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WETLANDS INTERNATIONAL

ECOLOGICAL VALUATION OF HUMAN-MADE AND FLOODPLAIN HABITATS IN THE UPPER NIGER BASIN, MALI

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CONTENTS

1. INTRODUCTION

1.1. BACKGROUND AND OBJECTIVES

In the Sahel water is a scarce resource and important food sources – such as rice, cattle and fish – are highly reliant on its availability: water here is truly the essence of life. The poorer human communities in particular cannot survive without these food resources. Therefore, effective water management measures are of paramount importance for safeguarding or improving human prosperity in the Delta, where more than a million people live. The Dutch governmental Program Partners for Water is directed at the support and stimulation of an integrated water management system, with emphasis on developing nations. The Niger River in West Africa is one of several river systems chosen as subject for a pilot project, focusing on the upper reach of the Niger, from mountain spring to the Inner Niger Delta in the Sahel (Fig. 1). The issue of ecological values (biodiversity) is one of the aspects of integrated water management. This report covers the ecological input of the Partners for Water program in Mali, carried out from 2002-2004.

The Niger is, for the most part, still a natural river system, with the Inner Niger Delta extending over an inland floodplain to around 30.000 km^2. In the upper reach of the system several large water engineering works are located, namely a hydroelectric dam at Sélingué and an irrigation dam for the Office du Niger, an important rice growing area (Bonneval *et al.* 2001). The works have been established solely on the basis of achieving primary economic objectives (irrigation and production of electricity),

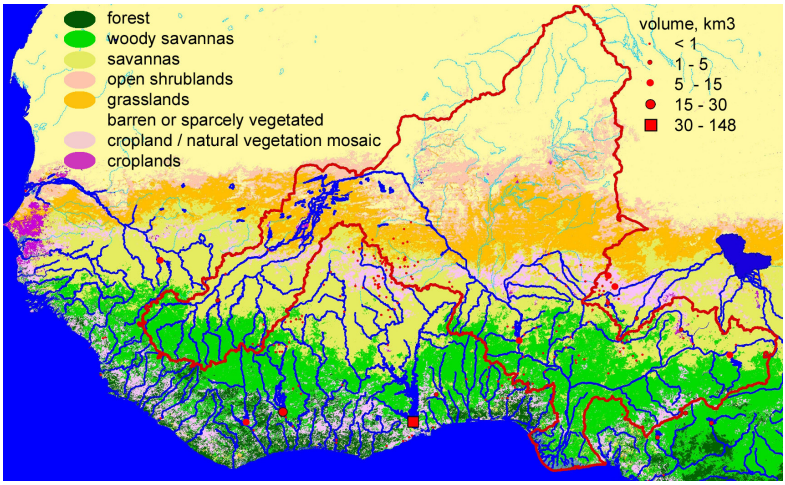

Fig. 1. *The Niger River Basin in West Africa (red delineation). Existing dams are indicated with red dots and squares.*
Fig. 1. Le Bassin du fleuve Niger en Afrique de l´Ouest (délimitation rouge). Barrages actuels sont marqués de points et petits carrés rouges.

without consideration for environmental and other cascading effects downstream. On the basis of earlier research in 1998-2001 (Wymenga *et al.* 2002; Zwarts & Diallo 2002) the Partners for Water project in Mali was developed, aimed at promoting integral management of scarce river water in the upper reach of the Niger.

The primary objective of the project was:
To promote, at catchment level, effective water management in the Upper Niger Basin, with respect to water management practices and the construction of water engineering works. In this consideration hydrological, socio-economic factors on regional to national level (for Mali) are incorporated, as well as ecological factors on the international level and where possible nationally for Mali.

The project was carried out in the framework of the program 'Water for food and ecosystems'. Key output from this objective is a decision-support model for effective river management of the upper reach of the Niger River (Zwarts *et al.* 2005a-b). With this model the effects of water engineering works, through different scenarios, can be weighed against the desired ecological requirements and socio-economic benefits. The final output was realised in close co-operation with the PREM-program of the Duch Ministry of International Co-operation (PREM = Poverty Reduction and Environmental Management).

The project has been performed in a common effort of Malian partners (in particular Direction Nationale de l´Hydraulique [DNH] and Opération Pêche Mopti [OPM]), the Dutch Institute for Inland Water Management and Waste Water Treatment (RIZA-Rijkswaterstaat), Wetlands International and several other Dutch partners taking part in certain project components requiring special input. The project was managed and directed by RIZA-Rijkswaterstaat. The ecological project component is performed by Altenburg & Wymenga ecological consultants bv, of which this report carries the basic results. The final evaluation (Wymenga *et al.* 2005) is part of the overall publication (Zwarts *et al.* 2005).

1.2. STRATEGY OF THE PROJECT

Water extraction and interventions in the hydrological system upstream may have significant consequences downstream. Water extraction influences river discharge and therefore also the level of inundation downstream. Changes in the level and incidence of flooding consequently affect the production of fish and rice in the Delta. The levels of these resources are known to correlate strongly with the amount of flooding (e.g. Welcomme 1986.

Zwarts *et al.* 2005). Furthermore, the ecological qualities of the region are highly depending upon flooding as well (Wymenga *et al.* 2002). In the Niger hydrosystem an activity like water extraction for irrigation or water storage can lead to production loss in areas downstream. To achieve an integrated water management approach for the Niger River, benefits and losses upstream and downstream have to be carefully balanced.

In order to gain a sound perspective on the possibilities and constraints of integrated water management for the upper Niger River, the aforementioned aspects need to be taken into account. This is true for the Inner Niger Delta, as well as for locations in the Upper Basin with large hydrological interventions: the irrigation zone of Office du Niger and the reservoir area at Sélingué. Three types of data are required:

- Hydrological and meteorological data
- Socio-economic data
- Ecological data

Hydrological and meteorological data

The socio-economic and ecological states of floodplains in the Sahel are solely determined by the level of flooding. The level of inundation is determined by the discharge of the river at Ké-Macina, at the entrance of the Delta. The net flow of the river at a particular moment is the balance between supply and discharge of river water. Water loss takes place through evaporation, groundwater recharge, irrigation and impoundment.

For an integrated water balance all sources and sinks (water states) need to be quantitatively defined in a hydrological model. The modelling is carried out by Delft Hydraulics. The hydrological modelling is extended with statistical hydrological analysis (RIZA) and a digital terrain model through remote sensing (RIZA, Danube Delta Institute).

Socio-economic data

The economic prosperity in the Delta and other 'wet' areas of the Sahel is dependent on regional natural resources. Local human populations in these areas – sedentary or nomadic – live on fishing, rice cultivation and cattle breeding. Bird hunting also supplements the staple diet. Over the last decades traditional vegetable-growing has been stimulated greatly, leading to exploitations on a more commercial scale, particularly in the Office du Niger. Next to plenty of water, rice production is reliant on the limited use of fertilisers and insecticides (Bonneval *et al.* 2002), although this is mostly true for the artificially cultivated areas and less so for the Delta itself. The Delta is particularly reliant on the level of inundation (crue), which can vary considerably between years, and is indirectly influenced by water extraction upstream. In irrigated areas such as the Office du Niger and the rice growing area at the reservoir of Sélingué, people are much less reliant on the flooding dynamics and have therefore more security in their food supply.

Data needed cover food production and harvesting (rice, sugar cane, meat, fodder, fish) for each area in relation to hydrology, and – as far as possible – the extent to which local communities are reliant on these food sources. Data-collection was executed by Wetlands International in collaboration with Malian institutions and RIZA-Rijkswaterstaat.

Ecological data

For the ecological component waterbirds – wetland-related biodiversity - have been targeted as an indicator group. The reason for this is that data for waterbirds can be relatively easily and systematically collected. This gives the opportunity to quantify these values. Furthermore, there is a clear link to international nature conservation, considering the importance of the Niger Delta in harbouring sizeable populations of wintering

migratory birds from the Western Palearctic, next to a wealth of resident (afrotropical) species. The ornithological value of the region is correlated strongly with the water management practice of the region. Other ecological features requiring attention include large and highly threatened wildlife species such as the Hippopotamus, Nile Crocodile and West African Manatee.

Ecological data on waterbird populations are collected in qualifying areas. An important logistic constraint was that several areas needed to be covered in a relatively short time span. The Inner Delta alone is of considerable size. Therefore, a systematic monitoring was set up, covering key sites and key habitats. The following information and data were collected:

- Presence of habitat types – quantitatively and qualitatively - in the Inner Delta and in the artificially water managed areas (Office du Niger, Sélingué);
- Ornithological values of the different areas and relation with flooding performance and water states. This concerned Palearctic waterbird numbers as well as Afrotropical breeders (colonial breeding waterbirds);
- Other relevant information on typical faunal elements in the Delta and in the human-made habitats.

Given the enormous study area, only representative areas could be sampled. In addition to bird counts at congregation spots (e.g. colonies and roosts) in qualifying areas, data on bird densities in differing habitat types were collected as well. This allows comparison of the ecological quality between different areas.

1.3. SCOPE OF THIS REPORT

The project period spans 2003-2004. Ahead of the project start several scouting visits to the study area have taken place in 2002, the results of which are incorporated in this report. This report provides a first ecological assessment of the selected study areas. This report primarily focuses on a presentation of the results, while the analyses and interpretation in relation to hydrology and other aspects has been incorporated in the final output of the project (Zwarts *et al.* 2005a-b). The collection of data and their analysis will be maintained during 2004/2005, and extended to an eco-regional approach (Mali, Senegal and Guinea-Bissau) within the framework of a follow-up project (BBI).

Chapter 2 describes the methodology used in this project and a motivation for the choice of the study areas. Subsequently, a short description of the study areas is provided in chapters 3-5, together with occurring habitat types and the general results of the censuses and other relevant data obtained on waterbirds and biodiversity. Chapter 6 shows the results of the waterbird density counts carried out in different habitats and subhabitats, while chapter 7 gives a synthesis of the results so far, with pending ecological appraisal of the study areas. The report ends with conclusions and recommendations for future activities.

1.4. ACKNOWLEDGEMENTS

A&W and Wetlands International wish to acknowledge the support of all Malian and Dutch insitutions and related persons. In Mali this concerns in particular the Ministère de l'Environnement, the DNH, the ODRS and the ON for their support and submission of data. Mr. Guindo (ON-Service Environnemental) and Mr. Sangaré (ODRS-Service

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Inner Niger Delta floodplain, with Vetiveria nigritana *in front.*
Vue de la plaine inondable du Delta Intérieur du Niger, avec Vetiveria nigritana *au premier plan.*

2. METHODS AND DATA

2.1. STUDY AREAS

Upper Niger Basin

The Niger rises in the mountainous areas of Guinea and neighbouring Ivory Coast, and the catchment area comprises two main streams, the Niger – being by far the most important in terms of water supply – and the Bani as a tributary of the Niger. Mopti is situated at the confluence of both streams. The Niger still can be considered largely as a rather natural, untamed river system. This is expressed by a variable rain-driven crue[1], the predominant absence of embankments and the presence of a very extensive floodplain, the Inner Niger Delta. Nevertheless several hydrological interventions occur (among others Diarra & Diallo 2003, Hassane *et al.* 1999, Kuper *et al.* 2001, Orange *et al.* 2002).

Important interventions are for instance the barrage at Sotuba (1929, for power supply Bamako), the barrage at Markala (1947, for the irrigation of Office du Niger) and the Sélingué dam (1981 for power supply Bamako-Koulikoro-Segou). Within the Inner Niger Delta limited embankments are found, for example near Mopti (Opération Riz Mopti) and hydrological control systems in the northern lakes (Lac Horo, Lac Faguibine, Lac Fati). An overview of these hydrological structures is given by Diarra & Diallo (2003).

[1] 'Crue' refers to the rising of the flood between July and December (flood peaks across the Inner Niger Delta late September-December) while 'décrue' refers to the period of dropping water levels (October-April). Timing and time span of 'crue' and 'décrue' as well as period of lowest water levels ('étiage'; March-June) are related to flood volume.

Markala barrage at the downstream side – used for irrigation in the Office du Niger zone.
Barrage de Markala du côté aval – construit afin de pouvoir irriguer la zone de l'Office du Niger.

In the near future the construction of the Talo and Djenné dams in the Bani are planned, whereas there are also existing plans for infrastructures in the upper reaches (Fomi, Guinea) and upstream Gao (Tossaye). Zwarts *et al.* (2005a-b) give more and detailed information on the actual hydrological structures in the Upper Niger Basin and its expected hydrological consequences.

Study areas

The Inner Niger Delta is the core area in this study, given its outstanding ecological importance, its status as a largely uncontrolled floodplain, and as a base for the livelihoods of one million people (Wymenga *et al.* 2002). Other relevant areas in the Upper Niger Basin in the framework of this project are wetlands created through hydrological encroachments in the river system.

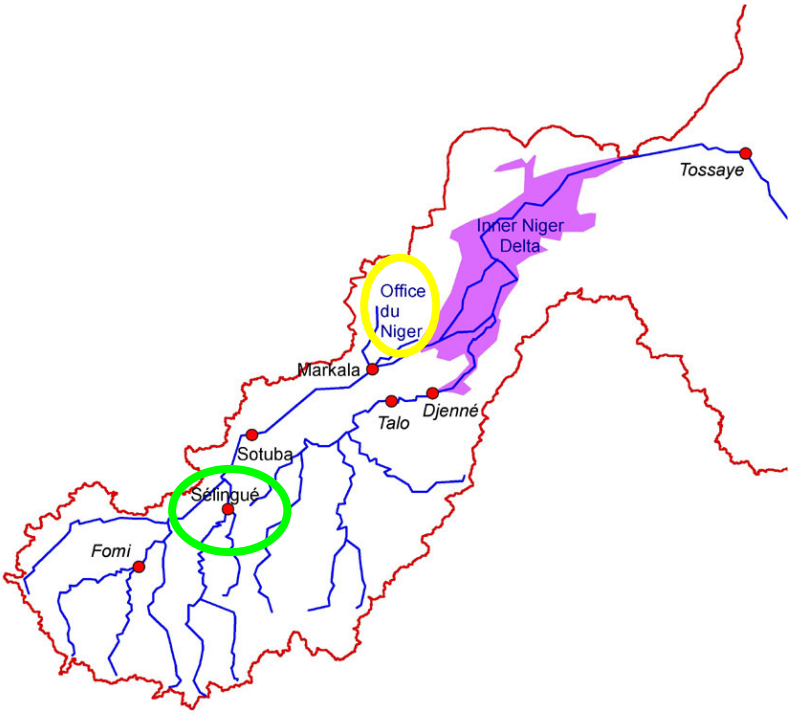

Fig. 2. *Study areas within the Upper Niger Basin: Sélingué lake area (green), the irrigation zone of Office du Niger (yellow), and the Inner Niger Delta (purple; see figure 4-6 for more detail). Also not-existing barrages (in study or planned in near future) are indicated (resp. Fomi, Talo, Djenné, Tossaye).*

Fig. 2. *Zones d'étude dans le Haut Bassin du fleuve Niger: la zone du barrage de Sélingué (vert), la zone irriguée de l'Office du Niger (jaune), et le Delta Intérieur du Niger (violet; cf. Fig. 4-6 pour plus de détail). Les barrages non-existants (phase d'étude ou planifié au proche futur) sont également indiqués: Fomi, Talo, Djenné et Tossaye respectivement).*

Of these the Sélingué reservoir and the Office du Niger irrigation zone were the study areas in the upstream region. In this respect paddy fields and other artificially inundated areas are also considered as wetlands. In the catchment area upstream of the Inner Niger Delta, substantial wetland habitats, in addition to the river bed, occur at both sides of the Sélingué barrage (the water basin, and the rice paddies downstream of the barrage) and in the so-called irrigation zone of the Office du Niger (Bonneval *et al.* 2000, Keita *et al.* 2002). The latter – also called the Delta Mort- is an extensive wetland, consisting of natural falas, irrigated rice paddies (74 km^2) and other wet habitats (Bonneval *et al.* 2002, see chapter 4). Besides these two major areas wetland habitats are nearly absent apart from the river bed, some smaller-scale paddy field polders and temporary, rain-fed wetlands (small lakes – mares). Summarizing, the three major wetlands have therefore been chosen as areas for comparative study (Fig. 2):

- *Inner Niger Delta* between Ké-Macina and Tombouctou, including the peripheral lakes in the north;
- *Irrigation zone of the Office du Niger* (Delta Mort) comprising irrigated rice paddies as well as (semi-)natural habitats;
- *Sélingué area*: barrage lake and adjoining rice polder.

2.2. HABITAT CHARACTERIZATION

The term habitat refers in this study to vegetation units, comprising one or more vegetation communities. Several habitat types are encountered in the study areas, though the variation is relatively limited. In the Inner Delta this is caused by the rather extreme environment: during the crue the Delta is completely flooded with a varying water level (up to 5 m) while desert-like conditions prevail during the dry season. Only a limited set of species is adapted to this highly dynamic environment. Moreover, there is a heavy human pressure (heavy grazing, forest cutting).

Within this project we focused in particular on the extent of wetland habitats, in the Inner Delta as well as in the human-made areas under hydrological control. Detailed mapping of vegetation habitats was not possible in the framework of this project. Since topographical maps only provide limited information we used remote sensing techniques for the Inner Delta to determine different habitats in this extensive area. To select suitable satellite images for remote sensing, quicklooks with low cloud coverage were selected (www.npoc.nl, www.glovis.com, Fig. 3) and combined as far as possible with available water levels (see Zwarts & Diallo 2002). The results of this remote sensing work are exentisvely reported by Zwarts *et al.* (2005a-b and appendices). The remote sensing work was a joint effort of RIZA, Danube Delta National Institute (DDNI, Tulcea Romania) and A&W. In this report only the summarised results are mentioned.

The artificial wetland areas were not mapped in detail, but the surface area of the major habitats was calculated. For the irrigation zone of the Office du Niger a satellite image was used in combination with existing maps (Bonneval *et al.* 2002). For the Sélingué area quicklooks of satelite images and already available topographical maps were sufficient to make a good estimate of the surface area of wetland habitats for the purpose of this project. In both areas field data were used as additional information.

In the Inner Niger Delta field data formed an important input for remote sensing (training sites, ground thruthing). Homogeneous areas of a specific habitat – *bourgou fields, rice paddies,* Acacia kirkii *flood forests* – were selected and measured with gps. Normally training sites of about 1 ha were chosen, as these were large enough to cover more than one pixel on the satellite image.

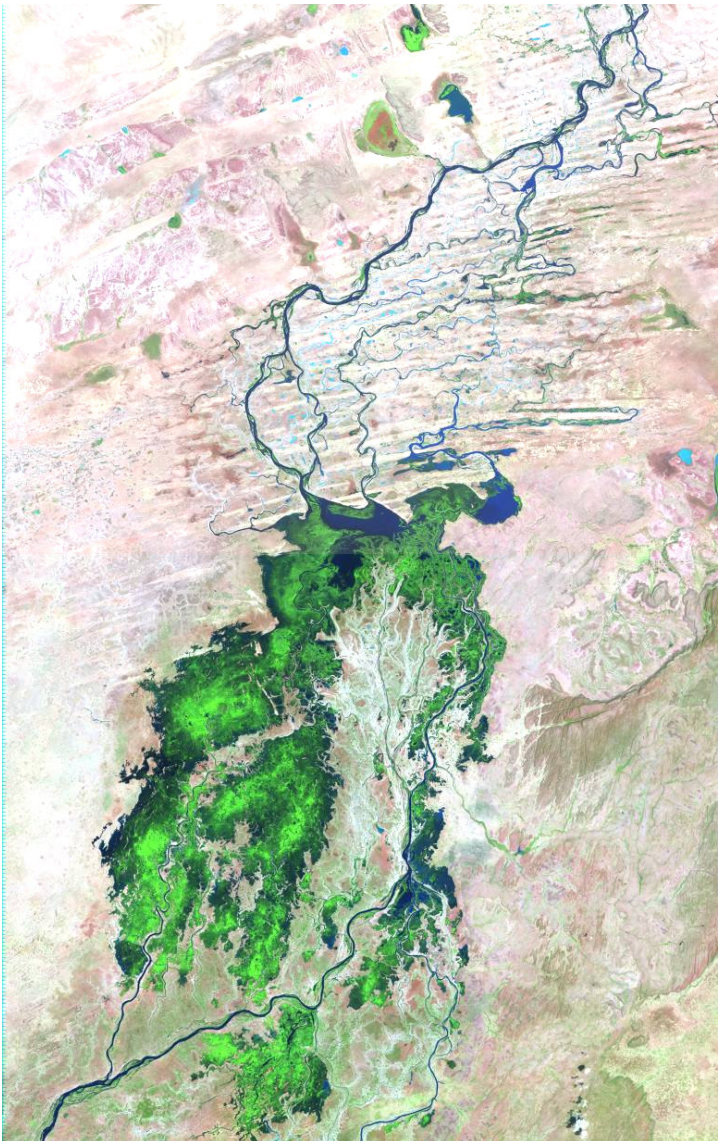

Fig. 3. *Example of two combined quicklooks of the Inner Delta (19 October 2002, path 197 row 49 & 50, www.npoc.nl - NASA). At the top of the image one can distinguish the northern lakes and in the central part the Debo complex. This quicklook shows the 'crue' situation, when water is rising. The water level at this date was 395 cm in Akka (Debo complex).*
Fig. 3. Exemple de deux images 'quicklook' composés du Delta Intérieur (19 octobre 2002, path 197 row 49 & 50, www.npoc.nl – NASA). Sont montrés les lacs périphériques du nord, le complexe Debo (centre de l'image) et la plaine inondée en amont de ce complexe. Ce 'quicklook' présente la situation de crue; le niveau d'eau à Akka (Lac Debo) fut de 395 cm à la date de cette image.

2.3. WATERBIRD CENSUSES

As indicator of the ecological value of the study areas we chose to measure the ornithological value. Though the species composition and numbers of birds represent only a part of the total ecological value of the study areas involved, this choice is motivated as follows. First, it is known that the floodplains of the Inner Delta are of paramount international value (Wymenga *et al.* 2002). Second, the focus on bird data allows for continuation of preceding efforts, and thereby extending the current monitoring series (van der Kamp *et al.* 2002a-b). Third, the systematic gathering of data gives the opportunity to quantify differences and values. Last but not least, birds are recognised by local inhabitants as of ecological value and also allow for involvement of counterparts of different national institutes, whereas other species groups are often only known to and can only be covered by specialists.

Counting periods

In the available project period a limited number of counts in the three study areas could be performed. It was important to select the periods providing the most relevant results. For the Inner Niger Delta these periods can be determined on the basis of long-term monitoring of the Debo-complex (i.e. van der Kamp *et al.* 2002a, Diallo *et al.* 2003). In general these data also give insight in the dynamics of the waterbird populations in wetlands in the Sahel. Based on these data, the following periods are most suitable for monitoring:

June – July

Period with lowest water levels in the Inner Delta (*étiage*), when concentrations of Afrotropical waterbirds concentrate in the remaining wet areas as well as Palearctic populations which stay the northern summer in Africa (predominantly subadult birds). It is of particular interest to get insight in the number of waterbirds in wetland habitats ouside the Delta during this critical period.

Dec – Jan

Normally in January the international African Waterfowl Census takes place and in this framework the Debo-area in the Inner Delta is counted in January. Before January the water levels in the Delta are relatively high, which means that waterbirds which frequent shallow habitats or areas with receding water lines (mudflats) have to be elsewhere, for instance on the margins where water recedes already, or in other wetlands. Therefore also December is potentially an important moment to census waterbirds in the Delta Mort and the Sélingué area.

Febr – March

During the décrue waterbirds concentrate in the Debo complex in the Inner Delta, especially when the water level in Akka (at Lac Debo´s lakeshore) drops below 200 cm (relative to the

Akka gauge). In most -recent- years this is in the course of February-early March. Concentrating waterbirds concern Afrotropical as well as Palearctic waterbirds, the latter preparing for migration. Because of this contraction, the situation in the other wetlands is worthwhile to be monitored as well, in order to assess potential links in numbers and distribution.

Focal areas

In all three study areas general counts have been carried out. Within the Inner Delta the counts concentrated on the central part, consisting of Lac Debo, Walado Debo and Lac Korientzé. This Debo-Korientzé area is part of the Inner Delta monitoring system, with key counts in January-February and June (see above). This area plays a key role in the Inner Delta given its position in the low-lying central part in the delta with banks which are rich in benthic fauna. Since information on the northern lakes is very scarce, apart from a series of aerial counts, additional data on these lakes have been gathered for this project via terrestrial counts in early March 2003 and 2004.

The irrigation zone of the Office du Niger has been counted in December, February and July, whereas an aerial survey in late June 2002 gave a first impression of the state and extent of the fala-paddy field zone, its woodlands and its related waterbird biodiversity. In June 2004 we carried out a special Fala ground survey, with counting and observation points and transects in three major falas: Boky-Wéré, Molodo and Kouroumari.

Waterbird counts in the Sélingué area were carried out upstream and downstream the barrage: on the lake and in the paddy field area. In June 2002 a preliminary survey took place, whereas the December, February and June-July counts give the results of systematic overall counts. Table 1 reviews all counts carried out between June 2002 and June 2004, with counting areas/sites and count types mentioned.

Table 1. *Waterbird counts executed from June 2002-2004. In June 2002 an aerial census took place in the framework of the PIN-project (Wymenga et al. 2002). This gave the opportunity for a quick scan of the Delta Mort, providing information included in this study. For methods of counting, see Diallo et al. (2003). Kor = Zone Korientzé, G Est = Gourao-est, DOEA = African Waterbird Census.*

Tableau 1. Aperçu des comptages d'oiseaux d'eau exécutés entre juin 2002 et juin 2004. En juin 2002 un recensement aérien a été effectué dans le cadre du projet PIN (Wymenga et al 2002). Cela a permis une impression générale du Delta Mort, plus des informations incluses dans cette étude. Pour méthodes de comptage v. Diallo et al (2003). DOEA = Dénombrements d'Oiseaux d'Eau en Afrique.

Date (dd-mm-yy)	Zone/site	Habitat	General	Density	terrestrial	aerial	Remarks
17-22 06 02	Debo-Kor	Lakeshore	O		O		
24 06 02	Delta Mort	Fala/rice fields	O			O	Survey
24/25 06 02	Inner Delta	Dried marsh	O			O	
11 06 02	Sélingué	Rice fields	O		O		Survey
12 06 02	Sélingué	Lake	O		O		
18-19 12 02	Delta Mort	Rice fields	O		O		
21,23 12 02	Sélingué	Rice fields	O	O	O		
22 12 02	Sélingué	Lake	O		O		
10-14 01 03	Debo	Marsh-lake	O	O	O		DOEA
02-08 02 03	Debo-Kor	Lakeshore	O	O	O		
15-19 02 03	Delta Mort	Rice fields	O	O	O		
21-22 02 03	Sélingué	Rice fields	O	O	O		
23 02 03	Sélingué	Lake	O		O		
03-08 03 03	Inner Delta-N	Marsh-lake	O	O	O		
17-22 06 03	Debo-Kor (G Est)	Lakeshore	O		O		
04-07 07 03	Delta Mort	Rice fields	O	O	O		
09-10 07 03	Sélingué	Rice fields	O	O	O		
11 07 03	Sélingué	Lake	O		O		
09-13 12 03	Delta Mort	Rice fields	O	O	O		
15-16 12 03	Sélingué	Rice fields	O	O	O		
17 12 03	Sélingué	Lake	O		O		
14-18 02 04	Delta Mort	Rice fields	O	O	O		
20 02 04	Sélingué	Rice fields	O	O	O		
21-22 02 04	Sélingué	Lake	O		O		
25-29 02 04	Debo-Kor (G Est)	Lakeshore	O	O	O		DOEA
05-07 03 04	Inner Delta-N	Marsh-lake	O	O	O		
11-17 06 04	Debo-Kor (G Est)	Lakeshore	O		O		
21-23 06 04	Sélingué	Lake	O		O		
25-30 06 04	Delta Mort	Fala	O		O		

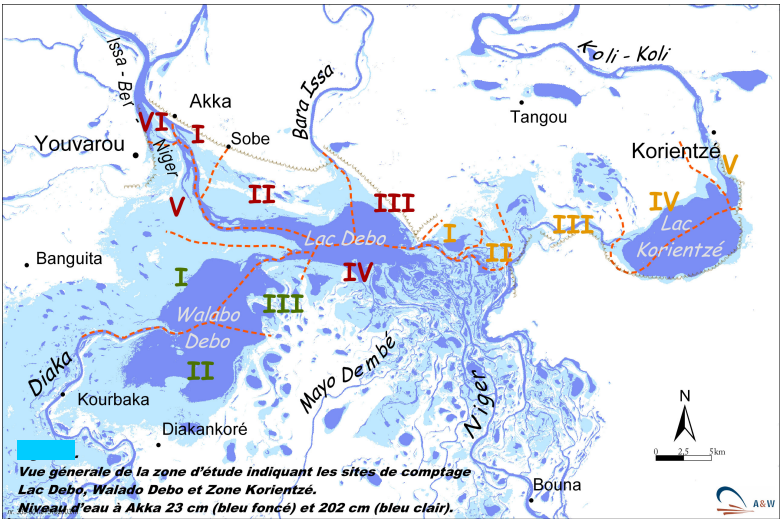

Fig. 4. *Counting zones in the Debo-Korientzé zone in the Inner Niger Delta (for counting trajects see Wymenga et al. 2002).*
Fig. 4. Sites de comptage dans la zone Debo-Korientzé du Delta *Intérieur (pour les détails des tronçons v. Wymenga* et al *2002).*

General counts

In the Inner Delta waterbird monitoring counts in Debo-Korientzé have been carried out as in 1998-2002 (i.e. van der Kamp & Zwarts 1998, van der Kamp & Diallo 2000, Wymenga *et al.* 2002). At receding water levels a standard track initially followed by boat was increasingly covered on foot along the emerging lakeshores. The area is divided in several counting zones (Fig. 4).

As 2002-2003 turned out to be a poor flood season (max. 411 cm, Debo gauge in Akka), only the January count was entirely done by boat, and February's partly on foot. The June counts have been done, as usual, on foot. All five transects of the

Korientzé area have only been covered in June 2002. Gourao-est (I) has been the only site counted since; at receding water levels many birds (terns in particular) use this site as a roost after feeding on Lac Debo.

The investigated northern lakes have partly been covered, in early March. In 2003 counts were done from two observation points (fishermen's settlements Bototo and Kaoua on the eastern shore) and along two boat tracks starting from these settlements in Lac Horo. In Lac Télé waterbirds were counted from the southern and eastern shore, and along a short boat track (3-500 m) from the mouth of the Niger supply channel towards the lake centre; in Goundam, Night Herons *Nycticorax nycticorax* spending the day on high trees along this channel were also counted. In 2004 avian biodiversity was assessed on stretches of lakeshore all around Télé, in this year the only surveyed northern lake, where we focused on waterbird density counts though.

Paddy field counts in the Office du Niger (ON) and Sélingué irrigation zones were systematically done from a number of observation points, in different sub-habitats:

- Open (Diabaly, Macina – both ON)
- Open with weeds on surrounding dikes and/or in channels (Molodo, Niono, Sélingué)
- Rice areas with small patchwork-like plots, in Baobab-trees landscape (Siribala - ON)

In the Sélinkegny Lake waterbirds have been counted at high, but already decreasing lake levels in December and February, and at its lowest level in June 2004, from a boat belonging to the ODRS (Office de Développement Rural de Sélingué), our partner in the area since the start of this project. In June 2002, 2003 and 2004 counts were also carried out on foot, along the low-water lakeshores of the widest part of the lake just upstream the dam; in

2002 only the eastside was covered, in 2003 and 2004 the east and westside.

