Describing habitat and finding colour rings of Black-tailed Godwits (Limosa limosa) in the Senegal River Delta, Senegal, from 2 – 9 July 2019

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Expedition report, University of Groningen & Global Flyway Network, The Netherlands

July 2019

Jos Hooijmeijer, Ruth Howison, Idrissa Ndiaye & Theunis Piersma

Introduction

The Black-tailed Godwit (*Limosa limosa*; BTG) is a meadow bird (Verstrael 1987; Thijse 1904). The current Dutch population is estimated at fewer than 40.000 breeding pairs (Kentie et al. 2016) and represents an important part of the total continental BTG population *Limosa limosa limosa*. However, the number of breeding pairs have declined rapidly over the last decades, as compared to the 120.000 pairs in the 1960s (Mulder 1972). This is mainly caused by a change in agricultural land use. Intensification and rationalisation have led to degradation of the breeding habitat, resulting in low reproduction. The population in the Netherlands cannot produce enough chicks for a stable population. (Vickery et al. 2001; Newton 2004; Tscharnke et al. 2005; Teunissen & Soldaat 2006; Roodbergen et al. 2012). After the breeding season godwits migrate to southern Europe (Spain and Portugal) and West-Africa where they stay for wintering (Márquez-Ferrando et al. 2009; Hooijmeijer et al. 2013).

Demographic research Southwest Friesland

To measure the changes in population numbers and the causes, in 2004 the University of Groningen started a long-term research in the south-western part of Friesland, The Netherlands. In 2007 the research area has expanded up to 8400 hectares and in 2012 it increased again with another 1600 hectares (Groen et al. 2012). A colour-marked population of godwits was set up to make them individually recognizable. The knowledge that has been collected with this research has been implemented by policy makers and nature conservation organisations.

Migration and wintering sites Black-tailed Godwit

In 1983-1984 the wintering sites of godwits were explored for the first time. At that moment most godwits were wintering in rice areas along the West-African coast in Senegal, Gambia, Guinea-Bissau and further. Big numbers of godwits also occurred in the inner Niger delta in Mali (Altenburg & van der Kamp 1985), but they probably belonged to the eastern European population. Recently, the wintering behaviour has partly changed with an increasing number of godwits deciding to winter in Southern-Spain at National Park Doñana. In the 1980s during the first counts, only 4% of the NW-European population used this area as a wintering site but recent estimations suggest a big change with up to 23% of the population wintering in Spain. The most important reason for this is probably the creation of new artificial fishponds and rice fields. It is remarkable that this increase is not driven by climatic changes in the Sahel zone of West-Africa (Márquez-Ferrando et al. 2013). For godwits, staying Iberia can be advantageous because they can skip a 3000 kilometre (v.v.) travel over the Sahara, a potentially dangerous migration route and save their fat stores for the next breeding season.

