Ship-based seabird and marine mammal surveys off Mauritania, 1-12 November 2016

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The research presented in this cruise report on pelagic biodiversity of the shelf break was carried out in the framework of the Programme « Biodiversity Oil and Gas », an initiative of the Mauritanian Ministry of Environment and Sustainable Development, in partnership with the Ministry of Energy, Oil and Mines and the Ministry of Fisheries and Maritime Economy. It is sponsored by the United Nations Development Programme (UNDP), the German Agency for International Cooperation (GIZ), the World Conservation Union (IUCN) and WWF. Financial support for this survey was also provided by Kosmos Energy, Dallas, Texas (USA).

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Cover page: Cape Verde Shearwater *Calonectris edwardsii* (top) and Cory's Shearwaters *Calonectris borealis* (bottom) (RvB)

Glossary

Forage fish	Forage fish, also called prey fish or bait fish, are small pelagic fish which are preyed on by larger predators for food. Predators include other larger fish, seabirds and marine mammals. Typical ocean forage fish feed near the base of the food chain on plankton, often by filter feeding. They include particularly fishes of the family Clupeidae (herrings, sardines, sardinella, menhaden, anchovies and sprats), but also other small fish.
Neritic	Shallow zone, coastal shelf waters, for this study defined as all surveyed areas with a water depth of <200m
Oceanic	Deep water zone, for this study defined as all surveyed areas with a water depth of >800m
Shelf break	Transition between oceanic deep water and shallow shelf waters, for this study defined as all surveyed areas with a water depth of 200-800m
SST	Sea surface temperature (°C), measured on board

Contents

(1) Rationale

The unique biodiversity and the significance as a breeding ground, stop-over, feeding and wintering area for charismatic megafauna of Mauritanian waters is beyond dispute. Yet, the area is constantly under threat, mainly as a result of human impacts such as (over-)fishing (Meissa & Gascuel 2014), bycatch, IUU fisheries[1] (Daniels *et al.* 2016), maritime traffic and an emerging offshore oil and gas industry (Rodriguez *et al.* 2016). The economic wealth for Mauritania generated by commercial (industrial) fisheries and the development of its offshore oil and gas reserves is incontestable. However, the risks involved for the unique marine fauna should be minimised as much as possible. Emblematic, often "non-commercial" species play essential roles in the marine ecosystem, and the inter- and intraspecific interactions within multi-species foraging assemblages are an aspect of particular interest. Their protection depends not only on the efforts of conservationists (for example on the breeding grounds) but certainly also on fisheries managers promoting long term economic wealth based on the fishery sector. The wildlife utilising Mauritanian waters has a breeding origin as wide apart as the Antarctic and the Arctic, and calving grounds of large marine mammals off Mauritania are currently just regaining their significance, now that severely depleted whale stocks are slowly recovering.

Since 2006, Mauritania is extracting oil from an exploitation site situated approximately 80 km offshore its capital Nouakchott. During the 2016 surveys, these extractions were still ongoing. Other oil and gas discoveries have been made as well in these deep waters around the shelf break and abyssal plain. Most companies present in Mauritania obey by codes of conduct stipulating to avoid and mitigate impacts on biodiversity. The Deepwater Horizon spill in the Gulf of Mexico became a text book example showing how a poor understanding of the regional ecological vulnerability resulted not only in severe reputational damage for the industry but also in long-term and largely avoidable impacts on the ecology and local economy. It may therefore be expected that companies develop environmental management policies based on detailed knowledge about the host environment. When working in a developing country, such as Mauritania, where national authorities have tight budget constraints for ecological research, responsible industry players should invest voluntarily in baseline data collection. It is remarkable that so far only the oil industry was found prepared to invest in data collection. A longer term vision from the fisheries perspective would call for in-depth ecological baseline studies, aside the stock assessments of commercial species, in order to safeguard fisheries opportunities also for future generations.

Today, Mauritania's national oil spill contingency plan recognises the most important sensitive coastal areas. Earlier surveys have clearly demonstrated that the shelf break harbours internationally important concentrations of seabirds and cetaceans, gathering in rather small, well-defined but also predictable areas. The offshore surveys conducted within the Programme Biodiversité Gaz et Pétrole (2012), an initiative of the Mauritanian Ministry of Environment, provide baseline data that are essential for implementing policies aimed at safeguarding the unique biodiversity for future generations. Oil companies are, or should be, particularly interested in the specific vulnerability of these areas, to allow them to enhance oil spill preparedness and to reduce risks involved with seismic operations. Given distinct seasonal patterns and migratory movements of almost all species utilising Mauritanian waters, our knowledge about the whereabouts of the most sensitive pelagic sea areas around the year is still incomplete. The present survey was meant to fill in a data gap between the disappearance of Southern Hemisphere non-breeding populations and the arrival of Northern Hemisphere breeding birds. A radical change in species composition and overall abundance in most species was expected, when comparing data collected in the (Northern Hemisphere) autumn and early winter. Further data gaps exist for the Northern Hemisphere summer (June-July), and the spring migration requires more information, given that the thus far collected data became outdated. With existing data, however, coarse oil-sensitivity maps were made to assist and advice the national government and environmental managers working for the various maritime sectors.

[1] Illegal, unreported and unregulated fisheries, IUU fisheries.

It is our aim to collate and share existing data collected by ourselves (within and prior to the present research programme), merge data into single databases, invite other scientists to join in and share data in order to try and complete the picture year-round. Further surveys, required to fill the currently most pressing data gaps that are still existing should be organised somewhere within the May-August period (**Fig. 2.1**).

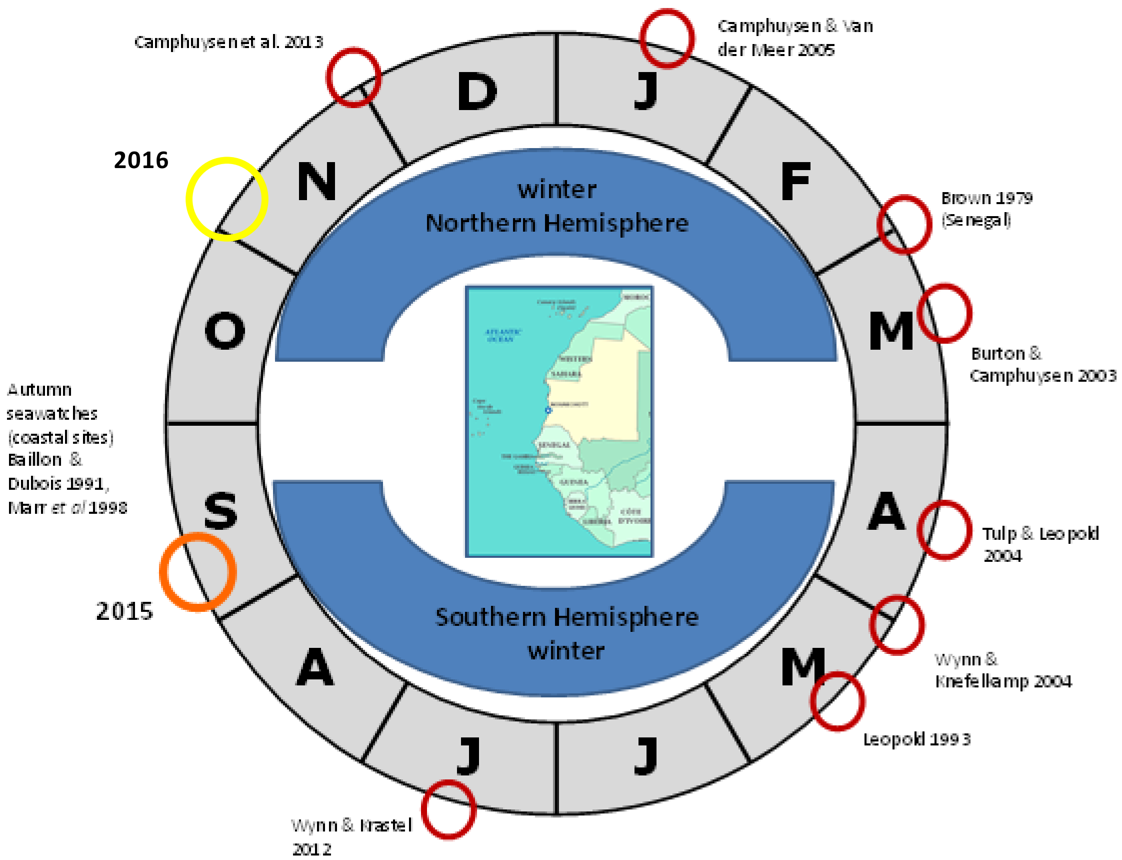


Fig. 2.1 Recent comprehensive surveys of seabirds and/or megafauna assemblages in Mauritanian waters, including some coastal seawatches and the contribution of the 2016 surveys in early November (yellow) with regard to timing and seasonality.

For the oil and gas industry, it is our ultimate aim to provide tailor-made sensitivity maps based on observed densities multiplied by species-specific and area-specific oil vulnerability indices (King & Sanger 1979, Begg *et al.* 1997, Camphuysen 1998, Camphuysen *et al.* 2007). With these maps, for any season, high quality advice can be provided regarding the sensitivity of particular areas within and around the Mauritanian upwelling system (cf. Carter *et al.*1993, Webb *et al.* 1995). Species-specific information is then invisible, even though this information is underlying the sensitivity maps, because it is irrelevant during contingency planning. For nature conservation agencies, intimate knowledge of the prime foraging areas and foraging habitats is essential information to improve conservation strategies.

(2) Introduction

Mauritanian waters are part of the Canary Current eastern Boundary Upwelling Ecosystem; i.e. one of only four such ecosystems in the World (California, Humboldt, Benguela and Canary currents; Chavez & Messié 2009). Together they generate about 25% of the world fisheries. In Mauritania, most fish is captured along the shelf break - a narrow stretch of sea measuring 50 to 250 km wide. This shelf break is formed by a steep drop off with a slope of 2.5 to 6° which starts at 70 Km from the coast, except in the Northern part were the continental shelf is at is widest (150 km; Antobreh & Krastel 2006). When the trade winds blow the surface waters away from the coast, cold and nutrient rich waters from deep in the ocean are drawn to the surface along this drop off. Intense tropical sunlight together with the influx of nutriments from the deep, provides perfect conditions for localized blooms of plankton – the foundation of highly productive food webs.

The productive shelf seas are targeted since the 1960, with increased intensity, by commercial fisheries. The local artisanal fleet uses relatively small but numerous vessels and occupy mostly the nearshore the coastal waters of the continental shelf. The industrial fleet targeting small pelagics and benthic species concentrates along and within the shelf break. This fleet is composed of European and Asian trawlers able to localize with sonar every fish school and to catch them at depths going beyond 1000 meters (IMROP, atlas maritime des zones vulnerable en Mauritanie 2012). Dwindling fishery resources and recent discoveries of oil and gas in this area have triggered a societal debate about the need to put a sound policy in place to protect the marine environment. More information about the ecological importance of this particular sea area is urgently required, and this is exactly what the project reported here is aiming at (Mauritanian Ministry of environment. Document du Programme Biodiversité Gaz et Pétrole 2012).

Seabirds and cetaceans have proven to be useful indicator species to map (productive) pelagic hotspots. The avifauna off Western Africa is usually dominated by surface feeding and shallow plunge diving, often plankton feeding seabirds, many of which are wintering birds originating from West Palaearctic breeding grounds (arctic, subarctic and temperate zones). Many seabirds are associated with large trawlers around the shelf-break, but the exact importance of these fishing activities for seabirds is still unclear.

This report presents the results obtained during the ship-based seabird and marine mammal surveys conducted between 1-12 November 2016 and must be seen as a preliminary analysis of the data and a further step in data collection. This cruise was part of the longer-term research project financed via the Programme "Biodiversity Gas and Oil" (BGO) which is spearheaded by the Mauritanian Ministry of environment and implemented in conjunction with the Ministry of Fisheries and the Ministry of Mining and Oil. The activities are funded primarily by the GIZ, UNDP/GEF and IUCN and co-sponsored by the private sector. The survey was carried out by the Mauritanian Institute for Sea Research IMROP in co-operation with Dutch (NIOZ) researchers, sponsored by Kosmos Energy. The project contributes to the objective of the Programme BGP to gain better insights into the overall ecological vulnerability of the area to oil and gas development and commercial fisheries in general and in particular to understand the sensitivity of the Shelf-break area to surface pollution during late summer. The report is one of the building blocks that will form the future guideline for sound oil spill preparedness in the shelf break area and prime oil and gas development site. In this cruise report species accounts and short ecological interpretations of the collected material are presented. The methods and protocols followed and a description of the methods chosen to analyse, map, present and illustrate the data can be found in our previous cruise report (Camphuysen 2015).

3 Methods and study area

3.1 Observer effort

The ship *Al Awam* surveyed the Mauritanian Continental shelf (Neritic zone) and slope (Shelf break) towards and from deeper Oceanic waters between Nouadhibou (Mauritania) and St. Louis (Senegal), 1-12 November 2016 (**Fig. 3.1**). Mean (± SD) daily observer effort amounted to 111.7 ± 17.4 5-minute counts, or 9.3 ± 1.5 hours of observation. With an average speed of 7.8 ± 0.3 knots, on 134.6 ± 23.1 km could be surveyed, given the 300m wide strip-transect covering an area of 40.4 ± 6.9 km² on a daily basis (**Table 3.1**). Transects were designed to cross the shelf break preferably at a 90° angle and followed a zigzag pattern with two shelf-slope crosses each day (surveying from dawn to almost dusk; **Fig. 3.1**). Data were collected in 5-minute periods and for each period, the geographical position was recorded as well as the ship's speed, sea state, sea surface temperature (SST), the presence of clearly visible fronts, lines of flotsam as well fisheries activities and the presence or absence of plastic floats (indicating set nets, drift nets or octopus pots).

Table 3.1 Observer effort per day: date, mean latitude (°N), number of 5-minute counts (*n*), area surveyed (km²), hours of observation, and distance travelled (km) for each of three pre-defined depth zones (m)**.**

					Counts			**Area surveyed**			
Dd	Mm	Yy	Latitude		Oceanic >800m	Shelf-break 200-800m	Neritic <200m	Oceanic >800m	Shelf-break 200-800m	Neritic <200m	
1	11	2016	20.4	°N	43	39	56	16.6	14.3	20.5	km²
2	11	2016	19.8	°N	60	29	15	22.0	10.5	5.4	km²
3	11	2016	19.0	°N	39	29	47	14.9	11.0	17.3	km²
4	11	2016	18.0	°N	41	37	34	14.9	13.3	11.7	km²
5	11	2016	17.0	°N	56	13	54	21.6	5.0	20.5	km²
6	11	2016	16.5	°N	53	21	42	19.3	7.9	15.4	km²
7	11	2016	17.5	°N	50	30	43	16.6	10.6	15.5	km²
8	11	2016	18.5	°N	45	34	34	16.5	12.5	12.4	km²
9	11	2016	19.5	°N	48	35	25	17.2	12.7	9.3	km²
10	11	2016	20.1	°N	38	17	64	12.3	5.9	22.0	km²
11	11	2016	20.3	°N			104			36.5	km²
12	11	2016	20.6	°N			65			22.5	km²
Totals					473	284	583	171.9	103.6	209.0	km²

					Hours			**Distance covered**			
	Mm	Yy	Latitude		Oceanic >800m	Shelf-break 200-800m	Neritic <200m	Oceanic >800m	Shelf-break 200-800m	Neritic <200m	
1	11	2016	20.4	°N	3.6	3.3	4.7	55.4	47.5	68.4	km
2	11	2016	19.8	°N	5.0	2.4	1.3	73.4	35.0	17.9	km
3	11	2016	19.0	°N	3.3	2.4	3.9	49.6	36.5	57.8	km
4	11	2016	18.0	°N	3.4	3.1	2.8	49.7	44.4	39.0	km
5	11	2016	17.0	°N	4.7	1.1	4.5	72.0	16.7	68.2	km
6	11	2016	16.5	°N	4.4	1.8	3.5	64.5	26.3	51.3	km
7	11	2016	17.5	°N	4.2	2.5	3.6	55.3	35.2	51.5	km
8	11	2016	18.5	°N	3.8	2.8	2.8	54.9	41.6	41.4	km
9	11	2016	19.5	°N	4.0	2.9	2.1	57.2	42.4	30.9	km
10	11	2016	20.1	°N	3.2	1.4	5.3	41.1	19.8	73.4	km
11	11	2016	20.3	°N	0.0	0.0	8.7			121.8	km
12	11	2016	20.6	°N	0.0	0.0	5.4			75.1	km
Totals					35.83	20.42	43.92	517.7	297.8	628.3	km

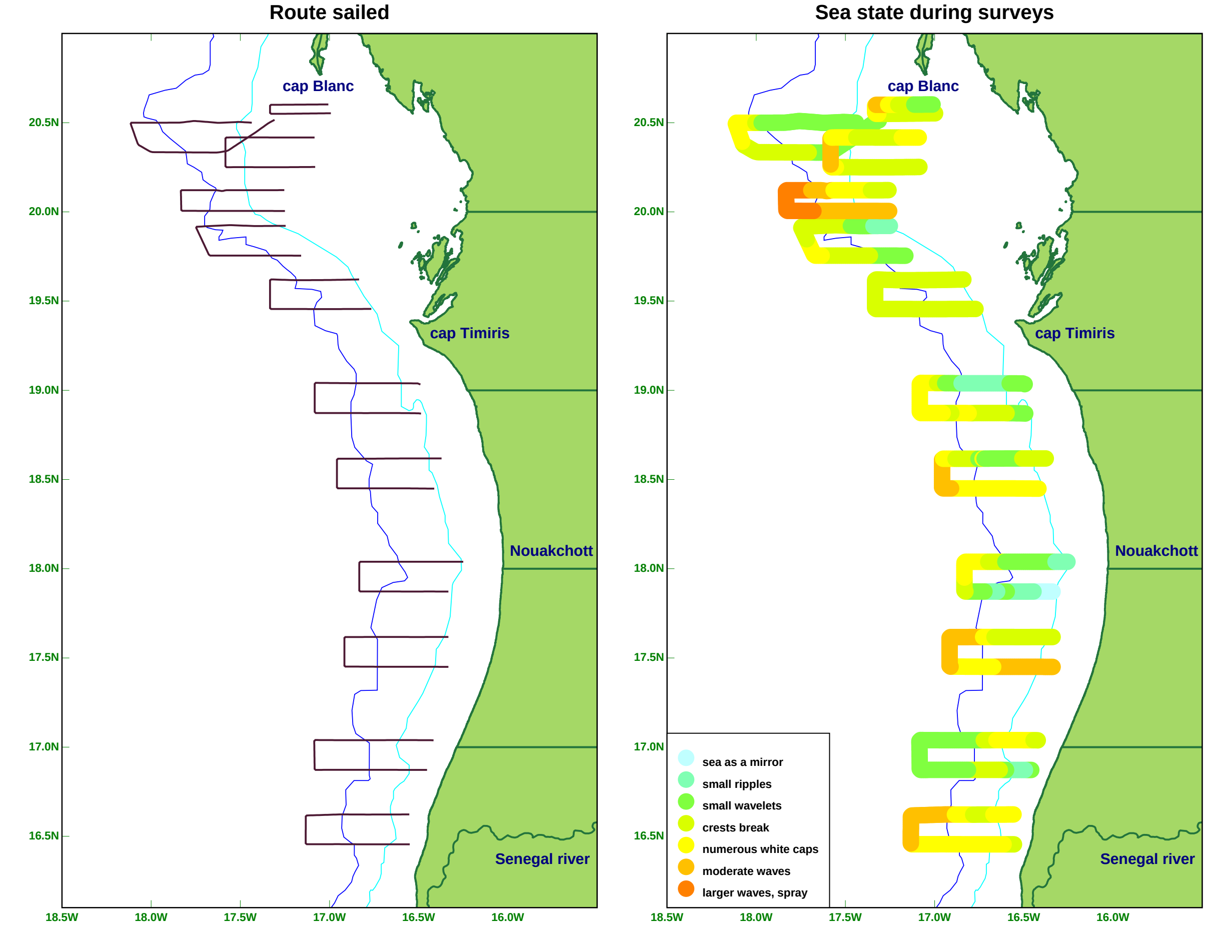


Fig. 3.1. Routes sailed (left) and sea states experienced during systematic surveys (right), 1-12 November 2016.

3.2. Survey methods

The surveys were conducted according to the strip-transect method in which a 300m wide transect on one side (with favourable light) and ahead of the ship was used, including a snap-shot for flying birds (Tasker *et al.* 1984, Camphuysen *et al.* 2004). Ship-attracted birds were labelled as such and could therefore be excluded from analysis if that was needed (Camphuysen *et al.* 2004). All observations were conducted by a team of two observers (CJC, RvB). Sightings by other observers on board were ignored to standardise the sampling and detection probabilities as much as possible. The surveys included full behavioural observations using international procedures (Camphuysen & Garthe 2004). This allowed us to pin-point main feeding areas and it permitted us to describe and quantify species interactions encountered during these surveys.

3.3 Population estimates derived from strip-transect counts

The observer effort has subsequently been summarised in 10'x10' rectangles, each with a surface area of *c.* 343 km² (18.5x18.5 km; **Fig. 3.2**) to provide a spatial pattern in observed densities (number of birds or marine mammals per km²). This single dataset is too small and most birds are simply not recorded frequently enough to warrant a more refined spatial analysis using for example kriging techniques, but future analyses with merged data will be highly suitable for a more advanced spatial statistical analysis.