Detailed density counts

The approach of general counts of waterbirds in focal areas results in a good impression of their international importance whereas sites with large concentrations of waterbirds can be identified. However, this method does not cover the entire Delta and is in particular suitable for birds which are gregarious and do not conceal themselves in densely-vegetated habitats. Non-gregarious and diffusely distributed birds are easily underestimated in the general counts (e.g. Wood Sandpiper *Tringa glareola*, rails, passerines). Therefore, from 2002 onwards additional bird density counts were performed (representative sampling of different vegetation types).

An assessment of bird densities per vegetation type – by which units of homogeneous vegetation types are counted – gives the opportunity to determine the significance of different vegetation types and make an estimation of the total bird population in the Delta. Although this method does not cover all birds nor meets all constraints mentioned above, it is a systematic way to link these data to habitat availability.

Density counts in the Inner Delta have been carried out in the ORM zone around Mopti, along the Bani River (November and December 2003), in Lac Debo, Walado Debo and along the Diaka (January and February 2003, 2004), and in Lac Télé and Lac Horo (early March 2003, 2004).

Counting birds in the Office du Niger irrigation zone. Canals and ditches create linear structures of invasive Typha vegetation.
Comptage d'oiseaux dans la zone de l'Office du Niger. Les canalisations créent des structures linéaires d'une typhaie envahissante.

Density counts in the paddy field area of the irrigation zone of Office du Niger took place in February 2003, 2004, June 2003, 2004 and December 2002, 2003. Five different areas have been investigated: Diabaly, Niono, Molodo, Siribala and Kolongotomo. Detailed counts in the Sélingué area (December 2002, 2003, February 2003, 2004, and June 2003, were restricted to the paddy field area, but the general lake counts were also expected to provide some density data (see Chapter 6). Density counts were carried out as in the Delta Mort.

Counting method

Determining densities of waterbirds requires a strictly systematic approach. In the first place the surface area which is counted has to be exactly known. This can either be measured by gps on the basis of a detailed and correct map, or with a range-finder

(binoculars with laser-beam telemeter). Secondly, all birds have to be counted. Density counts from a single observation point are considered resulting in under-recorded smaller species (as shown by the different counting methods, see Chapter 6) whereas well-searched habitat units are expected to give more reliable overall results. All species which have not exactly been counted must be omitted in future analyses. These strict rules are needed, since in the analysis the sampled plots (each count of a plot can be considered as a separate sample) have to be representative for the sampled habitat. This also gives a third demand: of all habitats which are analysed sufficient data (number of sampled plots) have to be gathered. Sufficient in this respect means: sufficient to calculate a statistically reliable mean density.

The number of samples needed depends statistically on the standard deviation, or in other terms, on the variation in the distribution of birds. For bird species which show a homogeneous distribution relatively few plots are needed to calculate a statistically reliable mean density, while for species with a scattered distribution a lot of sampled plots are needed.

Counting technique was basically standard, using a range-finder to assess surface areas of plots counted. Counts were done from 1) one point in a circle or part of a circle (using range-finder), or 2) in rectangular areas (rice paddies) by walking around (Fig. 5). Counted areas were, on average, less than 0,5 ha in paddy fields but this average more than tripled in the IND: some 3 ha for wild rice and more than 5 ha for bourgou. Observation modes and methods varied too, from steady -terrestrial- to less stable -boat-points, and from fixed-point to crossed-plot assessments. Plots have been randomly selected, in different habitats: bourgou, rice field, wild rice (IND) and paddy field (DM and Sélingué).

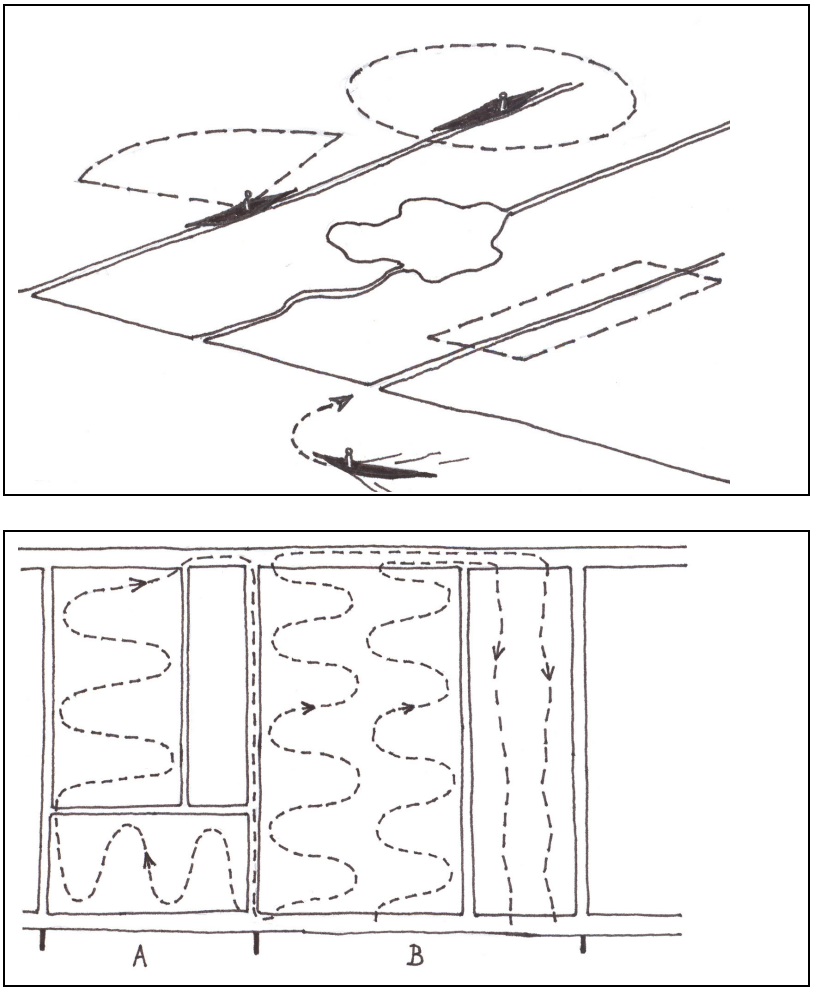

Fig. 5. *Schematic views of density count practice in the Upper Niger Basin. Upper panel: counting densities in floating vegetations (bourgou etc.) from a boat in the Inner Delta. Lower panel: counts on foot in rice paddies (Sélingué and Office du Niger) and other, non-geometrical wetland habitats.*

Fig. 5. Schématisation de la pratique des comptages de densité dans le Haut Bassin du Niger. Panneau supérieur: Delta Intérieur, à partir d'une pirogue dans des végétations flottantes (bourgou, nénuphars, etc.). En bas: rizières (notamment celles des zones de l'Office du Niger et de Sélingué), et autres habitats humides (non-géométriques).

As stated before for stratified plot sampling, the exact size of plots had to be known and all birds present had to be recorded. Length and width of plots were measured with a range-finder, or calculated from GPS-markings at the corners of plots (both methods checked, in case of reasonable doubt, by counting steps - if possible- in the field).

Density count practices were as follows, for natural vegetations and paddy fields: Plot sampling in *bourgou and other emerging vegetation* have been done in the Inner Delta in Lac Debo, Walado Debo, Lac Horo and Lac Télé. In nearly all cases boats were used (water depth > 80 cm), from which a variety of sectors and sometimes whole circles were counted. At lower water levels plots –circles, their sectors, rectangles- were crossed on foot.

The census method followed in the *paddy fields* has been similar to the way densities were assessed in the Inner Delta. Within the focal areas a number of clustered plots were selected at random. Waterbird and wetland-related species were then accurately counted from the surrounding dikes in case of well-flooded or recently harvested plots, or by wading and walking through either the bigger plots or plots with dense weeds and/or regrown rice (except stands of dense rice to be harvested, where we clapped hands and yelled). See Figure 5.

Each plot was given a code for habitat and its state (unaffected, grazed, crop phase, etc), water depth and coverage, vegetation

cover and height, whereas count date, locality and established plot surface were also noted, on field forms.

The census method was based on the assumption that all birds in the plots would be recorded. To meet this criterion, several techniques were used, all of which were accompanied by shouting, hand-clapping and throwing mud into the vegetation to assure that all birds were flushed and recorded. This was achieved by (a) walking parallel transects by 2 or 3 persons with between-person distances of 20-50 m (depending on vegetation density/height, to assure full coverage), (b) crisscrossing a plot by one observer with or without a second observer watching from the side and keeping note of birds, (c) encircling small plots and flush birds with noise and throwing mud, and (d) boating transects in water deeper than about 80 cm, using observation belts of varying width (20->100 m) for the various bird species (clearly -in circles and sectors as well- a Great Egret can still be spotted when >100 m away, but for Sedge Warbler a narrower belt had to be used).

While plot-sampling, a keen eye was also kept on neighbouring fields because flushing birds was hardly ever confined to the plot at hand. In order to reliably count birds in the near-distance, it was necessary to keep track of birds which had already been flushed some time before. This was rather easy, as the Inner Delta constitutes a flat environment with wide vistas. When a particular area had been thoroughly counted by the counting team(s), hundreds of meters were silently passed without counting, to resume plot-sampling in an area where all birds were still present.

Materials

Telescopes (15/40*60 and 20/60*70) and binoculars (8*40, 7*50, 10*25) have been used for the above-mentioned general counts. Means of transport were a WI four-wheel drive car, and boats from WI, ODRS and local fishermen. The aerial count has been executed with a shoulder-winged Cessna 172.

For the density counts, special binoculars (7*42) with the ability to measure distances by laser-beam have been used to be able to define the radius of a (circle)sector, or the lengths and widths of rice-plots. Densities could then be calculated from these defined areas. This so-called range-finder could also be used to identify species and make sure that they occurred within the selected sites. When wading through sectors one person standing in the centre of the circle involved held the range-finder while guiding the other within the sector.

3. INNER NIGER DELTA

3.1. SHORT CHARACTERIZATION

General description

The Inner Niger Delta in Mali is one of the largest floodplains in Africa, intensively used by local populations for their subsistence. Rising in the mountainous regions in Guinea, the river Niger flows through Mali, forming an immense delta between Ké Macina and Tombouctou. Though local rainfall is concentrated mainly in July and August, the maximum of the flood is usually reached in October-December, depending on the height of the flood. The water discharge of the Niger is subject to a large annual fluctuation and as a consequence the inundated area varies also: in the last century the inundated area varied between 9,500 km² in 1984 and 44,000 km² in 1957. Recent series of severe drought years occurred in the 1970s, 1980s and early 1990s. From earlier studies it is known that the production of fish – the main protein source for the local populations – is strongly related to the inundated surface area. The means of subsistence for local populations thus depends heavily on the height of the flood: water rules life in a real sense (Zwarts *et al.* 2005).

Remote sensing data show that consecutive series of lower and higher floods lead to a shift in the zoning of the vegetation (Zwarts & Diallo 2002). Also, local people tend to shift their rice cultures to more suitable places during long periods of drought. Flood forests, which still remained in the lower parts of the Delta, were cleared for rice cultivation, thereby eliminating roosts of granivorous birds.

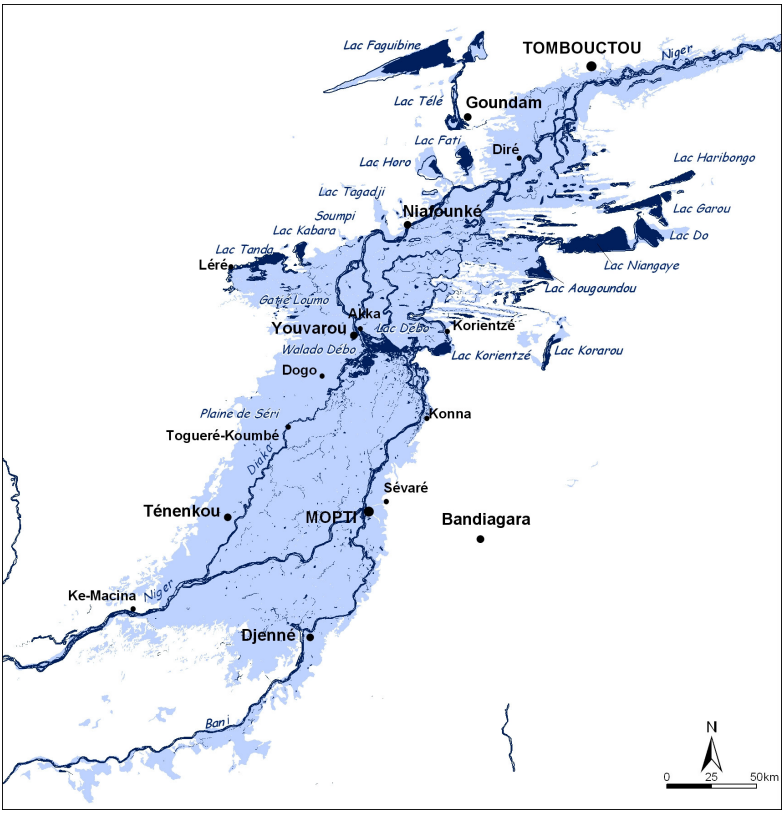

Fig. 6. *Inner Niger Delta with the Debo complex (Lac Debo, Walado Debo and Zone Korientzé) and the lakes (dark blue) in the north. The light blue shows the maximum inundation zone (Zwarts et al. 2005).*
Fig. 6. Delta Intérieur avec -en bleu foncé- les lacs du centre (Lac Debo, Walado Debo, Lac Korientzé) et du nord, sur une assise bleu clair marquant la zone inondée maximale (Zwarts et al. 2005).

Socio-economic organisation

The Delta is inhabited by more than one million people living partly (semi)nomadic and partly in the larger settlements. For a more detailed description of the socio-economic organisation of

the Delta see, for example, Moorehead (1991) and Wymenga *et al.* (2002). Here only a few characteristics are mentioned.

In the course of the centuries a complex system of land use and management of natural resources (the Dina law) has been developed in the Delta, in which different ethnic groups are involved as herdsmen and fishermen. Up to now, this traditional system has played an important role in controlling the use of natural resources by the local communities. Together with the decentralisation policy of the Malian government, this means that local communities are highly involved in the management and use of natural resources in the Delta.

Wetlands International works together with 28 villages in the Delta (Kone 2002). In all these villages natural resources are used more or less intensively. Basically, this includes rice cultivation, grazing, fishing and waterbird exploitation. Each specific resource or all the resources belonging to a particular territory have their own controllers, according to traditional management principles. These principles are still respected, though land tenure conflicts are not uncommon. The decentralization policy of the Malian government has recently improved the local situation and supports the local communities in managing their own natural resources. In the case of the still existing flood forests of Akkagoun and Dentaka, the surrounding villages are involved in conservation and sustainable use of these forests through participation in management projects initiated by the IUCN (1989).

Impression of the landscape in the northern Delta with dichotomous Doum Palm Hyphaene thebaïca *(upper panel), and aquatic vegetations in Lac Horo (a. o. Polygonum spec. – 'Kouma').*

Page 36 : Paysage à Palmiers Doum Hyphaene thebaïca *dans le nord du Delta Intérieur (image supérieur) où se situe Lac Horo (en bas), avec des végétations aquatiques ; sont montrés 'Kouma' Polygonum spec. au premier plan, et un 'îlot' de 'Loubou' dans un champ de* Potamogeton spec.

3.2. MAJOR VEGETATION TYPES

General introduction

The Inner Niger Delta consists of two major parts: the southern and the northern delta. Lac Debo and Walado Debo are positioned in between and can be seen as the the northern limit of the southern floodplain being as good as totally flooded at highest water levels (Fig. 3 and 6).

The Debo complex includes huge areas of floating *Gramineae* - local name: 'bourgoutières'- consisting of *Echinochloa stagnina* ('bourgou') and *Vossia cuspidata* ('didéré') in its deepest parts (4-5 m). Succession towards shallower water shows other, more varied plant communities in which bourgou and didéré gradually disappear; interspersed water-lily beds *Nymphea spec.* appear and wild rice *Oryza longistaminata* becomes dominant, followed by species like *Vetiveria spec.* and *Cynodon dactylon* in the fringes of the inundation and on levees. At lowest water levels (< 1 m, Lac Debo gauge, Akka) *Cyperus articulatus* reappears from rhizome mats in emerging river banks, but hardly reaches its full-grown stage due to cattle grazing. *Cyperus* fields can cover substantial surfaces in areas with weak slopes, like in Lac Debo (see also Wymenga *et al* 2002).

The southen part of the Delta -the 'marsh delta'- is a very open floodplain with almost no forests, trees or shrub, which can be attributed to heavy grazing (and cutting in the past). Low-lying

Mimosa pigra shrub can be found on levees. Only a few flood forests remain and a number of scattered remnants of former flood forests (van der Kamp *et al.* 2002b, Beintema *et al.* 2002). Such remnants are important areas and have high potential for regeneration of flood forests, particularly in the Pora region, near Aman Nangou, Bouna and Gourao.
The delta north of the central Debo complex is characterised by parallel dune formations of ancient eolic origin (the so-called *Erg de Niafounké*; see Fig. 3 for an impression), with characteristic Doum Palm *Hyphaene thebaïca*, floodable areas in between and a number of lakes in its peripheral zone. The investigated northern lakes (Télé and Horo) are covered by huge stretches of aquatic vegetation; the other lakes on the west- and eastbank have far less and often patchy vegetation.

Unlike most of the west bank lakes where water levels are being controlled by sluices, Lac Télé is an unaffected part of the delta where incoming flood water also fills Lac Faguibine further downstream (cf. Fig. 6). However, when floods recede, water does not flow back to the Niger due to the natural slope towards Faguibine (Kuper *et al.* 2000). In March 2003 Télé was covered by large extents of waterlilies *Nymphea spec.* in its deeper parts where the initial growing stage of bourgou-like *Gramineae*, now restricted to the peripheral inundation zone, perished in a single devastating downpour during the preceding rainy season. More than 200 mm of rain (never recorded before) filled the lake rapidly with some meters of water, not only drowning the regrowing water vegetation but also the local sorghum culture. Moreover, about a thousand houses were said to have been destroyed. Contrastingly, the March 2004 situation showed a uniform-looking *Gramineae* vegetation throughout the lake, with prevailing *Echinochloa stagnina* in the deeper parts and fringing Horia horia and/or Garsa (local sonraï names for less deep-standing bourgou-like grasses) zones. Smaller *Nymphea* species

were still -though inconspicuously among the grassy vegetation- present, but *Nymphea lotus* fields like in 2003 were not seen.

Lac Horo represents one of the lakes where water is controlled by a dam which has substantially modified its natural flooding. Water is admitted later, whilst staying longer than normal. Satellite imagery shows the lake greatly covered by water vegetation (cf. Fig 3). During our stay we investigated the eastern part of the lake, where aquatic vegetation basically consisted of large extents of -repectively- *Potamogeton spec.* (local name: 'mounya'), *Nymphaea spec.*, 'Loubou' and 'Kouma' *Polygonum spec.*, in a 40-150 cm depth range. Open water occurred from lakeshore to some 40 cm deep, whereas the adjoining *Potamogeton* area, with mainly submerged vegetation, gave an open water impression as well.

Surface area of habitats

With the aid of remote sensing technique Zwarts *et al.* (2005b) calculated the surface area of a number of major vegetation types of the lower inundation zone of the Inner Delta. In this report a summary of the results on surface areas is given (Table 2). It is important to realise, that the surface area of wetland habitats in the Inner Delta is completely depending on flood performance. This means that surface areas for major wetland habitats can only be given in relation to the height of the flood.

Table 2 shows that wild rice and bourgou-vegetation are most abundant in the lower inundation zone, while also an area of more than 1.000 km^2 consists of low-lying grasslands. These are mainly concentrated in the areas around Lac Debo and Walado Debo. Besides the vegetation types in Table 2 other vegetation communities occur, like Vetiveria-fields, *Mimosa pigra* shrub and drier habitats on the higher and more sandy river banks. These are mostly present in smaller areas along the river or gullies.

***Table 2**. Surface area (km²) of major vegetation types in the Inner Niger Delta in the lower inundation zone (<360 cm Akka gauge) in February 2003. From Zwarts* et al. *(2005b). The surface area of flood forests is from Wymenga* et al. *(2002).*
Tableau 2. Superficie (km2) des principales végétations de la basse zone inondable du Delta Intérieur (<360 cm échelle Akka, Lac Debo), en février 2003. Données Zwarts et al. *(2005); pour* Acacia kirkii *-forêts inondables- cf. Wymenga* et al. *(2002).*

Major vegetation type	Surface area (km²)
Inundated surface area at 360 cm at Akka	11,000
Typical floodplain habitats	
Cultivated rice	1,040
Wild rice fields – *Oryzaies*	1,260
Wild rice & waterlily fields (*Nénuphars*)	173
Bourgou & Didéré	1,039
Bourgou, Didéré & waterlily	504
Low-lying *Cyperus*-grasslands	1,105
Flood forests of *Acacia kirkii*	> 500 ha

Major vegetation types as habitats for waterbirds

Major vegetation types act as important habitats for waterbirds. The habitats which have potential for bird density assessments are listed and described hereafter (see also Chapter 6). On the scale of the Delta they represent substantial expanses of vegetation or open areas like mudflats, and are therefore suitable for extrapolation models.

Open water and sandy mudflats

Aquatic vegetation is seemingly lacking in the Niger River and its branches, probably caused by the force of the river flow and poor water transparency. Open water is also found in the deeper parts of the big lakes, although these are often bordered by wetland-related vegetation like bourgou (see next). However, at receding

water levels huge stretches of sandy and muddy substrates emerge, in the Niger riverbed and particularly in the lake areas - i.e. Lac Debo, Walado Debo, Lac Korientzé- with their weak slopes. These lakes are situated in the low-lying central Delta with the longest annual flood duration. Sand- and mudflats may contain high mollusc concentrations whereas in suitable areas vegetation cover develops; in the lowest parts *Cyperus articulatus* dominates with adjoining sparse vegetation of short-cycled (3-4 weeks) annuals.

Bourgou and Didéré

Bourgou fields are located in the deeper areas of the inundation zone, and occur in 2-5 m water depth. The inundation period may span up to 6-7 months. Characteristic plant species are Bourgou *Echinochloa stagnina* and Didéré *Vossia cuspidata*; having similar features Didéré is considered, however, an invasive species growing slightly higher up in the area. Their emerging foliage can be very dense, resulting in 50-100 % coverage. Other species seen in this zone are *Utricularia inflexa* and *U. reflexa* occurring very locally. Under eutrophic conditions (i.e. near villages and waterbird colonies) Water Salad/Lettuce *Pistia stratiotes* may develop; a satellite image of the Debo complex -November 1999- gives a neat example of its occurrence in the Dentaka flood forest (see Wymenga *et al.* 2002).

At the onset of the rainy season the bourgou starts to grow on moist soil, and keeps doing so in the upcoming river flood later on. Plant growth is able to follow floods up to some 5 m high, whilst reaching as much as 25 tons dry matter per hectare, including a contribution by sustained mowing (Hiernaux & Diarra 1982). By the end of the flood period bourgou is harvested and grazed; its nutritious qualities for cattle are more and more recognized, which has led to several 'bourgou crop' initiatives over

the past decades. Didéré is also harvested but its nutritious value is substantially lower.

Waterlily ponds

On average waterlily fields are being encountered in less deep water than bourgou; Quensière (1994) mentions 1,2-1,8 m at maximum flood level, with some five months of inundation. They are dominated by *Nymphaea* species, rooted hydrophytes with floating leaves. In Walado Debo's clear water *Nymphoides indica* and *N. ezannoi* are mostly seen, whereas *Nymphaea lotus*, *Neptunia oleracea* and waterplants with submerged leaves like *Ceratophyllum spec.*, *Utricularia inflexa* en *U. reflexa* may also be noted. Gallais (1967) states that waterlily fields are formed in open areas within bourgou fields in relatively shallow water. Large stretches of waterlilies are found in Walado Debo and elsewhere in the marsh delta, but also in some northern lakes (Horo, Télé). Waterlily ponds are used for agriculture and fisheries during the dry season, whilst waterlily tubers for human consumption are collected too. In Lac Télé these tubers (of *Nymphaea lotus* in particular) were massively harvested and traded on the local market in early 2003, after unexpectedly abundant rainfall in the preceding rainy season (see page 39).

Rice fields

Wild rice *Oryza longistaminata* may serve as food for the local populations in case of cultivated rice shortage. Inundations in this zone do not exceed 2 m nor last longer than 3 months (Quensière 1994). Wild rice shows often huge areas of dense vegetation, but in this apparent 'monoculture' are also observed some other species like *Acroceras amplectens*, *Panicum subalbidum*, *Vetiveria nigritana* and *Caperonia palustris*. This is probably due to the shorter inundation period compared to practically monospecific bourgou.

The wild rice zone is often exploited as an area for cultivated rice crops, with *Oryza sativa* and *O. glaberrima* ('riz flottant'). Mopti, Tenenkou and Timbuctoo have their own rice polders, secluded parts of the Inner Delta where water is partly controlled. Rice crops elsewhere in the Inner Delta comprise relatively modest expanses in traditional paddy field areas around villages.

Vetiveria fields

On higher grounds in the delta like sandy elevations, pond margins and delta fringes, vegetation comprises *Vetiveria nigritana*, a reed-like grass growing in tufts, and interspersed wild rice. Hiernaux (1982) mentions three types of Vetiveria fields (low, intermediate and high standing) with corresponding inundation periods and water depths. Vetiveria in relatively deep water -flooding period 4-5 months, depth at flood peak 0.6-1.5 m- can be accompanied a.o. by *Eragrostis barterti*, highstanding *Vetiveria* by *Andropogon gayanus* and *Panicum anabaptistum* (irregular inundations), whereas *Hyparrhenia rufa* occupies an intermediate position.

Key species in the *Vetiveria* zone are *Vetiveria nigritana* and *Mimosa pigra*, wild rice being encountered through the whole *Vetiveria* depth range and beyond (see above). *Cynodon dactylon* et *Brachiaria mutica* are characteristic for the inundation fringes.

Acacia kirkii flood forests

In the past *Acacia kirkii* flood forests were characteristic for the floodplains of the Inner Delta. Another tree species occurring in this zone is *Ziziphus amphibius*. Vegetation varies widely in this area, from open spaces to thick cover. At high flood levels the emerging forest canopy forms an impenetrable tangle, most favourable to waterbird roosts and breeding colonies. Without human interventions *Mimosa pigra* may fringe the forest in more open areas with other aquatic vegetation (Didéré, wild rice, etc.).

Our own observations show the forest's capacity to stand in 2-3 m of water at the peak of the flood (Akka gauge 500 cm).

Half a century ago the Inner Delta held more than 20 flood forests. Overexploitation in these forests and long periods of drought since the 1970s (firewood collection and clearance for rice crops a.o.) have led to the disappearance of the majority of these forests. Drought driven clearance for rice cultivation was a dramatic decision, the more so as these crops turned out to give very low yields. Skinner *et al.* (1987) found six forests left, each holding a waterbird breeding colonie. Quensière (1994) mentions four intact forests, and in 1998-2001 only two substantial flood forests -Akkagoun and Dentaka- with breeding colonies existed (Wymenga *et al* 2002). The other forests are history, or too small and degraded (Fig. 7).

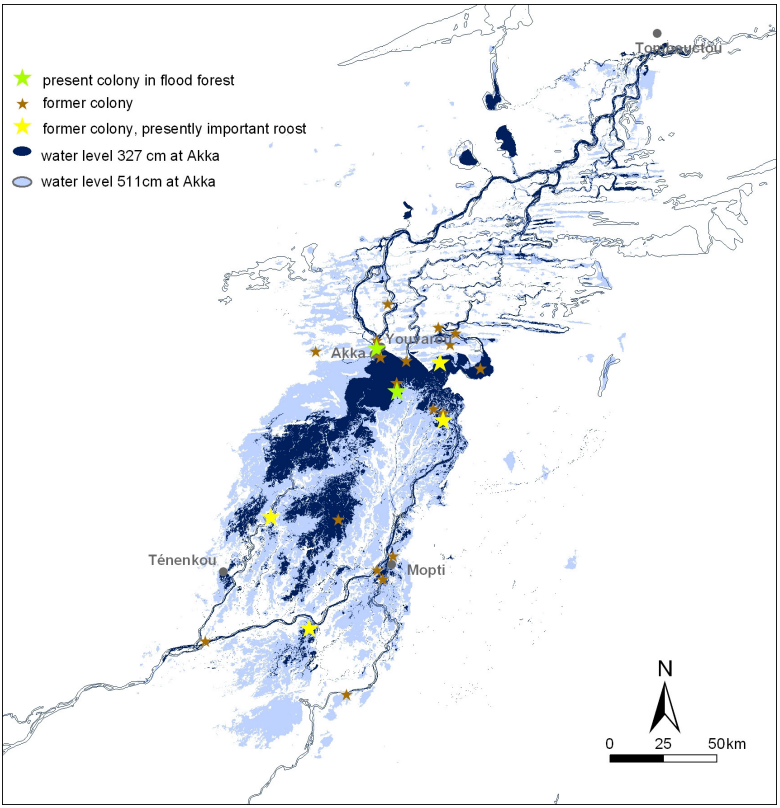

Fig. 7. Present breeding colonies of waterbirds in the flood forests of Akkagoun and Dentaka, remnants of flood forests now used as roosts by high numbers of waterbirds, and former forests (Skinner et al. 1987).

Fig. 7. Colonies nicheuses actuelles des forêts inondées de Dentaka et Akkagoun, forêts dégradées aujourd'hui servant de dortoirs pour des grands effectifs d'oiseaux d'eau, et lieux de forêts disparues (Skinner et al. 1987).

3.3. CENSUS RESULTS

Census results of waterbirds

Between June 2002 and June 2004 seven general waterbird counts have been executed in the Inner Niger Delta. The aerial count of June 2002 and five Debo counts are the continuation of the monitoring activities executed in 1998-2001 (van der Kamp *et al.* 2002a), but in the framework of this project centred around some strategic moments during the year. For justification of the timing of these counts see Chapter 2. Appendix 1 shows the results of the 2002 aerial census, with remarkable but temporary wet and moist conditions in the lake area on the westbank, caused by rainfall (see Section 3.2). Appendix 2 gives the results of the IND censuses including first counts done in some northern lakes (Horo and Télé).

January and February counts

During the décrue (receding flood) water bodies become increasingly scarce in the Delta and surroundings, an important reason why birds congregate in the low-lying area of the lakes of Debo, Walado Debo and Lac Korientzé. From the studies in Wymenga *et al.* 2002 (notably van der Kamp *et al.* 2002c) we knew already that the Debo-complex attracts large numbers of birds when the water level at Akka is dropping below 200 cm. In Table 3 the overall results of the January census of 2003 and February 2003 and 2004 are compared with previous counts in the area in the same period. The major part consists of Palearctic birds at that time and we see large fluctuations related to water level in the area (cf. van der Kamp *et al.* 2002c).