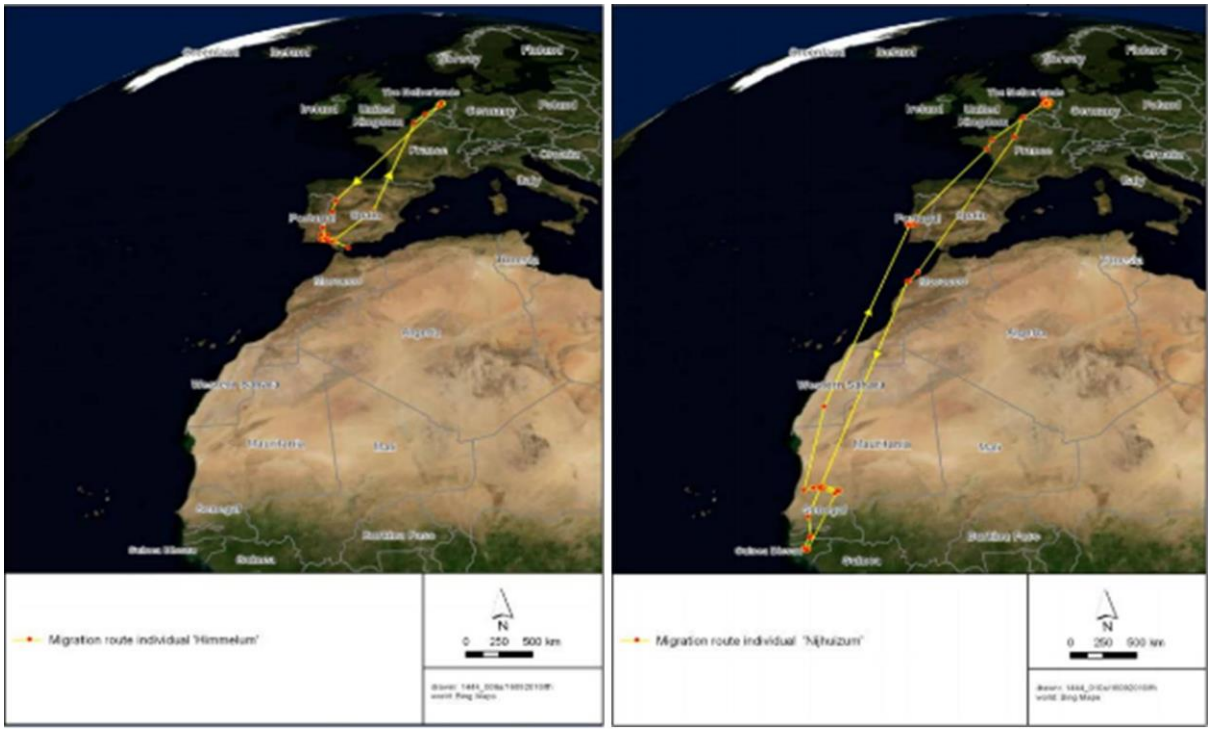

***Figure 1**. Two migration routes of satellite tagged birds in 2009. The left map shows the route of an Iberian wintering bird. On the right an African wintering bird. Iberian wintering birds save a 6000 km flight and don't need to cross the Sahara twice (Hooijmeijer et al. 2011).*

Conservation

The change in wintering grounds is remarkable and an important reason why we want to do (demographic) research in West-Africa. We know now that juveniles are more likely to make these kind of shifts than adults (Verhoeven et al., 2017), but not how they develop their individual migration strategy and perhaps thereby change the migration pattern of the species. These changes can also have consequences for the survival rate of both adults and juveniles. Moreover they can lead to differences in reproductive success, for example due to differences in body condition upon arrival on the breeding grounds. Both are demographic parameters that can rapidly influence population dynamics. A better understanding of these processes is therefore also important from a conservation point of view; the Black-tailed Godwit qualifies since 2006 as "Near Threatened" on the IUCN Red List.

Until now, West-Africa is the only area along the migratory flyway from where we don't receive many observations of colour-marked individuals. Only small numbers of colour-ringed birds have been reported, mainly by birdwatchers and, recently, by local scientists. Unfortunately the numbers of sightings are too small to make demographic comparisons between wintering sites.

Expeditions West-Africa and Iberia

In November 2014 the University of Groningen, in cooperation with Global Flyway Network and financially supported by Birdlife Netherlands, embarked upon their first expedition to the wintering grounds in West-Africa and since then we visited the area 2-3 times per year. We aim to set up a demographic research project in this area in close cooperation with local scientists, volunteers and conservation organisations. The most important goal of the first missions was to get a good overview of the wintering grounds, resighting conditions, local facilities and knowledge and to make a start with setting up a dataset of individually recognizable godwits that winter in West-Africa. Secondly we made a pilot study of habitat choice and prey choice. At this moment comparable research is done in NP Doñana (Spain), Extremadura (Spain) and the Tejo/Sado estuaries near Lisbon (Portugal). The last two are used as stop-over sites in February. Therefore it is mandatory to continue our

research at all these locations to find links between wintering sites, stop-over sites and breeding sites. Research questions we want to get into in the future with our work in West-Africa, Spain, Portugal and the Netherlands are:

- What is the overall difference in adult mortality between birds wintering in West-Africa and Iberia? And where along the flyway do these differences occur?
- Can birds change their wintering strategy during their life? And is this age-dependent?
- Does reproductive success determine where birds winter?
- Has the wintering strategy consequences for their migration and breeding phenology? And are there consequences for their reproductive success?

Habitat study

Anthropogenic alteration of natural wetlands is having a major impact worldwide with consequences (both negative and positive) for migratory species such as continental black-tailed godwits. The majority of continental black-tailed godwits breed in grassland meadows situated in north-west and Eastern Europe (March – July) after which they migrate southwards for the non-breeding period (mid July – February), finding forage resources within wetlands and agricultural rice fields. On their migratory route black-tailed godwits pass through France and either stage or spend the non-breeding period in southern Spain and Portugal. Many will make the Saharan crossing to overwintering sites in West Africa, namely; the Senegal Delta and coastal region of Senegal, The Gambia, Guinea-Bissau, Guinea, Sierra Leone and central Mali.

Concentrating our efforts in Senegal, we used remote sensing products (Sentinel C-SAR1 12-day, and Modis EVI 16-day time series) (Howison et al. 2018) and 5 years of good quality locations of black-tailed godwits (equipped with PTT satellite tags) to generate a spatially and temporally explicit habitat prediction model using MaxEnt modelling. We found that during the non-breeding period black-tailed godwits show a preference for stable habitats within a relatively low productivity range (EVI value 0.1-0.2), which are associated with open wetlands, low vegetation cover and shallow surface water. However, remote sensing data is difficult to interpret without accurate ground-truthing information. Additionally, godwits spend much of their time foraging either on the mudflats of saline mangrove wetlands or in wet rice fields, and little is known of the nature of the prey items or the chemical residues left in the sediment drained from agricultural lands, at different times of the year. In this study we aimed to conduct a survey categorizing and describing habitats, measuring environmental variables such as water salinity and soil penetration pressure, feeding efficiency of the godwits, their body condition and carefully searching the substrate to establish the identity of godwit prey items.

Between 2 and 9 July 2019 we visited the most import areas in the Senegal River delta and Djoudj NP Northern Senegal to record resightings of individual birds and describe godwit habitat. In this report we present a daily overview of our findings with photos, locations we visited, numbers present and the first conclusions and recommendations.

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Summary

Consecutive trips to West-Africa at different moments in the godwit annual cycle have allowed us to build up our knowledge of their itinerary, and learn about how godwits not only rely on manmade landscapes in their breeding grounds but also in rural Africa.

We encountered decent sized flocks of godwits, up to 800 birds. By simply adding up all numbers encountered at different sites, we estimate that between 3-4000 godwits were present in the Senegalese part of the Senegal delta, but turnover is probably high with fresh arrivals from Europe and birds moving further south. We assume we covered all important spots by checking all known major locations visited by satellite tagged birds between 2013 and 2019 in this time of the year: before the rains and the opening of the inlets of the Djoudj NP to allow the artificial annual flooding. We encountered low ring densities, 1:160 (2077 birds checked) compared to 1:60 in Iberia during spring migration.
We hypothesize several reasons for that:

- The low ring densities are found in groups where majority of the birds present were juveniles from previous years remaining in the Senegal Delta, skipping the first years migration(s) to the northern breeding grounds which might have a different ring density;
- The birds present come disproportionately from areas with low ring density. In our study area in SW Friesland we have high numbers of godwits with a very high ring density. If a lot of those birds did not arrive yet so early (for instance because we have a good breeding season, which causes them to stay longer in The Netherlands), this could reduce ring density.