For each rectangle, abundance estimates were calculated based on birds recorded within the 300m strip-transect. Of the 90 sub-sampled rectangles, mean coverage amounted to 5.38 ± 2.59 km², range 0.23-13.40 km² (*i.e.* on average 1.6 ± 0.8%, with a maximum of 4.2% of the total surface area). Poor coverage was in four rectangles (light blue in **Fig. 3.2** (left), 0.09 ± 0.02% of the total surface area). In order to obtain estimates of total numbers within the studied area (that is within all sufficiently surveyed rectangles), a mean density ±

SD was calculated over the numbers of birds per km² found in each of 86 well-covered rectangles. An extrapolated number was calculated by using the overall mean density found for all 111 10x10' rectangles covering similar areas around the shelf slope, as indicated in **Fig. 3.2** (right; unsurveyed blocks and poorly surveyed blocks included). As an example: an overall density of 1.42 Pomarine Skuas per km² calculated over 86 properly surveyed 10x10' rectangles would lead to an estimate of *c.* 54,100 individuals for all 111 rectangles drawn in **Fig. 3.2**-right. For small birds such as storm-petrels, grey phalaropes and floats of fish nets, objects that were apparently easily missed a distance, a species-specific correction factor was calculated based on assessments of densities within 4 distance bands away from the ship (see Species Accounts, see also Camphuysen *et al.* 2013). Densities were multiplied with by 1.22 (all storm-petrels combined), 1.16, and 1.36 respectively.

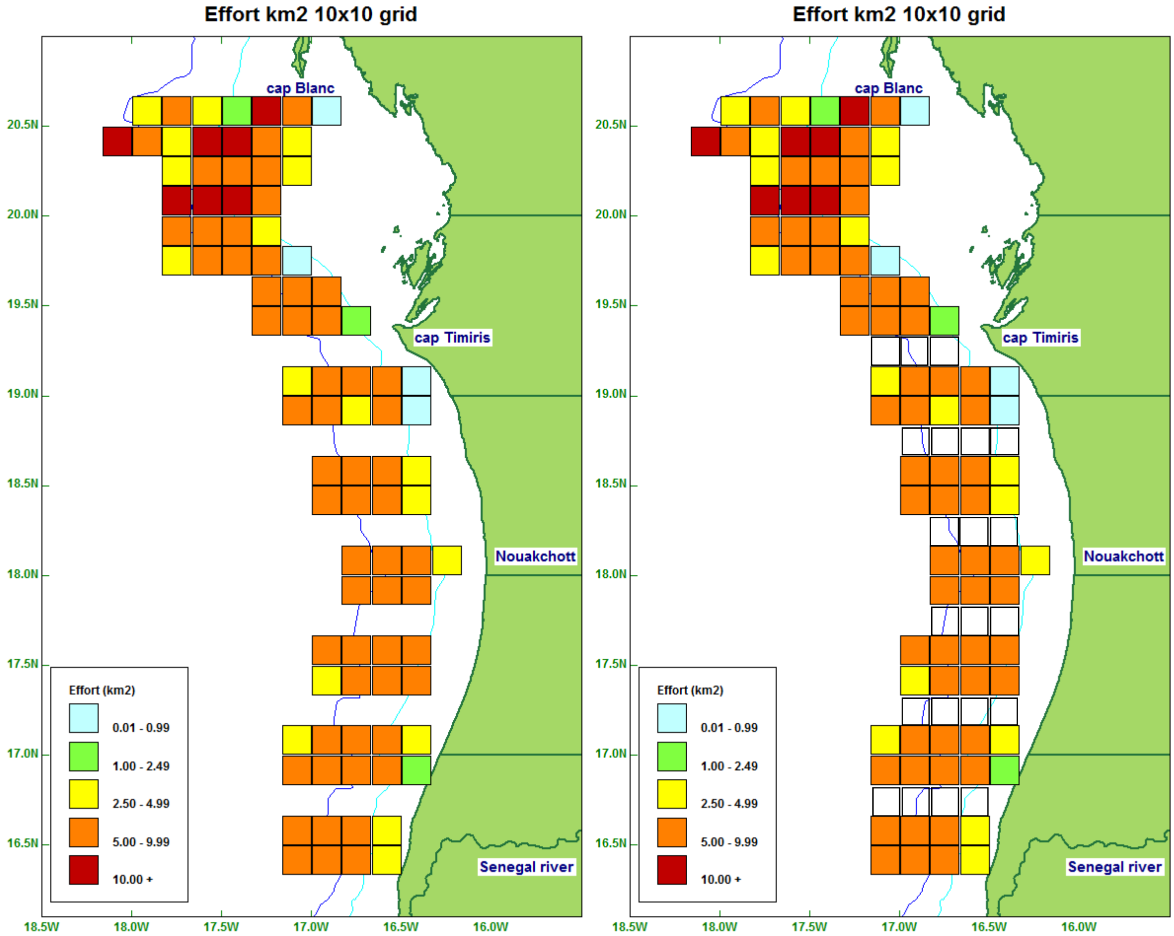


Fig. 3.2 Observer effort as km² per 10x10'grid square (left, 90 sub-sampled rectangles in total), and area used for extrapolation (right): 111 10x10' rectangles and the positioning of unsurveyed (*i.e.* blank) rectangles relative to the surveyed grid cells.

3.4 Oceanographic features, bathymetry, sea surface temperature

All 28 transects aimed at crossing the Shelf-break at a more or less right angle (perpendicular), travelling from west to east or vice versa. Records of depth (m) were kept every 15 minutes and missing values were imputed for each 5-minute period by assuming linear change between subsequent recordings (**Fig. 3.3**). All counts in waters less than 200m deep were classified as "**Neritic**", counts in waters between 200 and 800m deep were considered "**Shelf break**", whereas counts in deeper waters were listed as "**Oceanic**". Total survey time spent in each of these areas amounted to 100.2 hours, of which 35.8% (35.8 hours, 171.9 km² surveyed) in Oceanic waters, 20.4% (20.4 hours, 103.6km² surveyed) over the Shelf break and 43.8% (43.9 hours, 209.0 km² surveyed) within the Neritic zone (**Table 3.1**).

Sea surface temperatures ranged from 17.4-28.1°C, with a clear spatial pattern from south (warm, homogeneous) to north (cooler) (**Fig. 3.3**). A large area of notably cooler waters were encountered around 20°30'N, to the south of Cap Blanc, within the neritic zone (20°C or considerably lower), indicating upwelling of cooler waters from the deep (**Table 3.2)**. Otherwise, sea surface temperatures rarely dropped below 20°C (**Table. 3.2**). The highest SSTs were measured along the southernmost four transects (surveyed 5-6 November 2016), especially over deeper waters in that area.

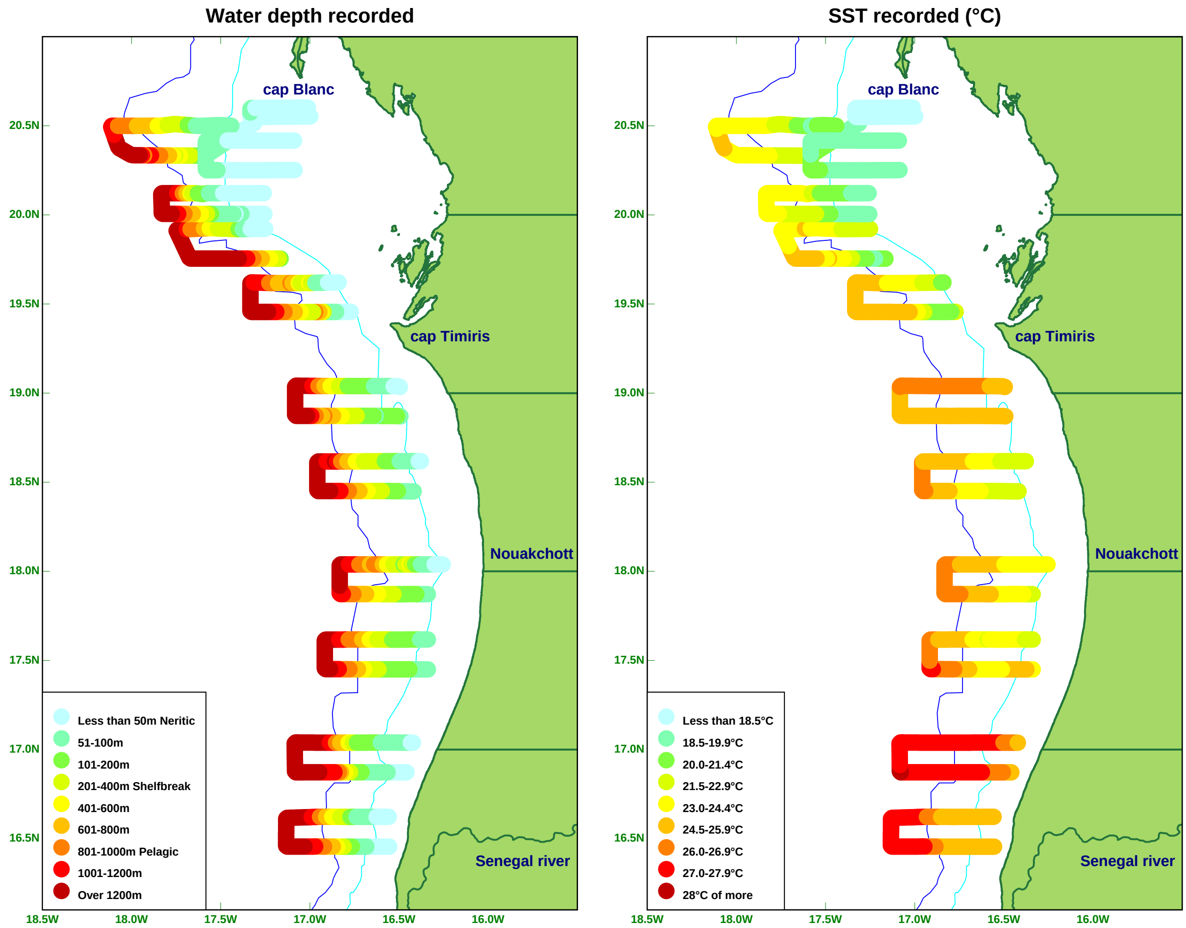


Fig. 3.3 Routes sailed and water depth (m, left) or sea surface temperature (SST, °C, right) recorded or interpolated during the surveys, 1-12 Nov 2016. Measurements were once every 15 minutes and for each 5-minute period inbetween two measurements, a value was calculated based on the earlier and later values assuming linear trends.

Table 3.2 Survey dates arranged according to mean latitude (°N), from north to south, with the range of observed sea surface temperatures (SST, °C) and the mean SST for each day.

	Date	Latitude			Min		Max				
12	Nov	20.58	°N,	range	17.4	-	18.4	,	mean	17.8	°C
1	Nov	20.43	°N,	range	19.5	-	24.7	,	mean	22.2	°C
11	Nov	20.33	°N,	range	18.6	-	20.6	,	mean	19.4	°C
10	Nov	20.06	°N,	range	19.4	-	24.4	,	mean	21.8	°C
2	Nov	19.84	°N,	range	19.8	-	24.8	,	mean	23.2	°C
9	Nov	19.53	°N,	range	20.5	-	25.1	,	mean	23.8	°C
3	Nov	18.96	°N,	range	24.9	-	26.7	,	mean	25.8	°C
8	Nov	18.54	°N,	range	21.7	-	26.1	,	mean	24.2	°C
4	Nov	17.96	°N,	range	22.7	-	26.8	,	mean	24.9	°C
7	Nov	17.54	°N,	range	22.8	-	27.0	,	mean	25.0	°C
5	Nov	16.96	°N,	range	24.7	-	28.1	,	mean	27.3	°C
6	Nov	16.54	°N,	range	24.9	-	27.9	,	mean	26.5	°C

3.5 Meteorological data

Weather conditions were favourable to excellent during most of the survey, with light winds, clear skies and bright sunshine during most of the days. Sea state ranged from still (0) to occasionally 6 (larger waves, more spray), but was mostly sea state 2 (small wavelets) to 4 (numerous whitecaps) on nearly all days. These relatively small wind waves, combined with a gentle (light to moderate) swell, gave good to excellent observation conditions during most of the programme.

Table 3.3 Survey dates and sea states experienced during these days. Values indicate the number of 5-minute periods per day for each of these conditions. Surveys would have been discontinued if >sea state 6 (near gale or gale conditions).

	Sea state						
Date	**0**	**1**	**2**	**3**	**4**	**5**	**6**
01 Nov 2016			84	35	19		
02 Nov 2016		9	28	55	12		
03 Nov 2016		22	26	26	41		
04 Nov 2016	10	27	39	16	20		
05 Nov 2016		9	73	23	18		
06 Nov 2016				15	64	37	
07 Nov 2016				31	26	66	
08 Nov 2016			20	23	50	20	
09 Nov 2016				108			
10 Nov 2016				10	19	50	40
11 Nov 2016				63	26	15	
12 Nov 2016			10	37	12	6	

3.6 Commercial and artisanal fisheries

Large stationary trawler (RvB).

The Islamic Republic of Mauritania has some of the world's most fish-abundant waters due to its strong upwelling coastal currents and a large continental shelf favouring the development of fisheries resources (COFREPECHE *et al.* 2014). During this project, with an offshore survey generally conducted at well over 5 nm from the nearest Mauritanian coast (Senegalese border and Cap Blanc), we only distinguished between industrial large vessels (pelagic and demersal trawlers or other gears) and artisanal fisheries (pirogues). Conform ESAS survey techniques, for each 5-minute period of observation, fishing vessels within visible range (by eye) were identified and counted. Codes included (1) no fishing vessels around, (4) vessels at >2km distance, (6) vessel(s) at <2km distance, (7) vessel(s) at 0.5-2km distance, and (9) fishing fleet around the observation vessel (at least 5 vessels). Under 'trawlers', a variety of fishing gears was included (it was not always possible to identify the gear deployed, even though IMROP experts were available during these surveys), including genuine pelagic trawlers, possible bottom trawlers, and long-liners. As usual, most of the Chinese vessels (distant water fleets) were inactive and usually sorting and boxing catches while afloat or anchored. These sorting vessels could attract large numbers of seabirds and several fleets were approached to assess the species composition and the numbers of birds attracted. During these fleet approaches (which required deviations from the planned course), strip-transect counts were discontinued temporarily, and the tracklines/surveys were picked up again after such visits.

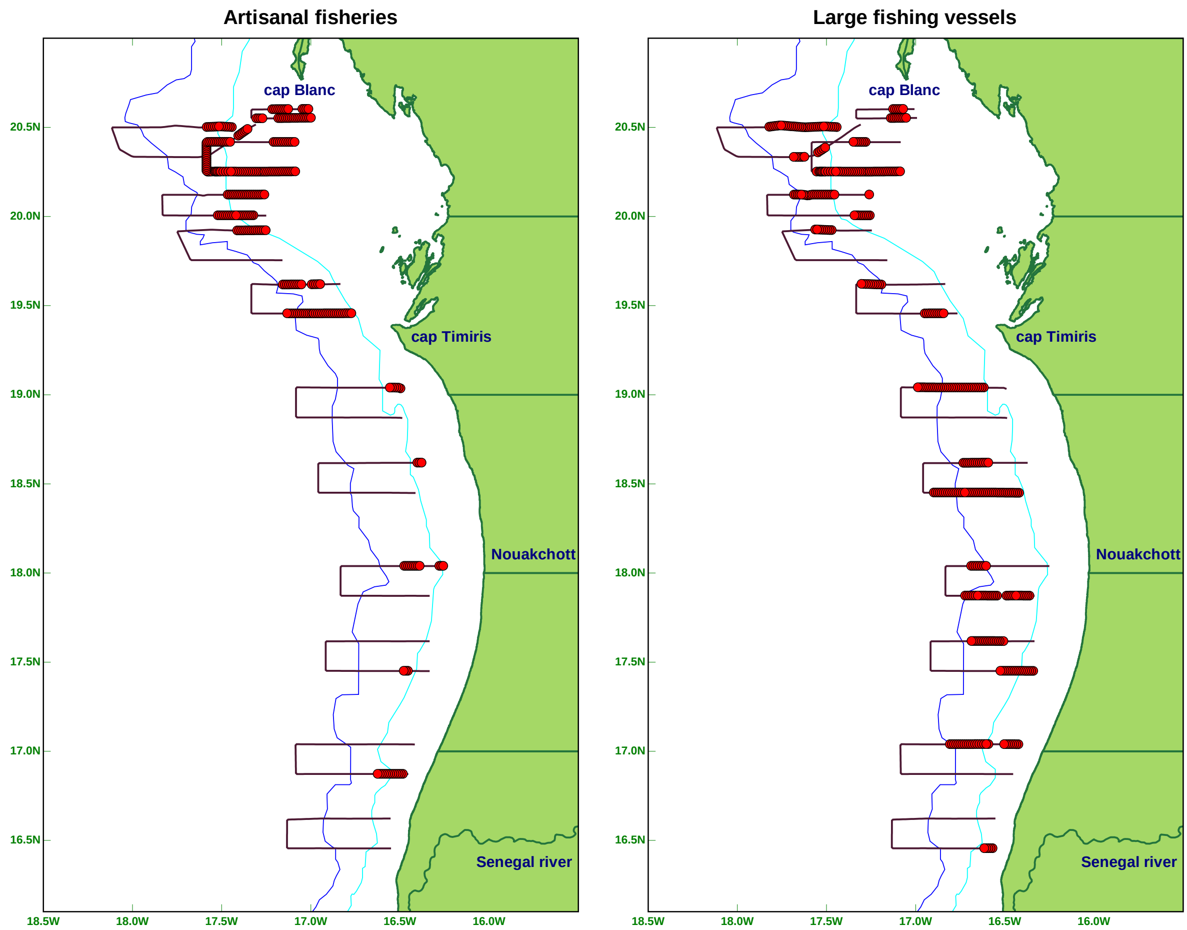


Fig. 3.4 Routes sailed and 5-minute counting periods with artisanal pirogues in sight (left) or with larger, industrial fishing vessels or trawlers within visible range (right), 1-12 Nov 2016. Note that large vessels may be visible at considerably larger distances than pirogues, but the more widespread occurrence of larger vessels versus the highly concentrated occurrences of artisanal fleets is evident from these graphs.

Table 3.4 Number (*n*) of 5-minute counts and percent of time (%) with visible industrial (trawlers) or artisanal (pirogues) fishing vessels (FV) per depth zone (Oceanic >800m, Shelf break 200-800m, Neritic <200m depth).

	Number of 5-minute counts					%% Percentage of total survey time				
	Artisanal	Trawler	Both	None	Sum	Artisanal	Trawler	Both	Total	None
Oceanic	2	33	0	438	473	0.4	7.0	0	7.4	92.6
Shelf-break	35	110	3	142	284	12.3	38.7	1.1	50.0	50.0
Neritic	240	220	81	204	583	41.2	37.7	13.9	65.0	35.0
Totals	277	363	84	784	1340	20.7	27.1	6.27	41.5	58.5

In total, industrial and artisanal fishing vessels were both recorded for 41% of the total survey time (n= 1340 5-minute counts; **Table 3.4**). Within the Neritic zone (<200m deep waters), the presence of fishing vessels was recorded during 65% of the survey time (41% artisanal fleets, 38% trawlers, but both during 14% of the time), with a clear concentration in more northerly areas (18-20°N; **Fig. 3.4**). Very few pirogues were seen over deeper waters (Oceanic) and also trawlers were recorded only in 7% of the time of all surveys and also over the Shelf-break, the presence of trawlers (39% of the time), clearly exceeded that of artisanal pirogues (12% of the time).

Artisanal pirogue accompanied by Common Terns *Sterna hirundo* (RvB).

Chinese fishing vessel of the Chinese distant water fleet, setting gear (RvB).

Artisanal pirogue (RvB)

Large freezer trawler (RvB)

Illegal freezer trawler operations nearshore off Nouakchott, 8 November 2016 (RvB)

4. Results

4.1 General results and main findings

After covering the entire Shelf-break area off the Mauritanian coast between 1-12 November 2016, a total of at least 28 species of marine birds and 11 species of cetaceans were recorded. The top-ten most numerous seabirds are listed in **Table 4.1**.

Table 4.1 Top 10 most abundant species of seabirds observed, 1-12 November 2016, on board Al Awam off the Mauritanian coast. Shown are English, French and Latin names, number observed (*n*), overall density (*n* km^{-2}), extrapolated number for all 111 rectangles (Fig. **3.2**), and overall densities (*n* km^{-2}) in deep oceanic, shelf-break and neritic waters (peak densities in bright yellow).

						n/km²		
English name	French name	Scientific name	*n*	*n*/km²	extrapol	Oceanic	Shelf-break	Neritic
European Storm Petrel	Océanite tempete	*Hydrobates pelagicus*	2017	4.17	193600	0.54	0.73	8.90
Black Tern	Guifette noire	*Chlidonias niger*	1142	2.36	90000	4.25	2.35	0.81
Northern Gannet	Fou de Bassan	*Morus bassanus*	1000	2.07	78800	0.08	0.36	4.57
Cory's Shearwater	Puffin cendré	*Calonectris borealis*	926	1.92	73000	1.08	0.68	3.23
Leach's Storm Petrel	Océanite culblanc	*Oceanodroma leucorhoa*	859	1.78	82500	4.23	1.16	0.06
Common Tern	Sterne pierregarin	*Sterna hirundo*	694	1.44	54700	0.97	1.31	1.89
Pomarine Skua	Labbe pomarin	*Stercorarius pomarinus*	686	1.42	54100	0.27	0.70	2.73
Red Phalarope	Phalarope à bec large	*Phalaropus fulicarius*	364	0.75	33300	0.33	0.11	1.43
Wilson's Storm-petrel	Océanite de Wilson	*Oceanites oceanicus*	259	0.54	24900	0.31	0.59	0.70
Long-tailed Jaeger	Labbe à longue queue	*Stercorarius longicaudus*	102	0.21	8040	0.13	0.13	0.32

With 12 different species, the tubenoses were well represented, followed by terns (6 species) and skuas (4 species; **Table 4.2**). Pomarine Skuas and Cory's shearwaters were particularly widespread, being present in 64 (71%) and 59 (66%) of a total of 90 surveyed 10'x10'rectangles (**§ 4.3**). Black Terns (45%), Common Terns (40%), and Long-tailed Skuas (39%) were seen in just less than half of the surveyed rectangles.