Table 3. *Results of January and February counts in the Debo-complex in 2003-2004 in comparison with other counts in the same month in 1998-2002 (data from Diallo* et al. *2002).*
Tableau 3. Effectifs totaux des recensements d'oiseaux d'eau de janvier et février 2003-2004, comparés à ceux des mêmes mois de 1999-2002 (données Diallo et al. *2003).*

Month	Water level Akka (cm)	Total
jan-99	330	25565
feb-99	133	106489
jan-00	390	24427
feb-00	238	63078
jan-01	323	18743
feb-01	140	135336
feb-02	140	118665
jan-03	150	101013
feb-03	167	99021
feb-04	234	66857

Fig. 8 relates the total figures in Table 3 to the water level, and it is clear there is a strong relationship. The new data which were gathered in the framework of this project correspond well with the known pattern. For the monitoring of the waterbirds in the Delta it is therefore crucial to link the waterbirds to the water level, and preferably perform counts when the water level has dropped below 200 cm (see Wymenga *et al.* 2002). Is goes without saying that also logistical circumstances play a role in the timing of monitoring of the Debo-complex.

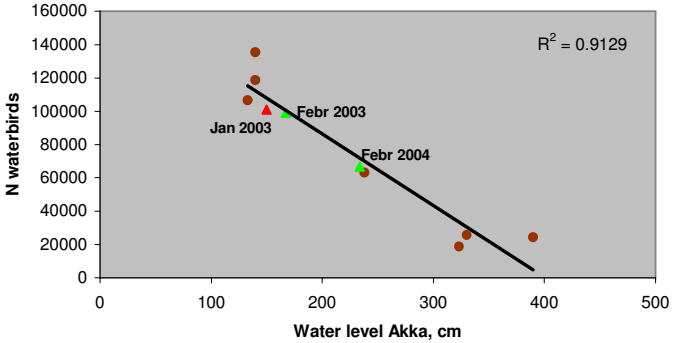

Fig. 8. *Total waterbird numbers in the Debo-complex January-February in relation to the water level. Data in Table 3.*
Fig. 8. Effectifs totaux d'oiseaux d'eau en janvier-février dans le complexe Debo, en relation avec les niveaux d'eau. Données en Tableau 3.

June counts

June counts have been performed since 1999 in the Debo-complex and are aimed to establish the concentrations of birds during the *étiage* (lowest water level) period. Waterbirds present concern 1) Palearctic birds which stay the northern summer in the Sahel zone and 2) Afrotropical waterbirds which concentrate at the last wet spots in the Sahel during the dry season. As can be seen in Table 4 Afrotropical waterbirds are by far the most numerous; herons *Ardeidae* have substantial numbers, but totals are strongly determined by species like Spur-winged Goose *Plectropterus gambensis* and Kittlitz's Plover *Charadrius pecuarius*, both having populations obviously related to flood performance (Wymenga *et al* 2002, Zwarts *et al* 2005).

Like the data from the January and February census, the June numbers show large fluctuations, though this varies a lot between species (Table 4, Appendix 2). Reasons for these fluctuations can relate to variation in reproduction success in the preceding breeding season or variation in the mortality. Unlike the situation in January and February, the June numbers show a tendancy to increase with higher water levels but strongly changing water levels within the minor river bed may veil the actual numerical relationships (Fig. 9).

Table 4. *Results of June counts in the Debo complex in 2003–2004 in comparison with other counts in the same month in 1999–2002 (data from Diallo et al. 2003). See Table 3.*
Tableau 4. Effectifs totaux des recensements d'oiseaux d'eau de juin 2003-2004, comparés à ceux des mêmes mois de 1999-2002 (données Diallo et al. *2003). Cf. Tableau 3.*

Month	Water level Akka (cm)	Total
Jun-99	24	22815
Jun-00	40	38979
Jun-01	48	41672
Jun-02	24	40867
Jun-03	37	30796
Jun-04	42	49635

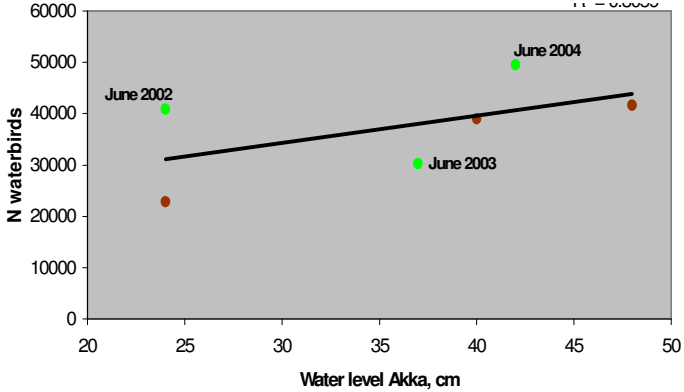

Fig. 9. *Total waterbird numbers in the Debo-complex in June in relation to the water level at Akka. Data in Table 4.*
Fig. 9. Effectifs totaux d'oiseaux d'eau en juin dans le complexe Debo, en relation avec les niveaux d'eau. Données en Tableau 4.

Northern Lakes

General count results represent waterbird numbers seen by day on Lac Télé proper (the bulb-shaped lake at the southern end of this wetland), and on the eastern part of Lac Horo and its shore, in the afternoon and at dusk. Data are presented in Appendix 2. Table 5 shows numbers of the most numerous species. The presence of Ferruginous Duck *Aythya nyroca* in high numbers was already known, as during aerial censuses by Girard & Thal (2000, 2001) also large concentrations were encountered. Also large numbers of Common Moorhen *Gallinula chloropus* were counted in the densely vegetated Lac Horo. It is clear that these relative small species are missed in aerial surveys like performed in June 2002 (Appendix 1).

Table 5. *Maximum number of a selection of waterbirds in Lac Télé, Fati and Horo in early March 2003. Ref. column: see Table 6*

Tableau 5. Effectifs maximaux d'une sélection d'espèces d'oiseaux d'eau dans les lacs Télé, Fati et Horo, début mars 2003. Colonne 'refers to' : v. Tableau 6.

Species	N March 2003	1%-criterion	Refers to
Nycticorax nycticorax	600	1.200	Eur-e/Méd-e/MerN
Plegadis falcinellus	750	530	MerN/Eur-so
Dendrocygna viduata	4000	3800	Af-o/c
Plectropterus gambensis	1300	1.000	Af-o
Anas querquedula	8500	20000	(Eur) - Méd-e/MerN
Aythya nyroca	1600	530	Subsah
Gallinula chloropus	2265	10000	Subsah
Chlidonias leucopterus	2760	20000	Eur-c/e

Data on other fauna

The Inner Niger Delta hosts nowadays the remnants of a rich fauna of big(ger) mammals. Hippopotamus *Hippopotamus amphibius* and West African Manatee *Trichechus senegalensis* constitute the aquatic mammals, both with populations of 50-100 animals in regularly monitored parts of the southern delta. For Hippos this is based on own observations during monthly fieldtrips, whereas the Manatees estimation is mainly based on interviews and other information of local fishermen. Observation of other big mammals are exceptional, concerning vagrants like an immature Elephant *Loxodonta africana* at Lac Debo in the early 1980s (S. Konta, WI), and 2 Giraffe *Giraffa camelopardalis ssp. peralta* (DRCN Goundam) in late 2002 between Timbuctoo and Goundam.

Other scarce but regularly seen mammals are Green Monkey *Cercopithecus aethiops* (Mayo Dembé area; single observations

delta upstream and Niger just north of Akka, Lac Debo) and the Striped Jackal *Canis adustus*, observed in drier habitats but in 1999 trapped in the high flood, at the mouth of the Mayo Dembé (see picture in Wymenga *et al* 2002). In 2002 a young Patas Monkey *Cercopithecus patas* was offered for sale in a fishermen's village near Diafarabé. Gazelle *Gazelle rufifrons* are said to still occur in the northern delta, but quantitative data are lacking. They have never been recorded during several aerial Inner Niger Delta waterbird censuses in 1999-2002. Wild Cats *Felis sylvestris* are seen (once found dead, Mayo Dembé) now and then (mostly singles, rarely two), while in the mid-nineties we once found a freshly dead (drowned?) African Civet *Civettictis civetta*, just downstream Akka, on the riverbank.

Big reptiles like Nile Crocodile *Crocodylus niloticus* do not seem to occur any more; Akka people -centre of the Delta- report to have seen their last one in the 1970s. Monitor Lizard *Varanus niloticus* are still fairly common, but their meat and skin are appreciated.

3.4 ECOLOGICAL VALUES

Ornithological significance

The executed counts and earlier results show that the Delta holds very large concentrations of waterbirds including afrotropical birds as well as palearctic migrants (breeding in Europe and western Asia). In the Debo complex – the study area in the central part of the Delta consisting of Lac Debo, Walado Debo and Lac Korientzé - at least **twenty-seven species** are present in internationally (very) important numbers (Table 6). In comparison with other sahelian floodplains, the Inner Niger Delta is especially important for species like Purple Heron *Ardea purpurea*, Glossy Ibis *Plegadis falcinellus*, Spur-winged Goose

Plectropterus gambensis, Kittlitz's Plover *Charadrius pecuarius*, Spotted Redshank *Tringa erythropus* and Caspian Tern *Sterna caspia.* Aerial January censuses executed in the 1970s, 1980s (CRBPO-France; IUCN/WWF) and in 1999-2001 (ONCFS-France, Girard & Thal 1999, 2000, 2001) underline the crucial importance of the Delta for afrotropical and palearctic *Anatidae* (see also Wymenga *et al* 2002).

The northern lakes revealed some ornithological surprises. Lac Horo appeared to be a stronghold for Little Grebe *Tachybaptus ruficollis* (estimate >100 pairs) and Common Moorhen *Gallinula chloropus* (5-10.000); the latter were probably residents as birds sold on the local market showed hardly any fat in early March. Little Grebes were heard in many places and may breed here in substantial numbers, whereas elsewhere in the Inner Delta it is considered a rarely observed species. Whiskered Tern *Chlidonias hybridus* may breed here as well (see hereafter), according to descriptions of birds and eggs found by local fishermen. Like in Horo, local fishermen in Lac Télé were involved in birdcatching activities (mainly hooklines); a 3-days check revealed *daily* catches of Great Bittern *Botaurus stellaris* (10 birds in 3 days), Purple Heron *Ardea purpurea* and Purple Swamphen *Porphyrio porphyrio*. The latter of these three species was confirmed breeding here in 2004; some hundreds of birds were actually observed, with several dozens of full-grown young and chicks of all sizes.

Large afrotropical wading birds are only present in (very) low numbers, which is partly the result of the severe drought in the 1970s and 1980s but predominantly as a result of human pressure such as hunting and disturbance or destruction of breeding sites. However, the Delta is important to a number of bio-indicator species like African Pygmy Goose *Nettapus auritus* (waterlily habitat), Black Crowned Crane *Balearica pavonina* (critically

Page 54. View of the sourthern part of Lac Korientzé at a low water level.. Vue de Lac Korientzé súd pendant la décrue.

endangered in the Delta) and the Great Snipe *Gallinago media* (Near-Threatened palearctic species). The Delta hosts small breeding colonies of Whiskered Tern *Chlidonias hybridus*, the first and only ones recorded in West Africa.

The presence and distribution of waterbirds in wetlands is driven by available food resources and the possibilities to exploit them. In the Debo complex, where huge concentrations of waterbirds were present during the receding floods, molluscs and fish provide crucial food resources. The possibilities for food exploitation are dictated by water levels; data which were gathered in Debo during the last decade, and more intensively during the project period 1998-2002, show how waterbirds respond to varying water levels (van der Kamp *et al.* 2002). Dropping water levels lead to concentration of fish stock and exploitable molluscs.

The Debo complex attracts large numbers of waterbirds when the delta water level drops, with major aggregations showing up below a water level of 200 cm (gauge at Akka, Lac Debo). Among these are ibises and several wader species, feeding on molluscs present on emerging mudflats and low-lying pastures. Though seemingly present in large quantities time is short and food is limited, as is shown in a first reconnaissance of the possible carrying capacity. The Debo complex plays a crucial role as fuelling station during the receding flood when afrotropical birds concentrate on the region's remaining wet places and palearctic birds prepare for migration to the breeding grounds in the north. However, birds are bound within narrow margins (van der Kamp *et al.* 2002).

Species	1%-criterium	Max. 1998-2004	x1% criterion	Refers to
Pelecanus onocrotalus	600	4300	7,2	Af-o
Phalacrocorax africanus	1.000	55867	55,9	Af-o/c
Anhinga rufa	250	641	2,6	Af-o/c
Ardea cinerea	2.200 - 2.700	5663	2,6-2,1	Eur – Méd-e/MerN
Ardea purpurea	(120) - 2.200	4171	(34,8)-1,9	(Eur) – Méd-e/MerN
Egretta alba	3.000	5534	1,8	Subsah
Egretta ardesiaca	1.000	390	0,4	Subsah
Egretta intermedia	1.000	5100	5,1	Subsah
Egretta garzetta	3.500	10915	3,1	Subsah
Ardeola ralloides	3.000	1663	0,6	Subsah
Nycticorax nycticorax	1.200	4620	3,9	Eur-e/Méd-e/MerN
Mycteria ibis	750	210	0,3	Subsah
Leptoptilos crumeniferus	2.000	380	0,2	Subsah
Threskiornis aethiopica	3.300	1037	0,3	Subsah
Plegadis falcinellus	530	10651	20,1	MerN/Eur-so
Platalea alba	1.000	893	0,9	Subsah
Plectropterus gambensis	1.000	11457	11,5	Af-o
Alopochen aegyptiacus	180	590	3,3	Af-o
Nettapus auritus	100	101	1,0	Af-o
Balearica pavonina	150	32	0,2	Af-o
Porphyrio porphyrio	1.000	673	0,7	Subsah
Himantopus himantopus	(340) - 770	2998	(8,8)-3,9	(Méd/MerN) - Eur-o/so
Pluvianus aegyptius	350	753	2,2	Af-o
Glareola pratincola	190 - 240	18310	96,4-76,3	Eur-so-se/Af-n/MerN
Vanellus spinosus	4.000	5732	1,4	Subsah
Charadrius hiaticula	2.100	4696	2,2	Eur-ne/Russia
Charadrius pecuarius	350	13676	39,1	Af-o
Charadrius marginatus	130	791	6,1	Af-o
Limosa limosa	1.700	26852	15,8	Eur-o
Tringa erythropus	1.000	4557	4,6	Sibérie-o
Tringa nebularia	3.100	2513	0,8	Eur-n
*Gallinago media**	350	135	0,4	Scandinavie
Calidris minuta	2.000	31802	15,9	Eur-n/Russia-no
Calidris ferruginea	7.400	3754	0,5	Sibérie-o
Philomachus pugnax	10.000	47281	4,7	Af-o
Chlidonias hybridus	260	3600	13,8	Eur-o/Méd-o/Af-no
Chlidonias leucopterus	20000	4009	0,2	Eur-c/e
Gelochelidon nilotica	130 - 270	3759	28,9-13,9	Eur-o-e/Af-o /MerN
Sterna caspia	65	3334	51,3	Eur
Sterna albifrons	340	345	1,0	Eur-o/Af-no
Circus aeruginosus	450	231	0,5	Eur

Table 6. *Maxima of a selection of waterbirds in Lac Debo, Walado Debo and Lac Korientzé in the central part of the Inner Niger Delta in 1998-2004 (Diallo et al. 2003, this report). Maximum numbers of Long-tailed Cormorant and African Darters are based on roost counts, Intermediate Egret´s maximum was observed in January 2000 (van der Kamp et al 2002). The figures are compared to the 1%-criterium presented by Delany & Scott (2002; for Philomachus pugnax: Fishpool & Evans 2001, Circus aeruginosus derived from Hagemeijer & Blair 1997). The last column denotes the biogeographical population on which these criteria are based: Af = Africa, Subsah = Africa south of the Sahara, Eur = Europe, MerN = Black Sea, Med =*
Mediterranean; n north, e east, s south, o west, c central. In case of doubt two populations and criteria are mentioned. Glareola cinerea was ommitted (11 counted, 1%-criterion 100 population Upper Niger Mali).

Tableau 6. Effectifs maximaux en 1998-2004, d'une sélection d'espèces d'oiseaux d'eau dans les lacs Debo, Walado Debo et Korientzé, au centre du Delta Intérieur (Diallo et al.2003, présent rapport). Les maxima des Cormorans africains et des Anhingas roux sont basés sur des comptages de dortoirs, le maximum des Aigrettes intermédiaires fut établi en janvier 2000 (van der Kamp et al. *2002). Ces effectifs sont comparés au critère-1% présenté par Delany & Scott (2002 ; pour Egretta alba/intermedia et Philomachus pugnax : Fishpool & Evans 2001 ; Circus aeruginosus : Hagemeijer & Blair 1997). La dernière colonne indique la population biogéographique sur laquelle le critère-1% est basé : Af = Afrique, Subsah = Afrique subsaharienne, Eur = Europe, MerN = Mer Noire, Med = Méditerranéenne ; n = nord, e = est, s = sud, o = ouest, c = centrale. En cas de doute deux populations et critères sont mentionnés. Glaréole grise* Glareola cinerea *a été omise (11 compté, critère-1% 100 pour la population du Haut Niger).*

Table 7. Estimated number of breeding pairs of colonial waterbirds in the Inner Niger Delta during four episodes in the last decades. The estimate of 1986-87 is based on Skinner et al. (1987). The figures for 1994/96 only cover Dentaka representing the major part of the population in the Inner Delta. Source: van der Kamp et al. (2002c) complemented with recent provisional estimates. + = present but numbers unknown.

Tableau 7. Nombres estimés de couples nicheurs d'oiseaux d'eau dans les colonies des forêts inondées du Delta Intérieur du Niger. Estimations faites durant quatre épisodes dans les décennies derniers. 1986/87 basé sur Skinner et al. *(1987), 1994-96 sur Dentaka seul, représentant la quasi-totalité des populations reproductrices (van der Kamp* et al. *2002c), et complémenté par estimations provisoires en 1999-2001 et 2004/2005.*

Species		1986/1987	1994-96	1999/2001	2004/2005
Cattle Egret	*Bubulcus ibis*	63000 – 65000	65000 – 90000	50000 – 60000	50000
Long-tailed Cormorant	*Phalacrocorax africanus*	17000 – 17500	16000 – 17000	18000 – 20000	19000
Great Egret	*Egretta alba*	2800 – 3100	500 – 1000	1500 – 1800	700
Little Egret - white morph	*Egretta garzetta*	900 – 1000	500 – 1000	500-1000	1500
Little Egret - dark morph	*Egretta garzetta (gularis)*	80 – 110	+	80	50
Intermediate Egret	*Egretta intermedia*	800 – 875	>200	1700	1800
Squacco Heron	*Ardeola ralloides*	550 – 650	+	500	500
Black Heron	*Egretta ardesiaca*	200 – 250	150	130	<50
Black-crowned Night Heron	*Nycticorax nycticorax*	1 – 10	100 – 300	1 – 10	<10
Grey Heron	*Ardea cinerea*	10 – 15	30 – 50	0	0
Black-headed Heron	*Ardea melanocephala*	10	1 – 5	2	<5
Purple Heron	*Ardea purpurea*	0	2 – 10	0	0
African Darter	*Anhinga rufa*	40 – 45	15 – 30	250 – 300	150
Sacred Ibis	*Threskiornis aethiopica*	30 – 40	50	200 – 250	100
Glossy Ibis	*Plegadis falcinellus*	0	150	0	0
African Spoonbill	*Platalea alba*	300 – 350	50	100 – 150	100-150
African Openbill	*Anastomus lamelligerus*	30 – 40	0 – 1	0	0

Breeding colonies

The Delta is of paramount importance for colony-breeding waterbirds in West Africa, especially Long-tailed Cormorant *Phalacrocorax africanus*, African Darter *Anhinga rufa* and several heron species. Of the 23 existing colonies in the Delta in the 1950s, only 7 remained in 1984-1985. This number dwindled to only two substantial colonies in 1998-2002. Cattle Egret and Long-tailed Cormorant are by far the most abundant species with rather stable populations, though the numbers of Cattle Egret seem to decline. Other species in substantial numbers are Great Egret (declining), Little Egret (stable or slight increase), Intermediate Egret (stable or slight increase), Squacco Heron (stable) and African Spoonbill (stable?). Other large wading birds are present in low numbers and seem to decline (Table 7).

The two large colonies -situated in the flood forests of Akkagoun and Dentaka- are ranking among the largest known breeding colonies of herons and cormorants in West-Africa. For some species they constitute the stronghold in the region. Even these two colonies are under constant threat of human pressure and disturbance. Especially the colony of Akkagoun is far from stable (van der Kamp *et al* 2002). Thanks to the effort of local populations - stimulated by the IUCN-Mali - these sites are guarded and disturbance is said to be limited.

Biodiversity and significance

The present biodiversity in the Inner Delta reflects the strong climatic and human pressures to which it has been exposed since long time. Large(r) herbivores and carnivores have become practically extinct, and what is observed today are some remaining species with alarmingly small populations, i.e. Hippopotamus *Hippopotamus amphibius*, Red-fronted Gazelle *Gazella rufifrons*, jackals *Canis spec.* and Striped Hyena *Hyaena hyaena*. Biodiversity is strongly related to flood performance,

occurrence of aquatic grassy vegetation and human interventions. Despite full legal protection of some species they face many threats. Beside climatic constraints like drought periods, the impact of pesticide use and the adverse effects of poaching activities should be mentioned as well.

Waterbird biodiversity is still high but the above-mentioned constraints have certainly had their influence on species and population sizes (see Wymenga *et al* 2002). Protection of nowadays threatened wildlife has to be put in practice through a framework of integrated consultations in which rural populations and relevant governmental and non-governmental institutions are involved.

4. DELTA MORT

4.1. SHORT CHARACTERIZATION

General description

The Delta Mort (: dead delta) actually forms a secluded part of the Niger Basin since the construction of the Markala dam in the 1940s; it became operational in 1947. In this low-lying delta the irrigation zone of Office du Niger was founded in the 1930s. It was initially meant for cotton production, but this was not succesful. In the first half of the century transformation to rice cultivation took place (Bonneval *et al.* 2002). Two old river branches (so-called Falas), connected with an irrigation canal system, act nowadays as water providers for agriculture in this area: one heading north through the Niono region, the other northeast towards the Macina region. By the end of the latest century 67000 ha of arable land was available, including 51000 ha of irrigated rice area (1999). The Malian government recently (1998) decided to reclaim another 17000 ha in this delta, whereas 30000-50000 ha would be planned for the next two decades (see also Bonneval *et al.* 2002). At present (2004) an area of about 74.000 ha is being irrigated and expansion is still going on (Fig. 10).

The total irrigable area goes even far beyond these targets and is estimated at 250000 ha, from a strictly hydraulic point of view. Two major problems are then to be foreseen. First, the hydrological constraint would be an unsufficient water supply during the counter-season cycle and at the start of the -traditional- wet season cycle, in May and June.

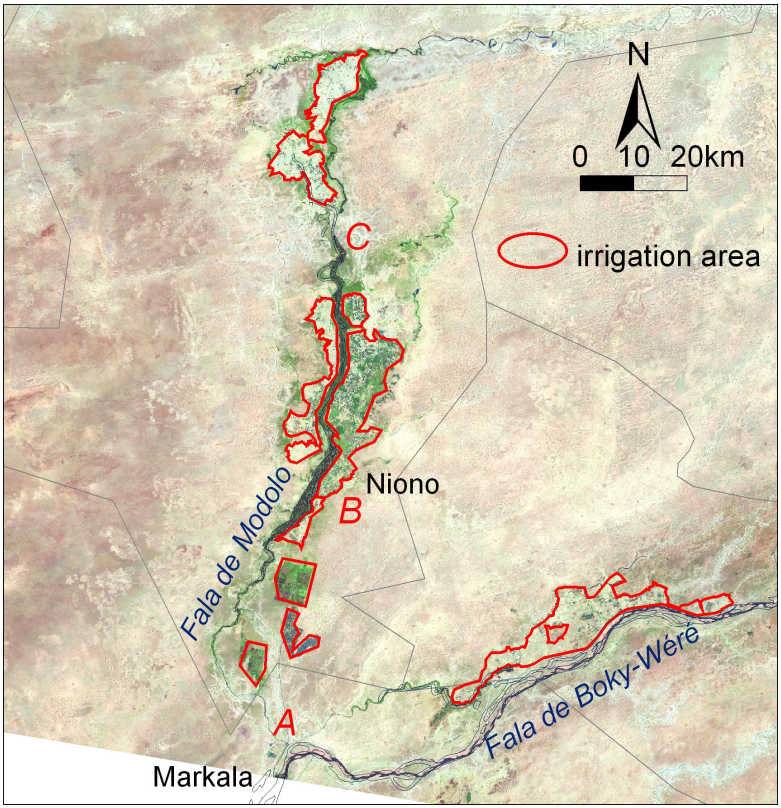

Fig. 10. *Irrigation zone of Office du Niger, northeast of Segou. At Markala water is taken from the Niger. At point A it is divided in two directions: towards Fala de Boky-Wéré (northeast) and Fala de Molodo (north). B and C are important water distribution points as w*

Fig. 10. Zone d´irrigation de l´Office du Niger, au nord-est de Segou. Prise d'eau du Niger au niveau de Markala. Au Point A l'eau se divise en deux directions : vers le nord-est par le Fala de Boky-Wéré, et vers le nord via le Fala de Molodo. B et C sont également des points importants pour la distribution d'eau.

Point A, north of Markala. The water is coming from the south (the two parallel canals at the top of the photo) and is directed towards the north (right side of the photo) and the east (left side).
Point A, au nord de Markala. L'eau vient du sud (les deux canaux parallèles en haut) en étant dirigée vers le nord (côté droit de l'image) et vers l'est (à gauche).

Second, it is expected that the huge water demand would have a substantial effect on the inundation extent of the Inner Delta downstream the Markala dam, where economic (fisheries, cattle breeding, rice growing) and ecological interests (mortality, survival of waterbirds and other wetland-related species) are closely related to river flood performance (Kuper *et al.* 2002, Wymenga *et al.* 2002). This latter problem is a core issue in the overall project of Partners for Water (see Introduction and Zwarts *et al.* 2005a).

The Fala area must have followed the Niger flood regime before the construction of the Markala dam and its related hydraulic infrastructure into the surrounding floodable areas. The dry conditions during low water in the river's year-cycle are nowadays eliminated; the marshy area has become a permanent wetland flowing through former dry savanna transformed into a huge rice cultivation area (figure 10).

Forest habitat also occurs in the Delta Mort, but the growing rural population has an impact on its sustained existence because of firewood demands. In areas where irrigation water is evacuated substantial forests including *Acacia nilotica* have developed (pers. obs.) where Herons and Egrets roost and breed: in early July 2003 a breeding colony of Cattle Egret and Squacco Heron (eggs of both species being removed by young boys) was spotted in an *A. nilotica* forest near Diabaly. These heron species were also found breeding in a small patch of *A. seyal* (Kokry; June-July 2002, 2003). However, these breeding sites are under serious stress due to reclamation programs and other human disturbance (see hereafter).

Socio-economic aspects

After gradual development of the Delta Mort zone since the Markala dam became operational, with periods of nationalisation and, since the early 1980s, liberalisation of the rice market, the restructured (since 1995) Office du Niger is now in full expansion. In 2000 an estimated 74000 ha of irrigated land north of the Niger River received water from Markala, including 5800 ha of sugar cane area, 3000 ha rice managed by the Opération Riz Segou, and 8000 ha of cultures outside the regular ON-embankments. Between 1998 and 2001 the Office du Niger population increased enormously, from 112000 to 264000 (two-third of them active). From 1978 to 1999 the number of families with parcels increased from 5000 to 20000, whereas total

allocated paddy field surface went from 37000 to 51000 ha. Figure 11 shows the development of irrigated area and the enormous growth of the population in the course of the former century.

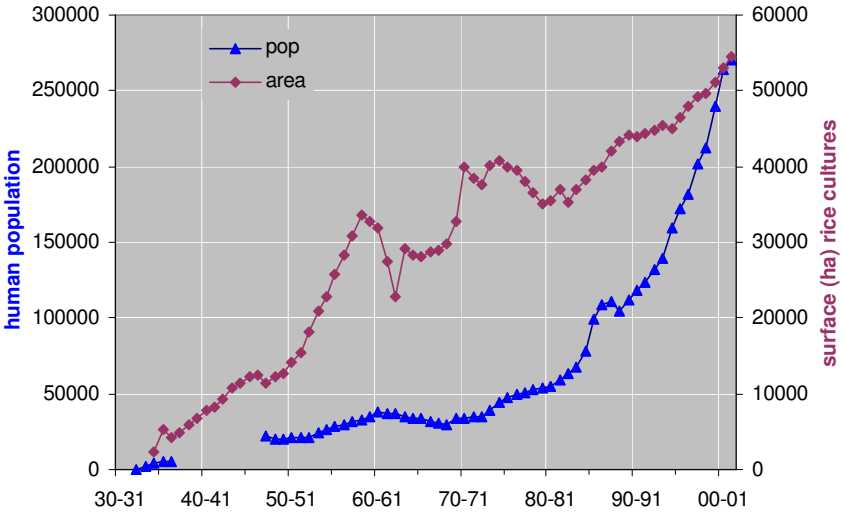

Fig. 11. Development of the human population and the surface area of rice cultures (ha), both within the Office du Niger irrigation zone. At present (2004) the total irrigation zone of the Office du Niger covers ca. 74,000 ha. Source: Office du Niger.

Fig. 11. La zone de l'Office du Niger : évolutions de la population humaine et de la superficie rizicole (ha). En 2004 la zone irriguée totale de l'ON comprenait environ 74000 ha. Source : Office du Niger.

The substantial decrease in parcel-size per family has in fact been part of the strategy to intensify rice cultivation, with better yields, but it is also related to land demand and individualisation: young family members increasingly want their own exploitations. A double-crop system initiated during the 1980s is nowadays still

Planting rice in the Office du Niger to increase crop yields; in the Inner Niger Delta rice is not planted but generally sown.

Repiquage de jeunes plantes de riz dans la zone de l'ON, afin d'améliorer les rendements ; par contre, dans le Delta Intérieur du Niger le riz est semé de façon générale.

developing but in terms of cultivated area represents only 12% of the wet season paddy field zone, far less (although more ha involved) than in Sélingué where cultivated surfaces during wet and dry season are more or less equal (see Chapter 5). Bonneval *et al.* (2002) and Wymenga *et al.* (2005) give an extensive review of the developments of the Irrigation zone of Office du Niger.

4.2. HABITATS

Rice fields

In irrigation zones like the Delta Mort water is under complete control for obvious reasons: these garanteed supplies have created the conditions under which large-scale rice cultivation has become a reality (Bonneval *et al.* 2002). Rice fields are therefore a major wetland habitat, where several varieties of rice are being grown. Farmers with a double-crop ('hivernage' and 'contre-saison') tend to use short-cycle rice rather than long-cycle, as they would have little time between crops to remove weeds from bordering rice field dikes and to plough the land. At present rice-planting ('repiquage') is generally practiced in order to maximize yields. In the Inner Niger Delta rice-sowing is applied, in traditional areas as well as in embanked polders with a semi-controlled water system. The period of December-May shows an arid post-harvest landscape except where dry season crops are practiced; these crops cover basically the mid-January – May period.