Despite the low ring density we still managed to get 67 resightings of 44 individual birds in just 4 full days of fieldwork. We encountered only 3 juvenile individuals but this shows that they can arrive already in Africa in early July. Birds were encountered in all moult stages of body feathers, tail, secondairies and primaries.
Their main food source is chironomids and body scores averaged around 3, we only encountered one wetland (Tilene, Pont Gendarme) where the godwits were foraging among the grazed tussocks of Juncus, and it was not possible to ascertain what they were eating from the sieve sample. Despite that in many places the rice harvest was in full swing, we did not see a single godwit foraging on rice.

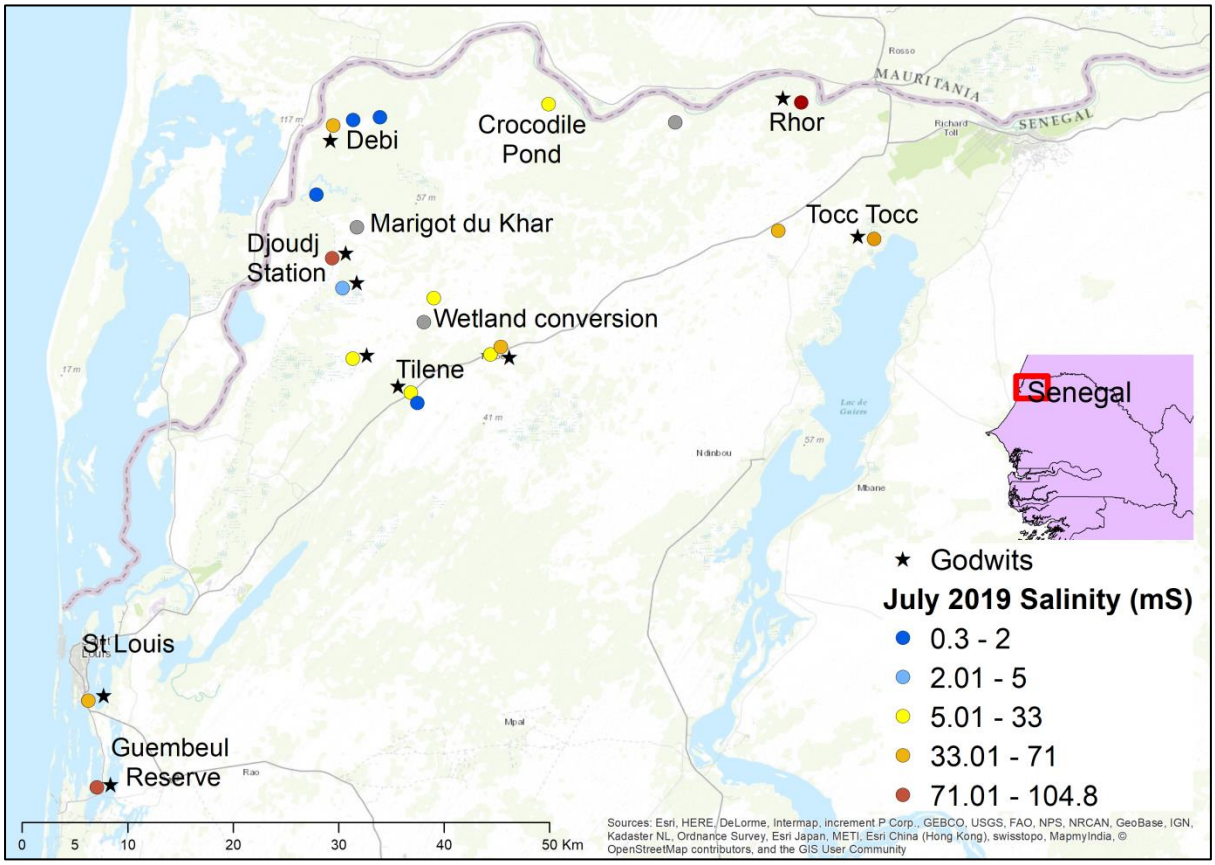
The damming of the Senegal River has led to the drying up of what was a naturally dynamic and expansive wetland complex. As a consequence of controlling the water flows, the majority of the landscape is completely dry. However, water drained from agricultural rice fields accumulates at the lowest elevations and forms wetland habitat profitable for water birds to use.
Rice agriculture is timed so that there are two main harvesting events. The first around mid-July and the second around September-October. Just before harvesting the farmers break the dikes and allow the rice paddies to drain. The water flows and accumulates into large shallow wet areas at the lowest elevations. Previously we thought that these areas were water buffer areas and that the farmers would pump the water back to the rice fields from these water storage areas. However, it seems more likely that the water management is largely gravity driven. Water comes into the agricultural fields from the large canals at higher elevation. When the water is no longer needed the water is drained out and accumulated at the lowest elevation. These water drainage basins are a crucial landscape element in facilitating good habitat for godwits and other water birds. We encountered high concentrations of water birds in these drainage basins (such as spur winged geese, whistling ducks, pelicans, breeding stilts, plovers, lapwings) suggesting that these species were spatially concentrated, due to the absence of wetland habitat in the larger landscape.