Long-tailed Skuas *Stercorarius longicaudes* (RvB)

Table 4.2 All species of seabirds observed, 1-12 November 2016, on board Al Awam off the Mauritanian coast, and their most likely breeding origin. Non-regional species are migrants that utilise these waters as stop-over or as wintering area (non-breeding season). Nomenclature and taxonomic order following Gill & Donsker (2016). Species that (also) breed in Mauritania are marked with an asterisk (*)

Code	English name	French name	Scientific name	Breeding origin
880	Scopoli's Shearwater	Puffin cendré (Mediterannée)	*Calonectris diomedea*	Mediterranean
885	Scopoli's/Corys shearwater	Puffin cendré	*Calonectris spp.*	
890	Cory's Shearwater	Puffin cendré (Atlantique)	*Calonectris borealis*	Regional
900	Cape Verde Shearwater	Puffin du Cap-Vert	*Calonectris edwardsii*	Regional
1560	Great Shearwater	Puffin majeur	*Ardenna gravis*	Sub-Antarctic
1570	Sooty Shearwater	Puffin fuligineux	*Ardenna grisea*	Sub-Antarctic
1680	Manx Shearwater	Puffin des Anglais	*Puffinus puffinus*	Boreal
1690	Balearic Shearwater	Puffin des Baléares	*Puffinus mauretanicus*	Mediterranean
1880	European Storm Petrel	Océanite tempete	*Hydrobates pelagicus*	Boreal
1920	Wilson's Storm-petrel	Océanite de Wilson	*Oceanites oceanicus*	Antarctic
1930	Band-rumped Storm Petrel	Océanite de Castro	*Oceanodroma castro*	Regional
1970	Leach's Storm Petrel	Océanite culblanc	*Oceanodroma leucorhoa*	Boreal
2070	White-faced Storm-petrel	Océanite frégate	*Pelagodroma marina*	Regional
2280	Northern Gannet	Fou de Bassan	*Morus bassanus*	Boreal
8880	Red Phalarope	Phalarope à bec large	*Phalaropus fulicarius*	Arctic
9020	Long-tailed Jaeger	Labbe à longue queue	*Stercorarius longicaudus*	Arctic
9040	Parasitic Jaeger	Labbe parasite	*Stercorarius parasiticus*	Arctic/Boreal
9050	Pomarine Skua	Labbe pomarin	*Stercorarius pomarinus*	Arctic
9060	Great Skua	Grande Labbe	*Stercorarius skua*	Boreal
9250	Audouin's Gull	Goéland d'Audouin	*Ichthyaetus audouinii*	Mediterranean
9490	Lesser Black-backed Gull	Goéland brun	*Larus fuscus*	Boreal
9830	Sabine's Gull	Mouette de Sabine	*Xema sabini*	Arctic
9980	Black-legged Kittiwake	Mouette tridactyle	*Rissa tridactyla*	Boreal/Arctic
10120	Black Tern	Guifette noire	*Chlidonias niger*	Boreal
10310	Bridled Tern*	Sterne bridée	*Onychoprion anaethetus*	Regional
10380	Caspian Tern*	Sterne caspienne	*Hydroprogne caspia*	Regional
10440	Common Tern*	Sterne pierregarin	*Sterna hirundo*	Boreal

Table 4.3 All cetaceans observed, 1-12 November 2014, on board Al Awam off the Mauritanian coast. Cetaceans utilise these waters as wintering area or as resident species, but their migratory pathways and local seasonality are largely unknown.

Code	English name	French name	Scientific name
26080	Blue / Fin / Sei Whale	rorqual	*large Balaenoptera spec.*
25140	Fin Whale	Rorqual commun	*Balaenoptera physalus*
25810	Sperm Whale	Cachalot	*Physeter macrocephalus*
25700	beaked whale	Baleine a bec	*Mesoplodon spec.*
25750	Killer Whale	Orque	*Orcinus orca*
25390	Risso's Dolphin	Dauphin de Risso	*Grampus griseus*
25250	Common Dolphin	Dauphin commun	*Delphinus delphis*
25270	Short-beaked Common Dolphin	Dauphin commun brévirostre	*Delphinus delphis delphis*
25340	Short-finned Pilot Whale	Globicéphale tropical	*Globicephala macrorhynchus*
25930	Clymene Dolphin	Dauphin de Clymene	*Stenella clymene*
25950	Atlantic Spotted Dolphin	Dauphin tacheté Atlantique	*Stenella frontalis*
26010	Bottlenose Dolphin	Grand dauphin	*Tursiops truncatus*
26070	unidentified dolphin	dauphin	*dolphin*

In terms of habitat differentiation and shifts in sea surface temperatures (SST), the most northerly part of the study area (19°-21°N latitude) was considerably more complex and had particularly over the shelf (Neritic zone) much lower water temperatures (indicating upwelling) than that further to the south (**Fig. 3.3**). Within this area, biodiversity was generally higher (seabirds as well as marine mammals), both industrial and artisanal fisheries were encountered with the highest frequencies (**Fig. 3.4**). The cooler waters (SST) south of Cap Blanc are indicative for the upwelling of nutrient-rich waters and the effect (or the attraction) is visible on many of the maps presented in the species accounts below.

Within this chapter, for the commoner species, two types of distribution maps are provided. One type of map provides all observations, but with ship-followers excluded from the analysis (*n* per 5-minute count, using sizable red dots to indicate total numbers observed) and maps giving observed densities ($n\ km^{-2}$, i.e. birds in transect corrected for observation effort) per 10'x10'rectangle (cf. **§** 3.3). These maps numbered nor subtitled (species names are in the heather), but they are imbedded within or very near the species entry in the species accounts.

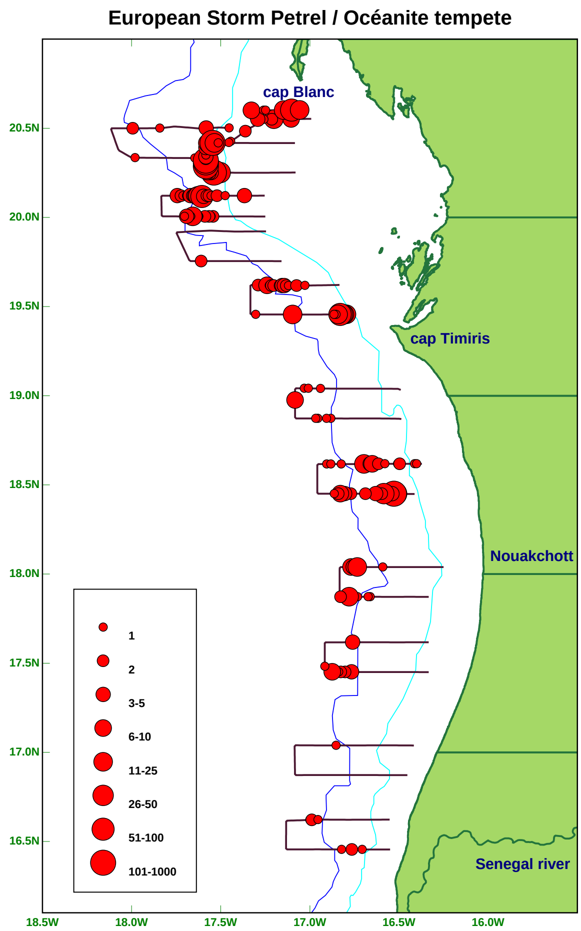
Common Terns *Sterna hirundo* onboard the Al Awam (RvB)

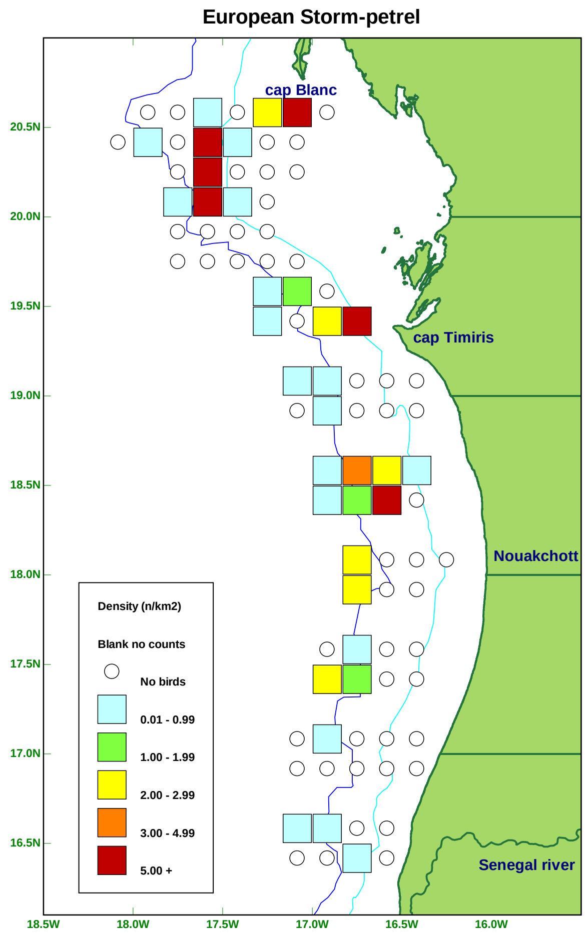
4.2 Species accounts

4.2.1 **Tubenoses** Procellariiformes (1) – **Storm-petrels**

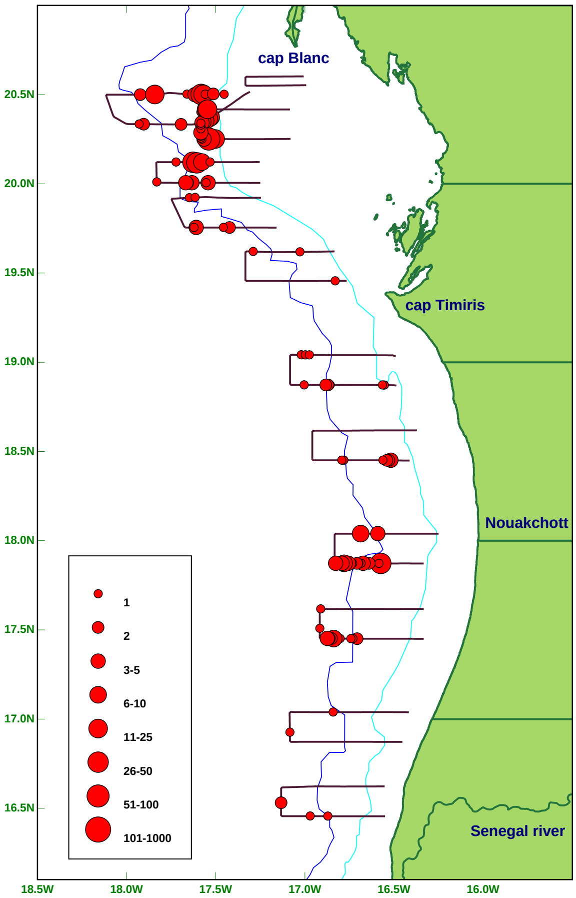
European Storm-petrels *Hydrobates pelagicus*

A total of 5 species of storm-petrels Hydrobatidae have been recorded in the November 2016 surveys, including one southern hemisphere species (Wilson's Storm-petrel *Oceanites oceanicus*), two migrants from the North Atlantic (European Storm-petrel *Hydrobates pelagicus* and Leach's Storm-petrel *Oceanodroma leucorhoa*), and two 'regional' species breeding in Macaronesia (Band-rumped Storm-petrel *O. castro*) and White-faced Storm-petrel *Pelagodroma marina*). The first three species were common and widespread (**Fig. 5.6**), but with European Storm-petrels and Wilson'S Storm-petrels confined to the Neritic zone and shallower parts of the Shelf-break and with the largely Oceanic Leach's Storm-petrels numerically predominating over deeper waters, i.e. the outer Shelf break and beyond (>700m deep waters).

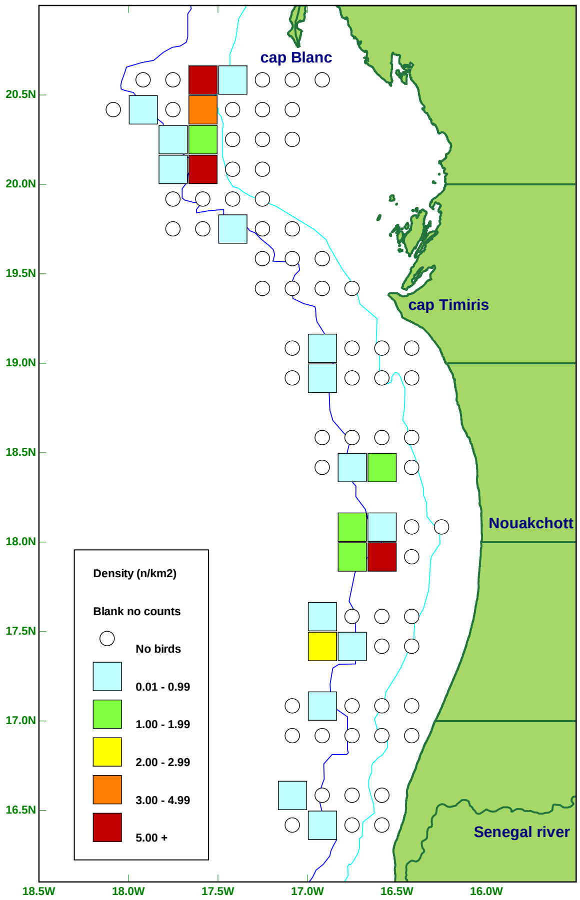




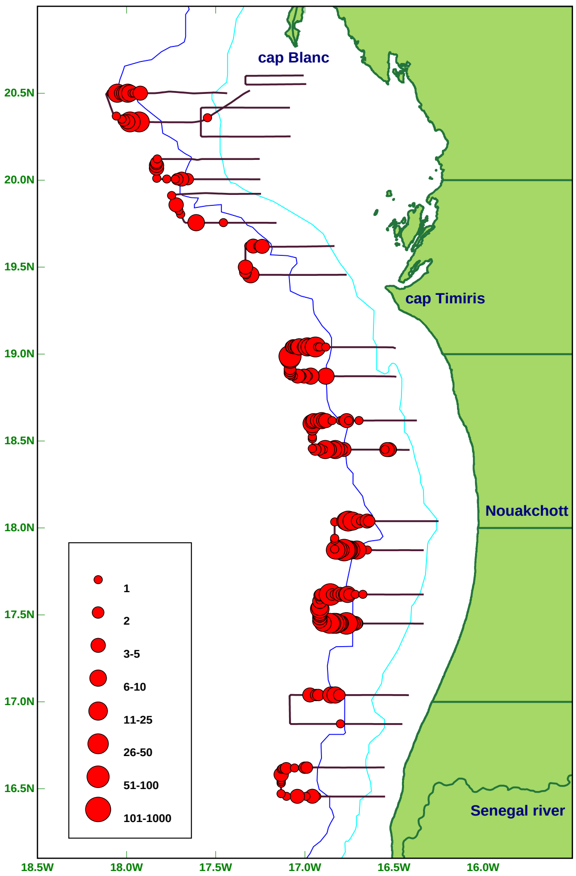
Wilson's Storm-petrel / Océanite de Wilson



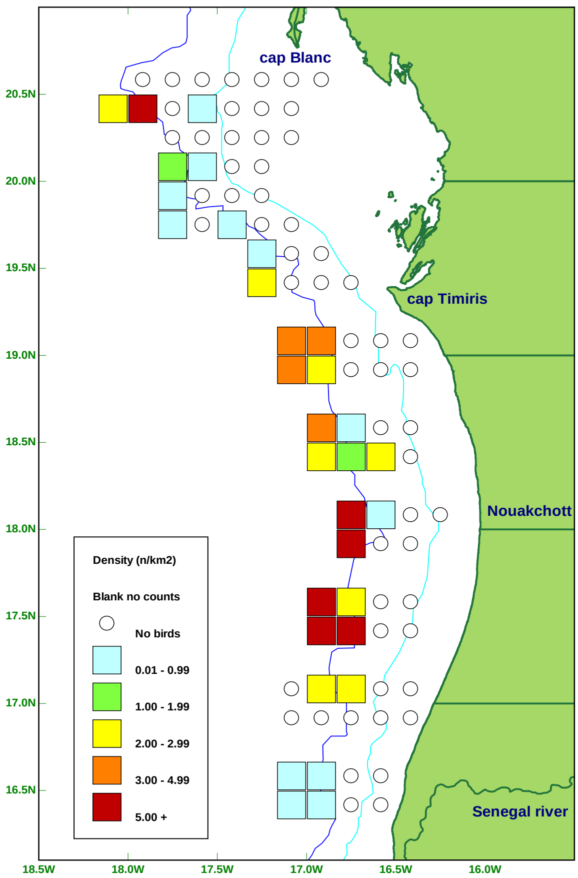
Wilson's Storm-petrel



Leach's Storm Petrel / Océanite culblanc



Leach's Storm-petrel



The maps above provide all observations, but with ship-followers excluded from the analysis (*n* per 5-minute count, red dots) on the left and observed densities (*n km*$^{-2}$, i.e. birds in transect corrected for observation effort) on the right for European, Wilson's and Leach's Storm-petrels respectively. When the observations are plotted against water depth (Fig. 5.1), the results clearly illustrate the more pelagic orientation of Leach's Storm-petrels relative to European and Wilson's Storm-petrels, but also that Wilson's Storm-petrels tended to congregate nearer to the Shelf-break than the other two species.

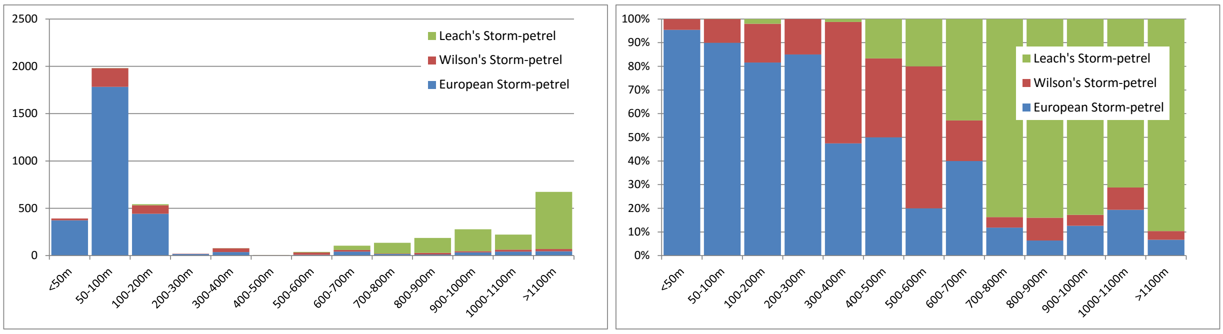


Fig. 5.1 Sightings of three species of storm-petrels against water depth, inclusing absolute numbers observed (top) and % species composition per depth bin (bottom).

European Storm-petrel Océanite tempete *Hydrobates pelagicus* (3)

This is a common breeding species in the temperate northeast Atlantic, in the Mediterranean and on the Canary Islands. European Storm-petrels were still quite rare during the early September surveys in 2015 (only three sightings), while they are abundant winter visitors off the Mauritanian coast (Camphuysen & Van der Meer 2005, Camphuysen *et al.* 2013). As in November 2012 (Camphuysen *et al.* 2013), very large flocks were observed (see opening photo of this paragraph), which were a challenge to count precisely, but which made them relatively easy to detect even during fairly choppy conditions. Perhaps not surprisingly, given the collinearity between water depth and SST (nearshore waters are cooler) is there a clear difference in distribution between European and Leach's Storm-petrels over areas with different surface temperatures. The results summarised in **Table 4.4**, however, give further insight in habitat preferences for each of the commoner storm-petrels, with both European and Wilson's Storm-petrels having peak abundances around 20°C SST, but with the latter commoner in warmer conditions than the former. Leach's Storm-petrels were simply absent in the cooler areas and had peak abundances around 25-26°C SST.

Table 4.4 Commoner storm-petrels observed, 1-12 November 2014, on board Al Awam off the Mauritanian coast. Cetaceans utilise these waters as wintering area or as resident species, but their migratory pathways and local seasonality are largely unknown.

	Distance	**European Storm-petrel**		**Wilson's Storm-petrel**		**Leach's Storm-petrel**	
SST °C	km	*n*	*n* km^{-1}	*n*	*n* km^{-1}	*n*	*n* km^{-1}
17	48.4	134	2.8		0		0
18	65.4	33	0.5		0		0
19	129.3	207	1.6	90	0.7		0
20	87.3	1591	18.2	121	1.4	1	0.0
21	72.7	190	2.6	9	0.1		0
22	104.6	387	3.7	24	0.2	21	0.2
23	204.3	119	0.6	95	0.5	126	0.6
24	264.3	91	0.3	58	0.2	105	0.4
25	263.7	45	0.2	29	0.1	444	1.7
26	178.6	55	0.3	44	0.2	551	3.1
27	191.3	6	0.0	5	0.0	81	0.4
28	5.2						

Larger flocks of European Storm-petrels were only seen in the north, and if at all attracted by fishing vessels, it were often the fish oil slicks generated during hauling or sorting the catch that attracted these birds. The petrels were seen drinking the oil and when slicks and fishing vessels became separated as a result of currents and wind, it were (only) the storm-petrels that followed the slicks and they further ignored the source, the ships themselves and the discards provided there. Oceanic fronts were of interest for European Storm-petrels for the exact same reason as they are of interest for most plankton feeders such as other storm-petrels and for example Grey Phalaropes. Associations with other species involved mostly other storm-petrels, but associations were seen with the following species and surface phenomena: Scopoli's Shearwater, Cory's Shearwater, Cape Verde Shearwater, Great Shearwater, Sooty Shearwater, Wilson's Storm-petrel, Leach's Storm Petrel, Northern Gannet, Red Phalarope, Long-tailed Skua, Parasitic Skua, Pomarine Skua, Great Skua, Lesser Black-backed Gull, Sabine's Gull, Black Tern, Common Tern, fish oil slick (natural), fish oil slick (near fishing vessel). Only three flocks with European Storm-petrels were formed were numerous species occurred and these were all near fishing vessels.