Marshlands

Falas and their adjoining forelands have turned into permanent -artificial- wetlands, whereas the primary irrigation canals contain permanent water too. Open water and abundant aquatic vegetation with interspersed agricultural plots give a natural looking marsh appearance. Main vegetation comprises *Typha* and

Photos left: Fala de Molodo bordered by dense Typha *stands (top) and (lower panel) water control unit (sluice) in Fala de Molodo with a dense carpet of* Salvinia molesta *in front. Pictures taken March 2005.*

Photos à gauche : Fala de Molodo bordé d'une dense typhaie (en haut), et l'écluse entre Niono et Molodo (en bas) bouchée par un tapis de Salvinia molesta*, un nouvel envahissant -depuis 2004- de la zone. Photo prise en mars 2005.*

Nymphea fields, whereas *Azolla* spec. and Waterhyacinth *Eichhornia crassipes* also occur. The latter is an invasive species occurring in the Niger River since the early 1990s and causing problems at sluices or even economic damage, i.e. at the Sotuba hydro-electric power station inlet in Bamako. *Typha* is also considered a pest causing problems in small irrigation canals, but from an ecological point of view, and based on first observations, this vegetation may be of major importance to waterbirds.*Nymphea* fields form a major habitat too in the Inner Delta whereas *Typha*, *Eichhornia* and *Azolla* are hardly seen there, as they seem to favour more steady and eutrophic water conditions. Nevertheless, waterhyacinths have been observed in 1999-2001 on the Niger downstream the Markala dam at high water, and floating plants have been noted as far as Sévéri (Mayo Dembé) and on the Diarenndé near Koumbé Niasso. During our fieldtrip to the northern lakes we were informed that waterhyacinths occur since 2002 on Lac Fati, the deepest lake of the Inner Delta, some 200 km further downstream and nowadays having a flood-controlling waterinlet (dam). *Salvinia molesta* is a rapidly spreading new-comer –since the 2004/2005 flood season- in the Office du Niger.

4.3. ORNITHOLOGICAL IMPORTANCE

Census results

Waterbird counts (general and density) were done synchronously in order to optimise the comparability of these two approaches. The Fala areas were surveyed through an incidental aerial inspection and some counts from field observation points. The initial aerial survey was followed by five general counts in paddy fields and one in fala areas (Dec , Feb and June-July 2003, 2004). Appendix 4 gives the results; Table 7 shows the most numerous species in the general counts. Delta Mort totals include birds seen in three standard areas (Diabaly, Molodo and Niono); two other relatively small sites (Siribala, Macina) only covered in July 2003, December 2003 and February 2004 are left aside to improve comparability of the results.

In all general counts Cattle Egret *Bubulcus ibis* and Spur-winged Lapwing *Vanellus spinosus* are the most common waterbird species, both resident breeders with a known tolerance for drier habitats. However, Senegal Wattled Lapwings *Vanellus senegallus* were never seen in rice habitat, although some birds were observed during the fala survey in June 2004. Squacco Heron *Ardeola ralloides* shows an increase in June-July and turned out to breed then, in fala and *Acacia* habitats. Other *Ardeidae*, except Yellow-billed Egret *Egretta intermedia*, seem to be mainly winter/dry season visitors. Waders are relatively rare, with a marked absence of Black-tailed Godwit *Limosa limosa* in paddy fields and Ruff *Philomachus pugnax* almost so.

Table 8. *Results of counts in the irrigation zone of Office du Niger and the fala area (June 2004). Only species with more than 20 individuals have been shown. For full results see Appendix 3.*

Tableau 8. Résultats des comptages effectués dans la zone irriguée de l'ON et -juin 2004- dans la zone des falas. Seules les espèces à totaux dépassant 20 sujets sont montrées. Cf. Appendice 3 pour les résultats intégraux.

Date	Dec-02	Feb-03	Jul-03	Dec-03	Feb-04	Jun-04
Species / habitat	riz	riz	Riz	riz	riz	falas
Long-tailed Cormorant	1	1	2	0	2	392
African Darter	0	0	0	0	0	67
Grey Heron	63	53	37	0	39	8
Intermediate Egret	10	20	39	0	3	38
Little Egret (white morph)	11	71	41	19	2	13
Cattle Egret	319	470	290	325	198	461
Squacco Heron	10	10	38	6	10	463
Night Heron	0	0	0	0	0	345
White-faced Whistling-duck	0	0	0	0	0	598
Spur-winged Goose	0	0	0	0	0	102
Knob-billed Goose	0	0	0	0	0	33
African Pygmy Goose	0	0	0	0	0	22
Purple Swamphen	0	0	0	0	0	77
Lesser Jacana	0	0	0	0	0	21
African Jacana	14	8	16	2	4	33
Black-winged Stilt	2	28	0	0	1	28
Common Pratincole	0	71	0	0	1	1
Spur-winged Lapwing	143	171	166	99	134	177
Black-tailed Godwit	0	0	0	0	0	125
Wood Sandpiper	10	24	0	0	26	15
Black-shouldered Kite	0	0	0	3	2	42
Yellow Wagtail	65	42	0	56	57	0
Totals	702	1043	641	538	522	3208

In density counts (see Chapter 6) the overall picture changes, Cattle Egret and Spur-winged Lapwing still high-ranking but in February convincingly outnumbered by two palearctic migrants: Yellow Wagtail *Motacilla flava* and Wood Sandpiper *Tringa glareola*, both species liable to be overlooked in larger-scale counts. A secretive afrotropical wader, Greater Painted-snipe *Rostratula benghalensis*, turns up in July and is only noted in density counts.

Ornithological significance

The rice cultivation area in the Delta Mort holds considerable numbers of several waterbird species. Waterbird counts in June-July and December-February indicate, however, that biodiversity in paddy field habitat is less high than in natural wetland habitat. The Inner Niger Delta held 3-4 times more species than the rice fields in the Delta Mort (see Appendix 6; File:334app6blad:biodiv alg). This is explained by the fact that waterbird counts in the IND covered a variety of habitats (in a vast wetland) whereas rice fields are monotypic.

To assess the Delta Mort's ornithological importance the two major habitats, as mentioned before, should therefore be taken into consideration: the Fala area and its adjoining rice-polder landscape show clear interrelations. Waterbirds and wetland-related species like herons, egrets and Yellow Wagtail *Motacilla flava,* and even palearctic migrants like Western Turtle Dove *Streptopelia turtur* (among several afrotropical dove species; see also *Ecological constraints*) exploit the paddy field wetlands as feeding zone whilst using the Fala area and adjacent forests as a roost. Others use the nowadays permanent Fala marshes also as breeding area, with a surprising, isolated breeding case of Night Heron *Nycticorax nycticorax* in the Boky Wéré fala (4 full-grown young with downy head-feathers; late June 2004); other suspected or definite breeders are Little Bittern *Ixobrychus*

minutus ssp. payesi, Cattle Egret *Bubulcus ibis*, Squacco Heron *Ardeola ralloides*, Green-backed Heron *Butorides striatus* and possibly other *Ardeidae,* Purple Swamphen *Porphyrio porphyrio*, Allen's Gallinule *Porphyrio alleni*, Black Crake *Amaurornis flavirostra,* other *Rallidae*, and Marsh Owl *Asio capensis*. The fala zone is also a boreal-winter quarter for palearctic passerines, i.e. Sedge Warbler *Acrocephalus schoenobaenus* and other *Acrocephalus* species, Sand Martin *Riparia riparia*, and afrotropical prinias and cisticolas are widespread species.

Ecological constraints

During December and February very few ducks and geese were present in the irrigation zone, and we obtained no indications of huge *Anatidae* and -to a lesser extent- *Ardeidae* numbers similar to those found in the Inner Delta. Larger numbers of *Anatidae* may occur temporarily (fishermen's information), just after the rainy season in september-november, but feeding areas deteriorate under post-crop, arid conditions in December. By this time palearctic ducks start to increase their food intake, to be able -by fat storage and other corporal adaptations- to undertake the long migration (4-6000 km) towards their Eurasian breeding grounds.

Unlike the Delta Mort, the Inner Delta offers steady feeding conditions in a dynamic ecosystem, where food stocks can normally be depleted during an entire dry season-cycle (boreal winter). Another important constraint is the possible lack of sufficient large-scale resting areas. The falas are long but their width is limited, allowing favourable hunting conditions and other disturbance by people having their (often unofficial) crops in the Fala's forelands.

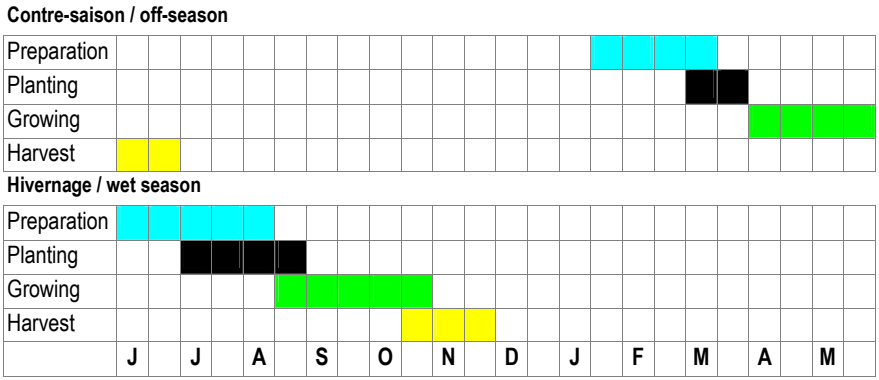

Fig. 12. *Global annual cycle of wet season and off-season rice cultures in the Office du Niger.*
Fig. 12. Aperçu global des cycles de rizicultures hivernales et contre-saison dans la zone de l'Office du Niger.

Ardeidae numbers are relatively small compared to the IND-Debo counts. However, considering the extent of the irrigation zone and, more widely, the extent of rice cultivation areas on regional/international level, rice field habitat may very well be of major importance to herons and egrets. Besides, Debo numbers show contracting, more visible populations whereas in the Delta Mort they stay widespread.

Poor wader numbers may be explained by the area's irrigation scheme, where crops are harvested in November-December. Recent developments to grow dry season crops, turning arid post-harvest polders into favourable pre-migration wetlands, have high potential for waders as is shown for Wood Sandpiper, and may attract other species under these more steady (double-crop) wetland conditions. However, the dry post-harvest December-

January period will stay a potential bottle-neck for waders staging in the area.

Hunting

Although nationally, hunting is a widespread traditional activity, carrying or having a gun seems to be mainly a folkloric or self-defence issue. Disturbance by shooting -legally and illegally- is not often observed, but -as a reference- in the Inner Niger Delta it gradually increased during the nineties, from (roughly) 0-5 to 5-15 shots heard/day during mid-winter waterbird counts in the Debo area (pers. obs.).

It was therefore particularly alarming to see a foreign leisure-hunting group having a shooting party just west of Kogoni (northern DM; Feb 15th 2004), where over 600 shots were recorded in a 70-minutes span. The group surrounded a European Turtle Dove *Streptopelia turtur* night roost and shot at in-flying birds. This is a migrant species of European concern (Heath & Evans 2000) with rapidly declining breeding populations in western Europe, using natural and human-made wetlands in sub-saharan Africa as winter quarters and pre-migration fat-storage areas, while feeding -mainly- on remaining post-harvest rice grains.

In the Delta Mort the birds seem to benefit from the growing (yields in the) rice cultivation area. We counted tens of thousands of birds visiting two different night roosts (Fig. 13), whereas the total DM-population may be well over 100,000 birds.

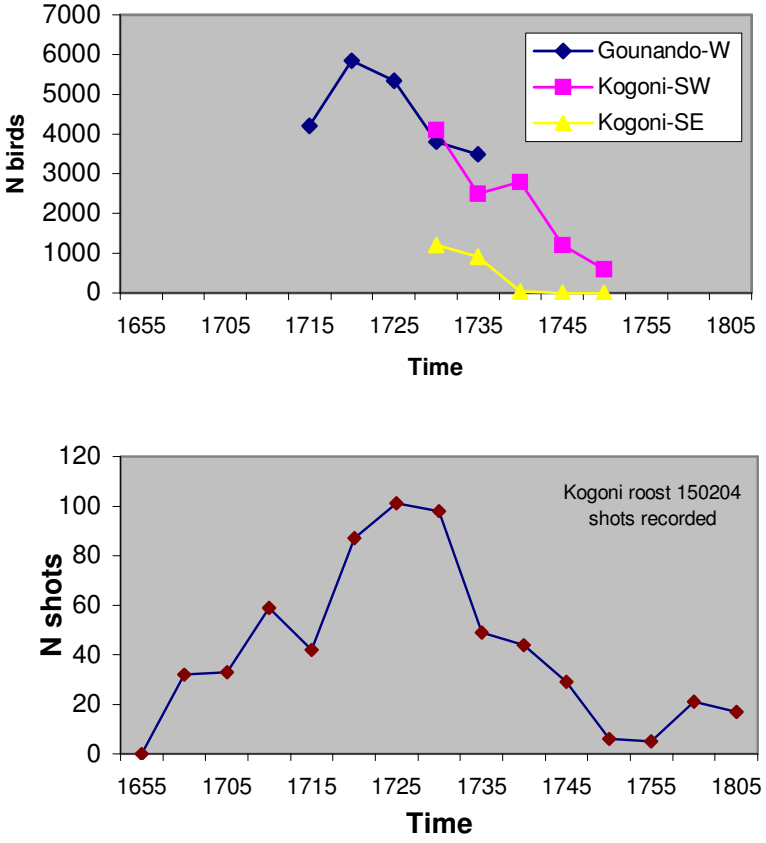

Figure 13. Fragmented roost count results of European Turtle Dove Streptopelia turtur *at two different sites in the Delta Mort. February 2004. Lower panel shows counted shots at one of these sites.*

Fig. 13. Comptages partiels de la migration crépusculaire des Tourterelles des bois Streptopelia turtur*, comparés aux coups de fusil cumulatifs lors d'une partie de chasse à côté d'un dortoir.*

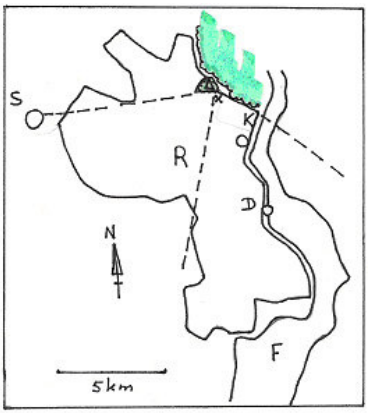

Fig. 14. *Locations in the Office du Niger irrigation zone where roost migration of European Turtle Doves* Streptopelia turtur *was recorded. Both areas are situated in the northern Delta Mort. Green* = Acacia nilotica, *triangle=heronry and roost of Turtle Doves, G=Gounando, S=Sokolo, K=Kogoni, D=Diabaly, F=Fala area, R=rice area, x=observation point.*

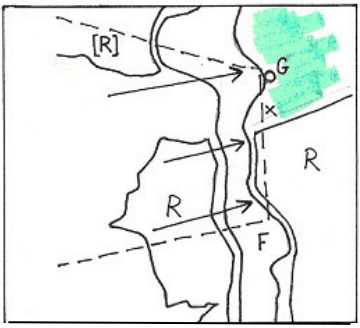

Fig. 14. *Sites de dortoir dans la zone de l'ON où la migration crépusculaire des Tourterelles des bois* Streptopelia turtur *a été quantifiée à la mi-février 2004. Les deux sites se situent dans le Delta Mort septentrional.*

Biodiversity and international importance

Considering the Delta Mort as an integrated eco-zone, its waterbird biodiversity almost doubles compared to the results of the rice field counts alone. Marshy habitats have been rather superficially looked at and need further, more profound investigation in order to establish national, (eco-)regional and international importance of this area.

Purple Swamphen *Porphyrio porphyrio* (hundreds seen), African Pygmy Goose *Nettapus auritus* (some dozens) and African Darter

Anhinga rufa (>50), vulnerable species, have been observed in substantial numbers and are comparatively well represented within West Africa as -potential- breeding species in the area; they favour the Nymphea-Typha habitats with some trees and bushes. Marsh Owl *Asio capensis*, generally described as an uncommon to rare breeding species in West Africa (Borrow & Demey 2001), is a fairly common breeding species, with main breeding numbers probably in the fala sectors although during density counts a nest (1 fresh egg, two birds around, mid-December 2003) was found in a harvested paddy field. Marsh Owls are observed throughout the year and consume rats, mice and insects whereas another insect-eating raptor species, the African Swallow-tailed Kite *Chelictinia riocourii*, having a seasonal pattern, shows up by the end of the year and disappears in the following months. Some 3000 birds were noted at night roosts in December 2003.

Counts may also reveal the Delta Mort's international importance -Ramsar Convention: 1% of (sub)population occurring- for Eurasian Marsh Harrier *Circus aeruginosus*, Purple Heron *Ardea purpurea* and other afrotropical and palearctic species. As shown above, organized hunting may have a considerable impact on migrant European Turtle Doves -a European Conservation Concern species- feeding in wetlands like paddy fields.

4.4. IMPORTANCE FOR OTHER FAUNA

Available data

No census results are available on other fauna. A mammalian fauna list, merely based on a literature search for an area including not only the Delta Mort, reportedly existed but seems to have vanished during restructuration of the National Direction of Nature Conservation (comm. DRCN-Segou).

According to local people Hippopotamus *Hippopotamus amphibius*, West African Manatee *Trichechus senegalensis* and Monitor Lizard *Varanus niloticus* would occur on the adjacent Niger River. Fishermen in Mio and Molodo claim the incidental occurrence of Hippos, whereas rumours on big crocodiles ('as big as pirogues') occurring in the Fala area have not substantiated during further investigations. However, the fala zone contains apparent suitable habitat: grassy and muddy places, huge stretches of *Typha* beds and open water with submerged vegetation and bushy shores. Patas *Cercopithecus patas* and Green Monkeys *C. aethiops* occur in wooded areas. The rice area holds considerable populations of rats, mice and insects (i.e. grasshoppers, locusts, beetles, etc.) attracting avian predators like Marsh Owl *Asio capensis*, Black-shouldered Kite *Elanus caeruleus* and African Swallow-tailed Kite *Chelictinia riocourii* (see above).

Significance

The area holds suitable habitat for West African Manatee *Trichechus senegalensis,* Hippopotamus *Hippopotamus amphibius* and Nile Crocodile *Crocodylus niloticus,* at present rare or incidental species in the area. Protection of these species would be a challenge, but considering the rural population pressure it would request a long traject of consultation and creating awareness before concrete protection measures could be taken. Expanses of forests are quite substantial in places, and constitute habitat for monkeys and possibly small antelopes (duikers), not to mention its function for waterbirds: roosts and breeding colonies. Restauration, safeguarding, protection and surveillance of ecologically strategic sites (forest expanses, but also Typha and other wetland habitat) should be part of an integrated approach for ecological restoration activities in the Office du Niger area. Furthermore, the Fala area is in urgent need of more detailed investigations, followed by/combined with monitoring programmes.

Cultivation of rice in the ODRS paddyfiels downstream the Sélingué dam (up), and view of the Sélinkegny Lake at Carrière (major fishing port).
Riziculture dans la zone aménagée de l'ODRS en aval du barrage de Sélingué (en haut), et vue du lac Sélinkegny à Carrière, l'un des principaux ports de pêche.

5. SELINGUE LAKE AREA

5.1. SHORT CHARACTERIZATION

General description

The Sélingué dam has been built in one of the major Niger tributaries, the Sankarani, and the lake covers a maximum area of 40900 ha at the highest lake level, when it is 80 km long, about 20 m deep in some places and its width then roughly varies between 3 and 8 km (figure 15; Maïga 2001). The dam became operational in 1980 and provides electricity for the Bamako-Koulikoro-Ségou common network. Situated in woodland habitat it did not come as a big surprise to see several hundreds of emerging dead trees in the lake during our counts (see picture). Various grassy habitats develop -on sandy, clayey, gravelly or even stony grounds- between woodland and waterline when the water in the lake falls off; lowest levels are recorded in June. Downstream the dam some 1350 ha of mainly rice crop area -out of 55000 ha planned- have been reclaimed as compensation for the loss of arable land and dwelling grounds of 30 villages and hamlets.

Main differences between the Delta Mort and the Sélingué area, apart from the Sélinkegny Lake, are their extents (Sélingué irrigation area less than 3 % of DM), their crop scheme balances between counter-season and rainy season (so far Sélingué tends to grow relatively few rice during the rainy season whilst giving priority to traditional dry cultures) and their geographical situation (more rain at lower latitude in Sélingué, and situated in rather hilly woodland area compared to the flat and open Delta Mort and Inner Delta).

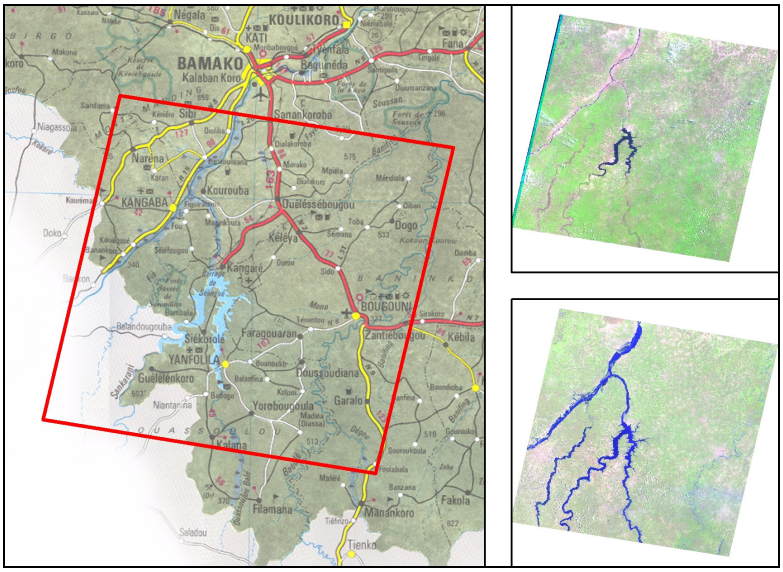

Fig. 15. Map and quicklooks of the Sélinkegny Lake area, at the bottom 12 September 2001 (high water level, at the end of the rainy season) and 7 March 2002 (dry season in progress). The rice polder lies just north of the dam.

Fig. 15. *Carte et 'quicklooks' (images satellitaires à grande échelle) de la zone du Lac Sélinkegny. A droite l'image du 12 septembre 2001 en bas (hautes eaux vers la fin de la saison des pluies) et du 7 mars 2002 (saison sèche). Le polder rizicole se situe juste au nord du barrage.*

Socio-economic aspects

The Sélingué zone has an agricultural and fisheries vocation as it is situated in the guinean climate belt, with abundant rainfall (1100-1200 mm) and several water courses in the area. Since the construction of the Sélingué dam, creating the Sélinkegny Lake, the resident Wassoulou population consisting of Peulh people has increased considerably, with fishermen and new rice-farmers settling in the area. However, it affected the fruit-culture, one of the main economic activities, by the inundation of mango, guava and orange orchards. Cattle numbers increase especially during

the dry season when pasture-lands emerge with receding water levels, and rice stubble-fields become available. The ODRS (Office de Développement Rural de Sélingué) coordinates the agricultural activities of 15 villages in some 1600 parcels, and of fisheries executed by 4000 fishermen spread over 72 settlements.

Agriculture

The ODRS manages a double-crop system in a polder of 1350 ha, where at present some two-third is rice cultivation area; 18% is horticulture and 5% maize and other dry cultures. Average rice yield per ha is 4.48 and 5.82 ton for wet and dry season crop respectively, giving an estimated total of 9146 ton paddy per year. Table 9 shows wet and dry rice crop yields per year, over 1991-2000.

Table 9. *Cultivated rice area (Nha) and yields per annum, for wet and dry season crops. Period 1991-2000. Source: ODRS*
Tableau 9. Zone rizicole (N ha) et rendement/an, pour les cultures hivernales et contre-saison. Période 1991-2000. Source : ODRS.

Year	Cultivated hectares		Crop yield in tons/ha	
	Counter-season	Wet season	Counter-season	Wet season
1991	607	784	5,13	2,24
1992	692	795	4,98	2,92
1993	732	797	4,78	3,90
1994	810	817	4,40	3,66
1995	822	792	3,56	2,35
1996	852	795	4,31	?
1997	853	774	2,88	3,29
1998	810	669	3,04	3,58
1999	780	667	4,67	2,46
2000	757	?	5,27	4,36

Table 8 also shows roughly equal surfaces cultivated in wet and dry season, with a positve trend towards dry season crops. Moreover, dry season yields are mostly higher than wet season yields. This is explained by the fact that rice-farmers spend more time to their dry season crops, whereas during the rainy season time is shared between rice parcels and traditional dry culture exploitations. Harvested rice is partly used for own consumption, the rest being sold to village associations or private traders.

Figure 16. *Rice cultivation in the Sélingué paddy field area, north of the dam, 1983–2002. Source: google earth.com.*
Riziculture dans la zone de Sélingué, 1983 – 2002, au nord du barrage. Source : Goodgle earth.com.

Fisheries

Yearly fish catches account for some 4500 tons in recent years, of which 70% is sold fresh. Up to 86 species are being caught, with fishing gear including drift-, cast- and drag-nets, hook-lines and fish-cages. Fishing boats comprise pirogues and pinasses (pirogues with outboard engin). Main fishing-ports are Carrière (eastbank, near the Sélingué dam) and Faraba (westbank, Sankarani upstream), but 72 fishermen's settlements have been counted around the lake. In June 2004, at the lowest lake level, some small settlements (up to some fifteen hoods together, taken off the pirogues) were observed at the lakeshore around the Sankarani - O. Balé bifurcation point. These fishermen came from adjoining villages, but also from places further upstream where fishing grounds temporarily dry up. Zwarts *et al.* (2005) report more extensively on the fisheries in the Selingué area.

5.2. HABITATS

Rice fields
A 1350 ha irrigation zone has been created along the eastbank of the Sankarani just behind the Sélingué dam. At present some 600-800 ha of paddy fields are being cultivated, both during the rainy and dry season. In early July 2003 and June 2004 we noticed abundant weeds growing on rice fields and dikes giving the area a green, near-marshy look in some places. In 2003 the rainy season crop cycle was about to start, but human activity was still low. Last patches of dry season rice were (about to be) harvested, first cultivated plots were being planted, weeds were removed here and there, and few small beds with seedlings for the coming crop were noted. Waterlilies were regularly observed in inundated fields. June 2004 made a somewhat drier impression, and the final harvest stage was more visible. In both years December made the dry post-harvest impression as described for the Delta Mort, whereas February showed the initial dry season rice crop, with substantial planted area in 2003 but only first seedbeds and inundations in a relatively dry, post harvest area in 2004.

Lake
Mainly a large open water lake with variable depths (in space and time), shallow margins with many dead trees and surrounded by woodlands. Maximum and minimum water levels vary between 449 m and 441 m (lake gauge) as a rule, with even lower levels in some years. The lake is widest between the dam and the confluence of the rivers Sankarani and Ouassoulou Balé both being part of the bifurcated lake at high water. At decreasing water levels clayey, sand- and gravelbanks emerge, whereas the two rivers may lose their lake-like appearance (pers. comm. Mr. Sangaré, ODRS).

Table 10. *Counts in the Sélingué area. Only species with more than 20 individuals are shown. Full results in App. 4.*
Tableau 10. Comptages dans la zone de Sélingué. Seules les espèces à plus de 20 oiseaux sont montrées. Résultats intégraux v. Appendice 4.

	Jun-02	Dec-02	Feb-03	Jul-03	Dec-03	Feb-04	Jun-04
	lac	lac	Lac	lac	lac	lac	lac
Long-tailed Cormorant	19	316	545	60	0	2555	181
Grey Heron	0	50	51	1	63	49	3
Little Egret (white morph)	0	61	40	1	21	32	6
Cattle Egret	77	96	136	0	67	221	145
White-faced Whistling-duck	14	4438	14960	154	1294	14000	36
Egyptian Plover	30	0	0	25	0	0	27
Common Pratincole	12	0	0	31	0	2	61
Spur-winged Lapwing	12	2	35	70	0	73	139
Kittlitz's Plover	46	0	1	83	0	0	143
Gull-billed Tern	0	0	37	0	0	5	0
Osprey	0	17	32	2	18	49	7
Black Kite	0	519	0	1	76	357	25
Totals per count and site	210	5499	15837	428	393	13124	824
		riz	riz	riz	riz	riz	riz
Grey Heron		31	1	0	2	10	0
Great Egret		10	0	45	1	0	0
Intermediate Egret		0	45	14	5	3	1
Little Egret (white morph)		68	17	0	48	0	0
Cattle Egret		1095	1569	5	502	1380	0
Squacco Heron		8	13	23	6	3	10
Hamerkop		20	6	0	15	3	0
African Jacana		6	15	154	8	31	5
Black-winged Stilt		15	143	0	0	10	0
Common Pratincole		43	40	0	0	8	0
Spur-winged Lapwing		595	344	108	253	201	8
African Wattled Lapwing		163	165	8	71	179	4
Wood Sandpiper		111	140	0	10	72	0
Yellow Wagtail		94	0	0	7	46	0
Totals per count and site		2249	2498	334	943	1974	49

5.3. ORNITHOLOGICAL IMPORTANCE

Census results

Like in the Delta Mort systematic general counts and density assessments have been done in the paddy field area and in the Sélinkegny Lake (its official name since 1987). Densities were mainly assessed in the paddy field zone, but could also be derived for some species counted on the lake. Table 7 shows the results of the general counts carried out on the lake and in the rice polder.

Most common species in the paddy fields were Cattle Egret *Bubulcus ibis* and Spur-winged Lapwing *Vanellus spinosus*, followed by another species with relatively arid conditions tolerance, the African Wattled Lapwing *Vanellus senegallus*, which surprisingly lacked in the Delta Mort counts. In Sélingué it was quite common although most birds had disappeared in July. Wood Sandpiper *Tringa glareola* and (only December) Yellow Wagtail *Motacilla flava* occurred quite numerously too, whilst in density counts they largely outnumbered the before-mentioned top two, just like in the Delta Mort. In the July 2003 counts African Jacana *Actophilornis africana* turned out to be most common (general and density), followed by Spurwing (general), Great Egret *Egretta alba*, , Squacco Heron *Ardeola ralloides* and, remarkably, Greater Painted-snipe *Rostratula benghalensis* (density). Other highlights were Forbes's Plover *Charadrius forbesi* seen in February and an apparent dry season visitor in southern rice habitat, and Great Snipe *Gallinago media*, a near-threatened, vulnerable species of European Conservation Concern.

Lake Sélinkegny

Lake count numbers in December and February were mainly determined by White-faced Whistling Duck *Dendrocygna*

viduata. 80-95% of the totals concerned this species, whereas established numbers were quite impressive: their roosting population on the lake increased between December 2002 and February 2003 from 4500 to 15000 birds, largely beyond the Ramsar 1%-threshold (2500) for international importance. In December most birds were seen on the Sankarani just upstream the confluence, whereas in February they roosted on the lake just south of the dam. From December 2003 to February 2004 the same shift in numbers and distribution was observed, although less birds showed up in the standard area counted. However, their total number turned out quite similar when we extended our lake count (Fig. 17). Substantial numbers were found more upstream, possibly since counter-season rice cultivation was delayed in comparison with the year before (see also Ornithological significance).