Permitting grazing by large numbers of cattle within the Djoudj National Park during the dry season opens up the vegetation, which otherwise would be tall dense stands of Typha, Juncus or Phragimites reed beds. Without the grazing the habitat would rapidly become unsuitable for wader species that require more open habitats.

Therefore, dry season cattle grazing has benefits to:

- The neighbouring farmers, since outside of the core wetland area of the reserve, the only remaining vegetation is the scattered savanna trees (Acacia, Buxifolia, occasional Baobab and shrubs). The ground is completely bare, with very little for the cattle to survive on. Thus the reserve forms an important dry season forage resource for the pastoralists and their huge cattle herds.
- Habitat for water birds, since the many 100's of cattle graze the tall reed vegetation back down to ground level. The draining of the rice fields before the first harvest provides the first wetland habitats and is followed by the rainy season and the artificial flooding from the Senegal river which wets up the whole landscape. Godwits profit from the opened vegetation and use the wetland reserve, moving out to alternative habitats when the reeds grow too dense and tall.

Thus, the activities of farmers create wet (drainage) and open (cattle grazing) habitats that water birds may profit from. However, this type of land management continues to assume that natural populations must find their resources in landscapes that are created by inefficient farming practices. If drainage would be improved by canalizing the flow of water back to the drainage canals or the river, and maximizing the land use for rice production (i.e. replacing the drainage areas with crops) these vital wetland habitats used by water birds would disappear. If cattle grazing was no longer permitted in the reserve the open habitats would soon disappear into dense tall reed beds.



Map of the areas visited, godwits encountered, and variation in salinity values of wetlands during the expedition

Daily reports

02 July 2019

We travelled from The Netherlands to Charles de Gaulle airport in Paris after a half our delay. The connecting flight to Dakar, Senegal was delayed by about 1.5 hours. We arrived in Dakar really late but the hotel had arranged a pickup to transfer us to the Black & White hotel in Toubab Dialaw.

View of Toubab Dialaw, the area is under rapid development, as most of the buildings in the surrounds were under construction.

03 July 2019

Misty in the morning clearing around 08h30, 35 ^{o}C midday temperature, nice breeze and mainly overcast skies.

Idrissa Ndiaye, our partner for expeditions in Senegal and driver Saliou Diop came to meet us at the hotel, we did some shopping arranged internet access for navigation and headed north to the Djoudj National Park. The landscape was extremely dry, there was almost no vegetation at ground level – mostly bare soil, some thorny shrubs among the iconic Sahelian Acacia trees.