Table 4.5 Particularly large flocks of European Storm-petrels observed, with date, time of day, latitude (decimal degrees N), longitude (ibidem W), presence of fishing vessels in the area (1= absent, 4= distant, 7= close, 9= fleet of vessels near observation platform), number of petrels observed and the key attraction (Notes).

Poskey	Dd	Mm		Hr	Min	Latitude	Longitude	Fisheries	Artisanal	Trawler	Number of birds	Notes
180005562	11	11	2016	11	55	20.29	-17.58	4	X		1130	
180005185	8	11	2016	8	40	18.45	-16.53	4		X	154	Front
180005564	11	11	2016	12	5	20.31	-17.58	4	X		153	
180005555	11	11	2016	10	35	20.25	-17.54	9	X	X	129	Fishing vessel
180005578	11	11	2016	13	15	20.42	-17.55	9	X		121	
180005565	11	11	2016	12	10	20.32	-17.58	4	X		113	
180005293	9	11	2016	7	25	19.46	-16.83	4	X		93	
180005185	8	11	2016	8	40	18.45	-16.53	4		X	86	Fish oil slick
180005675	12	11	2016	11	40	20.60	-17.10	4		X	86	
180005184	8	11	2016	8	35	18.45	-16.52	4		X	57	Front
180005482	10	11	2016	14	10	20.12	-17.61	7		X	52	Fish oil slick
180005190	8	11	2016	9	5	18.45	-16.59	4		X	49	Fish oil slick
180005292	9	11	2016	7	20	19.46	-16.82	4	X		49	

Based on the observed densities (see above), considering that only relatively few birds were attracted to the observation platform, crude estimates of total numbers of European Storm-petrels present within the study area arrived at 193,600 individuals with average densities of 0.54 km^{-2} in the Oceanic areas, 0.73 km^{-2} over the Shelf-break and 8.90 km^{-2} within the Neritic zone.

Wilson's Storm-petrel Océanite de Wilson *Oceanites oceanicus*

Abundant high-latitude sub-Antarctic and Antarctic storm-petrel that migrates into the northern Hemisphere around May and that returns in Oct-Nov in the southern Hemisphere (Onley & Scofield 2007). During the earlier northern Hemisphere winter surveys in Mauritanian waters (Nov-Apr), Wilson’s Storm-petrels are very scarce, while the species is abundant in summer (Leopold 1993, Wynn & Krastel 2012). Wilson’s Storm-petrels were by far the ‘dominant’ storm-petrels during the 2015 September survey, with 1149 records scattered over the entire study area. In early Nov 2016, Wilson’s Storm-petrels were still fairly abundant, albeit clearly outnumbered by European Storm-petrels over the Neritic zone and by Leach’s Storm-petrels in deeper waters. The habitat preferences were similar to that of European Storm-petrels. The Nov-Dec surveys in 2012 produced only a single sighting of Wilson’s Storm-petrel, which suggests that this species moves away from NW Africa in the course of November.

Based on the observed densities (see above), considering that only relatively few birds were attracted to the observation platform, crude estimates of total numbers of Wilson’s Storm-petrels present within the study area arrived at 24,900 individuals with average densities of 0.31 km^{-2} in the Oceanic areas, 0.59 km^{-2} over the Shelf-break and 0.70 km^{-2} within the Neritic zone.

Leach's Storm-petrel Océanite culblanc *Oceanodroma leucorhoa*
Band-rumped Storm-petrel Océanite de Castro *Oceanodroma castro*

Leach's and Band-rumped species are not particularly closely related, but seemingly overlap in habitat requirements off the Mauritanian coast (Camphuysen & Van der Meer 2005, Camphuysen *et al.* 2013). Leach's Storm-petrels breed in the northern Pacific and Atlantic Oceans and spend the non-breeding season in the tropical and South Atlantic Ocean (Camphuysen 2007a) and in the tropical Pacific Hemisphere (Onley & Scofield 2007). Identification difficulties resulting from tail and primary moult and a chronic lack of time during the earlier censuses, made us alert on potential misidentifications with this group of petrels. The 2012 surveys yielded many records of 'band-rumped' storm-petrels that were not free of doubt. Therefore, in the analysis of the Nov-Dec 2012 surveys, also because both species are highly pelagic but relatively scarce, sightings of the two species combined. Both occurred almost exclusively within the Oceanic zone with only three sightings within the shallow Neritic zone. Densities at the time were too low and the distribution patterns were too fragmented for a meaningful estimates of total numbers. During the present survey we decided to pay extra attention to this and we have tried to obtain photographic material to confirm identifications. Much to our surprise, nearly all birds we encountered were Leach's Storm-petrels. At first glance dubious birds (more likely to be band-rumped when seen) turned out to be Leach's Storm-petrels following closer inspection of the material at hand. Only two sightings of Band-rumped Storm-petrels remained:

3	Nov	2016	1	ind	19.04	°N	-16.96	°W	26.1	°C SST	1025	m depth
4	Nov	2016	1	ind	17.87	°N	-16.73	°W	25.9	°C SST	748	m depth

Large flocks of Leach's Storm-petrels, comparable to those of European Storm-petrels, were not seen, but still, 29 records involved flocks of at least ten birds (maximum 91 individuals). Oddly, very few of these larger congregations were associated with trawlers, fronts, or fish oil slicks generated by fishing vessels. Most larger flocks were in waters with seawater temperatures of 25-26°C, south of 19°N latitude. Mixed flocks were formed with other storm-petrels (over the Shelf-break), or with terns (Black Tern and Common Tern), but then mostly in the pelagic zone. Leach's were also seen feeding on natural fish oil slicks, formed when subsurface tuna were chasing small pelagics. Associations were seen with the following species and surface phenomena: Cory's Shearwater, European Storm Petrel, Wilson's Storm-petrel, Long-tailed Skua, Pomarine Skua, Sabine's Gull, Black Tern, Bridled Tern, Common Tern, Sandwich Tern, Risso's Dolphin, Atlantic Spotted Dolphin, fish fry balls and/or fish oil slicks (natural) stirred up by bonito's (unidentified small tuna), and Sun-fish.

Based on the observed densities (see above), considering that only relatively few birds were attracted to the observation platform, crude estimates of total numbers of Leach's Storm-petrels present within the study area arrived at 82,500 individuals with average densities of 4.23 km^{-2} in the Oceanic areas, 1.16 km^{-2} over the Shelf-break and 0.06 km^{-2} within the Neritic zone.

White-faced Storm-petrel Océanite frigate *Pelagodroma marina*

A regional, Macaronesian seabird species, breeding on the Selvagens (*P.m. hypoleuca*) and on the Cape Verde Islands (*P.m. eadesi*), highly pelagic in nature, migratory and dispersive. Two sightings of in total three individuals during the cruise in November 2016:

4	Nov	2016	1	ind	17.87	°N	-16.72	°W	25.9	°C SST	714	m depth
7	Nov	2016	2	ind	17.46	°N	-16.92	°W	27.0	°C SST	1353	m depth

4.2.2 **Tubenoses** Procellariiformes (2) – **Shearwaters**

Cory's Shearwaters *Calonectris borealis*

Scopoli's Shearwater Puffin cendré (Mediterannée) *Calonectris diomedea*

Cory's Shearwater Puffin cendré (Atlantique) *Calonectris borealis*

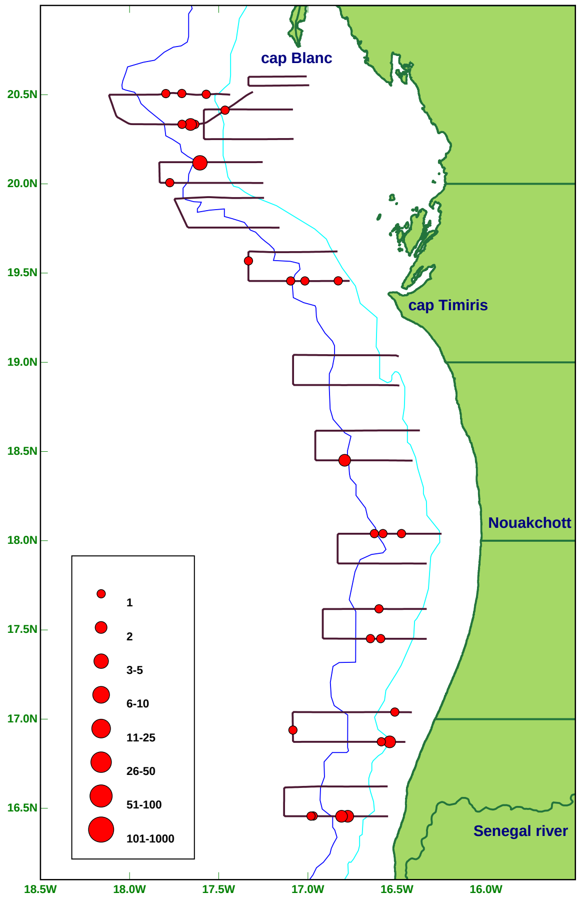
Cape Verde Shearwater Puffin du Cap-Vert *Calonectris edwardsii*

What was formerly known as 'Cory's Shearwater *Calonectris diomedea*' is now a complex of three closely related taxa, one mostly confined to the Mediterranean (Scopoli's Shearwater *C. diomedea*), one to Macaronesian and Portuguese Atlantic waters (Cory's Shearwater *C. borealis*) and one endemic to the Cape Verde Islands (Cape Verde Shearwater *C. edwardsii*). The maps below provide all observations, but with ship-followers excluded from the analysis (*n* per 5-minute count, red dots) on the left and observed densities ($n\ km^{-2}$, i.e. birds in transect corrected for observation effort) on the right for Scopoli's, Cory's and Cape Verde Shearwaters respectively. Only Cory's Shearwaters were abundant and widespread during the November surveys, and the numbers of Cape Verde Shearwaters were much reduced in comparison with the 2015 September surveys (Camphuysen 2015).

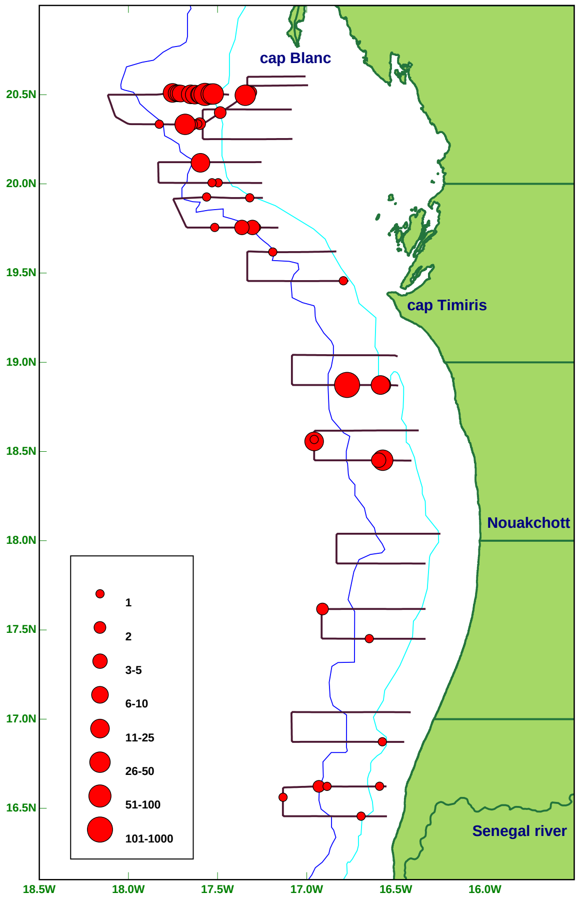
Some distinct differences in behaviour were observed. Cape Verde Shearwaters had a much greater tendency to follow the research vessel than the other two other species (80% ship-associated, *n* = 580, versus 13% *n*= 5049 in Cory's and 14% *n*= 42 in Scopoli's Shearwater). Cory's Shearwaters were commoner near fishing vessels than the other two (29% versus 10 and 11% for Scopoli's and Cape Verde Shearwater respectively). Associations with fronts and a role within multi-species foraging associations (MSFAs) were more typically seen in Cory's and never in the others (but the numbers for the others were also much smaller). The excessively strong tendency to associate with the research vessel of Cape Verde Shearwaters makes population estimates rather weak. For the other two (known to follow the research vessel during earlier surveys!) the estimates can be fairly robust.

Ship-following was much less of an issue than in winter surveys of this region (Burton & Camphuysen 2003, Camphuysen & Van der Meer 2005, Camphuysen et al. 2013). Based on the observed densities (see above), considering that only relatively few birds were attracted to the observation platform, crude estimates of total numbers of Cory's Shearwaters present within the study area arrived at 73,000 individuals with average densities of 1.08 km-2 in the Oceanic areas, 0.68 km-2 over the Shelf-break and 3.23 km-2 within the Neritic zone. At best a few hundreds of Scopoli's Shearwaters occurred in the area (only 4 individuals in transect; total guesstimate 320 individuals). With regard to the Cape Verde Shearwaters, however, our strip-transect surveys were less productive, given that a great majority of the birds seen were ship-attracted. Estimates would arrive at just over 1000 individuals, the majority of which over the inner shelf-break and the shelf, but with 80% ship-attracted birds this estimate is highly unreliable.

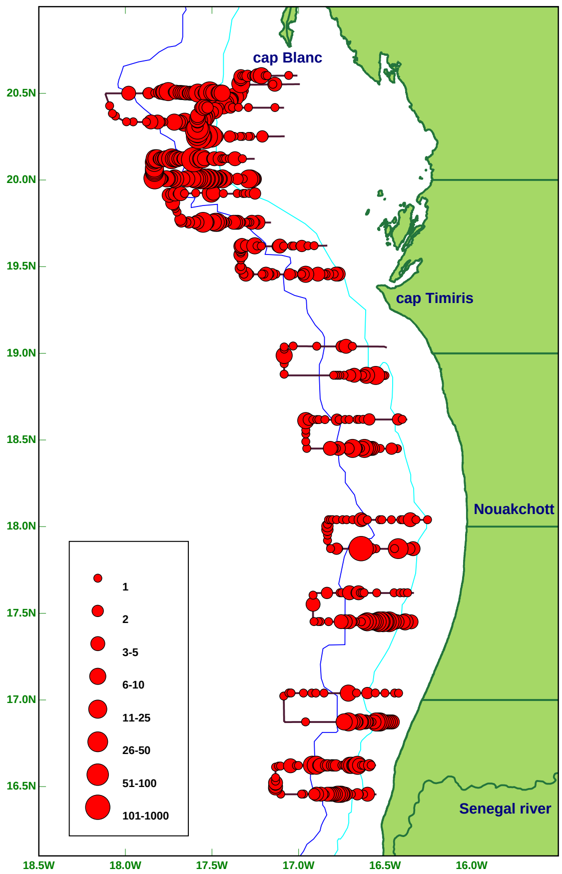
Scopoli's Shearwater / Puffin cendré (Mediterannée)



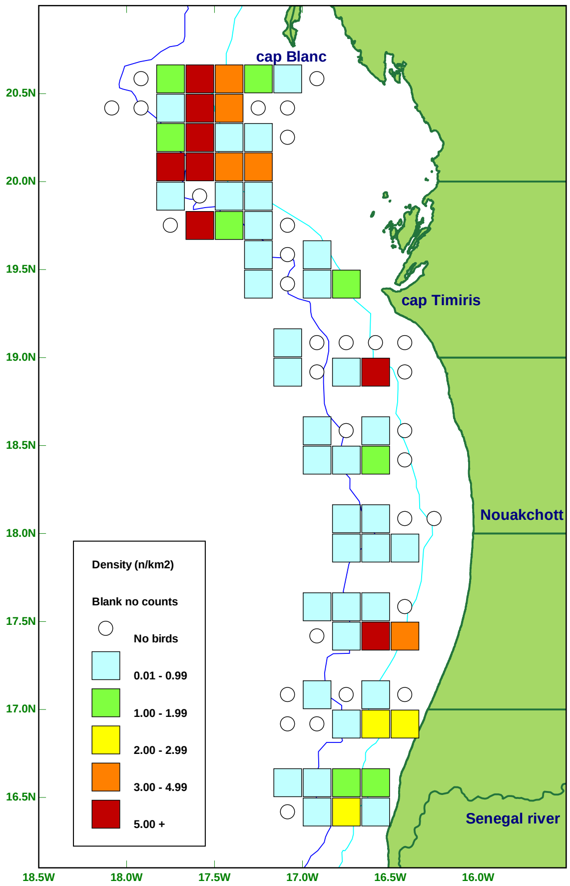
Scopoli's/Corys shearwater / Puffin cendré



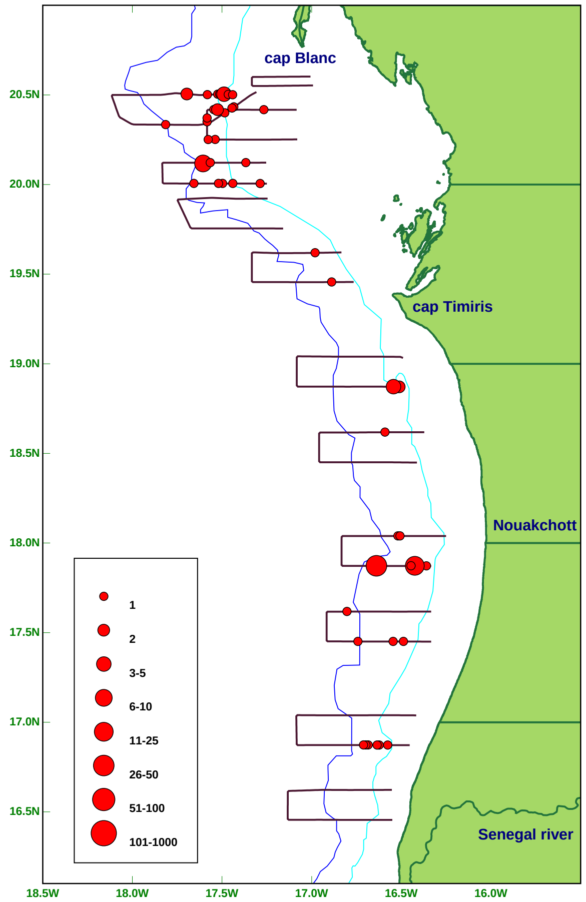
Cory's Shearwater / Puffin cendré (Atlantique)



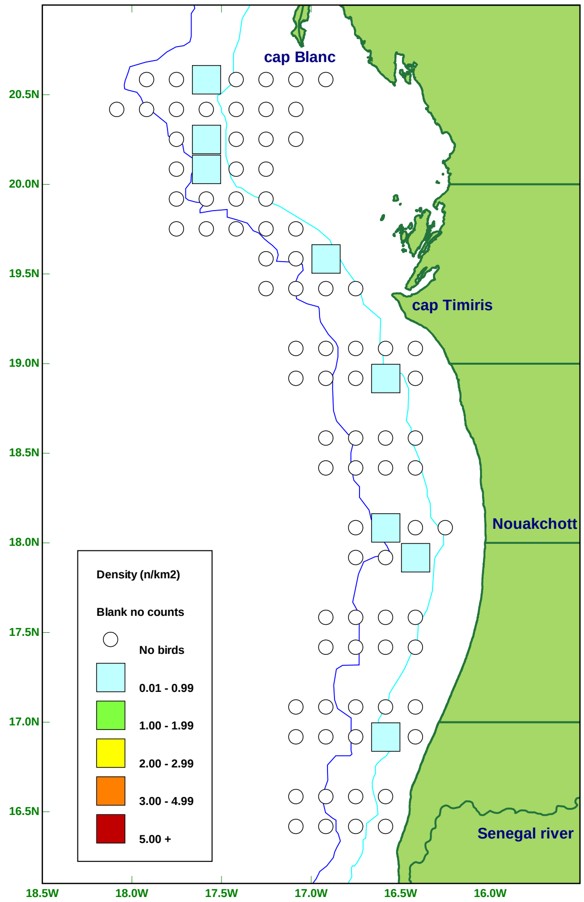
Cory's and Scopoli's Shearwaters



Cape Verde Shearwater / Puffin du Cap-Vert



Cape Verde Shearwater



Great Shearwater Puffin majeur *Ardenna gravis*

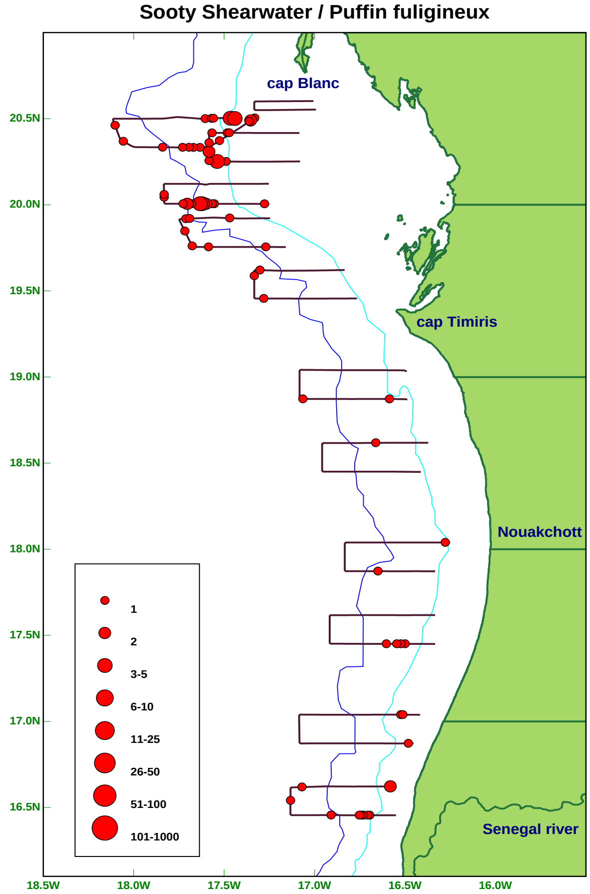
Sooty Shearwater Puffin fuligineux *Ardenna grisea*

Passage migrants from the southern hemisphere, with breeding colonies on Tristan da Cunha and some other small islands in the South Atlantic (Great), on the Falkland islands, in Tierra del Fuego and in the South Pacific (Sooty; Cramp & Simmons (1977). With a breeding season commencing around October, the birds seen in Mauritanian waters in November must either be rushing 'home', or are mostly (immature?) non-breeding birds).