Osprey *Pandion haliaetus* were counted along a standard boat transect (see Fig. 17). Their number doubled from December to February, with increases on all subtransects. This may be contraction of birds wintering on the lake, triggered by receding water levels, or first pre-migratory movements of birds from elsewhere invading emerged sandbank habitat along the river downstream. Shore counts in June-July revealed very modest bird numbers, with Spurwings, Egyptian Plover *Pluvianus aegyptius* and Kittlitz's Plover *Charadrius pecuarius* among the more common species. Rare species, although seen yearly, were White-headed Lapwing *Vanellus albiceps* and Grey Pratincole *Glareola cinerea*; observations of the latter may constitute the most upstream records in the Malian Niger Basin so far (2 in 2003, 1 in 2004).

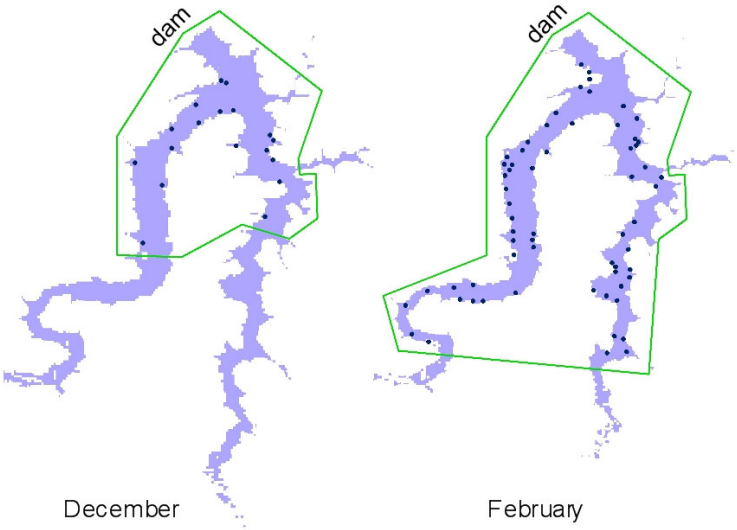

Figure 17. *Sélinkegny Lake with Osprey* Pandion haliaetus *distribution mid-December 2003 and mid-February 2004.*
Figure 17. Distribution du Balbuzard pêcheur Pandion haliaetus dans le Lac Sélinkegny, mi-décembre 2003 et mi-février 2004.

Two species with remarkable densities were found on the Sélinkegny Lake next to the paddy fields of Sélingué: palearctic Osprey *Pandion haliaetus* and afrotropical White-faced Whistling Duck *Dendrocygna viduata*. Both species show increasing numbers between December and February, when the lake's water level decreases. Our counts in 2002/2003 and 2003/2004 suggest that both species contract, but in different ways. The Ospreys roughly double their number but stay evenly distributed along the shoreline (see Figure 17), while White-faced Whistling Ducks initially occur more upstream on the lake (both tributaries: Ouassoulou Balé and Sankarani) and concentrate more and more near the Sélingué dam where the reservoir is at its widest, and the

distance to the irrigation zone very short (<1 km). This concentration is probably triggered by the onset of the counter-season paddy cycle. Paddy farmers consider them a pest but densities can not be established as they feed at night. Counts on the lake seem to suggest that densities in the rice may be high (>10 birds/ha), but the species has also been observed feeding on submerged lake vegetation, and is told to visit surrounding water holes as well.

Ornithological significance

At first sight the Sélingué rice polder hosts more waterbirds than the Delta Mort, considering the general and density counts. However, extrapolations would provide far more birds for the irrigation zone of the Office du Niger than for Sélingué by the obvious difference in surface area: 60000 against 1350 ha. As was assessed for the Office du Niger, biodiversity seems relatively low (see Appendix 6) compared to natural wetland habitat, but here again: paddy field habitat as counted in Sélingué is monotypic (although between the two crop cycles during the rainy season it appeared to be green, weedy, and marshy in places) whereas natural wetland often is a mosaic of several (micro)habitats.

In July 2003 African Jacana *Actophilornis africana* was by far the most common species together with Spur-winged Lapwing *Vanellus spinosus*, and small secretive marsh birds like Lesser Moorhen *Gallinula angulata* and Lesser Jacana *Microparra capensis* were regularly seen, providing new distribution data for these uncommonly observed species (cf. Borrow & Demey 2001). An African Crake *Crex egregia* was seen in an irrigation ditch during density counts. Second-common wader species in July (just before palearctic arrivals) was the afrotropical Greater Painted-snipe *Rostratula benghalensis*, mainly turning up in density counts. The Sélingué irrigation zone may serve as a dry season staging area for species like Cattle Egret *Bubulcus ibis* and

African Wattled Lapwing *Vanellus senegallus*. They had practically disappeared from the area in July but remaining birds of latter species had half-grown young. Wood Sandpiper *Tringa glareola*, Cattle Egret and Yellow Wagtail *Motacilla flava* were the most numerous species in February density counts (like in the Delta Mort); in early July 2003 Wood Sandpipers were still lacking in the area but we saw and heard three birds heading south over the area without hesitation.

Biodiversity and international importance

Taking the rice and the lake area as an ecological entity, since clear links between both habitats were noted here too (as in the Delta Mort), then waterbird biodiversity substantially increases, although numbers seen on the lake were generally low during the waterbird counts. A major and striking difference with the Delta Mort -as far as appropriate sites have been covered in the right period- is the occurrence of internationnally important numbers of White-faced Whistling Duck *Dendrocygna viduata* roosting on the Sélinkegny Lake (criterion 6 Ramsar Convention, see above), underlining the rest and safety aspects of *Anatidae* presence. Whether the nearby rice polder with its relatively small surface constitutes the only feeding ground for this species is questionable. Farmers consider them as a pest as they graze and trample their rice seedling beds, but according to others they may feed in surrounding marshy habitats as well. Being the only species around in vast numbers, it reconfirms the conclusion of Roux & Jarry (1984) that most *Anatidae*, afrotropical and palearctic, spend the dry season (boreal winter) in the sahelian belt.

Sélinkegny Lake is also an important wintering area for Osprey *Pandion haliaetus;* a preliminary estimate of 50-100 birds based on mid-winter counts in 2002-2003 could be maintained in 2004 when over 60 birds were counted on some 70% of the lake.

Another barrage lake, Lake Volta in Ghana, is estimated to hold some 400 wintering Osprey (K. Goudswaard, in Wymenga *et al* 2002). Dead trees at the lakeside served as a night roost for Long-tailed Cormorant *Phalacrocorax africanus* (several hundreds), Cattle Egret (1500-2000) and Black Kite *Milvus migrans* (>500). Breeding colonies were not found, but overall counts in this eco-zone are expected to reveal whether this is a reality or not: fishermen claimed breeding 'herons' more upstream the lake. In June 2004 bush cover along the Sankarani just downstream the dam hosted several white heron species (100-200 birds in total) and <10 Black-crowned Night Herons *Nycticorax nycticorax* roosting, whereas Squacco Herons *Ardeola ralloides* in full summer plumage are assumed breeders in this area.

Rice area and lake combined will certainly meet criterion 5 of the Ramsar Convention: a wetland should be considered internationnally important if it holds regularly 20000 waterbirds or more.

5.4. IMPORTANCE FOR OTHER FAUNA

Available data

No census results available, but according to local people there is rich wildlife around: Crested Porcupine *Hystrix cristata*, monkeys and several antelope species. This qualification may be a bit biased as the Wassoulou region in which Sélingué is situated has a hunting tradition. Bats *Chiroptera* -many species, see Kingdon 1997- are found in the area, preyed upon by Bat Hawks *Macheirhamphus alcinus*, seen at dusk (July 2003) in Sélingué. This species is not mentioned by Lamarche (1981), but reportedly occurs in the Dogon region and at the border between Mali and Ivory Coast (Borrow & Demey 2001).

In July 2003 we found Hippopotamus *Hippopotamus amphibius* traces on the westbank of the Lake near the Sélingué dam, and local villagers confirmed the incidental occurrence of two hippos in this area. The status of West African Manatee *Trichechus senegalensis* is unclear: some people agree on its occurrence, others don't.

Significance

With data entirely lacking, the large Sélinkegny Lake is in need of more thorough biodiversity investigations. This holds not only for waterbirds but also for mammals and reptiles. The Ramsar Convention criteria do not only relate to waterbirds but also to threatened and vulnerable species, refuge and survival function of wetlands, and to fish (nursery function, unique species, specific growth stage area), etc.

6. DENSITIES OF WATERBIRDS

6.1. INTRODUCTION

Waterbird census work mostly has a general character, executed in specific areas often including composite habitat. Results can be highly accurate in open habitats, but reliability decreases with habitat complexity: reeds, tall grasses, bul-rush and other higher vegetation substantially influence assessed numbers. Comparability of census results depends on habitats, periods and (numbers and experience of) counters involved. Moreover, non-gregarious species or species hiding (partly) in vegetation cover are heavily underestimated in such general waterbird censuses.

Subsaharan Africa comprises a vast area where waterbird counts have been done in only a fraction of the total wetland area available. Wetlands International´s IWC (International Waterbird Census) made a great effort to improve this situation, by organizing national and regional training courses and getting more and more local counters involved in its IWC network. Nevertheless many sites in Africa will stay uncounted for the years to come, and the idea came up whether it would be possible to assess bird densities in a range of natural and human-made wetland habitats, and be able -in combination with satellite image analysis- to extrapolate these for total area of identified habitats available within biogeographical and/or climatic zones. Density assessments would not only allow the before-mentioned extrapolations for human-made wetlands but also give indications on waterbird contraction in large-scale floodplains at decreasing water levels.

In this chapter results of the density counts done in the Inner Niger Delta -a natural floodplain- and two human-made upstream wetlands, the Delta Mort and the Sélingué area, are analysed. In Chapter 2.3 the methods are worked out, but we start this chapter with a number of methodological aspects.

6.2. METHODOLOGICAL ASPECTS

To handle the limitations described previously, an alternative census method was adopted, i.e. to complete counts in small plots of known size. In general methods are described in Chapter 2; here additional methodological aspects are worked out.

The large variation in bird density, the likelihood of numerous samples having zero birds and logistical problems voted against random sampling in a large number of plots. Instead, stratified sampling was chosen as the proper census method in the Inner Delta. Bird counts were performed in specified vegetation types under various water depths. The vegetation map (Zwarts et al. 2005) was used to determine the surface of main habitat types, such as bourgou and rice fields. For each flood level, the digital flooding model (Zwarts et al. 2005) enabled the calculation of the total surface of the flooded area. In combination with the vegetation map, the surface of bourgou, rice field and other habitats on dry ground and standing in 10, 20, … 500 cm of water could then be determined. Stratified sampling in each of these habitats and water categories would allow the calculation of an average bird density per habitat.

Location of plots

All density counts were performed between 1 November and 15 March 2001/2002, 2002/2003, 2003/2004. Table 11 gives an overview where and in which zones plots have been sampled.

Table 11. *Overview of the number of plots per focal area and per zone within these areas. For location of the zones see resp. Fig. 6 (Inner Niger Delta), Fig. 10 (Office du Niger) and Fig. 15 (Sélingué area).*
Tableau 11. Aperçu du nombre d'échantillons de terrain par zone d'étude et réparti sur les sites sélectionnés. Pour les positions des zones v. Fig. 6 (DIN), Fig. 10 (Office du Niger) et Fig. 15 (Sélingué).

Zone	1	2	3	4	5	6	7	Total
Inner Niger Delta	172	178	29	92	80	58	4	613
Office du Niger	370	189	208	76	90			933
Sélingué area	42	28	39	25	81	15		230
Total								1776

1	Inner Niger Delta	2	Office du Niger	3	Sélingué
1	Lac Debo	1	Diabaly	1	sector 11
2	Walado Debo	2	Molodo	2	sector 12-13
3	Lac Horo	3	Niono	3	sector 15
4	Lac Télé	4	Siribala	4	sector 19
5	Mopti	5	Macina	5	sector 20
6	Bani			6	sector 24
7	Konna				

Alltogether 613 counts were made in the *Inner Niger Delta*, most of which near the central lakes. Other sites visited were Mopti and surroundings, the Bani area in the south and Lac Télé in the very north (Fig. 18).

Inner Delta density counts have been carried out in November and December 2003 (ORM zone, Bani), January 2003 and February 2003, 2004 (Lac Debo, Walado Debo, Diaka) and early March 2003, 2004 (Lac Télé ; Lac Horo only 2003). Boats were used as observation platforms where and when counts could not be done on foot; crossing plots deeper than some 80 cm turned out to be practically impossible. Boat counts include transect counts (band width max. 40 m each side, over 40 m only bigger species) and counts from an observation point.

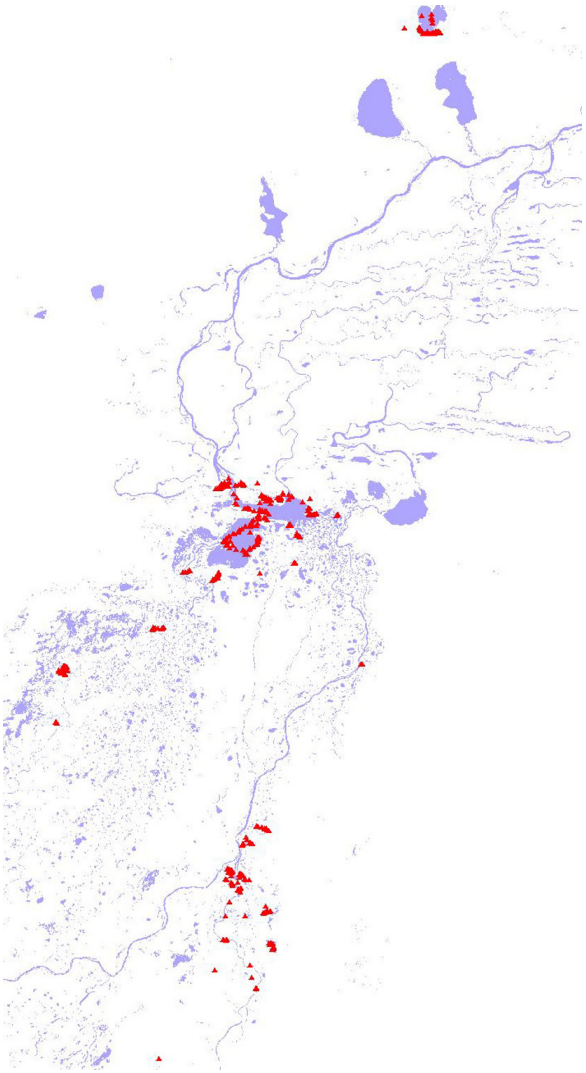

Fig. 18. *The distribution of 613 IND sites where bird density counts in plots were made.*

Fig. 18. *Distribution des 613 sites échantillonnés dans le cadre des comptages de densité d'oiseaux d'eau.*

As stated in Chapter 2 density counts from a single observation point are considered resulting in under-recorded smaller species whereas well-searched habitat units were expected to give more reliable overall results. The under-recording effect was reduced by limiting the radius of the observed circle(-sector); in case of large circles smaller species were -like with transect counts- not taken into account for analysis. Plot sampling at Lac Télé was done in the heavily grazed emerging grasslands on the southern shore, with a bourgou-like vegetation. Densities on Lac Horo have only been assessed in dense 'Loubou' and 'Kouma' vegetation, where vegetation height was 25-30 cm and 40-60 cm respectively.

Density counts in the paddy field area of the irrigation zone of Office du Niger took place in February 2003, 2004, July 2003 and December 2003. Five different areas have been investigated from north to south: Diabaly, Niono, Molodo, Siribala and Kolongotomo. The latter two are situated in the area where rainfall creates an open landscape with widespread dry-ground Baobab *Adansonia digitata* trees, but these may have broken down –due to wet paddy field conditions- in the Macina irrigation area with the Kolongotomo density count site.

Density counts in the Sélingué area were restricted to the paddy field area, and were carried out as in the irrigation zone of Office du Niger, during combined missions. Inundated parcels in these human-made habitats generally contain less than 20 cm of water and could therefore all be checked on foot, either by walking on surrounding dikes in case of small/narrow parcels (<40m) or across when larger units were to be checked (Figure 5).

Main vegetation types

Densities were assessed in 14 vegetation types (Table 12) most of which were encountered in the Inner Niger Delta. In the analysis these 14 vegetation types were reduced to 6 major types.

Bourgou (+ dideré, poro and nénuphar) were collectively named 'bourgoutière. These are in all cases floating vegetations. Three types of grasslands were joined (bare, cynodon, cyperus), whilst another 5 vegetation types only fond in stagnant water (kouma, loubou, horio, garsa, daroun) in the lakes in the north were classified as "stagnant". Most plot counts were performed in bourgoutière, wild rice, cultivated rice fields and grassland.

Table 12. *Overview of vegetation types in which plot sampling took place, plot numbers and summed surface area sampled per vegetation type. DIN Inner Niger Delta, ON irrigation zone of Office du Niger, Sel Sélingué area.*

Tableau 12. Aperçu des types de végétation avec le nombre de comptages de densité y effectué, et leurs superficies couvertes. DIN = Delta Intérieur du Niger, ON = Office du Niger, Sel = Sélingué.
(Number of plots sampled = nombre d'échantillons, Summed surface sampled = superficies sommées des échantillons)

	Number of plots sampled			Summed surface sampled (ha)		
	DIN	ON	Sel	DIN	ON	Sel
Ricecult	64	933	230	107	259	155
Bourgou	293			1395		
Rizsauv	75			234		
Horia	44			139		
Cyperus	32			104		
Nénuphar	29			62		
Kouma	18			1		
Mimosa	15			6		
Loubou	11			0,5		
Garsa	7			51		
Daroun	7			26		
Bare	7			18		
Cynodon	6			15		
Poro	5			3		
Total	613	933	230	2161	259	155

Quantification of results

The plot sampling not only gives a deeper insight in the utilization of vegetation types by waterbirds but also offers the opportunity to estimate the total numbers of birds present. In Zwarts *et al.* (2005) such an estimate is made, using the densities per vegetation type and multiplying these with the surface area of these vegetation types. In this report the analysis and presentation of results is restricted to the densities per vegetation type. Since bird density not only varied per vegetation type, but also with water depth, the latter was routinely registered for each plot.

6.3. DENSITIES PER VEGETATION TYPE

General

The overall mean densities per vegetation type have been presented in Appendix 5, as means per 1000 ha. The overall list contains 62 waterbird species, wetland-related and some widespread afrotropical passerines; it is based on all species found in the three zones considered, except some -in the chosen habitats- rare (or rarely seen) species. Further analysis focuses on three major habitats in the IND. Other IND habitats have been either insufficiently covered, occur in relatively modest expanses or may be lumped to other habitats.

Irrigated areas Office du Niger and Sélingué

Densities in these human-made wetland habitats have been assessed during rainy as well as dry season. Sélingué has substantially higher densities in both seasons compared to the DM but as shown above paddy fields were relatively dry due to special conditions. However, this difference was also noted before these agro-technical actions took place.

Table 13. *Densities of waterbirds per 1000 ha in the riceculture of the Office du Niger (ON) irrigation zone and in the rice polders of the Sélingué area (Sel). On the basis of these densities population estimates for the whole irrigated area are made for the period December-February and June-July. For ON this extrapolation covers 55.000 ha and for Sélingue 1.350 ha.*

Tableau 13. Densités d'oiseaux d'eau par 1000 ha dans la riziculture de l'Office du Niger et de Sélingué. Estimations des populations totales y présentes en décembre-février et en juin-juillet ont été faites à base des densités établies. Les extrapolations ont été appliquées sur 55000 ha pour l'ON et sur 1350 ha pour Sélingué.

	Irrigation zone Office du Niger				Irrigation zone of Sélingué			
Data	N / 1000 ha		Popul. estimate		N / 1000 ha		Popul. estimate	
Species/period	Dec-Feb	Jun-Jul	**Dec-Feb**	**Jun-Jul**	Dec-Feb	Jun-Jul	**Dec-Feb**	**Jun-Jul**
Long-tailed Cormorant	0	0	**0**	**0**	0	173	**0**	**225**
African Darter	0	0	**0**	**0**	0	0	**0**	**0**
Grey Heron	10	0	**550**	**0**	0	0	**0**	**0**
Black-headed Heron	0	0	**0**	**0**	6	0	**8**	**0**
Purple Heron	0	0	**0**	**0**	0	16	**0**	**21**
Great Egret	0	184	**0**	**10120**	32	0	**42**	**0**
Yellow-billed Egret	85	28	**4675**	**1540**	282	28	**367**	**36**
Little Egret	30	0	**1650**	**0**	173	0	**225**	**0**
Little Egret_Reef Heron	0	0	**0**	**0**	6	0	**8**	**0**
Cattle Egret	1240	277	**68200**	**15235**	2950	0	**3835**	**0**
Squacco Heron	72	381	**3960**	**20955**	165	692	**215**	**900**
Great Bittern	0	0	**0**	**0**	0	0	**0**	**0**
Little Bittern	0	11	**0**	**605**	0	0	**0**	**0**
Green-backed Heron	0	25	**0**	**1375**	0	544	**0**	**707**
Sacred Ibis	0	0	**0**	**0**	0	0	**0**	**0**
Glossy Ibis	0	0	**0**	**0**	0	0	**0**	**0**
Hamerkop	2	19	**110**	**1045**	109	0	**142**	**0**
White-f. Whistling Duck	0	0	**0**	**0**	0	55	**0**	**72**
African Pygmy Goose	0	0	**0**	**0**	0	0	**0**	**0**
Common Moorhen	0	0	**0**	**0**	0	0	**0**	**0**
Lesser Moorhen	0	4	**0**	**220**	0	127	**0**	**165**
Purple Swamphen	0	0	**0**	**0**	0	0	**0**	**0**
African Jacana	0	293	**0**	**16115**	302	6156	**393**	**8003**
Lesser Jacana	0	0	**0**	**0**	6	294	**8**	**382**

Black-winged Stilt	179	0	**9845**	**0**	100	0	**130**	**0**
Collared Pratincole	105	0	**5775**	**0**	92	0	**120**	**0**
Greater Painted-snipe	0	97	**0**	**5335**	7	697	**9**	**906**
Spur-winged Lapwing	1284	889	**70620**	**48895**	871	426	**1132**	**554**
African Wattled Lapwing	0	0	**0**	**0**	1191	160	**1548**	**208**
White-headed Lapwing	0	0	**0**	**0**	0	40	**0**	**52**
Common Ringed Plover	0	0	**0**	**0**	0	0	**0**	**0**
Little Ringed Plover	0	0	**0**	**0**	152	0	**198**	**0**
Kittlitz´s Plover	6	0	**330**	**0**	31	0	**40**	**0**
Forbes´s Plover	0	0	**0**	**0**	87	0	**113**	**0**
Spotted Redshank	0	0	**0**	**0**	0	0	**0**	**0**
Marsh Sandpiper	0	0	**0**	**0**	0	0	**0**	**0**
Common Greenshank	17	0	**935**	**0**	73	0	**95**	**0**
Green Sandpiper	3	0	**165**	**0**	17	0	**22**	**0**
Wood Sandpiper	1207	0	**66385**	**0**	3971	0	**5162**	**0**
Common Sandpiper	0	0	**0**	**0**	41	0	**53**	**0**
Common Snipe	30	0	**1650**	**0**	120	0	**156**	**0**
Great Snipe	27	0	**1485**	**0**	142	0	**185**	**0**
Jack Snipe	0	0	**0**	**0**	4	0	**5**	**0**
Little Stint	32	0	**1760**	**0**	3	0	**4**	**0**
Temminck´s Stint	0	0	**0**	**0**	8	0	**10**	**0**
Curlew Sandpiper	0	0	**0**	**0**	0	0	**0**	**0**
Ruff	3	0	**165**	**0**	299	0	**389**	**0**
Ruddy Turnstone	0	0	**0**	**0**	0	0	**0**	**0**
Gull-billed Tern	0	0	**0**	**0**	0	0	**0**	**0**
Marsh Owl	29	141	**1595**	**7755**	0	0	**0**	**0**
Pied Kingfisher	0	21	**0**	**1155**	0	0	**0**	**0**
Yellow Wagtail	5854	0	**321970**	**0**	3536	0	**4597**	**0**
Red-throated Pipit	0	0	**0**	**0**	6	0	**8**	**0**
Yellow-thr. Longclaw	0	0	**0**	**0**	0	150	**0**	**195**
Sedge Warbler	0	0	**0**	**0**	0	0	**0**	**0**
Savi´s Warbler	0	0	**0**	**0**	0	0	**0**	**0**
Bluethroat	0	0	**0**	**0**	0	0	**0**	**0**
Crested Lark	399	0	**21945**	**0**	35	0	**46**	**0**
Zitting Cisticola	146	94	**8030**	**5170**	28	11	**36**	**14**
Prinia spec	47	0	**2585**	**0**	0	0	**0**	**0**
Northern Red Bishop	0	0	**0**	**0**	0	17	**0**	**22**
Yellow-crowned Bishop	13	59	**715**	**3245**	0	39	**0**	**51**
Totals	10821	2521	**595155**	**138655**	14844	9625	**19297**	**12513**

Dry season (Dec-Feb) numbers were higher through influxes of palearctic migrants and intra-regional movements of afrotropical species. Main **palearctic** species involved were Black-winged Stilt *Himantopus himantopus*, Wood Sandpiper *Tringa glareola* and Yellow Wagtail *Motacilla flava* (several former subspecies nowadays split into species but still subject to discussion), and Common Snipe *Gallinago gallinago*, Great Snipe *Gallinago media* and Lesser Ringed Plover *Charadrius dubius* to a lesser extent.

As to **afrotropical** species substantial shifts were noticed for Yellow-billed Egret *Egretta intermedia*, Cattle Egret *Bubulcus ibis*, Spur-winged Lapwing *Vanellus spinosus*, African Wattled Lapwing *Vanellus senegallus* (only Sélingué), and wetland-related passerines like Crested Lark *Galerida cristata* and Zitting Cisticola *Cisticola juncidis*. Other species counteracted this general shift: rain season showed -for at least one of the zones considered- increased numbers of Long-tailed Cormorant *Phalacrocorax africanus* (sel), Great Egret *Egretta alba* (dm), Squacco Heron *Ardeola ralloides* (both), Green-backed Heron *Butorides striatus* (both), African Jacana *Actophilornis africana* (both), Lesser Jacana *Microparra capensis* (sel) and Marsh Owl *Asio capensis* (dm).

DM-Sélingué compared to IND cultivated rice habitat

As density counts in the Inner Niger Delta have only been executed during the dry season (Nov-Mar) a comparison can only be made for this period. Waterbird density in IND cultivated rice is obviously higher -roughly 2-3 times- than in the irrigated rice areas. A major bias towards the IND is caused by strong numerical representation of Black-winged Stilt *Himantopus himantopus*, Collared Pratincole *Glareola pratincola*, Kittlitz's Plover *Charadrius pecuarius*, Little Stint *Calidris minuta*, Ruff *Philomachus pugnax* and Crested Lark *Galerida cristata*.

Remarkably, Wood Sandpiper *Tringa glareola* and Yellow Wagtail *Motacilla flava* seem to have higher densities in the Delta Mort and Sélingué. As for the number of species found there are no big differences, although Sélingué tends to have the highest biodiversity (on the list used: 31 species). The IND (rice) has 27 species which is also the average for all three zones.

Inner Niger Delta

Densities have been assessed in various habitats, but as mentioned above only three major habitat types are looked at more closely (see 6.3 and 6.4) as they represent very large vegetation units in the IND. Basic data are presented in Appendix 5 and Table 14, and are summarized in Fig. 19. As satellite image analysis shows in the deepest parts of the floodplain predominantly Bourgou *Echinochloa stagnina* and Didéré *Vossia cuspidate* occur, these are taken together as bourgou habitat. In the middle depth range wild rice *Oryza longistaminata* prevails (including patchy *O. glaberrima*), whereas cultivated rice ('floating rice') habitat is found in the upper reaches of the delta, around villages and temporary settlements.

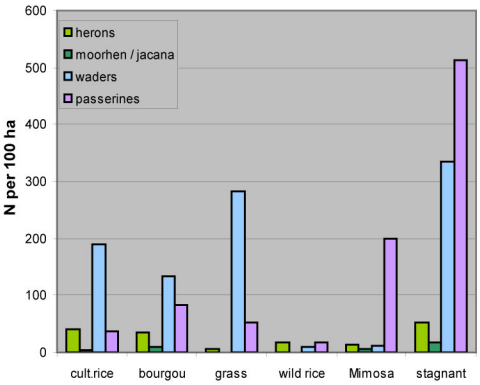

Figure 19. *Waterbird densities in the Inner Niger Delta for six different lumped vegetation types. Data in Table 14.*

Fig. 19. Densités d'oiseaux d'eau dans le Delta Intérieur pour six types de végétation groupés. Données v. Tableau 14.

Table 14. *Average bird density per 1000 ha in six habitat types. Summed numbers are also given for heron species, moorhens + jacana, waders and passerines (below).*

Tableau 14. Densité d'oiseaux moyenne par 1000 ha, dans six types d'habitat différents. Effectifs sommés -en bas- sont également donnés pour Ardeidae *(hérons-aigrettes), 'poules d'eau et jacanas', limicoles ('waders') et passereaux.*

Bird species	cult.rice	bourgou	grass	wild rice	mimosa	stagnant	Mean
Long-tailed Cormorant	0	1596	13	6	0	330	855
African Darter	0	60	0	0	0	0	30
Grey Heron	55	272	7	426	0	77	214
Purple Heron	41	450	22	6	185	297	293
Great Egret	0	148	0	0	0	121	96
Yellow-billed Egret	0	212	41	0	0	719	218
Little Egret	82	231	249	40	926	342	226
Little Egret black morph	0	20	12	0	0	0	12
Cattle Egret	3715	658	247	1309	0	871	1041
Squacco Heron	129	1292	45	15	295	2385	1025
Great Bittern	0	56	0	0	0	0	30
Glossy Ibis	0	86	0	0	0	363	98
Lesser Moorhen	0	3	0	0	556	0	18
Purple Swamphen	0	124	0	0	0	567	145
African Jacana	377	642	0	1	0	151	389
Lesser Jacana	34	205	0	42	0	1029	260
Black-winged Stilt	898	727	434	0	0	1459	706
Collared Pratincole	5589	1606	2219	349	0	115	1711
Greater Painted-snipe	0	37	0	0	0	6	20
Spur-winged Lapwing	543	253	366	155	0	28	246
Common Ringed Plover	23	292	1403	3	0	6	267
Little Ringed Plover	4	140	0	0	0	593	152
Kittlitz´s Plover	298	384	1702	0	0	0	369
Spotted Redshank	120	4	10	0	0	0	17
Marsh Sandpiper	0	16	47	0	0	0	12
Common Greenshank	122	6	76	0	0	0	24
Wood Sandpiper	844	3301	3332	379	869	7896	3187
Common Snipe	94	59	0	28	0	72	52
Great Snipe	27	14	188	0	201	0	32
Little Stint	1152	1554	6836	37	0	1962	1754
Curlew Sandpiper	0	57	2698	0	0	51	258

Ruff	9150	4844	8992	106	0	21251	7152
Yellow Wagtail	1957	5266	4339	1217	6491	17206	5919
Sedge Warbler	0	1620	0	17	7599	33897	5807
Bluethroat	0	141	0	0	2451	0	146
Crested Lark	1653	1095	867	433	936	74	879
Zitting Cisticola	0	179	66	131	0	25	117
Prinia spec	0	65	0	6	2377	0	104
TOTAL	26981	27778	34263	4718	22940	91958	33938

Herons	4054	3445	625	1796	1406	5175	16502
Moorhens / jacana	412	973	0	43	611	1747	3786
Waders	18905	13334	28338	1059	1069	33503	96208
Passerines	3610	8368	5272	1804	19854	51202	90110
number of counts	64	327	45	74	15	87	612

The difference in waterbird densities as compared to human-made wetlands is a bit more pronounced than for the rice comparison between these zones alone. Bourgou and cultivated (floating) rice show relatively high densities, but wild rice holds strikingly low numbers resulting in the lowest densities among all quantified habitats.