We reached the outskirts of St Louis around 17h00. Here we found the first large group of 785 godwits at Leye Bar Boye lagoon with only 2 colour ringed individuals. We conducted a full habitat survey, water salinity in the estuary was 47.3 mS (for comparison, sea water is on average is 33 mS), and we found many small chironomids in the mud when we sieved out a sample to find out what the godwits were feeding on. Feeding frequency averaged about 30 items per minute. The lagoon also held hundreds of Lesser and Greater Flamingo's, Eurasian Spoonbills, two species of pelicans and many Curlew Sandpipers.

We then moved on to the north of the estuary next to St Louis; this estuary is horribly polluted, there is human faeces and plastic rubbish everywhere. Despite this we encountered a group of 173 godwits who were literally foraging around the rubbish. Their intake rates were lower averaging about 15 items per minute, dividing their time between feeding and preening.

After this we headed to the Djoudj research station; at the lake next to the research station there were around 300 godwits, with an average intake of 30 items per minute. In this group ring density was much higher with 4 ringed on 112 individuals checked.

We slept at the Djoudj Biological Centre as we would do for the rest of the trip.

The extremely dry savanna landscape en route from Dakar to the Djoudj research station, ground cover is almost completely absent

Polluted estuary of St Louis, here godwits forage in the tidal water searching for food items among the plastic waste

Godwits in the artificial wetlands next to the Djoudj research station, new godwits arrived in the evening flying high overhead and descending rapidly to the shallow water among the flock

04 July 2019

Mostly sunny, 35 ^{o}C, gentle breeze.

After breakfast we went on the roof of the Biological Centre to have a look at the godwits that were present in the adjacent wetland. We counted 486 birds that were almost all foraging in the water on Chironomids. Reading rings was far from easy but after 2,5 hours we had scored 16 ring combinations, including 2 Spanish and a German bird. Fat scores averaged 2,89 on a 1-5 scale (n=46). So far we have not seen a single juvenile yet but many adult birds are in active moult of primairies, secondairies, body and and tail feathers. A surprise was to find out that the salinity of the water next to the Djoudj Research Station is really high 80.7 mS.

We moved on in the direction of Ross Bethio and checked several wetlands. The water drainage basin of the ricefields next to the Biological Centre were stuffed with waterbirds, mainly Spurwinged and Egyptian Geese, both species of whistling ducks and almost 300 godwits. However these were mainly too far away and too deep in the water to see rings. Salinity here was much lower at 7 mS. Halfway we visited a former wetland that was visited by godwits in 2016 but had now been drained and was being prepared for rice cultivation. This whole day we witnessed that the entire former Senegal River floodplain is being tuned into agricultural land, mainly ricefields.

In Ross Bethio we turned right and just after Tilene at Pont Gendarme we scanned a small wetland. We found at least 50 godwits that were foraging in a grazed marshland surrounded by Typha. The godwits seemed to be foraging in the root bases of grazed Juncus plants, it was not clear what they were foraging on as the mud sieve sample did not yield anything conclusive, we collected mud samples for DNA and chemical analysis in the lab. We scored 1 ring combination but we might have missed a large part of the birds present. Only part of the Typha wetland was grazed and it was

impossible get a good overview because the birds might have been foraging in the higher vegetation as the satellite location points suggested.
We moved north and next to the village of Rhor on the borders of the Senegal river, we discovered a large water body that contained the water that had been drained from the ricefields prior to the harvest to make fields dry and suitable for large machinery. These waterbodies are present in many places in this time of the year because this is the time of the first annual harvest with a second one in November. After planting/ sowing the fields are being kept wet with water that comes from a big network of irrigation channels; the water in the retention basins just evaporates after some time making them extremely salty. But nonetheless these water bodies can be full of Chironimids providing good food for godwits. We found 300 godwits in this area but unfortunately no rings. The datapoints of the satellite birds show that the godwits also used the ricefields adjacent to this water body. We found quite some spilled rice from the harvest but did not see any godwits foraging on it so it remains unclear if the godwits used these fields to forage on rice or anything else.
We left the ricefields and arrived back at the Biological Center at 20h00 where Da had prepared a nice meal for us.