Only 9 Great Shearwaters were seen:

10	Nov	2016	1	ind	20.01	°N	-17.58	°W	21.9	°C SST	240	m depth
10	Nov	2016	1	ind	20.01	°N	-17.72	°W	22.3	°C SST	912	m depth
10	Nov	2016	1	ind	20.01	°N	-17.80	°W	24.0	°C SST	1293	m depth
10	Nov	2016	1	ind	20.02	°N	-17.83	°W	24.4	°C SST	1441	m depth
10	Nov	2016	1	ind	20.05	°N	-17.83	°W	24.3	°C SST	1497	m depth
10	Nov	2016	1	ind	20.10	°N	-17.83	°W	24.0	°C SST	1591	m depth
10	Nov	2016	1	ind	20.12	°N	-17.74	°W	23.3	°C SST	1167	m depth
10	Nov	2016	1	ind	20.12	°N	-17.53	°W	21.4	°C SST	58	m depth
11	Nov	2016	1	ind	20.25	°N	-17.54	°W	20.1	°C SST	56	m depth

Sooty Shearwaters (84 individuals) were seen more regularly (see map). Both Great and Sooty Shearwaters were typically seen in flight travelling in a southerly direction. Based on the observed densities, crude estimates of total numbers of Sooty Shearwaters present within the study area arrived at 870 individuals with average densities of less than 0.01 in all depth zones. Given the nature of their behaviour (travelling southwards), this estimate has little value for the study area.



Sooty Shearwater *Ardenna grisea*

Balearic Shearwater Puffin des Baléares *Puffinus mauretanicus*

Small shearwaters, formerly seen as a subspecies of the Manx Shearwater. A red-listed species breeding on the Balearic Islands in the western Mediterranean. Numerous Balearic shearwaters enter the Atlantic in late summer. Two sightings, solitary individuals, 10 and 11 Nov 2016.

10	Nov	2016	1	ind	20.01	°N	-17.54	°W	21.3	°C SST	100	m depth
11	Nov	2016	1	ind	20.27	°N	-17.58	°W	20.6	°C SST	80	m depth

Manx Shearwater Puffin des Anglais *Puffinus puffinus* (31 records)

A boreal to subtropical species, with very large nesting colonies in the North Atlantic (United Kingdom, Ireland, Iceland, Faeroe islands, France, the Channel islands; with a total of more than 300,000 pairs on islands off Wales, Scotland and Ireland), smaller colonies in Macaronesia (Azores, Canary Islands and Madeira). Migrates across the Atlantic towards South American wintering grounds. In total only five sightings, three on 1 Nov, one on 5 Nov, and one on 11 Nov 2016, all in remarkably shallow waters:

1	Nov	2016	1	ind	20.50	°N	-17.34	°W	19.6	°C SST	40	m depth
1	Nov	2016	1	ind	20.43	°N	-17.44	°W	19.9	°C SST	48	m depth
1	Nov	2016	1	ind	20.40	°N	-17.48	°W	20.2	°C SST	55	m depth
5	Nov	2016	1	ind	17.04	°N	-16.57	°W	27.6	°C SST	90	m depth
11	Nov	2016	1	ind	20.42	°N	-17.36	°W	19.5	°C SST	35	m depth

4.2.3 **Gannets** Pelicaniformes

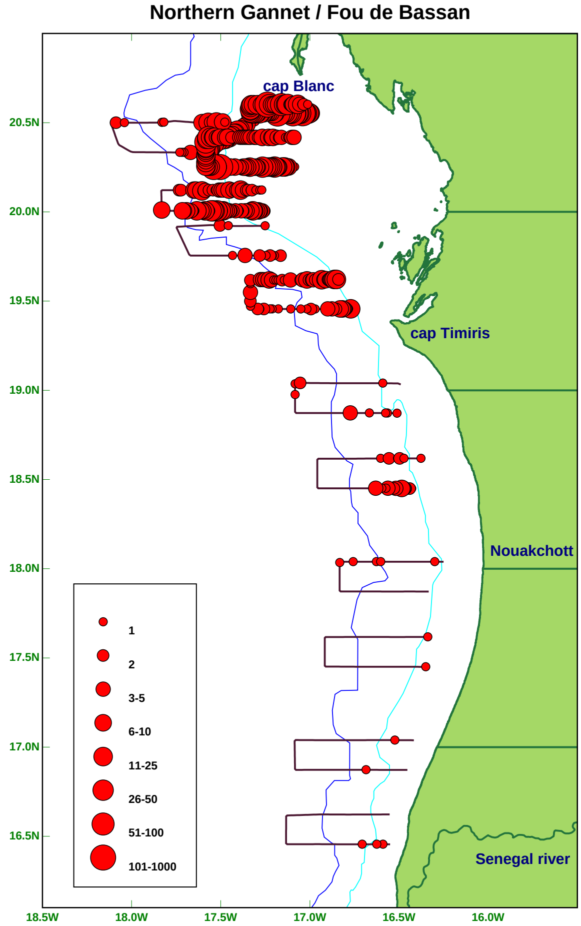
Northern Gannet *Morus bassanus*

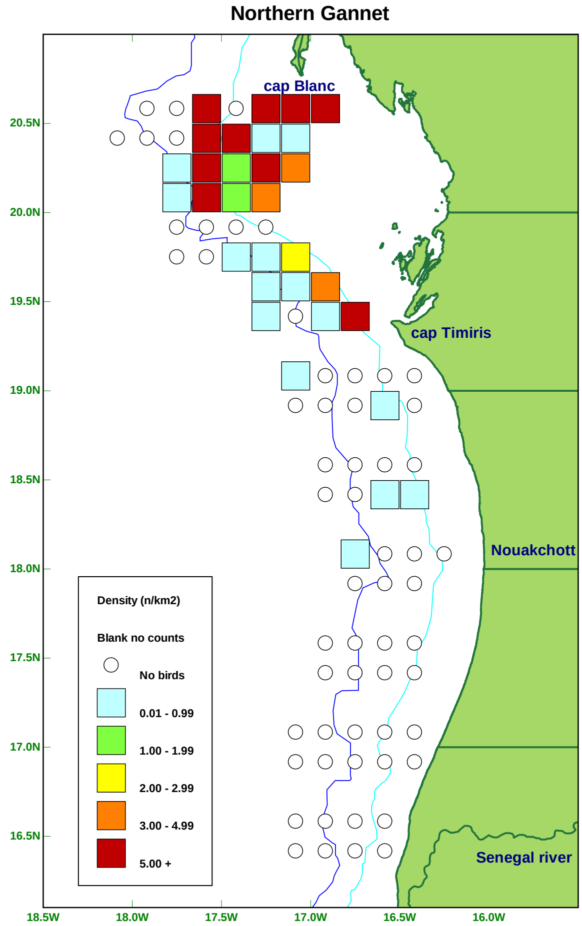
Northern Gannet Fou de Bassan *Morus bassanus*

This species had been established as one of the most abundant wintering seabirds of the NW African coast and its absence during the Sepember 2015 cruises was striking In surveys conducted in the exact same area in November 2012, not only were gannets the most numerous seabirds encountered (an estimated 325,000 individuals based on an average density of 11.8 individuals km^{-2}), but gannets comprised 86% of the avian biomass at the time recorded over the Mauritanian outer shelf and shelf break zone (Camphuysen *et al.* 2013). In the present survey, 1-12 November 2016, Northern Gannets were abundant, although not (yet) quite so numerous and widespread as during surveys later in the Northern Hemisphere winter (Burton & Camphuysen 2003, Camphuysen 2003, Camphuysen & Van der Meer 2005). The presence of numerous fresh juveniles (see opening photo above) showed that also the newborns had found their way south. The maps below provide all observations, but with ship-followers excluded from the analysis (*n* per 5-minute count, red dots) on the left and observed densities (*n km*$^{-2}$, i.e. birds in transect corrected for observation effort) on the right.

Of 3269 Northern Gannets that could be aged, 52% were fully mature birds, 16.5% were immatures (plumages indicative for ~2-5 year old individuals) and 31.5% were juveniles. Surveys later in the year yield more mature birds, so that their arrival to these breeding grounds is apparently later in November. Large foraging aggregations have been observed during this survey, and of all gannets observed, 16% were actively feeding (33% of which in MSFAs), further underlining the significance of this area as a winter foraging and staging area. Dolphins did not form a major attraction to the gannets observed and only 9 individuals were seen in association with dolphin herds.

Northern Gannets occurred in higher densities only in the northern part of the study area and were near-absent south of Nouakchott. The shelf (cooler waters) and the inner half of the Shelf-break were key area where gannets could be seen in numbers. Based on the observed densities (see above), considering that only relatively few birds were attracted to the observation platform, crude estimates of total numbers of Northern Gannets present within the study area arrived at 78,800 individuals with average densities of 0.081 km^{-2} in the Oceanic areas, 0.357 km^{-2} over the Shelf-break and 4.57 km^{-2} within the Neritic zone. Camphuysen *et al.* (2013) arrived at an estimate that was nearly five times higher in surveys conducted late November-early December 2012.





4.2.4 **Waders** Charadriiformes

Grey Phalaropes *Phalaropus fulicarius*

Red [Grey] **Phalarope** Phalarope à bec large *Phalaropus fulicaria*

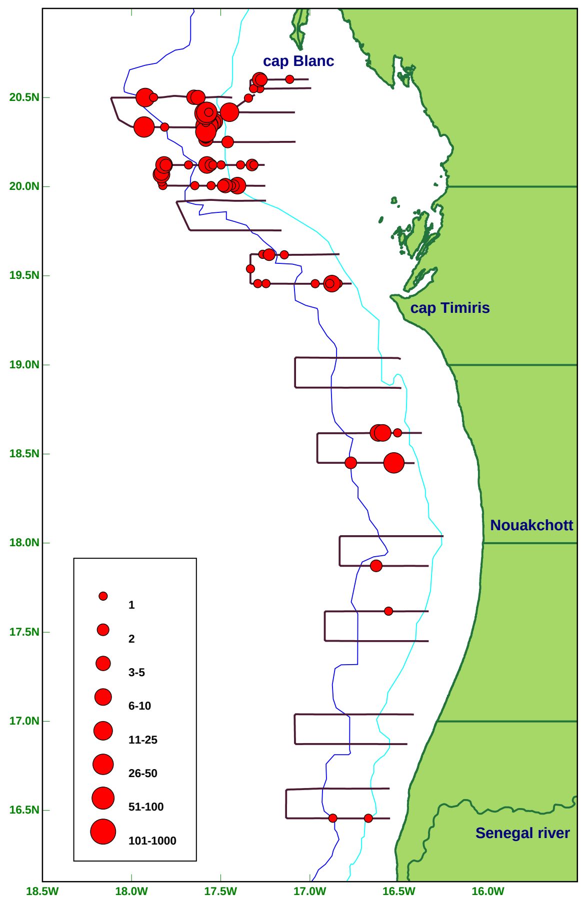
Red Phalaropes are 'marine waders' breeding in the high arctic, in the extreme north of Asia, North America and Greenland (much smaller numbers on Iceland, Spitsbergen and Bear Island) and wintering in high numbers off the NW African coast. This is arguably the most essentially oceanic of all phalaropes. Of interest for these birds, as for planktivorous storm-petrels Hydrobatidae, are convergent processes at the upwelling front that may concentrate zooplankton and small prey fish (Wynn & Krastel 2012). In November 2016, the strongest SST gradients were found around 20°20'-20°35'N latitude (**Fig. 3.3**). Prominent concentrations of

Red Phalaropes occurred in areas where the sea surface temperature was low (<20°C, SST), which includes some sightings in the shallower parts of the Neritic zone:

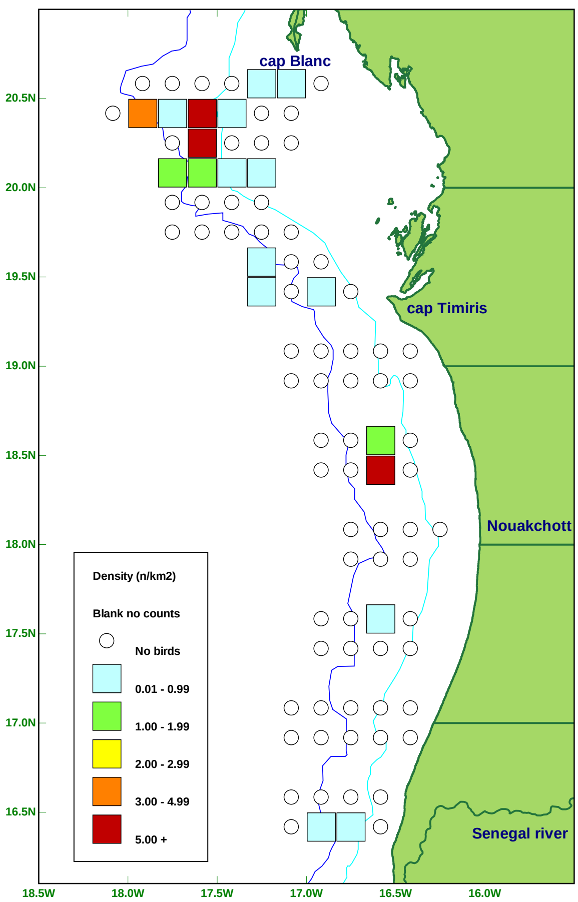
1	Nov	2016	99	ind	20.34	°N	-17.58	°W	20.6	°C SST	72	m depth	Neritic
11	Nov	2016	53	ind	20.41	°N	-17.58	°W	19.6	°C SST	69	m depth	Neritic
11	Nov	2016	49	ind	20.31	°N	-17.58	°W	20.1	°C SST	82	m depth	Neritic
11	Nov	2016	39	ind	20.42	°N	-17.58	°W	19.6	°C SST	67	m depth	Neritic
1	Nov	2016	32	ind	20.33	°N	-17.93	°W	23.3	°C SST	1000	m depth	Oceanic
8	Nov	2016	32	ind	18.45	°N	-16.53	°W	22.1	°C SST	134	m depth	Neritic
1	Nov	2016	23	ind	20.50	°N	-17.92	°W	23.5	°C SST	646	m depth	Shelf-break

These observations corroborate earlier reports of the importance of a narrow mixing zone at the continental shelf edge to phalaropes (*cf.* Brown 1979, Briggs *et al.* 1984, Wynn & Knefelkamp 2004, Camphuysen *et al.* 2012). Observed numbers were highly variable within this core area, however. Red Phalaropes were probably still arriving in Mauritanian waters (even lower numbers were observed in September 2015) and overall numbers were still modest. At least 56% of the birds observed were actively foraging and even faint surface signals of oceanic fronts yielded some sightings of phalaropes. Red Phalaropes never joined multi-species foraging associations and co-occurrences with other seabirds were always coincidental (attracted by frontal conditions), without inter-specific interactions. Based on the observed densities (see above), crude estimates of total numbers of Red Phalaropes present within the study area arrived at 33,300 individuals with average densities of 0.33 km^{-2} in the Oceanic areas, 0.11 km^{-2} over the Shelf-break and 1.43 km^{-2} within the Neritic zone. Densities peaked with sea surface temperatures of 19-20°C.

Red Phalarope / Phalarope à bec large



Grey Phalarope



Migratory waders observed:

Whimbrel	2	Nov	2016	1	ind	19.76	°N	-17.28	°W	20.1	°C SST	667	m depth	Shelf-break
Grey Plover	1	Nov	2016	1	ind	20.33	°N	-17.65	°W	21.5	°C SST	111	m depth	Neritic
Grey Plover	5	Nov	2016	4	ind	16.87	°N	-16.58	°W	26.6	°C SST	61	m depth	Neritic
Grey Plover	6	Nov	2016	2	ind	16.51	°N	-17.13	°W	27.7	°C SST	1581	m depth	Oceanic

4.2.5 **Skuas** Stercorariidae

Long-tailed Skua *Stercorarius longicaudus*

With four species, the third most diverse group of seabirds encountered. Only Long-tailed and Pomarine Skuas occurred in reasonable numbers, Arctic and Great Skuas were relatively scarce.

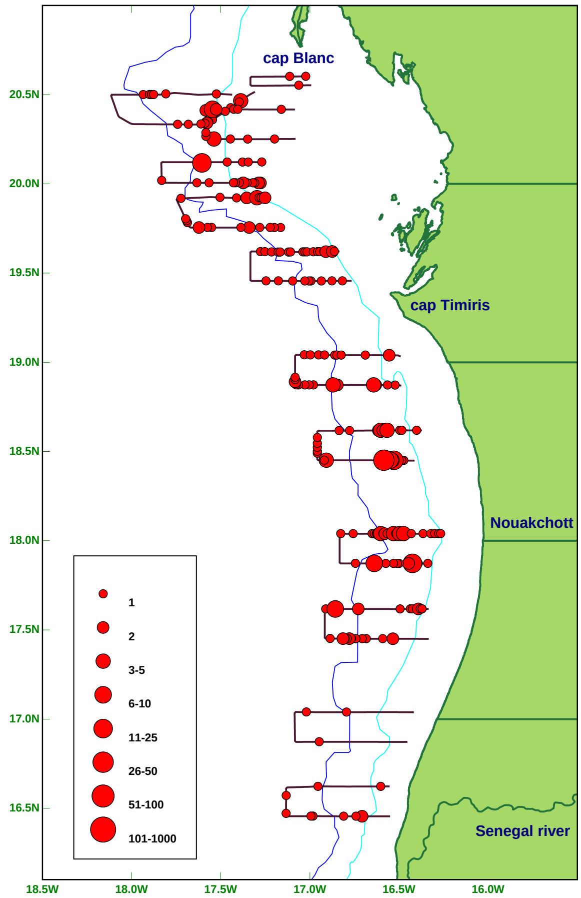
Long-tailed Jaeger/Long-tailed Skua Labbe à longue queue *Stercorarius longicaudus*

The Long-tailed Jaeger breeds circumpolar in coastal tundras mainly within 57-80°N. It is a marine species outside the breeding season (Del Hoyo *et al.* 1996) wintering mainly in the Southern Oceans (Furness 1987, Del Hoyo *et al.* 1996). In Mauritania it is seen as an Holarctic migrant wintering in small numbers with peak occurrences during passage (Nov-Nov and Feb-May; Isenmann *et al.* 2010). Long-tailed Skuas are rarely seen in coastal waters (Isenmann *et al.* 2010), suggesting a more pelagic life-style than the other smaller skuas off NW Africa.

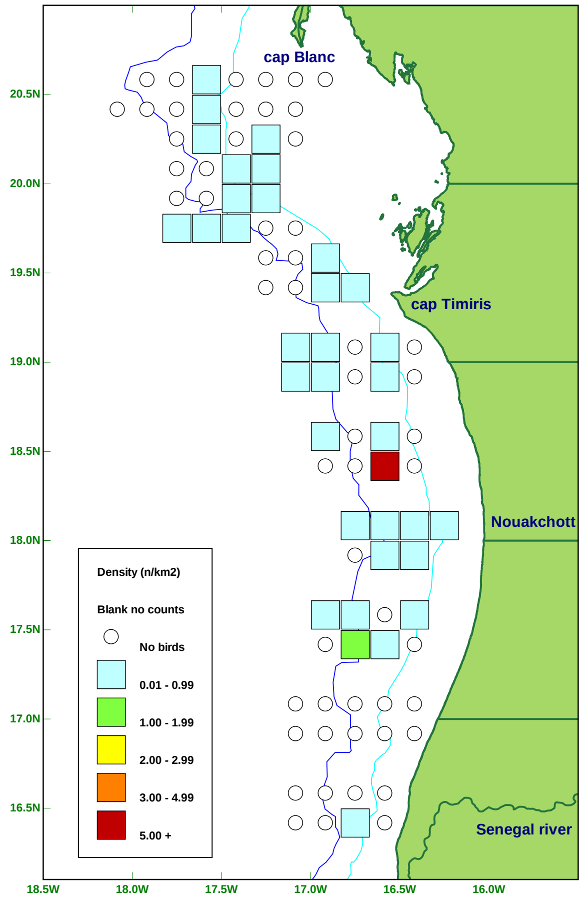
In November 2016, Long-tailed Jaegers were common and widespread with a total of 397 positively identified individuals. Sightings were common in all depth zones, but most abundant within the Neritic zone (21% of all records were within the Oceanic zone, 21% over the Shelf-break and 58% within the Neritic zone; G_{adj}= 24.6 , df=2, P<0.01). The maps below provide all observations, but with ship-followers excluded from the analysis (*n* per 5-minute count, red dots) on the left and observed densities ($n\ km^{-2}$, i.e. birds in transect corrected for observation effort) on the right for Long-tailed and Pomarine Skuas respectively.