Most of the other habitats (Appendix 5) showed higher densities than in bourgou, wild and cultivated rice, but their coverage is minor compared to these and therefore more hazardous to interpret. The bourgou-like habitats 'Horia' and 'Garsa' (sonrhaï terms) found in Lac Télé may be lumped with bourgou which also occurs in this area but in deeper (adjacent) ranges. Horia showed very high densities and had a better coverage than cultivated rice but substantial extents were only noted in Télé where it formed a seamless vegetation unit with strongly recovered bourgou in 2004. Densities in Horia habitat were for 80% composed by Ruff *Philomachus pugnax*, Yellow Wagtail *Motacilla flava* and Wood Sandpiper *Tringa glareola* (in decreasing order). Garsa scored relatively high too, some 80% of the density being accounted for by Yellow Wagtail, Wood Sandpiper and Glossy Ibis *Plegadis falcinellus*.

Waterlily *Nymphea* habitat overlaps with bourgou, wild rice, cultivated rice and even vetiveria (upper depth range) habitat; mixed plots (mostly occurring) have been assigned to either bourgou or wild rice for satellite image analysis. In Lac Horo two habitats covering large expanses -'Kouma' *Polygonum spec.* and 'Loubou', again sonrhaï terms- were checked for Sedge Warbler *Acrocephalus schoenobaenus*, practically the only wetland-related species around in this vegetation, but showing very high densities. These habitats consist of stagnant water plant species which are also found in irrigation ditches in the DM and Sélingué although they were not seen here in large(r) vegetation units.

Cynodon, 'Poro' and *Mimosa* habitat are all found in the upper depth range (*Mimosa* being the only *bush* habitat selected, with Chiffchaff *Phylloscopus collybita* -also found in flood forest- as characteristic species) whereas deep-lying *Cyperus* habitat was counted on recently emerged muddy sandflats, with plants just starting to grow ('a green haze over bare flats').

6.4. DENSITIES AND WATER DEPTH

There is a large variation in bird density per vegetation type, largely explained by water depth as shown for bourgou plots in 'Niger, a lifeline' 2005 (Fig. 5 in Appendice VIII). A swimming waterbird like the Long-tailed Cormorant was only observed if there was more than 40 cm of water. On the other hand, typical land birds such as Crested Lark, Cisticole and Prinia were usually only seen in bourgou on land.

Table 15 shows the assessed waterbird species densities at different water depths (including dry and humid), for stagnant water vegetations, grasslands, bourgou, wild rice and cultivated rice.

Table 15. *Average bird density (N/ha) in five habitat types on dry and wet ground and in five different classes of water depth.*
Tableau 15. *Densité moyenne (N oiseaux/ha) dans cinq types d'habitat divisés en sept classes de profondeur (sec jusqu'à 160-320 cm).*

Habitat	Species	dry	humid	<20cm	20-40cm	40-80cm	80-160cm	160-320cm	total
Stagnant	Herons	8.4		8.2	6.0	8.9	0.1	6.7	5.2
	Moorhens, jac.	0.0		0.5	5.4	3.9	0.0	0.0	1.7
	Waders	0.0		150.6	11.6	13.6	0.1	0.0	33.5
	Passerines	1.4		19.8	25.5	39.0	84.3	0.0	51.2
Grassland	Herons	0.0	0.2	1.6					0.6
	Moorhens, jac.	0.0	0.0	0.0					0.0
	Waders	0.0	10.5	73.8					28.3
	Passerines	0.0	5.1	3.0					5.3
Bourgou	Herons	0.8	1.1	2.3	4.9	6.5	1.6	1.6	3.5
	Moorhens, jac.	0.0	0.0	0.0	1.3	2.7	0.6	0.0	1.0
	Waders	1.8	8.0	34.0	12.8	4.2	0.1	0.0	13.4
	Passerines	8.8	11.7	12.3	7.8	7.6	0.7	0.6	8.4
Wild rice	Herons	0.1	4.3	2.3	0.0	0.6	0.1		1.8
	Moorhens, jac.	0.0	0.0	0.0	0.0	0.4	0.0		0.0
	Waders	0.0	0.8	1.8	0.7	1.8	0.0		1.1
	Passerines	0.3	1.4	3.1	0.7	2.7	0.0		1.8
Cultivated Rice	Herons	0.8	14.7	2.2	7.5	0.5	1.5	0.0	4.1
	Moorhens, jac.	0.0	0.0	0.1	0.0	3.7	0.0	0.0	0.4
	Waders	0.9	36.2	36.4	0.0	0.3	1.0	0.0	18.9
	Passerines	0.3	4.0	12.8	0.4	0.4	0.0	0.0	3.6

Stagnant	Number of density counts	1		14	7	21	30	1	74
Grass		10	21	14					45
Bourgou		22	23	78	51	90	38	25	327
W ild rice		16	16	25	7	8	2		74
Cult.rice		9	13	10	2	19	9	2	64

At the bottom of the table the number of counts done in the respective habitats is given for the entire depth range. These areas were derived from satellite image analysis, and are given for five different water levels in Akka (see Zwarts *et al.* 2005). The data are visualised in Fig. 20 and 21, whereas in Fig. 20 all species are shown in bourgou plots. These basic data are stored in a database and not included in this report.

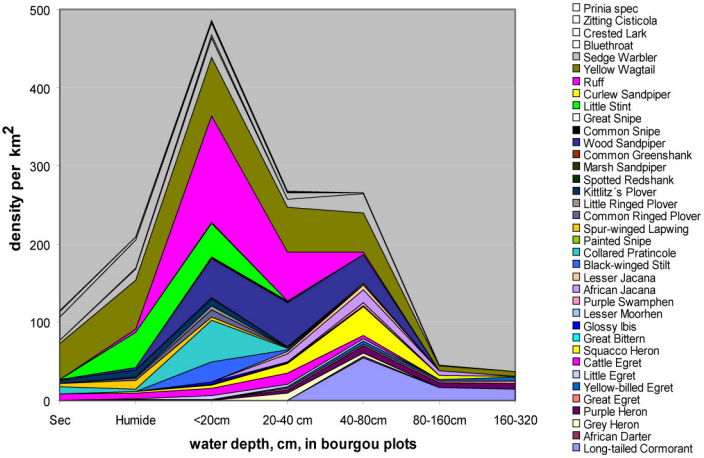

Figure 20. *Waterbird densities per water depth class in bourgou plots for all separate species in the Inner Niger Delta. Basic data not shown.*
Fig. 20. Densités de toutes les espèces d'oiseaux d'eau ciblées, présentées pour le bourgou dans le DIN, par classe de profondeur. Données de base non montrées.

Considering overall densities per depth interval, one can conclude that these are, for cultivated and wild rice, highest for 'humid' and '<20 cm deep'. For bourgou the situation is similar, with substantial densities over a bigger range (dry to 80 cm deep) but

'<20 cm' showing -again- the highest density. In general, cormorants, darters, herons and egrets tend to be more common in deeper areas, whereas waders prefer -as expected- the waterline area. Wetland-related passerines show a somewhat more diverse image.

A closer look at the assessed densities reveals that in bourgou habitat **Long-tailed Cormorant** *Phalacrocorax africanus* shows up fairly soon after the flood peak, reaching peak densities in the same depth interval (40-80 cm) as the **African Darter** *Anhinga rufa*; the latter almost exclusively favours this depth. Both species are practically absent in cultivated and wild rice.

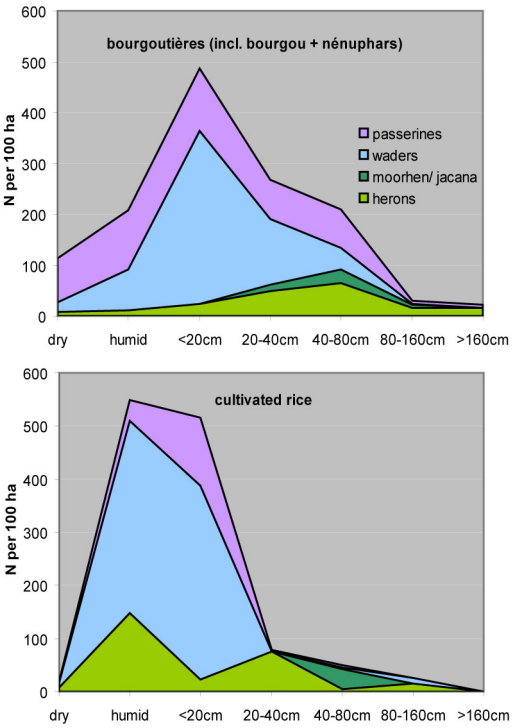

Figure 21. *Waterbird densities per water depth class in bourgou plots and cultivated rice in the Inner Niger Delta. Species lumped in four groups. Data in Table 15.*

Fig. 21. *Densités d'oiseaux d'eau par classe de profondeur dans les échantillons de bourgou et de riz cultivé dans le Delta Intérieur du Niger. Espèces groupées en quatre catégories. Données cf. Tableau 15.*

Herons and egrets show a wide depth range of maximum presence in bourgou, Great Egret *Egretta alba* and Intermediate Egret *Egretta intermedia* -both not seen during cultivated and wild rice counts- having highest densities in the deepest interval, and Cattle Egret *Bubulcus ibis* being the driest species although in modest densities compared to cultivated and even wild rice. Purple Heron *Ardea purpurea* figures in between (40-80 cm), whereas Grey Heron *Ardea cinerea* and Black-headed Heron *Ardea melanocephala* stand relatively dry (20-40 cm in bourgou, humid-40 cm in cultivated and wild rice). Most interesting is the steady winter occurrence of Great Bitterns *Botaurus stellaris* in the Inner Niger Delta. This previously unknown species for Mali favours a depth range of 0-40 cm and shows up in the Debo complex at water levels lower than 250 cm (see Wymenga et al. 2002). At least as surprising were two observations of a Little Bittern *Ixobrychus minutus* during density counts. The birds were flushed from very dense stands of bourgou near Walado Campement and Gourao. No single record had been obtained since the early 1990s and Little Bitterns were believed to have (practically) disappeared from the Niger Inundation Zone. Both bittern species were encountered in bourgou habitat only.

Jacanas -generally rather considered as waterlily-related species- are mostly found in the 20-80 cm depth range. The African Jacana *Actophilornis africana* was hardly observed in wild rice, whereas Lesser Jacana *Microparra capensis* occurred in all three habitats.

Waders were as good as absent in wild rice, while being regular to abundant in the other two habitats. They are seen along waterlines, on humid grounds and in <20 cm deep water. However, they can feed in deeper water as well, as shown by species like Wood Sandpiper and Ruff using floating vegetation

mass (see Discussion). Latter species has peak densities in cultivated rice.

Most abundant species among **wetland-related passerines** are Yellow Wagtail *Motacilla flava* and Sedge Warbler *Acrocephalus schoenobaenus* (palearctic migrants), and Crested Lark *Galerida cristata* (afrotropical) usually considered a 'dry' species but in the IND among the very first birds to colonize emerging grounds and being around well ahead in wild rice and bourgou. Yellow Wagtail occurs in all habitats, while Sedge Warbler merely does in bourgou.

6.5. DISCUSSION

Population estimates

Population estimates for the IND are also compared to a more detailed estimate focusing on the Debo complex where during 1998-2001 monthly waterbird counts have been done along standard trajects (Wymenga *et al.* 2002). For these traject observation areas -approximately delineated in GIS- the same conversion procedure has been carried out but only bourgou and 'grass' habitat (*Cyperus articulatus)* and adjacent sparse annual vegetation) were involved as these are the main vegetation units in the area.

Population estimates for the IND are based on waterbird densities found a) for species at different water depths in the above-mentioned major habitats which are situated in the *lower* inundation zone, and b) at decreasing water levels registered at the Akka gauge. Water depth related densities have been converted into population sizes for five different water level situations, by multiplying these densities, for each habitat, by their available surfaces. The accumulated surface-density products

provide the total population estimates at five different Akka water levels. However, these estimates are based on the assumption that waterbird densities within the selected depth intervals are not affected by decreasing water levels in Akka.

The overall average densities -taken for all IND density plots covered, upstream and mid-south/central range- may therefore cause over- or underestimations. This is clearly the case for species feeding in (dense) flocks like Long-tailed Cormorant, *Ardeidae* species, Glossy Ibis, Black-tailed Godwit (totally lacking in density assessments!), Spotted Redshank, Marsh Sandpiper and Common Greenshank. Overestimated totals relate notably to limited range species -on IND scale- like African Darter, Black-headed Heron, Sacred Ibis and the dark morph of Little Egret. It should be noticed that flock-feeding as mentioned above contains the limited range aspect too, as these species deplete food resources following receding flood waters and thus aggregate in zones. Presumed underestimations mostly occur in case of secretive or inconspicuous birds like *Rallidae* species, Common, Great and Jack Snipe, Green Sandpiper and Temminck's Stint, but they may also reflect their actual IND status, or recent numerical changes in population size (Common Snipe?). Overestimations may also occur, as shown for two secretive palearctic migrants, Great and Little Bittern.

Spur-winged Lapwing is the only widespread species giving obvious high overestimations, particularly in the lower depth range. Aerial IND surveys as well as monthly Debo-Korientzé counts in 1999-2001 suggest overall totals far beneath these figures. This reveals other possible errors: the vegetation map serving as the key estimate source may still contain elements of disputable interpretation due to technical analysis difficulties, or the estimate is based on insufficient counts in appropriate habitat.

Widespread Wood Sandpiper and the wetland-related passerines give first and new insight in their IND population sizes. Wood Sandpipers feed mainly in vegetation and show up in our monthly counts at lowest water levels when there is hardly any suitable habitat left. Even then their numbers are very modest, so detailed density counts appear to be the only way to quantify the species. As supposed earlier (see Wymenga *et al* 2002) Wood Sandpiper may be as common as Ruff, or may even outnumber latter species, the most abundant IND wader recorded so far. Another no.1 species may be the Little Stint estimated at some 1-200000 birds. If so, their wintering population in West Africa should be updated, as 200000 birds are given as a total for wintering zones in western Europe, the Mediterranean, Black Sea, North and West Africa (Wetlands International 2002).

Overall estimates

Total estimates for the different Akka water levels appear to be fairly consistent in the lower range (50 – 250 cm), but almost double at 350 cm due to very high and unrealistic estimates for Ruff, Collared Pratincole, Cattle Egret, Long-tailed Cormorant and possibly African Jacana. Subtracting the 'unrealistic' surplus in these estimations brings the overall estimate for this water level back into a similar numerical order of magnitude compared to the lower-ranges totals. The minor total at 450 cm indicates that massive bird numbers still occur beyond the limits of the habitats considered.

Wetland-related passerines seem to constitute an increasing part of the total estimates, from one third at 350 cm (subtraction discounted) to over 50% at the lowest level. A passerine not taken into account is the Sand Martin *Riparia riparia*, a palearctic migrant with huge wintering numbers in the Sahel. It has not been selected for density counts because of its aerial feeding behaviour. Over half a million birds have been counted at a single

roost in Lake Debo alone (Wymenga *et al* 2002), so a one million estimate for the IND does not seem unrealistic.

Besides this palearctic passerine the density list leaves other waterbird species unaccounted for, like Black-tailed Godwit *Limosa limosa* and *Sternidae* (terns); these occur in substantial numbers, but don't add weight to the total estimates, unlike the *Anatidae* (ducks and geese) with another million birds (Girard & Thal 1999-2001). This would give an approximate **estimate for the Inner Niger Delta** in the order of **six million water- and wetland-related birds**, based on counts in the main habitats of the lower inundation zone.

The Debo-Korientzé area: a more detailed look at estimates derived from density counts and general counts

Overall estimates for the entire Inner Niger Delta give a number of plausible looking figures for certain water levels but the general picture could be improved by doing density counts in some standard areas with a series of fixed plots. Waterbird numbers do not seem to increase with lower water levels, whereas they clearly do in the central Debo complex (Chapter 3).

Debo-Korientzé serves therefore as an example, being an area where standard general counts have been done in 1998-2001. By defining the areas counted along standard transects in GIS, a first attempt could be made to register waterbird contraction with satellite imagery. Predicted waterbird numbers at the same five water levels in Akka are compared to the results of the monthly general counts (average Nov-Mar 1998-2001), converted into interpolations for these different levels. The calculations of estimates were based on the surface area of different vegetation types within the counting zones (Fig. 22) combined with the densities.

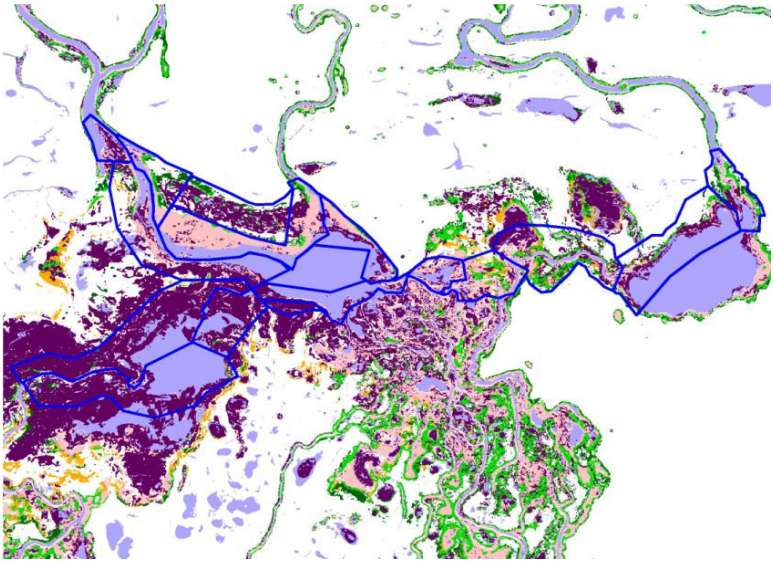

Fig. 22. *Vegetation map of the central lake area in the Inner Niger Delta with delineation of the counting areas. On the basis of this Figure the densities per habitat (estimates based on surface areas) were compared to the real counts in the counting areas.*
Fig. 22. Végétations de la zone centrale (lacs Debo-Korientzé) du Delta Intérieur, avec les tronçons de comptage délimités. A l'aide de cette Figure les densités par habitat (estimations basées sur superficies présentes) ont été comparées aux recensements intégraux y effectués en 1998-2004.

Remarkably, among predicted numbers are hardly any unrealistic figures: they do not go beyond numbers which have not been counted before in this area, albeit on different moments and/or in different years. Exceptions may be Little Stint and Ruff, but even here predicted numbers are not more than twice their maximum counted.

Herons and egrets often show decreasing trends towards low Akka levels, probably based on more substantial densities in bourgou habitat which is only available at higher water levels. However, several species show adverse trends in counted numbers as they deliberately try to stay in the area even when suitable bourgou habitat is hardly available, in order to deplete fish stocks 'out in the open', whether this is in the last bourgou stretches (with high densities: Purple Heron, Little Egret) or in open water (Great Egret, also Little Egret) and adjacent grass habitat with pools.

Other species feeding in open water conditions (inundated grass and bare habitat) show aggregations outnumbering their predicted concentration by far: 'bourgou-deprived' Grey Heron, Glossy Ibis and *Tringa* species. Well-matching open area species are the palearctic Black-winged Stilt, Great Ringed Plover, Curlew Sandpiper, Little Stint and Ruff, whereas afrotropical Spur-winged Lapwing and Kittlitz's Plover seem to anticipate their maximum numbers in June. Their predicted numbers for Nov-Mar are much higher than their actual numbers counted, and may somehow not take their breeding stage into account. Although both species seem to breed year-round there may be an increased reproduction activity between January and April, at decreasing water levels in the lower inundation zone and well ahead of the rainy season (moult period); this may cause a delay in their appearance in Debo-Korientzé. Moreover, they are both 'dry' species, which also contributes to this delay.

Considering the rather limited surface area counted -grass habitat in particular- it seems clear that in the Debo-Korientzé case the overall picture, although constituting an encouraging improvement compared to the IND estimates, can be even more precise by systematically counting densities in a standard approach, in relevant habitats and with sufficient coverage.

Estimates in human-made wetlands: ON and Sel

In Table 13 estimates for the total number of waterbirds in the irrigated areas are presented. For the Nov-Mar period both irrigated rice areas are best characterized by their four most abundant species: two palearctic migrants, Yellow Wagtail and Wood Sandpiper, and two afrotropical species, Spur-winged Lapwing and Cattle Egret.

Yellow Wagtail shows high densities compared to cultivated rice in the Inner Niger Delta (overall density in the IND being similar though) and the somewhat lower density in Sélingué may be explained by the lack of optimal roost capacity -large(r)-scale reed-like vegetation in water- at this latitude and therefore having reached the southern limits of their core winter quarters. In the Delta Mort it is by far the most numerous species. Wood Sandpiper has very high densities in the Sélingué paddy fields compared to the Delta Mort and the major IND habitats (cultivated rice, wild rice, bourgou), and seems to be the most numerous species in Nov-Mar. Assessed density may be related to the relatively wet state of this area, situated in a climate zone with more rainfall than in the Sahel where ON and IND are situated.

Cattle Egret and Spur-winged Lapwing are both very numerous, and estimates seem in the right order of magnitude. Cattle Egrets breed in the Delta Mort; although we were not in a position to thoroughly investigate the whole area, we found several colonies in June-July. Nov-Mar shows increased numbers for both areas but in Sélingué it is absent in June-July, and therefore presumably a non-breeding visitor. As to its position among the most numerous species in paddy fields, Spur-winged Lapwing is contested, for Sélingué, by the African Wattled Lapwing which seems to outnumber the Spurwing in Nov-Mar, but repeated general counts do not confirm this. This underlines the caution

with which estimates should be looked at, and the need to execute general counts as a reference for density-assessments and their related estimates.

Species with Delta Mort estimates between 1000 and 10 000 birds comprise Yellow-billed and Little Egret, Squacco Heron, Black-winged Stilt, Collared Pratincole, Common and Great Snipe, and Little Stint; among the wetland-related passerines Crested Lark shows total absence in June-July (as in Sélingué) indicating movements on an unknown scale but possibly between these human-made wetlands and the floodplains of the Inner Niger Delta. The palearctic Great Snipe -estimate some 1500 birds in the ON zone- is considered near-threatened, being now a Species of European Concern. Irrigated rice areas may therefore be of international importance for this species, as the Ramsar 1% criterion for the population concerned is 350 birds; this criterion identifies wetlands of international importance for waterbirds.

Some species in ON show remarkable increases between February and June: Great Egret (although the estimate seems not quite realistic), Squacco Heron, Greater Painted-snipe and Marsh Owl. Squacco Heron has been found breeding among Cattle Egrets but also in a colony consisting almost entirely of this species. The Delta Mort holds a remarkable population of Marsh Owl; its estimated size is probably unique in West Africa, and may be related, on the one hand, to prey stocks available in the area (granivorous birds, small mammals and insects), and on the other hand to fairly constant swampy conditions in the adjacent Fala zone.

More than half a million water- and wetland-related birds (the very abundant Sand Martin not even comprised, see IND below; *Anatidae*, however, almost lacking) in the irrigation zone of the Office du Niger gives an idea of the biodiversity potential in

human-made wetlands. Striking examples are the palearctic migrants Yellow Wagtail and Wood Sandpiper, both insect(larvae)-eating species constituting half to two-third of the total waterbird population in Nov-Mar. Irrigated rice being a monoculture seems to limit the occurrence or abundance of many species but the development of ecological infrastructures (forestry planning and management, assessment and protection of roost and breeding sites, aquatic buffer zones) in such areas has, so far, hardly been on the agenda of authorities involved. The 20000 birds estimate for Sélingué in Nov-Mar shows that even relatively small-scale irrigation zones -having waterbird densities similar to those assessed in large-scale wetlands- may classify as internationally important for waterbirds, according to Ramsar criterion 2c (regularly holding 20000 waterbirds).

7. SYNTHESE

7.1. INTRODUCTION

This report deals with the results of ecological investigations in three wetland zones of the Niger River Basin, as part of the Dutch Partners for Water program. The study fell under the Water for Food and Ecosystems program, and was carried out in 2003 and 2004, with some additional data from 2002. Key output was to present a decision-support model for effective water management in the upper reaches of the Niger River, in close cooperation with the PREM program of the Dutch Ministry of International Cooperation (see Ch. 1, Zwarts *et al.* 2005).

One of the main goals of this study was to calculate not only the upstream costs and benefits of existing and future hydrological interventions in the Niger River but downstream economic effects as well. The Inner Niger Delta, one of Africa's major natural floodplains, was therefore identified as the downstream study zone, whereas the irrigation areas of the Office du Niger (Delta Mort) and Sélingué, both human-made wetlands with adjacent water bodies, were studied as upstream examples of existing hydraulic Niger River interventions.

Results comprise hydrological, meteorological, socio-economic and ecological data, the latter being analysed and presented in this Ecological valuation report. Hereafter we resume the main outcome of this study focused on general counts and density assessments of waterbirds as wetland bio-indicators. The waterbird density counts constitute a new element in the

ecological valuation approach, in order to get to grips with under-recorded but potentially important –by status or numbers- species occurring in higher and/or more dense vegetations.

7.2. GENERAL COUNTS

Inner Niger Delta

Between June 2002 and June 2004 seven general waterbird counts have been executed in the Inner Niger Delta. The aerial count of June 2002 and the on-the-ground counts are the continuation of monthly monitoring counts in the Debo-Korientzé area carried out since late 1998 and by now centred around strategic moments of the year. For justification of the timing of these counts see Chapter 2. Appendix 1 shows the results of the 2002 aerial census, with remarkable but temporary wet and moist conditions in the lake area on the westbank, caused by rainfall (see Section 3.2). Appendix 2 gives the results of the IND censuses including first counts done in some northern lakes (Horo and Télé).

Delta Mort – Office du Niger

An aerial survey preceded six terrestrial counts: five in paddy field habitat and one in the fala area. Paddyfield counts were executed near (from N to S) Diabaly, Niono, Molodo and Siribala along the Molodo Fala, and Kolongotomo along the Boky-Wéré Fala. Waterbird counts in fala habitat were carried out at certain observation points along the Kouroumari, Molodo and Boky-Wéré falas; in latter case observations were also done during a short boat trip between Mio and Marakela. See for results Appendix 3.

Sélingué

General counts were carried out together with density assessments, as in the Delta Mort. These comprise six paddy field counts and seven counts in the adjacent lake zone. This lake was covered by boat in December and February, and on foot in June. Census results in Appendix 4.

The executed counts show that the **Inner Niger Delta** holds very large concentrations of waterbirds including afrotropical birds as well as palearctic migrants (breeding in Europe and western Asia). In the Debo-Korientzé complex (see a.o. Fig. 22) at least **twenty-seven species** are present in internationally (very) important numbers (cf. Table 6). In comparison with other sahelian floodplains, the Inner Niger Delta is especially important for species like Purple Heron *Ardea purpurea*, Glossy Ibis *Plegadis falcinellus*, Spur-winged Goose *Plectropterus gambensis,* Kittlitz's Plover *Charadrius pecuarius*, Spotted Redshank *Tringa erythropus* and Caspian Tern *Sterna caspia.* Aerial January censuses executed from the early 1970s until 2001 (CRBPO, IUCN/WWF and ONCFS) underline the crucial importance of the Delta for afrotropical and palearctic *Anatidae* (see Wymenga *et al* 2002). Furthermore a number of relevant bio-indicator species were recorded, like African Pygmy Goose *Nettapus auritus* (waterlily habitat), Black Crowned Crane *Balearica pavonina* (critically endangered in the Delta) and the Great Snipe *Gallinago media* (Near Threatened palearctic species). The Delta hosts small breeding colonies of Whiskered tern *Chlidonias hybridus*, the first and only ones recorded in West-Africa.

The northern lakes revealed more ornithological surprises. In early March, Lac Horo appeared to be a stronghold for Little Grebe *Tachybaptus ruficollis* (displaying; estimate >100 pairs) and Common Moorhen *Gallinula chloropus* (5-10.000) whereas the northern lakes hosted at least five species still (:maximum

numbers in January-February) occurring in numbers of international importance: Black-crowned Night Heron *Nycticorax nycticorax*, Glossy Ibis *Plegadis falcinellus*, White-faced Whistling Duck *Dendrocygna viduata*, Spur-winged Goose *Plectropterus gambensis* and Ferruginous Duck *Aythya nyroca*.

Compared to the Inner Delta, biodiversity in the irrigation areas of the **Delta Mort** and **Sélingué** is relatively low, in species as well as in numbers, but density assessments (see next) give a more balanced quantitative impression. Appendix 6 shows that the Inner Delta held 2-4 times more observed species than the irrigated paddyfields. However, combined with biodiversity in the adjacent non-cultivated wetlands (falas in DM, Sélinkegny Lake) this difference decreases to less than two times. This still major difference is explained by the fact that waterbird counts in the IND covered a variety of habitats (in a vast wetland) whereas rice fields are monotypic and not showing obvious concentration effects, but birds may shift -so far unnoticed- towards the fala zone during the dry post- or intercrop phase.

Most abundant species in the irrigated areas were Wood Sandpiper *Tringa glareola* and Yellow Wagtail *Motacilla flava*, a wader and a passerine from the Western Palearctic, and two Afrotropical species, Cattle Egret *Bubulcus ibis* and Spur-winged Lapwing *Vanellus spinosus*, both having a high tolerance for drier grounds. Great Snipe *Gallinago media* occurs in internationally important numbers in the Office du Niger zone, and may do so in Sélingué as densities seem a lot higher. However, the present surface area of the Sélingué paddy fields is limited.

7.3. DENSITY COUNTS

Many sites in Africa will stay uncounted for the years to come, despite great efforts made by Wetlands International to improve this situation in recent years (annual African Waterbird Census, see www.wetlands.org). This led to the idea whether it would be possible to assess bird densities in a range of natural and human-made wetland habitats, and be able -in combination with satellite image analysis- to extrapolate these for total area of identified habitats available within biogeographical and/or climatic zones. Density assessments would not only allow the before-mentioned extrapolations for human-made wetlands but also give indications on waterbird contraction in large-scale floodplains at decreasing water levels.

Waterbird counts were executed in plots of known size, with as uniform as possible vegetation. Plots were accurately described on standard forms, in order to be able to process and analyse collected data in a reliable way. A total of 1776 density counts have been executed between November 1st and March 15th 2001/2002 (try-outs), 2002/2003 and 2003/2004. Table 11 gives the details per study zone and site.

Surface areas counted

Density counts on waterbirds have been carried out in a variety of wetland habitats, including natural vegetations (IND) and paddy fields in human-made wetlands. Table 12 gives an overview of the number of counts per study zone, sorted according to vegetation type/habitat, and with corresponding surface areas counted. Cultivated rice *Oryza spec.*, Bourgou *Echinochloa stagnina* and wild rice *Oryza longistaminata* are the best covered wetland habitats, in numbers of counts as well as covered surface areas. These habitats form major vegetations in the Inner Niger

Delta, whereas cultivated rice is the only habitat taken into account in the irrigation zones of the Delta Mort and Sélingué.

