the carrying capacity of the delta is likely to decrease through the season, due to the drying up of the wetlands and thus numbers counted in autumn and early winter can hardly be compared to the mid-winter (January) situation.

One can only suggest that some species might have been more numerous when the wetlands were naturally flooded over large areas, while the same species or others may now take advantage of *e.g.* newly created rice fields and enlarged mudflats. Thus, Ruffs and Black-tailed Godwits probably take better advantage of the present well-conducted and much larger rice fields than they did of the mismanaged cultivations twenty years ago. Also, while more Little Stints and Wood Sandpipers might have occurred over flooded meadows at PNOD in the early 1990s (O. Girard, ONC, pers. comm.), during our survey Little Stints and various other wader species obviously benefited from the exposed mudflats due to low water levels in the same national park.

In its present aspect, the delta as a whole appears to be of international importance for the conservation of six species: Black-tailed Godwit, Little Stint, Ruff, Black-winged Stilt, Avocet and, in some years at least, Kentish Plover (Table 2). The most valuable areas for waders are the national parks of Djoudj and Diawling, the lagunas near Saint-Louis, including the Guembeul reserve, and the artificially flooded area in northern Ndiael. Also, Ruffs and Black-tailed Godwits depend largely on ricefields when foraging.

The situation observed 250 km to the north-east, at Aleg lake, showed that preserved natural habitats can support much greater densities of waders than the artificialised sites in the Senegal delta (Yésou & Triplet 1996). It is thus expected that improved management of the protected areas, partly linked to



the improvement of dykes or sluices there (Triplet & Yésou 1997; Triplet *et al.* 1997), will lead to better overwintering conditions for waders in the delta. Particularly, it is planned to recreate deltaic biotopes in Diawling NP : such a re-establishment of natural habitats must be of great benefit to waders as well as to other aquatic flora and fauna.

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The sediment-plane: an alternative tool for estimating prey accessibility to tactilely feeding waders

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Desholm, M., Harder, A.M. & Mouritsen, K.N. The sediment-plane: an alternative tool for estimating prey accessibility to tactilely feeding waders. *Wader Study Group Bull.* 85: 73-75.

A sampling method which considers the actual accessibility of infaunal prey to tactilely feeding Dunlins *Calidris alpina* is presented and compared with an ordinary core sample method collecting the sediment to a depth of 20 cm. The alternative method involved a sediment-plane, whose shaving depth was fitted to the maximum probing depth of Dunlins (3 cm). Our preliminary data showed a significant difference between the two sampling methods regarding the biomass of the amphipod *Corophium volutator* and the number of larger polychaetes (mainly Ragworms *Nereis diversicolor*). In comparison with the core samples, only about half of the amphipod dry weight and less than one third of the larger polychaete individuals were actually available to the Dunlins. We propose that a sediment-plane should be applied when studying the influence of bird-prey interactions on the spatial and temporal distribution of foraging waders in soft-bottom habitats.

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INTRODUCTION

In studies of the feeding ecology of waders, prey availability is a frequently applied parameter (Bengtson & Svensson 1968; Wolff 1969; Goss-Custard 1970, Schneider & Harrington 1981, Kelsey & Hassall 1989). In many surveys, prey availability is usually estimated as prey density on the basis of c. 20 cm deep core samples (e.g. Petersen 1981, Schneider & Harrington 1981, Kelsey & Hassall 1989, Matthews *et al.* 1992, Wilson & Parker 1996). This can be sufficient when studying larger wader species such as Oystercatcher *Haematopus ostralegus*, Bar-tailed Godwit *Limosa lapponica*, and Curlew *Numenius arquata*, that are able to reach deep into the sediment. However, in the case of the smaller sandpipers, *Calidridae*, that only have a limited vertical reach, the overall prey density obtained from 20 cm core samples may deviate significantly from actual prey accessibility.

If prey organisms consist of bivalves whose vertical position is relatively fixed, the sediment core can be cut into slices in order to obtain an exact vertical distribution of prey (Piersma *et al.* 1994). However, tube-dwelling polychaetes and amphipods, which are common prey organisms to an array of

wader species (e.g. Goss-Custard 1984; Worrall 1984; dit Durell & Kelly 1990), have the ability to withdraw themselves as a reaction to such sampling and slicing methods (see e.g. Zwarts & Wanink 1991). Consequently, the recorded vertical distribution of the invertebrate prey will not represent the actual prey accessibility to a tactilely feeding wader on an undisturbed mudflat. One means of overcoming this problem is to sample the sediment very quickly at the depth that corresponds to the bill length of the wader species of interest and thereby give the prey organisms the minimum amount of time to respond to the disturbance. Here, we report on a sampling device which does this for Dunlins *Calidris alpina*.

MATERIALS AND METHODS

The sampling device is basically a plane whose upper flat surface (21 cm wide, 30 cm long) glides on the sediment surface, beneath which is mounted a box (open at both ends) which moves through the substrate during sampling (Figure 1). On the top of the plane there is a pipe stub into which is fitted a 'pushing-stick'. The box measures 3 cm (height) x 7 cm (width) x 14.2 cm and hence collects an area of 100 cm² to a depth corresponding to the approximate bill length of Dunlins