View from the roof of the Djoudj research station

After the foraging bout in the early morning, godwits start chilling on the sandbanks in the wetland next to the Djoudj research station

We visited a former wetland that was visited by godwits in 2016 but had now been drained and was being prepared for rice cultivation

Water birds and cattle in the wet marsh near Tilene at Pont Gendarme, godwits foraging in the root bases of the grazed Juncus

Water body next to the village of Rhor on the borders of the Senegal river, created by runoff from the rice fields that were being drained before the first harvest.

5 July 2019

Overcast in the morning, clearing later in the morning, 37 ^{o}C.

We headed straight to Tocc-Tocc Reserve after breakfast, and the area did not disappoint us. We encountered over 700 godwits mostly foraging and resting in the shallow water. Intake rate was quite low averaging around 10 items/minute and when we did a sieve sample we discovered few large chironomids and proportionally higher sand content compared to other areas. Fat score averaged 3.31 (n=49). Very few colour ring combinations in the group have led us to think that the groups might be dominated by relatively young birds who have remained in Africa for the previous season or a lot of birds originating from an area with low ring density. We encountered the first two juveniles from this year.

Tocc-Tocc is a nature reserve governed by the local community. The water feeding into this shallow lake drains from nearby rice agriculture since the reserve is at a relatively low elevation point in the landscape.

The water was hypersaline at this time of the year at 71 mS, and it is remarkable that these saline conditions don't seem to bother the many wader species using these habitats, such as godwits, stilts, sandpipers, yellow billed storks, whistling ducks and spur winged geese.

On the way home we stopped at the shallow water basin next to the Biological Centre at the Diadiem rice fields and found 190 godwits present, but managed to read only one combination mainly because most birds were foraging in deep water.

Cattle and godwits together in the Tocc Tocc reserve

Godwits and a spur winged goose in the Tocc Tocc reserve

6 July 2019

Mostly overcast skies, 38 ^{o}C, strong winds and dust storms.

There were dark clouds when we started this morning and we expected it to start raining any moment, however it remained dry. Normally the rains arrive here in July and die out in September, bringing 200-300 mm of water. That is by far not enough to fill the flood plains of the Djoudj NP but that is covered by opening the sluices later this month around the 20th of July when the flood of rainwater arrives from the south through the Senegal river. For irrigation purposes and to prevent St Louis from getting flooded, the Diama dam was built in the late 1980's. Since then the flooding of the Senegal delta has become completely artificial and was the first step to turn the floodplains in to the huge rice fields as we know it nowadays.

Today we headed out for the Djoudj NP. We started at Marigot du Khar but found it was completely dry, forming an intermittent wet area, used by godwits (according to the satellite transmitter locations). In some old buildings we found tracks of huge African Rock Pythons and we saw one resting in a hole.

A lot of satellite data points showed up for this time of the year along the northern shores of the Grand Lac but it turned out to be puzzle how to get there. We got stuck halfway between the village of Debi and our destination (the Italian Pisano hunting camp on the borders of the wetland), the crossing was too muddy and not passable with our 4x4 vehicle. Fortunately we found a man with a horse cart that wanted to bring us there. At the camp we found a huge, dry, grazed Typha field. There was some water running in, drained from the nearby rice fields but we found no godwits. The same applied at a location called Crocodile pond, a bit further up north: bone dry, grazed wetlands with some wet areas due to drainage water from the rice fields.
We realized that these places are only suitable for godwits and other waterbirds because of the grazing that prevents the area from turning into a huge Typha Marsh. When the marsh starts to dry out the cattle eats the standing vegetation to the ground, thereby keeping the area open. And the drainage water from the rice fields creates the most important habitat for godwits in this time of the year because the rest of the NP is completely dry. Again as we see in many places throughout the year, godwits rely on manmade habitat by farmers!
Salinity in the Djoudj core reserve wet habitats was between 19 and 70 mS.
We fortunately found a group of 140 birds in a drainage basin just north of Debi where we could get close enough to see the legs. One bird turned out to be a chick from the British reintroduction program. We scored abdominal profiles of 46 individuals averaging 3.13. Just before dark we arrived back at the Biological Centre where spent our time till dark reading ring combinations. It was great to see newly arriving birds falling from the sky, perhaps straight from The Netherlands? Numbers had increased to 650 birds.