Assessed densities

Table 13 gives the densities per species found for the Office du Niger and Sélingué, whereas Fig. 19 and Table 14 show densities for the Inner Niger Delta split up in six lumped habitat types. A comparison between the Inner Delta and the two irrigation areas is presented in Appendix 5, where data of all covered habitats are presented, including June-July counts from DM and Sélingué.

DM-Sélingué compared to IND cultivated rice (paddy field) habitat

Waterbird density in IND cultivated rice is obviously higher - roughly 2-3 times- than in the irrigated rice areas. A major bias towards the IND is caused by strong numerical representation of Black-winged Stilt *Himantopus himantopus*, Collared Pratincole *Glareola pratincola*, Kittlitz's Plover *Charadrius pecuarius*, Little Stint *Calidris minuta*, Ruff *Philomachus pugnax* and Crested Lark *Galerida cristata*. Remarkably, Wood Sandpiper *Tringa glareola* and Yellow Wagtail *Motacilla flava* seem to have higher densities in the Delta Mort and Sélingué.

DM and Sélingué paddy fields compared

Densities in the human-made wetland habitats have been assessed during rainy as well as dry season. Sélingué has substantially higher densities in both seasons compared to the Delta Mort but here paddy fields were relatively dry due to agro-technical interventions. However, this difference was also noted before these land use activities were undertaken. Main **palearctic** species involved were Black-winged Stilt *Himantopus himantopus*, Wood Sandpiper *Tringa glareola* and Yellow Wagtail *Motacilla flava*, and a.o. Great Snipe *Gallinago media* (a European Concern Species) to a lesser extent. Palearctic species were practically absent in June-July.

As to **afrotropical** species substantial numbers in Dec-Feb were recorded for Yellow-billed Egret *Egretta intermedia*, Cattle Egret *Bubulcus ibis*, Spur-winged Lapwing *Vanellus spinosus*, African Wattled Lapwing *Vanellus senegallus* (only Sélingué), and wetland-related passerines like Crested Lark *Galerida cristata* and Zitting Cisticola *Cisticola juncidis*. Other species occurred more numerously in June-July: Squacco Heron *Ardeola ralloides* (Sél and DM), Green-backed Heron *Butorides striatus* (both), African Jacana *Actophilornis africana* (both), Lesser Jacana *Microparra capensis* (Sél) and Marsh Owl *Asio capensis* (DM).

As for the number of species found, there are no big differences although Sélingué tends to have the highest biodiversity (on the list used: 33 species). The IND (rice) and DM have both 26 species. See Appendix 6.

Overall estimates for the Office du Niger zone and the Sélingué area comprise, respectively, some 600000 and 20000 water- and wetland-related birds. Sand Martin *Riparia riparia* is, however, a common migrant species occurring in Nov-Mar, and not quantified during density counts because of its aerial feeding habits. It may add tens of thousands (DM) and >1000 birds (Sél) to these first overall estimates for the respective irrigation zones.

Densities per IND habitat

The difference in waterbird densities as compared to human-made wetlands is a bit more pronounced than for the rice comparison between these zones alone. Bourgou and cultivated (floating) rice show relatively high densities, but wild rice holds strikingly low numbers resulting in the lowest densities among all quantified habitats (cf. Table 14). Most of the other habitats (Appendix 5) showed higher densities than in bourgou, wild and cultivated rice, but these habitats have no major distributions and may therefore not hold vast numbers of birds. Very high densities

of Sedge Warbler *Acrocephalus schoenobaenus* were observed in expanses of 'Kouma' (*Polygonum spec.)* and 'Loubou' (sonrhaï terms) where it was practically the only wetland-related species around. Further investigations – via mistnetting - are needed to explore whether also the rare Aquatic Warbler *Acrocephalus aquaticus* is present in these habitats. These habitats represent stagnant water plant species which are also found in irrigation ditches in the DM and Sélingué although they were not seen here in large(r) vegetation units.

Water depth and densities

Overall densities do not show their relation with water depth. For obvious reasons a swimmer like a cormorant will not be found feeding on dry or humid ground, nor in <20 cm deep water, whereas a heron doesn't fish in deep water where it can not stand. To illustrate the role water depth plays, Table 15 gives the assessed densities per identified waterbird group, in five major IND habitats and for seven depth classes, ranging from dry via humid ground to 320 cm deep water. Fig. 20 shows a similar – visualised- picture for Bourgou habitat alone. The lumped habitats in Table 15 show highest densities in the 'humid' and '<20 cm' intervals, whereas the Bourgou image also gives substantial waterbird numbers in the 'humid' to '40-80 cm' depth range, but again highest overall densities in '<20 cm'. As expected, waders were mostly seen in '<20 cm' but surprisingly also in the 20 to 80 cm depth range; Ruff and Wood Sandpiper were noted feeding in cattle grazing areas, on floating vegetal mass often visibly mixed with cow dung (:flying insects, larvae).

Densities and population estimates

Population estimates for the IND are based on waterbird densities found a) for species at different water depths in the above-mentioned major -lumped- habitats situated in the *lower* inundation zone, and b) at decreasing water levels registered at

the Akka gauge. Water depth related densities have been converted into population sizes for five different water level situations ('Niger, a lifeline': Appendix VIII: Fig. 3), by multiplying these densities, for each habitat, by their available surfaces. The accumulated surface-density products provide the total population estimates for five different Akka water levels. However, these estimates are based on the assumption that waterbird densities within the selected depth intervals are not affected by decreasing water levels in Akka.

The overall average densities -taken for all IND density plots covered- may therefore cause over- or underestimations. This is clearly the case for species feeding in (dense) flocks like Long-tailed Cormorant, *Ardeidae* species, Glossy Ibis, Black-tailed Godwit (totally lacking in density assessments!), Spotted Redshank, Marsh Sandpiper and Common Greenshank. Overestimated totals relate notably to limited range species -on IND scale- like African Darter, Black-headed Heron, Sacred Ibis and the dark morph of Little Egret, or to secretive species like the palearctic migrants Great and Little Bittern.

Spur-winged Lapwing is the only widespread species giving obvious high overestimations, particularly in the lower depth range. This reveals other possible errors, like incorrect habitat surface areas due to technical analysis inconveniences, or estimates based on insufficient counts in appropriate habitat.

The density count approach gives first and new insight in the IND population sizes of widespread but poorly visible Wood Sandpiper and the wetland-related passerines. Wood Sandpipers feed mainly in vegetation and may be as common as Ruff, or even outnumber latter species, the most abundant IND wader recorded so far. Another high ranking IND species may be the Little Stint estimated at some 1-200000 birds; the total given for

wintering zones in western Europe, the Mediterranean, Black Sea, North and West Africa, is an estimated 200000 birds.

Total waterbird numbers in the IND *based on density counts* can be estimated at some 3 to 4 million birds. This is certainly a minimum as neither ducks and geese *Anatidae* nor an abundant species like Sand Martin *Riparia riparia* have been accounted for. They may represent, however, one million birds each (Girard & Thal 1999-2001; Wymenga et al. 2002). This would give an overall IND estimate of 5 to 6 million waterbirds and wetland-related passerines.

Densities and general counts: more detailed estimates for the Debo-Korientzé area

Waterbird numbers in the overall estimates for the entire IND do not seem to increase with lower water levels, whereas they clearly do in the central Debo complex (see Chapter 3) where standard general counts have been done in 1998-2001. Estimates for the Debo-Korientzé area may serve therefore as a better example. By defining the areas counted along standard transects in GIS, a first attempt could be made to register waterbird contraction with satellite imagery. Predicted waterbird numbers at the same five water levels in Akka (cf. overall IND estimates) are compared to the results of the monthly general counts (average Nov-Mar 1998-2001), converted into interpolations for these different levels.

Table 4 in 'Niger, a lifeline', Appendix VIII, shows, for 32 mostly widespread species, graphs with predicted numbers plotted against interpolated count results. The general impression is that both approaches provide similar trends, although predicted numbers are higher in more than 50% of the species shown. Remarkably, among predicted numbers are hardly any unrealistic figures: they do not go beyond numbers which have not been

counted before in this area, albeit on different moments and/or in different years. Exceptions may be Little Stint and Ruff, but even here predicted numbers are not more than twice their maximum counted. Well-matching open area species are the palearctic Black-winged Stilt, Great Ringed Plover, Little Stint, Curlew Sandpiper and Ruff, suggesting that habitats with higher or denser vegetation are in need of more, or more detailed coverage. Considering the rather limited surface area counted -grass habitat in particular- it seems clear that in the Debo-Korientzé case the overall picture, although constituting an encouraging improvement compared to the IND estimates, can be even more precise by systematically counting densities in a standard approach, in relevant habitats and with sufficient coverage.

7.4. COLONIAL WATERBIRDS

Table 7 presents estimated numbers of breeding pairs for the Inner Niger Delta, in four episodes during the latest two decades. Seventeen breeding species have been established breeding in IND flood forests, comprising cormorants, darters, herons, egrets, ibises, spoonbills and openbills. Presented numbers are from the Dentaka flood forest, holding by far the biggest colony in the IND. The Akkagoun flood forest holds mainly breeding Cattle Egret, after human interventions during consecutive breeding seasons.

In the 1980s and 1990s 15-17 species were found breeding in the Dentaka forest, whereas at the turn of the century 13 species remained, despite improved inundations in the Niger floodplain. African Openbills *Anastomus lamelligerus* were found breeding in the 1980s but disappeared completely from the IND during the 1990s, possibly triggered by the end of the Great Drought in 1994. Until then the IND may have served as an ecological refuge

for their reproduction. Other species had thriving populations as the 1994 flood boosted their breeding success. Black-crowned Night Heron *Nycticorax nycticorax* and -even more surprisingly- Glossy Ibis *Plegadis falcinellus* bred in substantial numbers, whereas Purple Heron *Ardea purpurea* also bred. Only Night Herons continued to breed since, although in small (established) numbers. Grey Heron *Ardea cinerea* was also breeding in fair numbers during the 1994-95 season but it rarely does since then; some years ago the remainder of four consumed juvenile birds were found in the fishermen's settlement of Dentaka. African Darter *Anhinga rufa*, Sacred Ibis *Threskiornis aethiopicus* and African Spoonbill *Platalea alba* did well since flood performances improved, but their populations decreased in recent years, at least partly through human interventions (Darter).

Most abundant species are Cattle Egret *Bubulcus ibis* and Long-tailed Cormorant *Phalacrocorax africanus* showing a slight population decline and a more or less stable population, respectively.

Flood forest degradation in the entire IND has caused the concentration of breeding populations, basically in the two above-mentioned forests. This makes these populations very vulnerable. Restoration and replanting of degraded and disappeared forests is therefore of crucial interest to these breeding species, but also benefits local populations (ecotourism, firewood).

7.5. CONCENTRATION OF WATERBIRDS

During the low water period (french: étiage) in the yearly flood cycle, major waterbird concentrations are observed in the central part of the IND: the Debo-Korientzé zone, containing some 70 % of the IND water at zero (IGN) Akka level. Other substantial

water bodies are then found in the northern IND: the peripheral lakes where water volumes and presence also depend on preceding flood performance.

Due to mutual decantation effects between Lac Debo and Walado Debo at this level it is hazardous to predict whether Walado Debo is totally dry or not at this zero Akka level but high floods increase the chances of an inundated Walado in June, at the end of the low water period. Crucial is the *required minimum ecological flow* during 'étiage', in order to avoid excessive depletion of fish stocks and other unsustainable exploitation of natural resources, and at the same time create favourable staging and feeding conditions for afrotropical and –mostly immature- palearctic waterbirds in the Debo-Korientzé zone. This minimum ecological flow issue needs further investigation.

7.6. OTHER FAUNA

IND

The Inner Niger Delta hosts nowadays the remnants of a rich fauna of big(ger) mammals. Hippopotamus *Hippopotamus amphibius* and West African Manatee *Trichechus senegalensis* constitute the aquatic mammals, both with populations of 50-100 animals in regularly monitored parts of the southern delta. For Hippos this is based on own observations, whereas the Manatees estimation is mainly based on interviews.

Other scarce but regularly seen mammals are Green Monkey *Cercopithecus aethiops* and the Striped Jackal *Canis adustus*, observed in drier habitats but in 1999 trapped in the high flood, at the mouth of the Mayo Dembé. In 2002 a young Patas Monkey *Cercopithecus patas* was offered for sale in a fishermen's village near Diafarabé. Red-fronted Gazelle *Gazella rufifrons* are

said to still occur in the northern delta, but quantitative data are lacking. Wild Cats *Felis sylvestris* are seen now and then (mostly singles, rarely two), while in the mid-nineties we once found a freshly dead (drowned?) African Civet *Civettictis civetta*, just downstream Akka, on the riverbank.
Big reptiles like Nile Crocodile *Crocodylus niloticus* do not seem to occur anymore. Monitor Lizard *Varanus niloticus* are still fairly common, but their meat and skin are appreciated.

Delta Mort
No census results are available on other fauna. A reportedly existing mammalian fauna list vanished during restructuration of the National Direction of Nature Conservation (comm. DRCN-Segou).

According to local people Hippopotamus *Hippopotamus amphibius*, West African Manatee *Trichechus senegalensis* and Monitor Lizard *Varanus niloticus* would occur on the adjacent Niger River. Fishermen in Mio and Molodo claim the incidental occurrence of Hippos. Patas *Cercopithecus patas* and Green Monkeys *C. aethiops* occur in wooded areas. The rice area holds considerable populations of rats, mice and insects (i.e. grasshoppers, locusts, beetles, etc.) attracting avian predators like Marsh Owl *Asio capensis*, Black-shouldered Kite *Elanus caeruleus* and African Swallow-tailed Kite *Chelictinia riocourii.*

Sélingué
No census results available, but according to local people there is rich wildlife around: Crested Porcupine *Hystrix cristata*, monkeys and several antelope species. Bats *Chiroptera* -many species, see Kingdon 1997- are found in the area, preyed upon by Bat Hawks *Macheirhamphus alcinus*, seen at dusk (July 2003) in Sélingué.
In July 2003 we found Hippopotamus *Hippopotamus amphibius* footprints on the westbank of the Lake near the Sélingué dam.

The status of West African Manatee *Trichechus senegalensis* is unclear.

With data entirely lacking, the large Sélinkegny Lake is in need of more thorough biodiversity investigations. The Ramsar Convention criteria do not only apply to waterbirds but also to threatened and vulnerable wetland-related fauna, refuge and survival function of wetlands, and to fish (nursery function, unique species, specific growth stage area), etc.

8. CONCLUSIONS

8.1. CONCLUSIONS

- Continued monitoring of the Debo complex reveals core information on population dynamics of many waterbird species, afrotropical as well as palearctic. Due to dynamic flood conditions (max. 411 cm in 2002, followed by 505 cm in 2003, Akka, Lac Debo) substantial decreases in numbers of internationally important species like African Darter *Anhinga rufa*, Purple Heron *Ardea purpurea* and Caspian Tern *Sterna caspia* seem to have taken place, with poor recovery rates in the next year. Kittlitz's Plover *Charadrius pecuarius* showed a further decrease in population-size (June counts) followed by soaring numbers in 2004, higher than the assessed *African* maximum in 2000. Other species like Collared Pratincole *Glareola pratincola* and Great Bittern *Botaurus stellaris* showed up in record numbers, but this may be rather due to supposed survival increase and/or fair reproduction success after 'good' flood years, followed by increased contraction under poor flooding conditions in 2002-2003.
- Human pressure on vulnerable bird species in the northern lakes may also have an impact on local or international waterbird populations.
- *Rallidae*, *Jacanidae* and other water-vegetation related waders and passerines are partly and sometimes entirely overlooked, in bourgou as well as paddy field habitats. : African Crake *Crex egregia*, Lesser Moorhen *Gallinula angulata*, African Jacana *Actophilornis africana*, Lesser Jacana *Microparra capensis*, Wood Sandpiper *Tringa glareola*, Yellow Wagtail *Motacilla*

flava a.o., Sedge Warbler *Acrocephalus schoenobaenus* and Bluethroat *Luscinia svecica*.

- For breeding species in the Inner Delta see Wymenga *et al* 2002. In the Delta Mort colonies of Cattle Egret and Squacco Heron were established, as well as certain breeding of Green-backed Heron *Butorides striatus*, Abdim's Stork *Ciconia abdimii* and Hamerkop *Scopus umbretta* ; latter species is also expected to breed in the Sélingué area. It would probably take little effort to obtain evidence on reproduction of many other species in the Delta Mort, like Little Bittern *Ixobrychus minutus*, *African Actophilornis africana* and Lesser Jacana *Microparra capensis*, *Rallidae*, African Marsh Owl *Asio capensis* (display flights seen), etc. Breeding of African Darter *Anhinga rufa* and Pygmy Goose *Nettapus auritus* may also be assessed. Breeding of African Wattled Lapwing *Vanellus senegallus* in the Sélingué area has been observed in July, and here too, many other breeding waterbird species will be found during more detailed investigations.

- First results suggest high densities for some species, afrotropical (*Ardeidae* and *Vanellus* species, Greater Painted-snipe *Rostratula benghalensis* in rice habitat) as well as palearctic birds (Purple Heron, Yellow Wagtail, Sedge Warbler in bourgou and similar aquatic habitat) ;

- Species occurrence and abundancy seems to reflect habitat preference but the time of the year in relation to water depth and constancy of water presence should be taken into account too ;
- Observed species numbers in checked rice and natural marsh habitat are similar whereas in the general counts the latter gave far more species;

- Many observed species have been hardly seen and are in need of more substantial coverage. In 'Niger, a lifeline': Appendix VIII: Fig. 4) 32 species regularly seen are being looked at more closely ;
- For bourgou habitat densities for these species have been calculated according to water depth, in unaffected and affected (grazed, cut) state. Most common species overall were Purple Heron, Squacco Heron, Wood Sandpiper, Ruff and the wetland-related species Yellow Wagtail and Sedge Warbler. The herons were most abundant in 40-80 cm water depth, the waders in <20 cm and the passerines had highest numbers in <20 and 20-40 cm (Yellow Wagtail), and in bourgou on dried out and moist soil (Sedge Warbler)!
- The status of some species may be better defined through these detailed counts. During general counts Great Bittern *Botaurus stellaris* turned out to be five times more common in plots when crossed through. Another species worth mentioning is the Bluethroat *Luscinia svecica* which occurred regularly in bourgou and the like.

8.2. RECOMMENDATIONS

- Considering the collected waterbird density data, with promising outcome, it is clear that substantially more effort should be put in density counts during 2004-2005, in order to maximize the number of species to be analysed, and to obtain more substantial results.
- Attention should be paid to bird density counting technique. Density counts from a single observation point, compared to plots crossed on foot, seem to have better scores for bigger species (*Ardeidae*); more plots crossed on foot may be needed, or more attention to birds flying away long before selected plots are counted ;

- In large-scale areas without clear landmarks like bourgou zones the use of a range-finder, with a tripod where or when relevant, is necessary. To operate efficiently more than one person are needed to cover plots to be counted.

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APPENDICES

1. Aerial counts Inner Delta, June 2002
2. General counts Inner Niger Delta
3. General counts irrigation zone ON
4. General counts Sélingué area
5. Mean densities per vegetation type
6. Biodiversity IND, ON and Sélingué

Appendix 1.

Aerial waterbird count in the Inner Niger Delta, June 24-25th, 2002.

Recensement aérien Delta Intérieur du Niger, les 24 et 25 juin 2002

Aerial census IND June 24-25th 2002		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Date	24-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun	25-jun
Species	Remarks				Dry, green						Dry	Dry	Dry	Dry		Dry
French	*Scientific*															
Cormoran africain	*Phalacrocorax africanus*		3					7	40						160	
Anhinga d'Afrique	*Anhinga rufa*	4						2	26						4	
Héron cendré	*Ardea cinerea*	100	20	150					14	101					100	
Héron pourpré	*Ardea purpurea*								3	2						
Grande Aigrette	*Egretta alba*			40				30	144						400	
Aigr. Garzette noire	*Egretta garzetta*							2	2							
Aigrette garzette	*Egretta garzetta*							520	300	100					51	
Hérons blancs	*Egretta spec.*	200						1900	520	200					200	
Héron garde-boeufs	*Bubulcus ibis*	200	20	390	28	180	293	650	80	6420					240	
Crabier chevelu	*Ardeola ralloides*	120		5			1	2184	51	341						
Bihoreau gris	*Nycticorax nycticorax*									40						
Cigogne d'Abdim	*Ciconia abdimii*														2	
Marabout d'Afrique	*Lept. crumeniferus*	550														
Ibis falcinelle	*Plegadis falcinellus*							748		92					20	
Dendrocygne fauve	*Dendrocygna bicolor*							90	6							
Dendrocygne veuf	*Dendrocygna viduata*	250	20	80			30	3700	2300	8000						
Oie-arm. De Gambie	*Plectr.. gambensis*	160						300	40						400	
Anserelle naine	*Nettapus auritus*							8		20						
Grue couronnée	*Balearica pavonina*	47														

Poule sultane	*Porphyrio porphyrio*							4	25	15						
Jac. à poitrine dorée	*Actophilornis africana*						30	26	92	1						
Echasse blanche	*Himantopus himantopus*			1080			40	361	103	72					980	
Vanneau à éperons	*Vanellus spinosus*	700	26	30			5	20	30	20					70	
Barge à queue noire	*Limosa limosa*						2	281	920	43						
Chevalier sylvain	*Tringa glareola*								40							
Combattant varié	*Philomachus pugnax*								10						10	
Limicoles non ident.	*Char/Scolop*	75													80	
Guifette moustac	*Chlidonias hybridus*								4							
Sterne hansel	*Gelochelidon nilotica*			11					10						4	
Sterne caspienne	*Sterna caspia*								40							
TOTALS PER SITE		2406	89	1786	28	180	401	10833	4800	15467	0	0	0	0	2721	0

1. IND-S
2. Gatié Loumo
3. Tanda
4. Kabara
5. Soumpi
6. Tagadji
7. Horo
8. Fati
9. Télé
10. Faguibine
11. Haribongo
12. Garou
13. Niangaye
14. Aougoundou
15. Korarou

Appendix 2. General waterbird counts in the Inner Delta, June 2002 - 2004.

Northern lakes included for the first time as terrestrial count sites. LD-WD = Lac Debo and Walado Debo. N-Lakes: Lac Téle and Lac Horo (eastern shore incl.). Recensements généraux d'oiseaux d'eau, DIN 2002-2004. Certains lacs du nord (Télé et Horo ; cf. p.51 pour détails) ont été inclus comme sites de comptage terrestre. LD-WD = Lac Debo, Walado Debo.

		LD-WD jun-02 lakes	LD-WD jan-03 lakes	LD-WD feb-03 lakes	LD-WD jun-03 lakes	LD+WD feb-04 lakes	LD+WD jun-04 lakes	N-Lakes mrt-03 lakes
English	*Scientific*							
Little Grebe	Tachybaptus ruficollis	0	0	0	0	0	0	20
Great White Pelican	Pelecanus onocrotalus	533	0	2	116	0	1602	0
Grey Pelican	Pelecanus rufescens	2	0	0	0	0	0	0
Long-tailed Cormorant	Phalacrocorax africanus	1105	6915	1014	380	2829	853	92
African Darter	Anhinga rufa	493	56	119	22	14	37	34
Grey Heron	Ardea cinerea	921	1722	3501	223	2246	952	14
Black-headed Heron	Ardea melanocephala	4	0	0	14	0	94	0
Purple Heron	Ardea purpurea	7	667	1242	1	974	29	130
Great Egret	Egretta alba	2521	1780	1158	531	1958	1060	0
Black Heron	Egretta ardesiaca	0	153	130	0	11	0	0
Intermediate Egret	Egretta intermedia	141	184	65	215	70	122	0
Little Egret (black morph)	Egretta garzetta	189	58	36	81	23	143	0

		LD-WD	LD-WD	LD-WD	LD-WD	LD+WD	LD+WD	N-Lakes
Little Egret (white morph)	Egretta garzetta	3661	3500	2418	1203	5723	5022	0
White egrets	Egretta/Bubulcus spec.	220	20	326	0	140	0	0
Cattle Egret	Bubulcus ibis	1803	592	99	5571	624	3752	0
Squacco Heron	Ardeola ralloides	39	680	1034	141	372	18	0
Green-backed Heron	Butorides striatus	2	3	0	1	1	5	0
Night Heron	Nycticorax nycticorax	1	400	0	0	500	8	600
Great Bittern	Botaurus stellaris	0	13	29	0	0	0	1
Yellow-billed Stork	Mycteria ibis	27	0	0	2	0	0	0
White Stork	Ciconia ciconia	0	12	0	0	2	0	0
Saddle-billed Stork	Ephippiorhynchus sen.	0	0	0	0	0	1	0
Marabou Stork	Leptoptilos crumeniferus	126	0	0	6	0	7	0
Sacred Ibis	Threskiornis aethiopica	46	30	86	1	44	70	0
Glossy Ibis	Plegadis falcinellus	1735	3672	3554	136	252	563	750
Eurasian Spoonbill	Platalea leucorodia	1	0	51	0	38	8	0
African Spoonbill	Platalea alba	759	0	140	0	1	450	0
White-faced Whistling-duck	Dendrocygna viduata	355	300	83	19	14	84	4000
Spur-winged Goose	Plectropterus gambensis	3086	19	208	797	685	11457	1300
Knob-billed Goose	Sarkidiornis melanotos	5	45	0	0	2	0	16
Egyptian Goose	Alopochen aegyptiacus	486	0	0	0	12	253	0
African Pygmy Goose	Nettapus auritus	0	0	6	0	0	0	40

		LD-WD	LD-WD	LD-WD	LD-WD	LD+WD	LD+WD	N-Lakes
Garganey	Anas querquedula	0	2110	336	0	60	0	8500
Shoveler	Anas clypeata	0	1	0	0	0	0	330
Ferruginous Duck	Aythya nyroca	0	0	0	0	0	0	1600
Black Crowned-crane	Balearica pavonina	0	0	0	0	1	0	0
Common Moorhen	Gallinula chloropus	0	9	0	0	0	32	2265
Lesser Moorhen	Gallinula angulata	4	0	0	0	0	0	0
Allen's Gallinule	Porphyrio alleni	0	2	0	0	0	0	0
Purple Swamphen	Porphyrio porphyrio	408	20	90	39	18	0	180
Lesser Jacana	Microparra capensis	12	1	0	20	3	21	30
African Jacana	Actophilornis africana	2472	268	264	445	30	467	90
Greater Painted Snipe	Rostratula benghalensis	102	0	2	9	2	49	0
Black-winged Stilt	Himantopus himantopus	1774	1280	1134	25	1775	1050	0
Senegal Thicknee	Burhinus senegalensis	29	0	0	11	0	1	0
Egyptian Plover	Pluvianus aegyptius	139	34	71	176	57	107	0
Cream-coloured Courser	Cursorius cursor	0	0	0	0	0	1	0
Temminck's Courser	Cursorius temminckii	3	0	0	0	0	0	0
Common Pratincole	Glareola pratincola	1550	18310	5257	2008	538	934	0
Spur-winged Lapwing	Vanellus spinosus	3365	221	506	3986	230	4400	40
White-headed Lapwing	Vanellus albiceps	0	0	0	5	0	2	0
African Wattled Lapwing	Vanellus senegallus	0	0	0	1	0	0	0

		LD-WD	LD-WD	LD-WD	LD-WD	LD+WD	LD+WD		N-Lakes
Grey Plover	Pluvialis squatarola	0	0	7	0	6	0		0
Ringed Plover	Charadrius hiaticula	8	1578	4136	8	2694	3		4
Little Ringed Plover	Charadrius dubius	0	30	19	0	31	0		26
Kittlitz's Plover	Charadrius pecuarius	8360	381	683	8969	286	13676		1
Kentish Plover	Charadrius alexandrinus	0	0	0	3	0	0		0
White-fronted Plover	Charadrius marginatus	30	0	0	187	0	172		0
Black-tailed Godwit	Limosa limosa	712	23987	20261	148	9136	367		0
Eurasian Curlew	Numenius arquata	0	200	91	12	140	18		0
Spotted Redshank	Tringa erythropus	0	932	2266	0	4557	0		0
Redshank	Tringa totanus	0	0	4	0	7	0		0
Marsh Sandpiper	Tringa stagnatilis	14	43	21	15	55	0		1
Common Greenshank	Tringa nebularia	898	722	403	554	2513	384		0
Green Sandpiper	Tringa ochropus	0	1	0	0	0	0		0
Wood Sandpiper	Tringa glareola	20	79	58	7	35	6		100
Common Sandpiper	Actitis hypoleucos	0	2	16	0	8	0		0
Ruddy Turnstone	Arenaria interpres	0	0	4	1	7	4		0
Great Snipe	Gallinago media	0	1	16	0	14	0		0
Common Snipe	Gallinago gallinago	0	0	3	0	0	0		0
Red Knot	Calidris canutus	2	0	0	0	1	0		0
Little Stint	Calidris minuta	26	5927	6090	105	13032	10		10

		LD-WD	LD-WD	LD-WD	LD-WD	LD+WD	LD+WD	N-Lakes
Temminck's Stint	Calidris temminckii	0	1	0	0	0	0	0
Dunlin	Calidris alpina	0	0	0	3	0	0	0
Curlew Sandpiper	Calidris ferruginea	2071	155	2475	2333	1356	382	0
Broad-billed Sandpiper	Limicola falcinellus	0	0	0	0	0	1	0
Ruff	Philomachus pugnax	14	11722	26785	66	4262	10	200
Lesser Black-backed Gull	Larus fuscus	0	122	101	0	100	0	0
Grey-headed Gull	Larus cirrocephalus	0	14	1	0	0	2	0
Black-headed Gull	Larus ridibundus	0	14	0	0	1	0	0
Whiskered Tern	Chlidonias hybridus	0	2607	2056	166	2217	149	30
White-winged Tern	Chlidonias leucopterus	44	2315	4009	181	2588	18	2760
Unident. Marsh tern	Chlidonias spec.	0	0	100	0	70	0	0
Gull-billed Tern	Gelochelidon nilotica	191	3759	3086	1190	1635	629	0
Caspian Tern	Sterna caspia	44	2847	2469	0	2586	13	0
Little Tern	Sterna albifrons	24	206	51	0	31	3	0
Osprey	Pandion haliaetus	0	0	1	0	0	0	0
African Fish-eagle	Haliaeetus vocifer	0	2	2	0	0	0	0
Eurasian Marsh Harrier	Circus aeruginosus	4	335	336	22	64	0	6
Pallid Harrier	Circus macrourus	0	0	0	0	0	0	1
Montagu's Harrier	Circus pygargus	21	1	5	23	3	0	0
Black Kite	Milvus migrans	2	3	346	0	122	2	0

		LD-WD	LD-WD	LD-WD	LD-WD	LD+WD	LD+WD		N-Lakes
Lanner Falcon	Falco biarmicus	2	0	0	2	0	2		0
Black-shouldered Kite	Elanus caeruleus	0	0	0	4	0	0		0
African Marsh Owl	Asio capensis	70	0	0	0	0	5		0
Pied Kingfisher	Ceryle rudis	184	81	169	62	49	75		0
Sand Martin	Riparia riparia	0	nc	nc	0	40	0		120
Yellow Wagtail	Motacilla flava	0	nc	nc	2	75	0		100
Grey Wagtail	Motacilla alba	0	nc	nc	0	6	0		0
Red-throated Pipit	Anthus cervinus	0	0	0	0	0	0		3
Totals per count and site		40865	101144	99031	30248	66976	49585		23394

Appendix 3. Waterbird counts in the irrigation zone of Office du Niger.