The observation platform itself was not particularly attractive to Long-tailed Skuas in Nov 2016 (only 5%, *n*= 397), and also fisheries formed only a slight attraction. In total 16% of all Long-tailed Skuas seen in November 2016 were seen in direct association of a fishing vessel. Based on the observed densities (see above), considering that only relatively few birds were attracted to the observation platform, crude estimates of total numbers of Long-tailed Skuas present within the study area arrived at 8040 individuals with average densities of 0.13 km^{-2} in the Oceanic areas, 0.12 km^{-2} over the Shelf-break and 0.32 km^{-2} within the Neritic zone. Fresh juveniles were seen (79 individuals, 29% of 270 aged birds). Of the remaining 191 individuals, 172 were idfentified as adults (64%), and the rest as 2^{nd} and 3^{rd} calendar year immatures (7%). Only one mature skuas was in summer plumage, other birds had often lost the long central tail feathers. Aerial pursuits were mostly aimed at Common Terns, but a variety of targets was recorded including: Cory's Shearwater (2 x), Cape Verde Shearwater (2 x), European Storm Petrel (1 x), Wilson's Storm-petrel (2 x), Leach's Storm Petrel (3 x), Long-tailed Jaeger (1 x), Lesser Black-backed Gull (1 x), Sabine's Gull (3 x), Black Tern (3 x), Common Tern (12 x), Sandwich Tern (2x). Large insects (all probably grasshoppers) were targeted by four birds and were successfully swallowed mid-air.

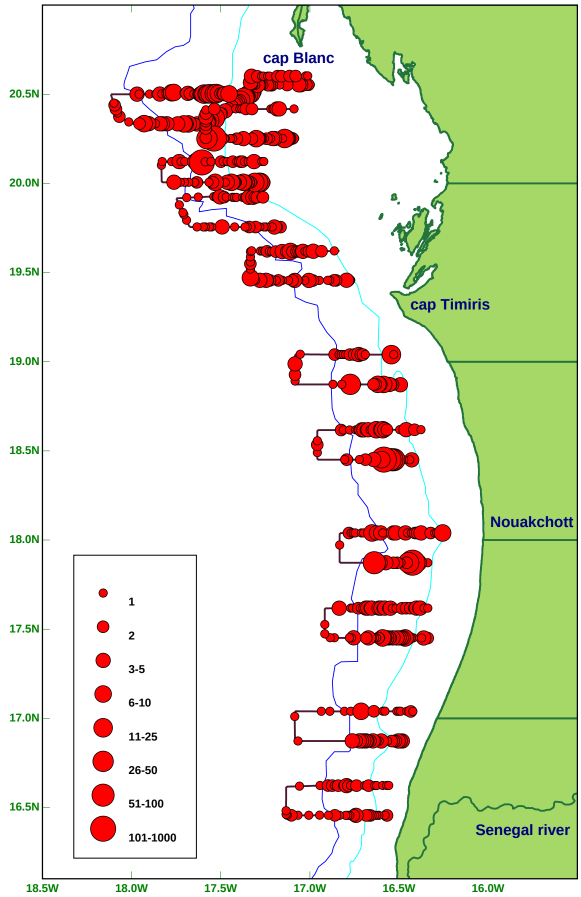
Long-tailed Jaeger / Labbe à longue queue



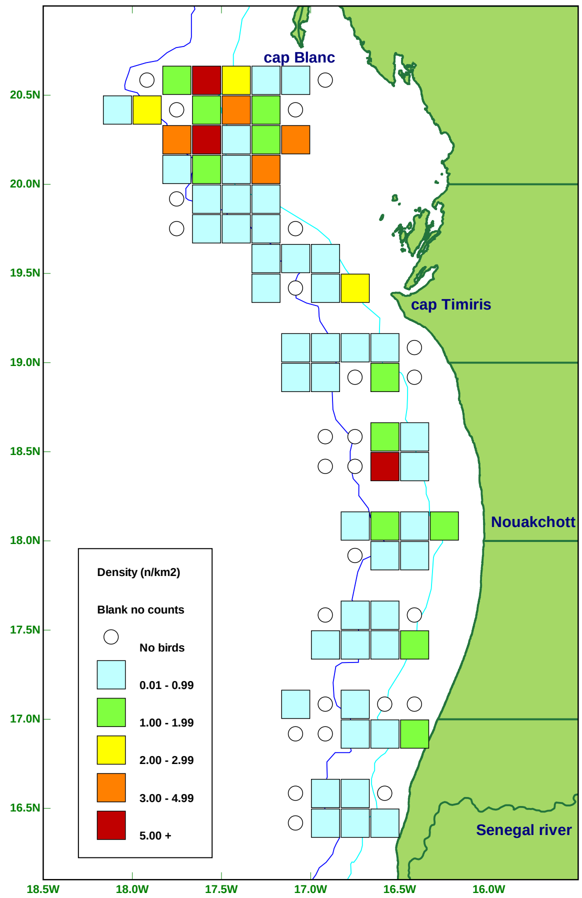
Long-tailed Skua



Pomarine Skua / Labbe pomarin



Pomarine Skua



Pomarine Skua Labbe pomarin *Stercorarius pomarinus*

The Pomarine Skua breeds on tundras of northern Russia, Canada and Alaska but is a marine species outside the breeding season (Del Hoyo *et al.* 1996). High numbers winter in upwelling regions of the tropics and subtropics, and that includes Mauritanian waters (Furness 1987, Camphuysen & Van der Meer 2005, Isenmann *et al.* 2010).

Pomarine Skuas were the most numerous skua encountered in November 2016, but numbers were highly concentrated in the northern part of the study area, and often near fishing fleets. The observation platform itself was less an attraction to Pomarine Skuas in Nov 2016 (only 11%, *n*= 3520) than in Nov-Dec 2012 (20%, *n*= 2134), but fisheries formed a major attraction. In total 47% of all Pomarine Skuas seen in November 2016 were seen in direct association of a fishing vessel. Of some fleets observed, Chinese vessels were inactive at daytime, and the skuas were perhaps just hanging around awaiting nocturnal foraging opportunities. Sightings were common in all depth zones, but with a strong inshore (Neritic) bias. In all, 8% of all records were within the Oceanic zone, 16% over the Shelf-break and 76% within the Neritic zone (*n*= 3520; G_{adj}= 997.5.1, df=2, *P*< 0.001). Based on the observed densities (see above), considering that only relatively few birds were attracted to the observation platform, crude estimates of total numbers of Pomarine Skuas present within the study area arrived at 54,100 individuals with average densities of 0.27 km^{-2} in the Oceanic areas, 0.71 km^{-2} over the Shelf-break and 2.73 km^{-2} within the Neritic zone. Juveniles were rare in the Pomarine Skua (only 16 individuals (1%) in 1951 properly aged individuals. The far majority was identified as adults (83%%), a fair number were immatures (16%) often in summer plumage. Of immatures, adults or unaged birds, 12% were dark phase birds, 88% were light phase individuals (n= 972), which is an identical score in comparison with the 2015 September surveys. Aerial pursuits were mostly aimed at shearwaters and Common Terns, but a variety of targets was recorded including: Scopoli's/Corys shearwater (1 x), Cory's Shearwater (6 x), Cape Verde Shearwater (3 x), Long-tailed Jaeger (1 x), Great Skua (1 x), Lesser Black-backed Gull (2 x), Sabine's Gull (3 x), Black Tern (2 x), Common Tern (6 x), Sandwich Tern (2 x), unidentified flying fish (1 x). Pomarine Skuas were seen to handle moribund fish and squid on several occasions, but often ignored floating dead fish near fishing vessels.

Parasitic Jaeger/Arctic Skua Labbe parasite *Stercorarius parasiticus*

The Parasitic Jaeger breeds circumpolar in coastal tundras, mainly within 57-80°N Latitude and it is a marine species outside the breeding season (Del Hoyo *et al.* 1996). Parasitic Jaegers winter primarily ion coastal areas of the Southern Hemisphere (Furness 1987, Del Hoyo *et al.* 1996). In Mauritania it is seen as an Holarctic migrant with a greater affinity for coastal waters than the three other smaller skua species (Isenmann *et al.* 2010).

Very few Arctic Skuas were seen, certainly in comparison with the September 2015 surveys. Only 19 individuals were detected and records were scattered all over the study area, with frequent sightings over deep water (Oceanic), suggesting that migratory birds were seen rather than birds using the area as a stop-over:

1	Nov	2016	1	ind	20.37	°N	-17.53	°W	20.1	°C SST	58	m depth	Neritic
1	Nov	2016	1	ind	20.33	°N	-17.99	°W	23.4	°C SST	1376	m depth	Oceanic
1	Nov	2016	1	ind	20.50	°N	-17.99	°W	23.8	°C SST	879	m depth	Oceanic
2	Nov	2016	1	ind	19.76	°N	-17.22	°W	19.9	°C SST	423	m depth	Shelf-break
2	Nov	2016	1	ind	19.76	°N	-17.32	°W	20.7	°C SST	847	m depth	Oceanic
2	Nov	2016	1	ind	19.76	°N	-17.42	°W	23.4	°C SST	1342	m depth	Oceanic
2	Nov	2016	1	ind	19.76	°N	-17.47	°W	24.2	°C SST	1473	m depth	Oceanic
2	Nov	2016	1	ind	19.76	°N	-17.48	°W	24.5	°C SST	1484	m depth	Oceanic
2	Nov	2016	1	ind	19.92	°N	-17.71	°W	23.5	°C SST	1248	m depth	Oceanic
3	Nov	2016	1	ind	18.87	°N	-16.67	°W	25.6	°C SST	141	m depth	Neritic

4	Nov	2016	2	ind	17.87	°N	-16.42	°W	23.2	°C SST	108	m depth	Neritic
4	Nov	2016	1	ind	17.87	°N	-16.65	°W	25.5	°C SST	506	m depth	Shelf-break
4	Nov	2016	1	ind	18.03	°N	-16.83	°W	26.7	°C SST	1340	m depth	Oceanic
11	Nov	2016	1	ind	20.25	°N	-17.09	°W	19.0	°C SST	13	m depth	Neritic
11	Nov	2016	1	ind	20.25	°N	-17.12	°W	18.9	°C SST	14	m depth	Neritic
11	Nov	2016	1	ind	20.25	°N	-17.15	°W	18.8	°C SST	18	m depth	Neritic
11	Nov	2016	1	ind	20.25	°N	-17.54	°W	20.1	°C SST	56	m depth	Neritic
11	Nov	2016	1	ind	20.42	°N	-17.09	°W	18.8	°C SST	20	m depth	Neritic

Common Terns were kleptoparasited twice, two further Arctic Skuas were chasing seabirds near trawlers, without a clearly identified victim.

Great Skua Grand labbe *Stercorarius skua*

The Great Skua breeds in NW Europe (Scotland, Faeroe Islands and Iceland) and following recent expansions has commenced breeding in Arctic areas (Jan Mayen, Bear Island, Svalbard) It is an almost strictly marine species outside the breeding season (Del Hoyo *et al.* 1996) wintering mainly in the northern hemisphere (Furness 1987, Del Hoyo *et al.* 1996). In Mauritania it is seen as an Holarctic migrant wintering in small numbers with peak occurrences in winter (Nov-Apr; Isenmann *et al.* 2010).

Great Skuas are a regular wintering species, but few had arrived during the November 2016 surveys. A majority of the 15 sightings occurred within the Neritic zone, which was quite a contrast with the Arctic Skua just mentioned:

2	Nov	2016	1	ind	19.75	°N	-17.21	°W	20.0	°C SST	352	m depth	Shelf-break
3	Nov	2016	1	ind	18.94	°N	-17.08	°W	25.8	°C SST	1512	m depth	Oceanic
9	Nov	2016	1	ind	19.46	°N	-16.82	°W	21.3	°C SST	33	m depth	Neritic
10	Nov	2016	1	ind	20.01	°N	-17.28	°W	19.6	°C SST	33	m depth	Neritic
10	Nov	2016	2	ind	20.01	°N	-17.29	°W	19.6	°C SST	34	m depth	Neritic
10	Nov	2016	1	ind	20.01	°N	-17.30	°W	19.6	°C SST	35	m depth	Neritic
10	Nov	2016	1	ind	20.01	°N	-17.47	°W	20.0	°C SST	66	m depth	Neritic
10	Nov	2016	1	ind	20.12	°N	-17.67	°W	23.6	°C SST	502	m depth	Shelf-break
10	Nov	2016	1	ind	20.12	°N	-17.54	°W	21.8	°C SST	70	m depth	Neritic
10	Nov	2016	1	ind	20.12	°N	-17.38	°W	20.0	°C SST	37	m depth	Neritic
11	Nov	2016	1	ind	20.25	°N	-17.53	°W	20.0	°C SST	53	m depth	Neritic
11	Nov	2016	1	ind	20.25	°N	-17.54	°W	20.1	°C SST	56	m depth	Neritic
12	Nov	2016	1	ind	20.55	°N	-17.08	°W	17.5	°C SST	22	m depth	Neritic
12	Nov	2016	1	ind	20.55	°N	-17.26	°W	18.2	°C SST	43	m depth	Neritic
12	Nov	2016	1	ind	20.57	°N	-17.33	°W	18.3	°C SST	50	m depth	Neritic

4.2.6 Gulls Laridae

Only four species of gulls were encountered during the November 2016 offshore surveys and inspections of coastal roosts revealed that most of the common wintering species had not yet arrived "at strength" in Mauritania. None of the gulls seen at sea are ‘local’ breeding birds, which all seem to forage in areas closer to the shore. Sabine’s Gulls *Xema sabini* were by far the most wide-ranging species, but it should be realised that these are also passage migrants that winter in substantial numbers off SW Africa.

Audouin's Gull Goéland d'Audouin *Ichthyaetus audouinii*

Audouin's Gull *Ichthyaetus audouinii*

A Palearctic migrant, breeding in the Mediterranean and common as a winter visitor and passage migrant in Mauritanian waters. The Audouin's gull is considered a rather specialised nocturnal forager on shoaling clupeids (Gonzalez-Solis *et al.* 1997), but little is known of their foraging activities in West Africa. During the November 2016 surveys, only a three sightings

5	Nov	2016	1	ind	17.04	°N	-16.43	°W	26.3	°C SST	45	m depth	Neritic
9	Nov	2016	1	ind	19.46	°N	-16.87	°W	20.9	°C SST	60	m depth	Neritic
12	Nov	2016	2	ind	20.60	°N	-17.18	°W	17.6	°C SST	39	m depth	Neritic

Numerous individuals were seen in Nouadhibou harbour, near Cap Blanc and on roosts in that general area (all off-effort sightings), suggesting that marine resources were not exploited at the time, or only during the night when surveys were discontinued.

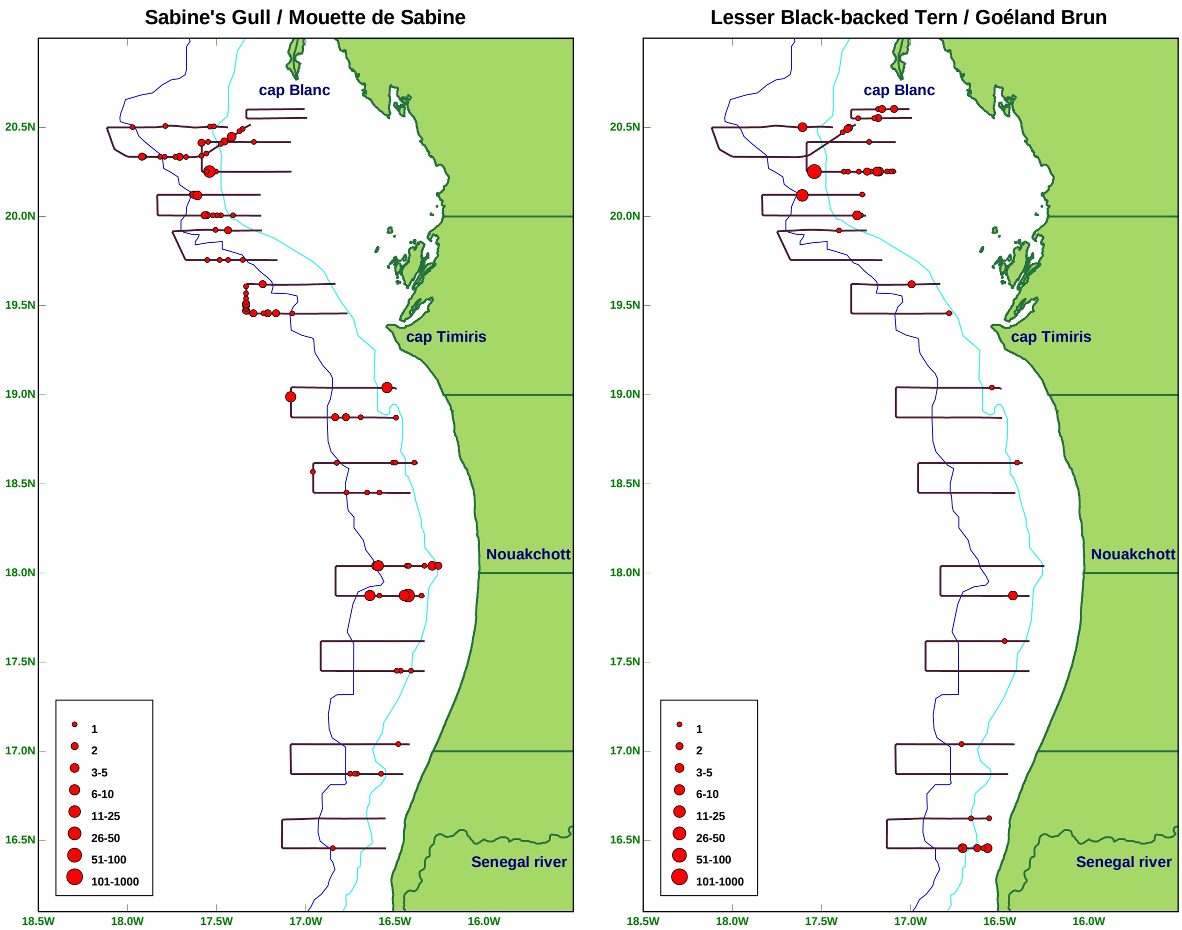
Sabine's Gull Mouette de Sabine *Xema sabini*

Sabine's Gulls *Xema sabini*

Sabine's Gulls in the Atlantic are Holarctic migrants breeding in the high Arctic (Greenland, Canada, Svalbard, Russia) that spend their non-breeding season mostly off South Africa (Cramp & Simmons 1977, Del Hoyo *et al.* 1996). Post-nuptial migration off the Mauritanian coast takes place from mid-August to November (Isenmann *et al.* 2010).

Sightings of Sabine's Gulls were fairly common in all depth zones, but with a clear inshore (Neritic) bias. In all, 21% of all records were within the Oceanic zone, 18% over the Shelf-break and 61% within the Neritic zone (n= 146; G_{adj}= 14.1, df=2, P< 0.01). Sightings were slightly more frequent to the southwest of Cap Blanc, in an area with relatively cool surface waters, to the northwest of Cap Timiris and off Nouakchott. Of 131 Sabine's Gulls with annotations, none were associated with the observation base, 34% were associated with fishing vessels (n= 204). Other associations were with oceanic fronts (2), fish oil slicks (3), and with cetaceans (4). Despite their migratory status (Isenmann *et al.* 2010), there was no clear flight direction prevailing and most birds seemingly utilised the Mauritanian shelf as a stop-over. Immatures (1) and juveniles (18) formed a minority, for 85% of the properly aged individuals were adults in winter plumage (n= 129). One oiled individual was seen (photo at paragraph header).

Based on the observed densities, crude estimates of total numbers of Sabine's Gulls present within the study area arrived at 3310 individuals with average densities of 0.08 km^{-2} in the Oceanic areas, 0.08 km^{-2} over the Shelf-break and 0.10 km^{-2} within the Neritic zone.



Lesser Black-backed Gull Goéland brun *Larus fuscus*

A Palearctic migrant, breeding in west Europe and an abundant winter visitor in Mauritania. Relatively small numbers (low thousands) were found at the traditional roosts in Nouadhibou and Nouakchott prior to and immediately following our surveys (tens of thousands of roosting birds are seen in winter in these areas).

In all, only 232 individuals were recorded during these surveys and of the 144 properly aged individuals, 62% were adults in winter plumage, 29% were immatures and the remainder (13 individuals) were fresh juveniles. Sightings were most frequent in the NW, but also off Senegal river. Only five birds were seen over the Shelf-break, the remainder was seen within the Neritic zone, underpinning an inshore preference for this bird. Of Lesser Black-backed Gulls with annotations, only six were associated with the observation base, but 44% were associated with fishing vessels (n= 232). Based on the observed densities, considering that only relatively few birds were attracted to the observation platform, crude estimates of total numbers of Lesser Black-backed Gulls present within the study area arrived at only ~1020 individuals.

Black-legged Kittiwake Mouette tridactyle *Rissa tridactyla*

Black-legged Kittiwake *Rissa tridactyla*

A Palearctic migrant, breeding in west Europe and further to the north in Arctic areas. A rare winter visitor in Mauritania. A single sighting (attracted by our own ship):

3	Nov	2016	1	ind	19.04	°N	-16.82	°W	26.4	°C SST	295	m depth	Shelf-break

4.2.7 Terns Sternidae

Common Tern *Sterna hirundo*

Palearctic migrants, Common Terns *Sterna hirundo* and Black Terns *Chlidonis niger*, at distance followed by Sandwich Terns, were by far the most numerous species; the regional species (e.g. Caspian and Royal Terns) were extremely scarce.

Caspian Tern Sterne caspienne *Hydroprogne caspia*

The Caspian Tern is a cosmopolitan species with a scattered distribution. Caspian Terns breed near large lakes and along ocean coasts (del Hoyo *et al.* 1996). Caspian terns are a resident species and year-round breeders in Mauritania and Senegal (with at least between 5,000-10,000 pairs in the Banc d'Arguin (Isenmann *et al.* 2010).