The intermittent wetland at Marigot du Kar

Tracking godwits in the Djoudj reserve with one horse power

Typha reedbed grazed completely to the ground by cattle, water present at this time of year originates from draining the adjacent agricultural rice fields before harvest

The Crocodile pond, in the north of the Djoudj reserve, again grazed to the ground by cattle and water in the low lying areas originates from the drained agricultural rice fields

7 July 2019

A sunny day with temperatures up to 36 °C and a nice breeze.

As we were finished with all habitat description data points on our wish-list we decided to revisit the sites with the highest number of godwits present to get some extra resightings. We started again at Tocc-Tocc reserve and found about 800 birds. The ring density was still low but only 2 of the resightings we scored were from birds we saw 2 days ago. We checked pretty much all the birds present so there must be quite some turn over at this site.

We left in the late morning and drove south to stop at Tilene, Pont Gendarme. We found a road to the back end of this wetland where we found more birds, in total about 120 but there might have been many more because the tall vegetation does not allow to get a good overview. Here a large herd of cattle were grazing in the wet marsh, this grazing opens up the vegetation, which makes the wetland suitable for waders. Where the cattle have not yet reached there are tall dense stands of impenetrable Typha.

Our next stop was at Maka, Leye Bar Boye lagoon where we encountered 550 birds with again a very low ring density, less than 1:300 birds!

We finished the day at the Biological Centre to find out that here also new birds had arrived although the numbers present were not any different from the previous days.

Cattle and godwits at Tocc Tocc

Godwits in the St Louis estuary near Maka; they were quite shy and difficult to approach

8 July 2019

Mostly overcast with midday temperatures around 35 ^{o}C.

Today was already our final day in Senegal. After breakfast we scored our last birds in the wetland next to the Biological Centre and arranged some financial affairs. We left at 11:00, we planned to stop just south of the Guembeul reserve for lunch, but as we turned off the main road we spotted some 65 godwits in the estuary. We managed to find one more code flag among the foraging godwits; surprising was that the salinity in this estuary was 104 mS.

In the meantime we noticed that the dirt road wasn't good, so we decided to turn back to St Louis to continue on the main road to Toubab Dialaw, our driver misjudged the soft sand on the edge of the road (understandable as the transition to soft sand was not very clear). Our car got stuck, but in true form of Africa, a few guys working on building a house a few meters up the road came to help dig out and push the car back onto solid surface. The whole ordeal only lasted about a half hour.

On the road again, a strong burning smell and smoke came out from under the hood of our vehicle. Saliou stopped the vehicle got out and opened the hood, he pulled out the burning and broken fan belt and tossed it into the back of the car, saying "It's fine we can continue." We started to wonder if we would make it on time for the flight back to NL!!

With slightly more rush on our itinerary caused by the small delays we continued straight to Toubab Dialaw where we had dinner with Idrissa and Saliou before they brought us to the airport to catch our flight back at 23:00 to arrive in Amsterdam the next morning. The end of another inspiring expedition!

Godwits foraging in the Guembeul estuary, with very high salinity (104 mS)

Team godwit (left to right): Da, Idrissa, Saliou, Jos, and Ruth

A slight miscalculation had us stuck in the soft sand, but luckily TIA, we could enlist the helpful assistance of two guys working on a new house nearby to help get us back on the road!