Waterbird counts Office du Niger 2002-2004. Riz = rice in the irrigated zone and falas are counts of fala areas. Recensements d'oiseaux d'eau dans la zone irriguée de l'Office du Niger, 2002-2004. Riz = zone de riz irrigué ; falas = zones humides des falas. Voir texte pour plus de détails.

Species			DM dec-02	DM feb-03	DM jul-03	DM dec-03	DM feb-04	DM jun-02	DM jun-04
			riz	riz	riz	riz	riz	falas	falas
French	English	scientific						aerial survey	
Grèbe castagneux	Little Grebe	Tachybaptus ruficollis	0	0	0	0	0		9
Cormoran africain	Long-tailed Cormorant	Phal. africanus	1	1	2	0	2		392
Anhinga d'Afrique	African Darter	Anhinga rufa	0	0	0	0	0	5	67
Héron cendré	Grey Heron	Ardea cinerea	63	53	37	0	39		8
Héron mélanocéphale	Black-headed Heron	Ardea melanocephala	19	2	0	0	3		3
Héron pourpré	Purple Heron	Ardea purpurea	4	10	0	0	2		10
Grande Aigrette	Great Egret	Egretta alba	1	9	0	1	1		11
Aigrette intermédiaire	Intermediate Egret	Egretta intermedia	10	20	39	0	3		38
Aigrette garzette	Little Egret (white morph)	Egretta garzetta	11	71	41	19	2		13
Hérons blancs	White egrets	Egretta/Bubulcus spec.	0	6	0	0	0	>50	0
Héron garde-boeufs	Cattle Egret	Bubulcus ibis	319	470	290	325	198	>300	461
Crabier chevelu	Squacco Heron	Ardeola ralloides	10	10	38	6	10	>100	463
Héron strié	Green-backed Heron	Butorides striatus	0	0	3	0	0		16
Bihoreau gris	Night Heron	Nycticorax nycticorax	0	0	0	0	0		345
Blongios nain	Little Bittern	Ixobrychus minutus	0	0	0	0	0		7
Cigogne d'Abdim	Abdim's Stork	Ciconia abdimii	0	0	3	0	0		10
Cigogne épiscopale	Woolly-necked Stork	Ciconia episcopus	0	0	0	0	0		1
Ombrette africaine	Hamerkop	Scopus umbretta	5	1	0	0	1		2
Dendrocygne veuf	White-faced W-duck	Dendrocygna viduata	0	0	0	0	0	100	598

Species			DM dec-02	DM feb-03	DM jul-03	DM dec-03	DM feb-04	DM jun-02	DM jun-04
Oie-armée de Gambie	Spur-winged Goose	Plec. gambensis	0	0	0	0	0		102
Canard à bosse	Knob-billed Goose	Sarkidiornis melanotos	0	0	0	0	0		33
Anserelle naine	African Pygmy Goose	Nettapus auritus	0	0	0	0	0		22
Râle à bec jaune	Black Crake	Amaurornis flavirostris	0	0	0	0	0		10
Gallinule poule-d'eau	Common Moorhen	Gallinula chloropus	0	0	0	0	0		12
Gallinule africaine	Lesser Moorhen	Gallinula angulata	0	0	0	0	0		6
Talève d'Allen	Allen's Gallinule	Porphyrio alleni	0	0	0	0	0		4
Talève sultane	Purple Swamphen	Porphyrio porphyrio	0	0	0	0	0		77
Jacana nain	Lesser Jacana	Microparra capensis	0	0	0	0	0		21
Jacana à poitrine dorée	African Jacana	Actophilornis africana	14	8	16	2	4		33
Rhynchée peinte	Greater Painted Snipe	Rostr. benghalensis	0	0	0	0	0		8
Echasse blanche	Black-winged Stilt	Him. himantopus	2	28	0	0	1	130	28
Oedicnème du Sénégal	Senegal Thicknee	Burhinus senegalensis	0	0	0	0	0		3
Glaréole à collier	Common Pratincole	Glareola pratincola	0	71	0	0	1		1
Vanneau à éperons	Spur-winged Lapwing	Vanellus spinosus	143	171	166	99	134	250	177
Vanneau à tête noire	Black-headed Lapwing	Vanellus tectus	0	0	0	0	0		5
Vanneau du Sénégal	African Wattled Lapwing	Vanellus senegallus	0	0	0	0	0		4
Pluvier pâtre	Kittlitz's Plover	Charadrius pecuarius	0	0	0	0	0		2
Barge à queue noire	Black-tailed Godwit	Limosa limosa	0	0	0	0	0		125
Chevalier aboyeur	Common Greenshank	Tringa nebularia	0	1	0	0	0		1
Chevalier sylvain	Wood Sandpiper	Tringa glareola	10	24	0	0	26		15
Combattant varié	Ruff	Philomachus pugnax	0	10	0	0	0		1
Sterne hansel	Gull-billed Tern	Gelochelidon nilotica	0	0	0	0	0		3
Balbuzard pêcheur	Osprey	Pandion haliaetus	0	0	0	0	0		1
Busard des roseaux	Eurasian Marsh Harrier	Circus aeruginosus	17	22	0	15	4		1
Busard cendré	Montagu's Harrier	Circus pygargus	5	2	0	1	2		0
Milan noir	Black Kite	Milvus migrans	0	9	0	0	27		13

Species			DM dec-02	DM feb-03	DM jul-03	DM dec-03	DM feb-04	DM jun-02	DM jun-04
Faucon lanier	Lanner Falcon	Falco biarmicus	0	0	0	0	0		2
Elanion blanc	Black-shouldered Kite	Elanus caeruleus	0	0	0	3	2		42
Elanion naucler	African Swallow-tailed Kite	Chelictinia riocourii	0	0	0	10	0		0
Hibou du Cap	African Marsh Owl	Asio capensis	1	0	0	0	1		3
Martin-pêcheur pie	Pied Kingfisher	Ceryle rudis	2	0	0	0	0		2
Bergeronnette printanière	Yellow Wagtail	Motacilla flava	65	42	0	56	57		0
		Totals	702	1043	641	538	522	>>485	3188

Appendix 4. General waterbird counts in the Sélingué - area.

Waterbird counts Sélingué area 2002-2004. Riz = rice cultures in the irrigated zone and lac are counts of the lake areas. *Appendice 4. Recensements généraux d'oiseaux d'eau zone de Sélingué, 2002-2004. Riz = rizières irriguées ; lac = zone du lac de barrage.*

	Sel riz dec-02	Sel riz feb-03	Sel riz jul-03	Sel 15/1612 03	Sel feb-04	Sel jun-04	Sel jun-02	Sel dec-02	Sel feb-03	Sel jul-03	Sel dec-03	Sel feb-04	Sel jun-04
	riz	riz	riz	riz	riz	riz	lac	lac	lac	lac	lac	lac	lac
Scientific name													
Phalacrocorax africanus	0	0	7	0	0	6	19	316	545	60	0	2555	181
Ardea cinerea	31	1	0	2	10	0	0	50	51	1	63	49	3
Ardea melanocephala	9	0	0	7	0	0	0	0	0	0	0	0	0
Ardea purpurea	1	0	10	0	0	0	0	0	1	0	0	0	0
Egretta alba	10	0	45	1	0	0	0	11	16	0	3	5	0
Egretta intermedia	0	45	14	5	3	1	0	0	2	0	0	0	0
Egretta garzetta	0	0	0	0	0	0	0	0	0	0	1	0	0
Egretta garzetta	68	17	0	48	0	0	0	61	40	1	21	32	6
Egretta/Bubulcus spec.	0	0	0	0	0	0	0	29	17	0	0	19	0
Bubulcus ibis	1095	1569	5	502	1380	0	77	96	136	0	67	221	145
Ardeola ralloides	8	13	23	6	3	10	0	0	0	0	1	0	0
Butorides striatus	0	0	19	0	0	1	0	0	0	1	0	0	1
Nycticorax nycticorax	0	0	0	0	0	1	0	0	0	0	0	0	0
Platalea alba	0	0	0	0	0	0	0	0	0	0	0	0	2
Scopus umbretta	20	6	0	15	3	0	0	0	0	2	0	0	0
Dendrocygna bicolor	0	0	0	0	0	0	0	0	0	0	0	0	0
Dendrocygna viduata	0	0	15	0	0	0	14	4438	14960	154	1294	14000	36
Plectropterus gambensis	0	0	0	0	0	0	0	0	7	0	0	8	10

	Sel riz dec-02	Sel riz feb-03	Sel riz jul-03	Sel 15/161203	Sel feb-04	Sel jun-04	Sel jun-02	Sel dec-02	Sel feb-03	Sel jul-03	Sel dec-03	Sel feb-04	Sel jun-04
Sarkidiornis melanotos	0	0	0	0	0	0	0	2	0	0	10	0	0
Nettapus auritus	0	0	0	0	0	4	0	0	0	0	0	0	0
Anas querquedula	0	0	0	0	0	0	0	15	0	0	0	0	0
Gallinula chloropus	2	0	0	0	0	0	0	0	0	0	0	0	0
Actophilornis africana	6	15	154	8	31	5	0	0	0	1	18	1	0
Rostratula benghalensis	0	0	1	0	0	1	0	0	0	0	0	0	0
Himantopus himantopus	15	143	0	0	10	0	0	0	0	0	0	22	0
Burhinus senegalensis	0	0	0	0	0	2	0	0	0	5	0	0	1
Pluvianus aegyptius	0	0	0	0	0	0	30	0	0	25	0	0	27
Cursorius temminckii	0	0	0	0	0	0	0	0	0	0	0	0	2
Glareola pratincola	43	40	0	0	8	0	12	0	0	31	0	2	61
Glareola cinerea	0	0	0	0	0	0	0	0	0	2	0	0	1
Vanellus spinosus	595	344	108	253	201	8	12	2	35	70	0	73	139
Vanellus tectus	0	0	0	0	0	0	0	0	0	0	0	0	12
Vanellus albiceps	0	0	0	0	0	0	2	0	0	1	0	0	0
Vanellus senegallus	163	165	8	71	179	4	1	0	1	0	0	0	8
Charadrius hiaticula	0	3	0	0	0	0	0	0	0	0	0	0	0
Charadrius dubius	4	0	0	0	1	0	0	0	0	0	0	0	0
Charadrius pecuarius	0	0	0	0	0	0	46	0	1	83	0	0	143
Charadrius forbesi	0	0	0	0	4	0	0	0	0	0	0	0	0
Limosa limosa	0	0	0	0	0	0	0	0	0	0	0	0	1
Tringa erythropus	1	0	0	0	0	0	0	0	0	0	0	0	0
Tringa nebularia	4	0	1	0	3	0	0	0	1	1	0	7	0
Tringa ochropus	1	1	0	2	0	0	0	0	0	0	0	0	0
Tringa glareola	111	140	0	10	72	0	0	0	0	0	0	0	0
Actitis hypoleucos	5	0	0	0	10	0	0	6	1	0	19	3	0

	Sel riz dec-02	Sel riz feb-03	Sel riz jul-03	Sel 15/161203	Sel feb-04	Sel jun-04	Sel jun-02	Sel dec-02	Sel feb-03	Sel jul-03	Sel dec-03	Sel feb-04	Sel jun-04
Calidris minuta	4	0	0	0	0	0	0	0	0	0	0	0	0
Calidris temminckii	1	0	0	0	0	0	0	0	0	0	0	0	0
Larus fuscus	0	0	0	0	0	0	0	1	0	0	0	0	0
Chlidonias hybridus	0	0	0	0	0	0	0	1	0	0	0	1	0
Chlidonias leucopterus	0	0	0	0	0	0	0	0	0	0	0	1	0
Gelochelidon nilotica	0	0	0	0	0	0	0	0	37	0	0	5	0
Pandion haliaetus	1	0	0	0	0	0	0	17	32	2	18	49	7
Haliaeetus vocifer	0	0	0	0	0	0	0	1	3	0	0	2	0
Circus aeruginosus	17	0	0	5	5	0	0	5	7	1	0	5	0
Circus pygargus	2	0	0	0	0	0	0	0	0	0	0	0	0
Milvus migrans	0	0	0	0	4	0	0	519	0	1	76	357	25
Falco biarmicus	0	0	0	0	0	0	0	0	0	0	0	1	0
Ceryle rudis	0	0	0	1	0	1	0	0	1	7	0	5	6
Megaceryle maxima	0	2	0	0	0	0	0	0	0	1	0	0	2
Motacilla flava	94	0	0	7	46	0	0	6	2	0	2	0	0
Anthus cervinus	2	0	0	0	0	0	0	0	0	0	0	0	0
Totals per count and site	2313	2504	410	943	1974	49	213	5576	15896	450	393	13124	824

Appendix 5. Mean densities of waterbirds (n per 1000 ha) in vegtation types.

Mean densities per 1000 ha (all water depth classes combined) in different vegetation types in the Inner Niger Delta, the irrigation zone of Office du Niger and the Sélingué area. For an explanation of vegetation and method see the text.

Appendice 5. Densités d'oiseaux d'eau (N/1000 ha) dans les divers types de végétation. Densités moyennes par 1000 ha (toutes les classes de profondeur prises ensembles) dans les différents types de végétation du Delta Intérieur, et des zones irriguées de l'Office du Niger et de Sélingué. V. texte pour les détails concernant les végétations et méthodes.

Period	Jun-Jul		November – March																All
Focal area	DM	Sel	DM	Sel	Inner Niger Delta														All
Species / vegetation type	Rice cult	Rice cult	Rice cult	Rice cult	Rice cult	Bour gou	cyper us	Kou-ma	Lou-bou	Horia	garsa	Riz sauv	Nune phar	mimo sa	Da-roun	Cyno -don	poro	bare	Total
Long-tailed Cormorant	0	173	0	0	0	1800	0	0	0	0	0	6	44	0	4880	0	0	87	855
African Darter	0	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	30
Grey Heron	0	0	10	0	55	303	10	0	0	66	536	426	11	0	0	0	0	0	214
Black-headed Heron	0	0	0	6	21	11	0	0	0	0	0	0	0	0	0	0	0	0	7
Purple Heron	0	16	0	0	41	451	30	0	0	523	400	6	480	185	0	0	208	0	293
Great Egret	184	0	0	32	0	165	0	0	0	184	20	0	2	0	327	0	0	0	96
Yellow-billed Egret	28	28	85	282	0	121	0	0	0	1197	233	0	0	0	1180	0	6725	265	218
Little Egret	0	0	30	173	82	252	302	0	0	64	0	40	0	926	3854	0	286	220	226
Little Egret_Reef Heron	0	0	0	6	0	23	0	0	0	0	0	0	0	0	0	0	0	78	12
Cattle Egret	277	0	1240	2950	3715	649	63	0	0	1273	1399	1309	757	0	1432	1515	649	0	1041
Squacco Heron	381	692	72	165	129	657	21	0	0	4215	510	15	4917	295	3074	227	14485	0	1025
Great Bittern	0	0	0	0	0	64	0	0	0	0	0	0	0	0	0	0	0	0	30
Little Bittern	11	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	5

Green-backed Heron	25	544	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sacred Ibis	0	0	0	0	12	1	3	0	0	0	0	0	0	0	0	0	0	0	0	2
Glossy Ibis	0	0	0	0	0	89	0	0	0	66	4099	0	73	0	0	0	0	0	0	98
Hamerkop	19	0	2	109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White-f Whistling Duck	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Pygmy Goose	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Moorhen	0	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	2
Lesser Moorhen	4	127	0	0	0	4	0	0	0	0	0	0	0	556	0	0	0	0	0	18
Purple Swamphen	0	0	0	0	0	2	0	0	0	1134	0	0	0	0	0	0	6667	0	0	145
African Jacana	293	6156	0	302	377	420	0	0	0	247	0	1	2673	0	667	0	333	0	0	389
Lesser Jacana	0	294	0	6	34	51	0	0	0	2058	0	42	1411	0	0	0	1114	0	0	260
Black-winged Stilt	0	0	179	100	898	175	104	0	0	2966	306	0	5873	0	0	530	0	1857	0	706
Collared Pratincole	0	0	105	92	5589	1806	3027	0	0	126	0	349	89	0	786	192	0	260	0	1711
Painted Snipe	97	697	0	7	0	0	0	0	0	0	102	0	373	0	0	0	0	0	0	20
Spur-winged Lapwing	889	426	1284	871	543	286	442	0	0	0	0	155	0	0	411	185	0	173	0	246
African Wattled Lapw	0	160	0	1191	22	11	0	0	0	0	0	2	0	0	46	0	0	0	0	8
White-headed Lapwing	0	40	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Common Ringed Plov	0	0	0	0	23	331	1703	0	0	0	0	3	0	0	91	0	0	1234	0	267
Little Ringed Plover	0	0	0	152	4	60	0	0	0	1220	0	0	893	0	0	0	0	0	0	152
Kittlitz´s Plover	0	0	6	31	298	434	2024	0	0	0	0	0	0	0	0	278	0	1452	0	369
Forbes´s Plover	0	0	0	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spotted Redshank	0	0	0	0	120	5	0	0	0	0	0	0	0	0	0	76	0	0	0	17
Marsh Sandpiper	0	0	0	0	0	18	38	0	0	0	0	0	0	0	0	152	0	0	0	12
Common Greenshank	0	0	17	73	122	7	106	0	0	0	0	0	0	0	0	0	0	0	0	24
Green Sandpiper	0	0	3	17	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Wood Sandpiper	0	0	1207	3971	844	2002	460	0	0	14494	15241	379	12954	869	320	17917	14830	3962	3187	
Common Sandpiper	0	0	0	41	0	12	0	0	0	0	0	0	0	0	0	0	0	114	7	
Common Snipe	0	0	30	120	94	67	0	0	0	143	0	28	0	0	0	0	0	0	52	
Great Snipe	0	0	27	142	27	7	264	0	0	0	0	0	74	201	0	0	0	0	32	

Jack Snipe	0	0	0	4	0	0	0	0	0	0	283	0	0	0	0	0	0	0	2
Little Stint	0	0	32	3	1152	1466	7246	0	0	3919	917	37	2635	0	91	2576	0	8617	1754
Temminck´s Stint	0	0	0	8	9	5	0	0	0	93	0	0	0	0	0	0	0	0	9
Curlew Sandpiper	0	0	0	0	0	65	3661	0	0	104	0	0	0	0	0	0	0	606	258
Ruff	0	0	3	299	9150	2384	8538	0	0	43616	611	106	27685	0	0	13346	2030	7332	7152
Ruddy Turnstone	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	1
Gull-billed Tern	0	0	0	0	0	0	7	0	0	0	0	10	0	0	0	0	0	0	2
Marsh Owl	141	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pied Kingfisher	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66	1
Yellow Wagtail	0	0	5854	3536	1957	4408	3605	786	0	31906	23236	1217	12052	6491	3501	10842	10676	2120	5919
Red-throated Pipit	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow-throated Longcl	0	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge Warbler	0	0	0	0	0	1717	0	103012	51882	359	691	17	222	7599	0	0	4472	0	5807
Savi´s Warbler	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1
Bluethroat	0	0	0	0	0	160	0	0	0	0	0	0	0	2451	0	0	0	0	146
Crested Lark	0	0	399	35	1653	1220	603	0	0	77	0	433	191	936	849	2644	0	551	879
Zitting Cisticola	94	11	146	28	0	202	93	0	0	22	102	131	0	0	137	0	0	0	117
Prinia spec	0	0	47	0	0	73	0	0	0	0	0	6	0	2377	0	0	0	0	104
Northern Red Bishop	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow-crowned Bishop	59	39	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2521	9625	10821	14844	26981	22082	32375	103798	51882	110071	48684	4718	73411	22940	21647	50480	62475	28995	33938
N ha counted			259	155	107	1395	104	1,3	0,5	139	51	234	62	5,7	26	15	3,1	18	2161
N species	15	17	23	36	27	46	23	2	1	24	16	22	20	12	16	13	12	17	52

Appendix 6. Biodiversity in study areas

Assessed biodiversity of the Inner Niger Delta, the Office du Niger zone and the area around Sélingué, by general and density (several habitats involved IND) count approaches, and these two combined.
Biodiversité établie dans le Delta Intérieur, la zone de l'Office du Niger et autour de Sélingué, selon les approches 'général' et 'densité' (divers habitats DIN), et ces deux pris ensemble.

Gcts = general counts, Dcts = Density counts

			Selriz Gcts	Sellac Gcts	SEL Gcts	SEL Dctsriz	Dmriz Gcts	Dmfala Gcts	DM Gcts	DM Dctsriz	DIN Gcts	DIN 1Driac	DIN 2Dorg	DIN 3Driaz	DIN D123	DIN Dallhat
Little Grebe	Grèbe castagneux	Tachybaptus ruficollis						●	●		●					
Great White Pelican	Pélican blanc	Pelecanus onocrotalus									●					
Grey Pelican	Pélican gris	Pelecanus rufescens									●					
Long-tailed Cormorant	Cormoran africain	Phalacrocorax africanus	●	●	■	x	■	■	■		●		■	■	■	■
African Darter	Anhinga d'Afrique	Anhinga rufa						■	■		●		■		■	■
Grey Heron	Héron cendré	Ardea cinerea	●	●	■		■	■	■	■	●	■	■	■	■	■
Black-headed Heron	Héron mélanocéphale	Ardea melanocephala	●		■	●	■	■	■		●	■	■		■	■
Purple Heron	Héron pourpré	Ardea purpurea	●	●	■		■	■	■		●	■	■	■	■	■
Great Egret	Grande Aigrette	Egretta alba	●	●	■	●	■	■	■	x	●		■		■	■
Black Heron	Aigrette ardoisée	Egretta ardesiaca									●					
Intermediate Egret	Aigrette intermédiaire	Egretta intermedia	●	●	■	●	■	■	■	■	●		■		■	■
Little Egret (black morph)	Aigrette garzette noire	Egretta g. guiaris	●	●	■	●					●		■		■	■
Little Egret (white morph)	Aigrette garzette	Egretta garzetta	●	●	■	●	■	■	■	■	●	■	■	■	■	■
Cattle Egret	Héron garde-boeufs	Bubulcus ibis	●	●	■	●	■	■	■	■	●	■	■	■	■	■
Squacco Heron	Crabier chevelu	Ardeola ralloides	●	●	■	●	■	■	■	■	●	■	■	■	■	■
Green-backed Heron	Héron strié	Butorides striatus	●	●	■	x	■	■	■	x	●					
Night Heron	Bihoreau gris	Nycticorax nycticorax	●		■			■	■		●					
Little Bittern	Blongios nain	Ixobrychus minutus						●	●	x			■		●	●
Great Bittern	Butor étoilé	Botaurus stellaris									●		■		●	●
Yellow-billed Stork	Tantale ibis	Mycteria ibis									●					
Abdim's Stork	Cigogne d'Abdim	Ciconia abdimii					■	■	■							
White Stork	Cigogne blanche	Ciconia ciconia									●					
Woolly-necked Stork	Cigogne épiscopale	Ciconia episcopus						●	●							
Saddle-billed Stork	Jabiru d'Afrique	Ephippiorhynchus senegalensis									●					
Marabou Stork	Marabout d'Afrique	Leptoptilos crumeniferus									●					
Sacred Ibis	Ibis sacré	Threskiornis aethiopica									●	●	■		■	■
Glossy Ibis	Ibis falcinelle	Plegadis falcinellus									●		■		■	■
Eurasian Spoonbill	Spatule blanche	Platalea leucorodia									●					
African Spoonbill	Spatule d'Afrique	Platalea alba		●	■						●					
Hamerkop	Ombrette africaine	Scopus umbretta	●	●	■	●	■	■	■	*						
White-faced Whistling-duck	Dendrocygne veuf	Dendrocygna viduata	●	●	■	x		■	■		●					
Spur-winged Goose	Oie-armee de Gambie	Plectropterus gambensis		●	■			■	■		●					
Knob-billed Goose	Canard à bosse	Sarkidiornis melanotos		●	■			■	■		●					
Egyptian Goose	Ouette d'Egypte	Alopochen aegyptiacus									●					
African Pygmy Goose	Anserelle naine	Nettapus auritus	●		■			■	■		●		■		■	■
Garganey	Sarcelle d'été	Anas querquedula		●	■						●					
Shoveler	Canard souchet	Anas clypeata									●					
Ferruginous Duck	Fuligule nyroca	Aythya nyroca									●					
Black Crowned-crane	Grue couronnée	Balearica pavonina									●					
Black Crake	Râle à bec jaune	Amaurornis flavirostris						●	●							
Common Moorhen	Gallinule poule-d'eau	Gallinula chloropus	●		■			●	●		●					*
Lesser Moorhen	Gallinule africaine	Gallinula angulata				x		●	●	x	●		*		*	*
Allen's Gallinule	Talève d'Allen	Porphyrio alleni						●	●		●					
Purple Swamphen	Talève sultane	Porphyrio porphyrio						●	●		●		*		*	*
Lesser Jacana	Jacana nain	Microparra capensis				●		●	●		●	■	■	■	■	■
African Jacana	Jacana à poitrine dorée	Actophilornis africana	●	●	■	■	■	■	■	x	●	■	■	■	■	■

Greater Painted-snipe	Rhynchée peinte	Rostratula benghalensis	•		•	•		•	•	x	•					•
Black-winged Stilt	Echasse blanche	Himantopus himantopus	•	•	•	•	•	•	•	•	•	•	•		•	•
Senegal Thicknee	Oedicnème du Sénégal	Burhinus senegalensis	•	•	•			•	•		•					
Egyptian Plover	Pluvian fluviatile	Pluvianus aegyptius		•	•						•					
Cream-coloured Courser	Courvite isabelle	Cursorius isabellina									•					
Temminck's Courser	Courvite de Temminck	Cursorius temminckii		•	•						•	•			•	•
Common Pratincole	Glaréole à collier	Glareola pratincola	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Grey Pratincole	Glaréole grise	Glareola cinerea		•	•											
Spur-winged Lapwing	Vanneau à éperons	Vanellus spinosus	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Black-headed Lapwing	Vanneau à tête noire	Vanellus tectus		•	•			•	•							
White-headed Lapwing	Vanneau à tête blanche	Vanellus albiceps		•	•	x					•					
African Wattled Lapwing	Vanneau du Sénégal	Vanellus senegallus	•	•	•	•		•	•		•	•	•	•	•	•
Grey Plover	Pluvier argenté	Pluvialis squatarola									•					
Ringed Plover	Pluvier grand-gravelot	Charadrius hiaticula	•		•						•	•	•	•	•	•
Little Plover	Pluvier petit-gravelot	Charadrius dubius	•		•	•					•	•	•		•	•
Kittlitz's Plover	Pluvier pâtre	Charadrius pecuarius		•	•	•		•	•	•	•	•	•		•	•
Kentish Plover	Pluvier à collier interrompu	Charadrius alexandrinus									•					
White-fronted Plover	Pluvier à front blanc	Charadrius marginatus									•					
Forbes's Plover	Pluvier de Forbes	Charadrius forbesi	•		•	•										
Black-tailed Godwit	Barge à queue noire	Limosa limosa		•	•			•	•		•					
Eurasian Curlew	Courlis cendré	Numenius arquata									•					
Spotted Redshank	Chevalier arlequin	Tringa erythropus	•		•						•	•	•		•	•
Redshank	Chevalier gambette	Tringa totanus									•					
Marsh Sandpiper	Chevalier stagnatile	Tringa stagnatilis									•		•		•	•
Common Greenshank	Chevalier aboyeur	Tringa nebularia	•	•	•	•	•	•	•	•	•	•	•		•	•
Green Sandpiper	Chevalier cul-blanc	Tringa ochropus	•		•	•				•	•		•		•	•
Wood Sandpiper	Chevalier sylvain	Tringa glareola	•		•	•	•	•	•	•	•	•	•	•	•	•
Common Sandpiper	Chevalier guignette	Actitis hypoleucos	•	•	•	•					•		•		•	•
Ruddy Turnstone	Tournepierre à collier	Arenaria interpres									•					•
Great Snipe	Bécassine double	Gallinago media				•				•	•	•	•		•	•
Common Snipe	Bécassine des marais	Gallinago gallinago				•				•	•	•	•	•	•	•
Jack Snipe	Bécassine sourde	Lymnocryptes minimus														•
Red Knot	Bécasseau maubèche	Calidris canutus									•					
Little Stint	Bécasseau minute	Calidris minuta	•		•	•				•	•	•	•	•	•	•
Temminck's Stint	Bécasseau de Temminck	Calidris temminckii	•		•	•					•	•	•		•	•
Dunlin	Bécasseau variable	Calidris alpina									•					
Curlew Sandpiper	Bécasseau cocorli	Calidris ferruginea									•		•		•	•
Broad-billed Sandpiper	Bécasseau falcinelle	Limicola falcinellus									•					
Ruff	Combattant varié	Philomachus pugnax				•	•	•	•	•	•	•	•	•	•	•
Lesser Black-backed Gull	Goéland brun	Larus fuscus		•	•						•					
Grey-headed Gull	Mouette à tête grise	Larus cirrocephalus									•					
Black-headed Gull	Mouette rieuse	Larus ridibundus									•					
Whiskered Tern	Guifette moustac	Chlidonias hybridus		•	•						•					
White-winged Tern	Guifette leucoptère	Chlidonias leucopterus		•	•						•					
Gull-billed Tern	Sterne hansel	Gelochelidon nilotica		•	•			•	•		•			•	•	•
Caspian Tern	Sterne caspienne	Sterna caspia									•					
Little Tern	Sterne naine	Sterna albifrons									•					
Osprey	Balbuzard pêcheur	Pandion haliaetus	•	•	•			•	•		•					
African Fish-eagle	Pygargue vocifer	Haliaeetus vocifer		•	•						•					
Eurasian Marsh Harrier	Busard des roseaux	Circus aeruginosus	•	•	•		•	•	•		•					
Pallid Harrier	Busard pâle	Circus macrourus									•					
Montagu's Harrier	Busard cendré	Circus pygargus	•		•		•		•		•					
Black Kite	Milan noir	Milvus migrans	•	•	•		•	•	•		•					
Lanner Falcon	Faucon lanier	Falco biarmicus		•	•			•	•		•					
Black-shouldered Kite	Elanion blanc	Elanus caeruleus					•	•	•		•					
African Swallow-tailed Kite	Elanion naucler	Chelictinia riocourii					•		•							
African Marsh Owl	Hibou du Cap	Asio capensis					•	•	•	•	•					
Pied Kingfisher	Martin-pêcheur pie	Ceryle rudis	•	•	•		•	•	•	x	•					•
Giant Kingfisher	Martin-pêcheur géant	Megaceryle maxima	•	•	•											
Sand Martin	Hirondelle de rivage	Riparia riparia	•		•		•	•	•		•					
Yellow Wagtail	Bergeronnette printanière	Motacilla flava	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Grey Wagtail	Bergeronnette grise	Motacilla alba									•					
Red-throated Pipit	Pipit à gorge rousse	Anthus cervinus	•		•	•					*					
		N species	41	42	68	33	28	50	52	26	98	26	39	18	41	46

x = appears only in density counts