Caspian Terns were abundant at beach roosts near Nouadhibou in November 2016, but were as always rare at sea during the censuses suggesting strictly nearshore foraging activities. A single sighting:

12	Nov	2016	1	ind	20.60	°N	-17.11	°W	17.4	°C SST	30	m depth	Neritic

Mauretanian Royal Tern Sterne royale *Thalasseus maximus albidorsalis*

Royal Terns of the subspecies *albidorsalis* breed along the northwest coast of Africa and that includes the coast of Mauritania, where it is confined almost exclusively to the Banc d'Arguin, Senegal, and Gambia (Isenmann *et al.* 2010). Breeding numbers are seemingly variable, but 15,000-17,000 pairs were listed for

1998 and 2004, and exchanges are expected to occur with the 23,000-43,000 pairs breeding in Senegal and 15,000 pairs in Gambia (Isenmann *et al.* 2010). Mauritanian breeders disperse in the non-breeding season and winter mainly from Morocco to Ivory Coast and Ghana (del Hoyo *et al.* 1996, Isenmann *et al.* 2010).

Offshore sightings were rare during the November 2016 surveys, and all sightings were within the Neritic zone:

3	Nov	2016	1	ind	19.04	°N	-16.59	°W	26.0	°C SST	72	m depth	Neritic
4	Nov	2016	1	ind	17.87	°N	-16.44	°W	23.3	°C SST	112	m depth	Neritic
9	Nov	2016	2	ind	19.46	°N	-16.84	°W	21.0	°C SST	43	m depth	Neritic
9	Nov	2016	2	ind	19.46	°N	-16.85	°W	21.0	°C SST	51	m depth	Neritic

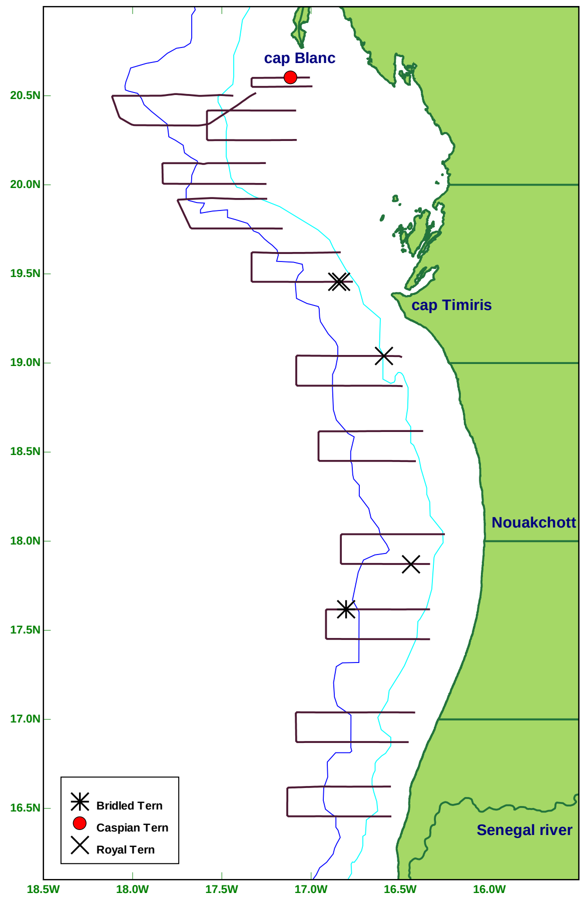
Bridled Tern Sterne bridée *Onochoprion anaethetus*

The Bridled Tern is migratory and dispersive, wintering widely through tropical oceans. It has markedly marine habits compared to most terns (del Hoyo *et al.* 1996). The Atlantic subspecies *melanopterus* breeds in Mexico, the Caribbean and in west Africa (Cramp & Simmons 1983, Olsen & Larsson 1995).

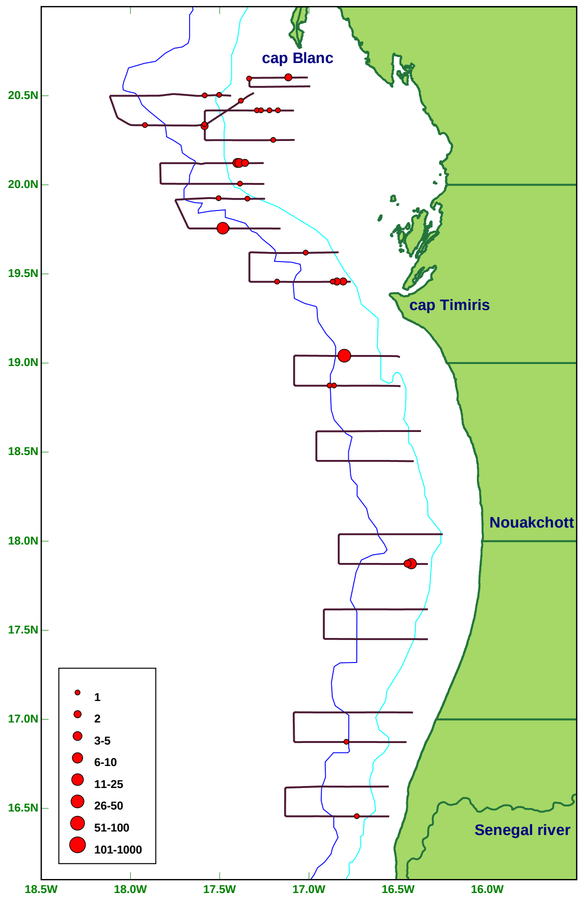
Rare, three individuals recorded during the November 2016 surveys during a single sighting:

7	Nov	2016	3	ind	17.62	°N	-16.80	°W	25.1	°C SST	1046	m depth	Oceanic

Caspian, Royal and Bridled Terns



Sandwich Tern Sterne caugek



Sandwich Tern Sterne caugek *Thalasseus sandvicensis* (281)

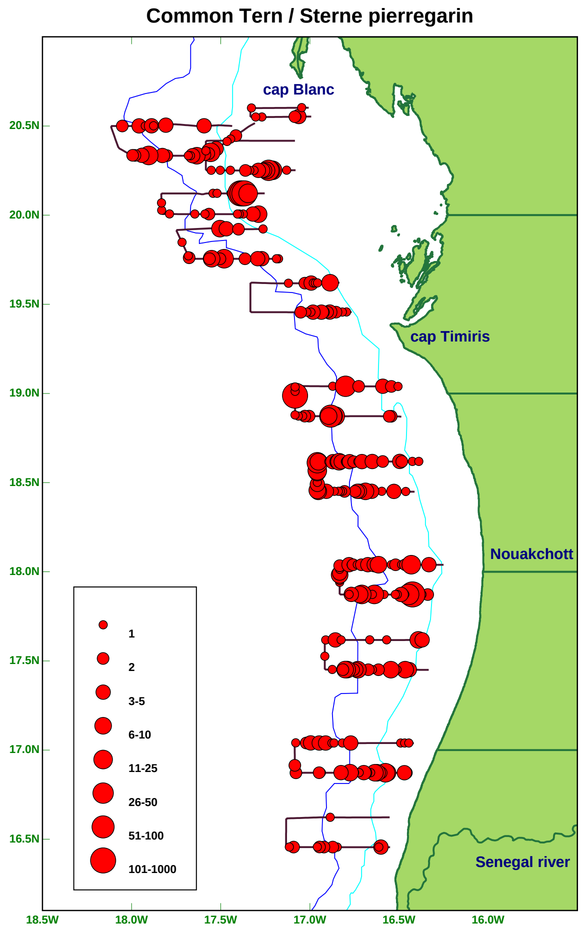
Sandwich Tern can be found in coastal colonies in Europe, Africa, Asia, Southern America. It is a highly migratory species, undergoing post-breeding dispersive movements north and south to favoured feeding grounds before migrating southward (del Hoyo *et al.* 1996).

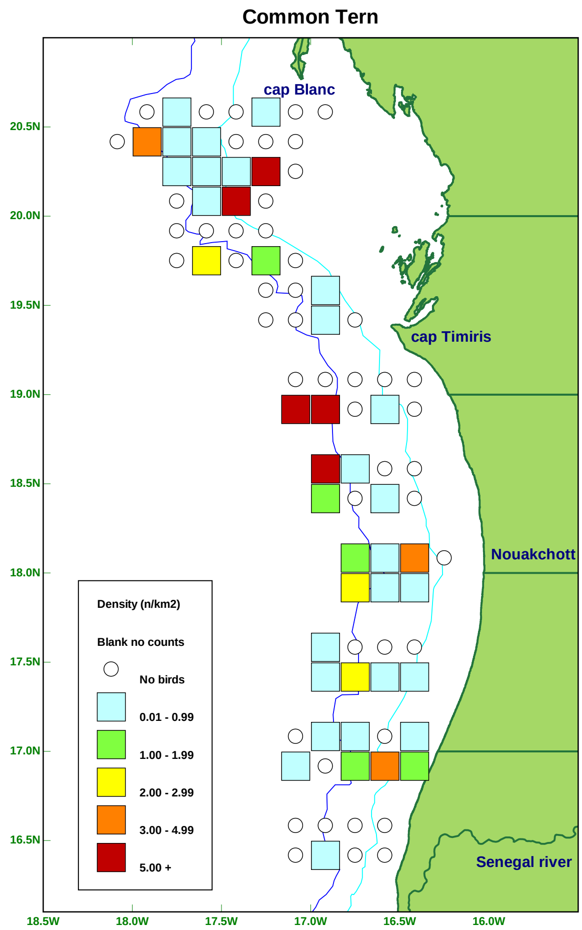
Sandwich Terns were fairly uncommon and most birds seen were somehow associated with the observation platform (often roosting on the top deck). Based on the observed densities, crude estimates of total numbers of Sandwich Terns present within the study area arrived at only a few hundreds of birds, with average densities of 0.06 km^{-2} in the Oceanic areas, 0.01 km^{-2} over the Shelf-break and 0.02 km^{-2} within the Neritic zone. We consider this a very unreliable estimate of overall abundance.

Common Tern Sterne pierregarin *Sterna hirundo*

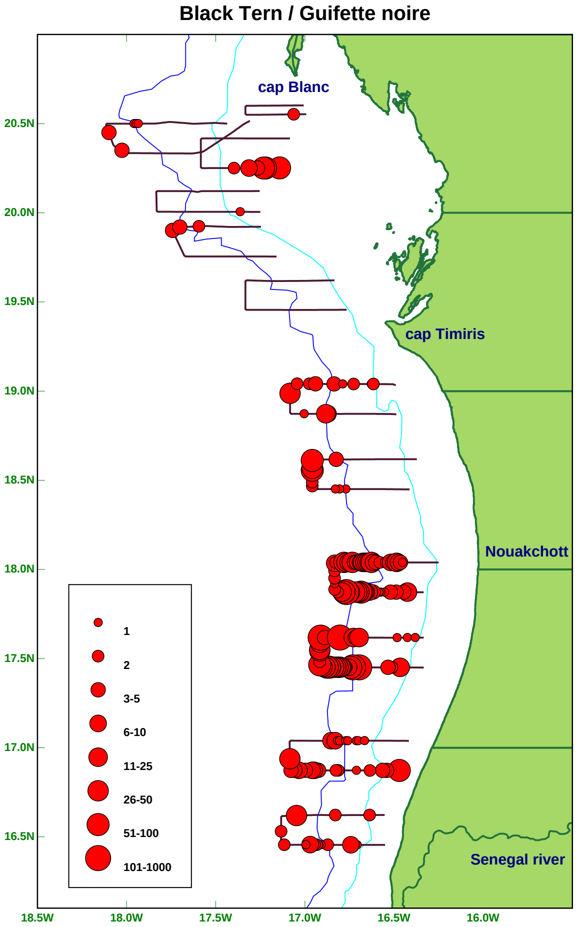
Common Terns have a circumpolar distribution and breed in temperate and subarctic regions of Europe, Asia and North America (Cramp & Simmons 1983, del Hoyo *et al.* 1996). Most populations of the Common Tern are strongly migratory. In Mauritania, Common Terns are abundant winter visitors (Isenmann *et al.* 2010). Only a few hundreds of pairs breed in NW Africa (Mauritania-Guinea Bissau).

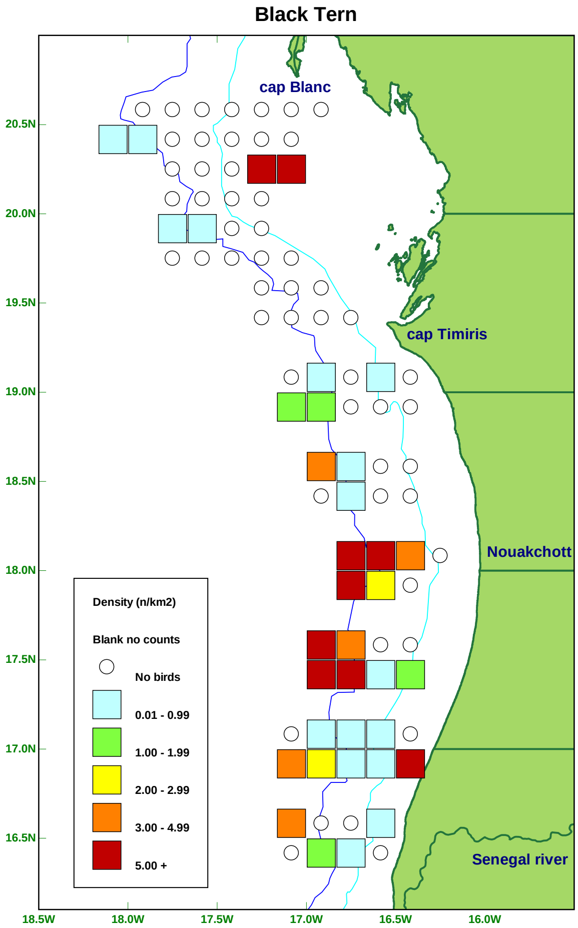
Common Terns were widespread throughout the study area in November 2016. The maps above provide all observations, but with ship-followers excluded from the analysis (*n* per 5-minute count, red dots) on the left and observed densities (*n km*$^{-2}$, i.e. birds in transect corrected for observation effort) on the right for Common and Black Terns respectively. Based on the observed densities, crude estimates of total numbers of Common Terns present within the study area arrived at 54,700 individuals, making this the one of the most abundant seabirds observed on this trip, with average densities of 0.97 km^{-2} in the Oceanic areas, 1.31 km^{-2} over the Shelf-break and 1.89 km^{-2} within the Neritic zone. So, sightings of Common Terns were fairly common in all depth zones, but with a clear inshore (Neritic) bias. In all, 21% of all records were within the Oceanic zone, 14% over the Shelf-break and 65% within the Neritic zone (n= 2604;G_{adj}= 260.3 , df=2, $P<0.001$). This is a much stronger bias towards the Neritic zone than in September 2015, when numerous Common Terns were seen to join Black Terns in tuna-driven feeding frenzies offshore (Camphuysen *et al.* 2015).





Of 653 Common Terns in which notes of directions of flight or any associations were made, 26% were associated with fishing vessels. A total of 262 terns were participating into MSFAs. A total of 26 Common terns were seen in associated with cetaceans. It is interesting that while Common Terns are well known for their shallow plunging behaviour, 553 individuals were recorded as “dipping” (no body contact with the water) and 2 in aerial pursuit (hunting insects in mid-air). Another large fraction was searching, but shallow plunging has not been recorded, suggesting that all prey were very small and at the water surface.





Black Tern Guifette noire *Chlidonias niger*

The Black Tern is a boreal species that breeds in freshwater marshes across most of Canada, the northern United States and much of Europe and western Asia (Cramp & Simmons 1983, Olsen & Larsson 1995, del Hoyo *et al.* 1996). In the African wintering areas Black Terns are truely marine birds that do not just feed in coastal waters, but also far offshore (Glutz von Blotzheim & Bauer 1982). According to these authors, lagoons and salt pans are used primarily as overnight roosts. Off the north coast of the Guinea Gulf, large mixed tern flocks, dominated by Black Terns, feed in August-October when a seasonal shift of the upwelling system reaches coastal waters with migratory surface shoaling sardines (*Sardinella aurita*). In winter and spring, this upwelling and the convergence runs 600 km away from the coast and the terns are by day well beyond the radar limits (>22 km offshore) of a previous study (Grimes 1977). What prey the Black Terns would be feeding on is unclear.

Based on the observed densities, crude estimates of total numbers of Black Terns present within the study area arrived at 90,000 individuals, making this the second most numerous seabird observed on this trip, with average densities of 4.25 km^{-2} in the Oceanic areas, 2.34 km^{-2} over the Shelf-break and 0.81 km^{-2} within the Neritic zone. So, sightings of Black Terns were fairly common in all depth zones, but with a clear offshore

(Oceanic) bias. In all, 62% of all records were within the Oceanic zone, 23% over the Shelf-break and only 14% within the Neritic zone (*n*= 3118;G_{adj}= 705.9 , df=2, P<0.001). This distribution is almost similar as that recorded in September 2015, whereas Common Terns were now stronger confined to inshore (Neritic) waters.

One of the key aspects of the early autumn surveys off the Mauritanian coast in 2015 was to find out if the major onshore roosts of Black Terns near Nouadhibou (40-50,000 individuals roosting in November 2014; *personal observations;* Camphuysen *et al.* 2015) would communicate with any offshore foraging locations, and if so, what the attraction would be to forage so far from land and in an oceanic environment. At the time, Black Terns were primarily foraging in close association with hunting bonitos (mostly Skipjack Tuna *Katsuwonus pelamis*), especially in warm Oceanic waters to the south of 20°N. Smaller numbers were seen foraging over the shelf break, usually without evidence for hunting tuna, and foraging was rare within the Neritic zone (Camphuysen *et al.* 2015). High numbers of Black Terns were recorded during these surveys and it was assumed that numbers would be lower in early November. However, while Bonito-driven fish schools were infrequent and far apart in November 2016, it appeared that foraging conditions over the shelf break were still good and high numbers of Black Terns were observed. Fronts (79 birds), fish oil slicks (46 birds; but only slicks generated by hunting tuna on small pelagics), and the occasional fishing vessel (25 birds) formed visible attractions. Otherwise, many foraging flocks were mono-specific and Common Terns were clearly less interested than before to share the Oceanic foraging opportunities.

4.2.8 **Marine mammals** Cetacea

Common Dolphins *Delphinus delphis*

With a total of 79 sightings and ~2618 individuals, cetaceans formed an important part of the Mauritanian megafauna observed during the November 2016 surveys. Toothed whales (Odontoceti) were by far the most numerous cetaceans encountered and at least 8 species were positively identified. By contrast, only 11 baleen whales (Mysticeti) were encountered, of which only Fin Whales *Balaenoptera physalus* (4 individuals) could be identified with certainty. All other large baleen whales were seen at distance.

Large baleen whales Mysticeti

Blue / Fin / Sei Whale	5	Nov	2016	1	ind	17.00	°N	-17.09	°W	27.5	°C SST	1805	m depth	Oceanic
Sei / Brydes Whale	3	Nov	2016	1	ind	19.04	°N	-17.02	°W	26.1	°C SST	1281	m depth	Oceanic
Large unidentified baleen whale	1	Nov	2016	1	ind	20.50	°N	-17.83	°W	23.5	°C SST	520	m depth	Shelf-break
	1	Nov	2016	1	ind	20.50	°N	-17.82	°W	23.3	°C SST	489	m depth	Shelf-break
	2	Nov	2016	1	ind	19.85	°N	-17.72	°W	24.2	°C SST	1539	m depth	Oceanic
Fin Whale	1	Nov	2016	1	ind	20.33	°N	-17.98	°W	23.2	°C SST	1356	m depth	Oceanic
	1	Nov	2016	2	ind	20.33	°N	-17.99	°W	23.4	°C SST	1376	m depth	Oceanic
	1	Nov	2016	2	ind	20.34	°N	-18.01	°W	23.5	°C SST	1396	m depth	Oceanic
	9	Nov	2016	1	ind	19.46	°N	-17.20	°W	24.9	°C SST	1089	m depth	Oceanic

Deep-diving toothed whales Odontoceti

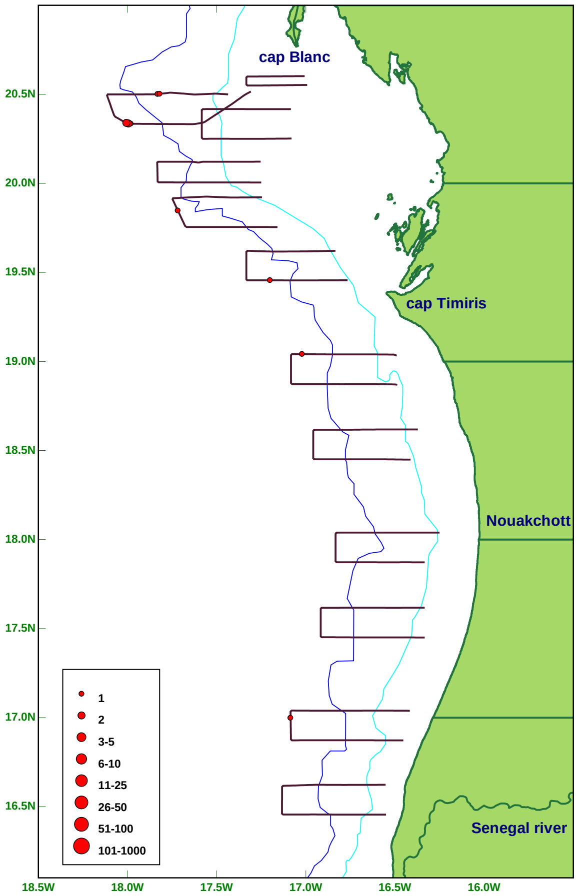
Sperm Whale	1	Nov	2016	4	ind	20.33	°N	-17.73	°W	22.0	°C SST	470	m depth	Shelf-break
	1	Nov	2016	2	ind	20.33	°N	-17.93	°W	23.3	°C SST	1000	m depth	Oceanic
	2	Nov	2016	6	ind	19.76	°N	-17.28	°W	20.1	°C SST	667	m depth	Shelf-break
	2	Nov	2016	1	ind	19.76	°N	-17.29	°W	20.3	°C SST	724	m depth	Shelf-break
	2	Nov	2016	1	ind	19.76	°N	-17.32	°W	20.7	°C SST	847	m depth	Oceanic
	2	Nov	2016	1	ind	19.76	°N	-17.56	°W	24.5	°C SST	1535	m depth	Oceanic
Sperm Whale (cont.)	2	Nov	2016	4	ind	19.92	°N	-17.59	°W	24.5	°C SST	799	m depth	Shelf-break

	2	Nov	2016	2	ind	19.93	°N	-17.56	°W	24.3	°C SST	562	m depth	Shelf-break
	3	Nov	2016	1	ind	18.87	°N	-16.98	°W	25.8	°C SST	967	m depth	Oceanic
	3	Nov	2016	1	ind	19.04	°N	-16.91	°W	26.1	°C SST	691	m depth	Shelf-break
	3	Nov	2016	1	ind	19.04	°N	-16.90	°W	26.2	°C SST	629	m depth	Shelf-break
	7	Nov	2016	1	ind	17.45	°N	-16.44	°W	25.4	°C SST	102	m depth	Neritic
	7	Nov	2016	1	ind	17.62	°N	-16.66	°W	24.0	°C SST	533	m depth	Shelf-break
	7	Nov	2016	1	ind	17.62	°N	-16.53	°W	23.7	°C SST	184	m depth	Neritic
	8	Nov	2016	2	ind	18.45	°N	-16.51	°W	22.0	°C SST	106	m depth	Neritic
	9	Nov	2016	1	ind	19.46	°N	-17.09	°W	24.8	°C SST	614	m depth	Shelf-break
	9	Nov	2016	1	ind	19.55	°N	-17.33	°W	25.0	°C SST	1377	m depth	Oceanic
	9	Nov	2016	1	ind	19.62	°N	-17.10	°W	24.2	°C SST	793	m depth	Shelf-break
	9	Nov	2016	1	ind	19.62	°N	-17.07	°W	24.2	°C SST	693	m depth	Shelf-break
	9	Nov	2016	1	ind	19.62	°N	-17.06	°W	24.1	°C SST	536	m depth	Shelf-break
small unidentified whale	6	Nov	2016	4	ind	16.62	°N	-16.74	°W	25.1	°C SST	97	m depth	Neritic
beaked whale	1	Nov	2016	1	ind	20.50	°N	-18.04	°W	24.0	°C SST	955	m depth	Oceanic
Short-finned Pilot Whale	5	Nov	2016	12	ind	17.04	°N	-16.84	°W	27.6	°C SST	882	m depth	Oceanic
	10	Nov	2016	23	ind	20.11	°N	-17.83	°W	23.9	°C SST	1606	m depth	Oceanic
	10	Nov	2016	18	ind	20.12	°N	-17.83	°W	23.8	°C SST	1578	m depth	Oceanic

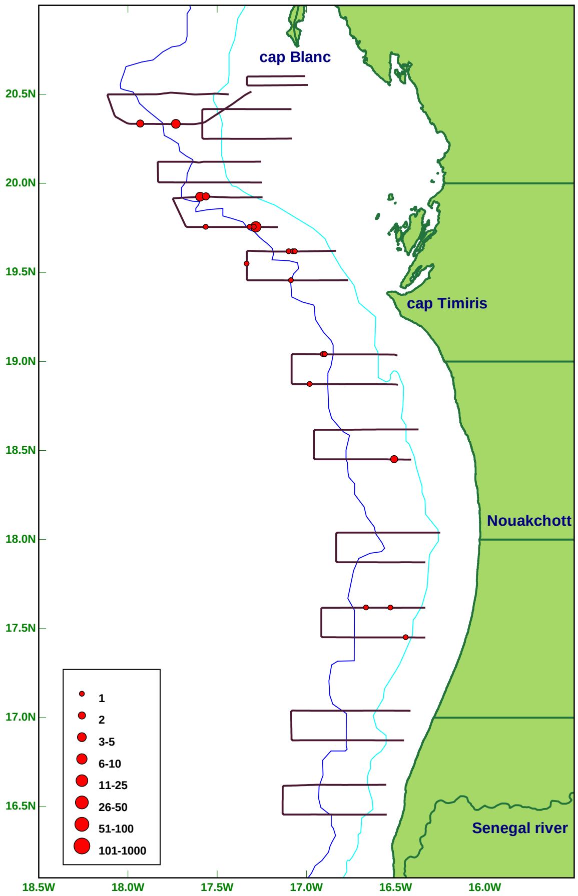
Dolphins Odontoceti

Killer Whale	1	Nov	2016	5	ind	20.33	°N	-17.67	°W	21.8	°C SST	212	m depth	Shelf-break
Risso's Dolphin	2	Nov	2016	3	ind	19.76	°N	-17.22	°W	19.9	°C SST	423	m depth	Shelf-break
Risso’s Dolphin	2	Nov	2016	17	ind	19.76	°N	-17.25	°W	19.9	°C SST	533	m depth	Shelf-break
	2	Nov	2016	10	ind	19.76	°N	-17.36	°W	22.1	°C SST	1055	m depth	Oceanic
	2	Nov	2016	10	ind	19.76	°N	-17.62	°W	24.7	°C SST	1776	m depth	Oceanic
	3	Nov	2016	8	ind	19.04	°N	-16.88	°W	26.2	°C SST	567	m depth	Shelf-break
	3	Nov	2016	28	ind	19.04	°N	-16.87	°W	26.2	°C SST	514	m depth	Shelf-break
	7	Nov	2016	3	ind	17.62	°N	-16.67	°W	24.3	°C SST	605	m depth	Shelf-break
Common Dolphin	1	Nov	2016	300	ind	20.37	°N	-18.07	°W	24.6	°C SST	1300	m depth	Oceanic
	1	Nov	2016	52	ind	20.50	°N	-17.91	°W	23.5	°C SST	676	m depth	Shelf-break
	2	Nov	2016	400	ind	19.76	°N	-17.36	°W	22.1	°C SST	1055	m depth	Oceanic
	2	Nov	2016	10	ind	19.93	°N	-17.57	°W	24.4	°C SST	612	m depth	Shelf-break
	2	Nov	2016	270	ind	19.92	°N	-17.52	°W	23.8	°C SST	372	m depth	Shelf-break
	2	Nov	2016	45	ind	19.92	°N	-17.40	°W	22.9	°C SST	162	m depth	Neritic
	3	Nov	2016	20	ind	19.04	°N	-16.70	°W	26.5	°C SST	129	m depth	Neritic
Short-beaked Common Dolphin	2	Nov	2016	45	ind	19.75	°N	-17.18	°W	20.2	°C SST	221	m depth	Shelf-break
	2	Nov	2016	115	ind	19.75	°N	-17.19	°W	20.1	°C SST	251	m depth	Shelf-break
	2	Nov	2016	8	ind	19.75	°N	-17.20	°W	20.1	°C SST	280	m depth	Shelf-break
	2	Nov	2016	111	ind	19.75	°N	-17.21	°W	20.0	°C SST	352	m depth	Shelf-break
	2	Nov	2016	15	ind	19.76	°N	-17.22	°W	19.9	°C SST	423	m depth	Shelf-break
	3	Nov	2016	130	ind	18.87	°N	-16.88	°W	25.7	°C SST	675	m depth	Shelf-break
	4	Nov	2016	330	ind	18.04	°N	-16.57	°W	24.6	°C SST	570	m depth	Shelf-break
	4	Nov	2016	2	ind	18.04	°N	-16.54	°W	24.5	°C SST	431	m depth	Shelf-break
Clymene Dolphin	2	Nov	2016	45	ind	19.80	°N	-17.70	°W	24.7	°C SST	1547	m depth	Oceanic
Atlantic Spotted Dolphin	1	Nov	2016	70	ind	20.33	°N	-17.90	°W	23.4	°C SST	1100	m depth	Oceanic
	1	Nov	2016	40	ind	20.33	°N	-17.92	°W	23.4	°C SST	1050	m depth	Oceanic
	2	Nov	2016	5	ind	19.92	°N	-17.66	°W	24.3	°C SST	941	m depth	Oceanic
	3	Nov	2016	12	ind	18.87	°N	-16.88	°W	25.7	°C SST	675	m depth	Shelf-break
	5	Nov	2016	4	ind	16.96	°N	-17.08	°W	27.6	°C SST	1749	m depth	Oceanic
	7	Nov	2016	30	ind	17.56	°N	-16.92	°W	26.9	°C SST	1459	m depth	Oceanic
	8	Nov	2016	175	ind	18.45	°N	-16.85	°W	25.3	°C SST	1103	m depth	Oceanic
Bottlenose Dolphin	1	Nov	2016	2	ind	20.50	°N	-17.64	°W	21.1	°C SST	98	m depth	Neritic
	2	Nov	2016	4	ind	19.76	°N	-17.25	°W	19.9	°C SST	533	m depth	Shelf-break
	10	Nov	2016	25	ind	20.11	°N	-17.83	°W	23.9	°C SST	1606	m depth	Oceanic
unidentified dolphin	1	Nov	2016	1	ind	20.33	°N	-17.79	°W	22.6	°C SST	613	m depth	Shelf-break
	1	Nov	2016	1	ind	20.36	°N	-18.04	°W	24.2	°C SST	1305	m depth	Oceanic
	1	Nov	2016	20	ind	20.50	°N	-17.93	°W	23.6	°C SST	635	m depth	Shelf-break
	2	Nov	2016	40	ind	19.76	°N	-17.35	°W	21.7	°C SST	1018	m depth	Oceanic
	2	Nov	2016	10	ind	19.92	°N	-17.69	°W	23.6	°C SST	1158	m depth	Oceanic
	2	Nov	2016	1	ind	19.93	°N	-17.54	°W	24.1	°C SST	462	m depth	Shelf-break
	3	Nov	2016	23	ind	18.87	°N	-16.85	°W	25.7	°C SST	518	m depth	Shelf-break
	3	Nov	2016	15	ind	19.00	°N	-17.08	°W	25.9	°C SST	1475	m depth	Oceanic
	3	Nov	2016	30	ind	19.04	°N	-16.96	°W	26.1	°C SST	1025	m depth	Oceanic
	5	Nov	2016	10	ind	17.04	°N	-16.94	°W	27.8	°C SST	1391	m depth	Oceanic
	9	Nov	2016	15	ind	19.53	°N	-17.33	°W	25.0	°C SST	1493	m depth	Oceanic

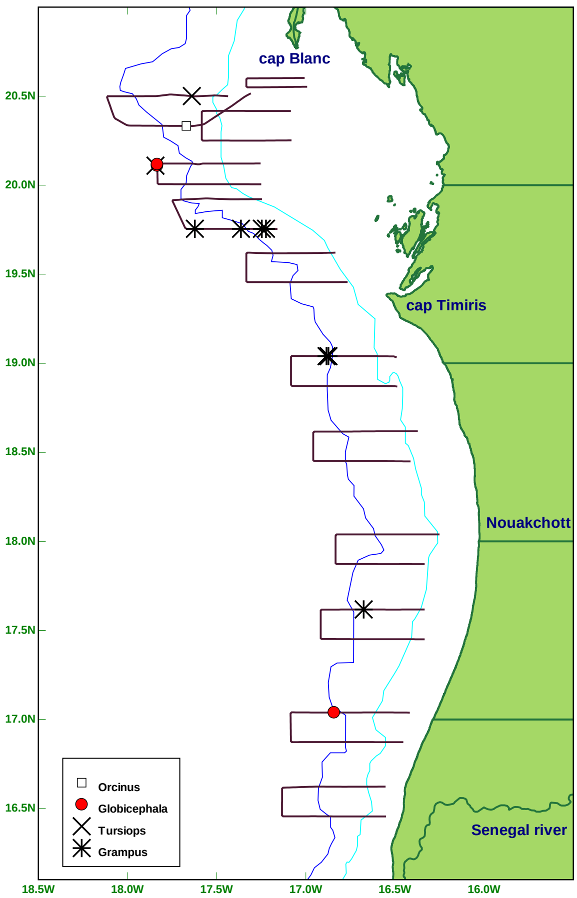
Large baleen whales



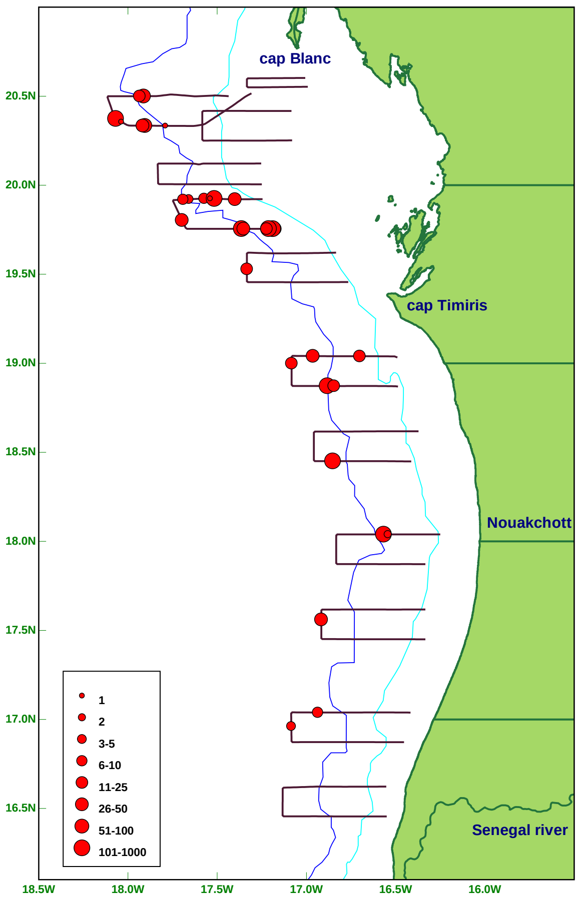
Sperm whales



Pilot Whales, Killer Whale, Risso's & Bottlenose Dolphins



Oceanic dolphins (Stenella & Delphinus spp)



Fin Whale Rorqual Commun *Balaenoptera physalus*

Fin Whale *Balaenopterus physalus*

Fin Whales, of the *Balaenoptera* genus, are the second largest animals that have ever existed. All six animals observed were seen in deep, Oceanic waters (1089-1296m depth), some of which at extremely close range, and one of which was lunge-feeding. five medium sized to quite large individuals were seen, and one sighting comprised an adult female with a free swimming calf (1 Nov 2016, 20.34°N, 18.01°W).

Sperm Whale Cachalot *Physeter macrocephalus*

Sperm Whales are the largest species within the toothed whale group Odontoceti. Large, probably all male Sperm Whales were seen on 25 occasions (34 individuals) and the sightings comprised four duos, one trio, a quartet and otherwise solitary individuals (**map**). The water depth ranged from only 102 (Neritic zone) to 1535m (Oceanic zone), with an average of 691 ± 361m. This meant, most Sperm Whales were seen over the Shelf-break (71%), but this included the shallower (upper) parts of the break and at least 4 individuals were found within the Neritic zone (12%; G_{adj}= 17.3 , df=2, P<0.01). The surface water temperatures (SST) in which Sperm Whales were seen varied from 20.1-26.2°C (mean 23.8 ± 1.8°C). It is clear that sightings were by no means restricted to the Timiris canyon system (cf. Camphuysen *et al.* 2015).

Killer Whale Orque *Orcinus orca*

One small pod of Killer Whales was encountered, including one adult male, at least three mature females and a young calf. The male was swimming quite far apart from the rest of the pod.

Short-finned Pilot Whale Globicéphale tropical *Globicephala macrorhynchus*

Short-finned Pilot Whales were considerably less common than during the September 2015 surveys. Only three encounters of small pods, once accompanied by oceanic Bottlenose Dolphins. All sigthings were within the Oceanic zone, at water depths of 882-1606m with SST ranging from 23.8-27.6°C. The animals were shy, surfaced often only briefly and sex or age identifications were rarely possible.

Short-finned Pilot Whale *Globicephala macrorhynchus*

Risso's Dolphin Dauphin de Risso *Grampus griseus*

Risso's Dolphin *Grampus griseus*

Seven pods of Risso's Dolphins (average pod size 11.3 ± 8.8 individuals, range 3-28, *n* = 7) were encountered, two of which in deep Oceanic waters, five over the Shelf-break (average water depth 781 ± 484m, range 423-1776m, *n*= 7). Sightings were with highly variable sea surface temperatures (SST 23.3 ± 2.7°C, range 19.9-26.2°C) and nearly all between 19 and 20°N latitude (see **map** above)

Bottlenose Dolphin Grand dauphin *Tursiops truncatus*

Bottlenose Dolphins were encountered within the Oceanic as well as within the Neritic zone, but the normally fairly slender and often relatively dark oceanic type was not seen. In fact, the Oceanic dophins encountered were particularly large. Not all (three) pods could be assigned to anyone type, the Bottlenose Dolphins associated with Short-finned Pilot Whales were not of the classic Oceanic type. During this last encounter, 23 Short-finned Pilot Whales and 25 Bottlenose Dolphins together, the latter joined the ship and started to ride the bow, whereas the Pilot Whales sank away and disappeared.

Oceanic dolphins dauphin ***Delphinus/Stenella* spp.**

Smaller, oceanic dolphins were seen in large numbers and this included at least Common Dolphins *Delphinus delphis*, Atlantic Spotted Dolphins *S. frontalis*, and possibly Clymene Dolphins *S. clymene* (31 encounters of pods when three brief glimpses of solitary (?) small dolphins are not taken into consideration). The smaller Oceanic dolphins, groups of slender unidentified dolphins included, were characterised by a mean pod size of 77 ± 106 individuals (range 2-400), within a depth range of 129-1749m (mean 884 ± 470m depth), and with sea surface temperatures (SST) averaging 23.9±2.3°C, range 19.9-27.8°C). All sightings are plotted above and in contrast to the surveys in September 2015, slender oceanic dolphins were much more numerous and widespread in the north, in cooler waters, but still with a clear bias to Oceanic conditions (50% of all individuals Oceanic, 48% Shelf-break, 2% Neritic; G_{adj}= 1333.9, df=2, P< 0.001). If discrete pods rather than individual dolphins are considered, there is a stronger bias towards the Shelf-break (35% of all pods Oceanic, 62% Shelf-break, 3% Neritic; G_{adj}= 38.0, df=2, P< 0.01).

Common Dolphins were assumed mostly **Short-beaked Common Dolphins** *Delphinus delphis delphis*. The Mauritanian type is a rather dull variety in which the characteristic flank pattern is not always particularly easy to see (Burton & Camphuysen 2003

The dolphin herds were often 'stampeding' (swimming closely together with high speed, in line or half circle formations), suggesting active foraging activities. Relatively few seabirds were attracted, however, and the classical dolphin-seabird interactions (with dolphins as beaters, driving forage fish towards the surface) were not particularly impressive in size on the side of seabirds involved. Associated seabirds comprised only 4 Scopoli's/Corys shearwater, 4 Cory's Shearwater, 2 Wilson's Storm-petrel, 3 Leach's Storm Petrel, 9 Northern Gannet, 6 Pomarine Skua, 4 Sabine's Gull, 26 Common Tern, and1 Sandwich Tern .

The encounter with **Clymene Dolphin** *Stenella clymene*, a fairly abundant species during the September 2015 surveys, is not without doubt, because the photographic material obtained is both not good, but also not convincing to confirm the field identification. **Atlantic Spotted Dolphin** *Stenella frontalis* were without doubt the second most numerous and frequent species, following Common Dolphins.

Common Dolphin *Delphinus delphis*

4.2.9 Further charismatic megafauna Turtle, sharks, rays, and fish

Sea turtles

- **Loggerhead Turtle** Tortue carette *Caretta caretta*
- **Olive ridley** Tortue olivâtre *Lepidochelys olivacea*
- **Green turtle** Tortue verte *Chelonia mydas*

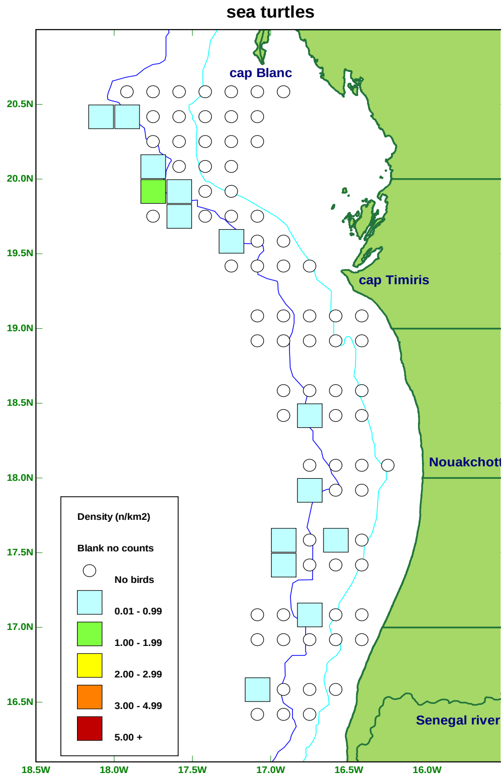
Hard-shelled marine turtles are in the family Cheloniidae. A total of 47 sea turtles were encountered during the November 2016 surveys, including at least 25 Loggerhead Turtles, seven Green turtles, and one Olive ridley, while 14 turtles remained unidentified. The identification of sea turtles from a moving observation platform is a challenge, and therefore, the results should always be treated with caution. The field identification of 15 turtles could be checked by examining the photographic material collected during the survey. The check revealed the presence of an Olive ridley (misidentified as a Loggerhead turtle) and altered the identification of two further individuals (Green to Loggerhead and vice versa). All other identifications were confirmed. The sighting of an Olive ridley is interesting given its recent (re-)discovery for Mauritanian waters (Mint Hama *et al.* 2013). Whereas in the previous survey, all turtles were seen in the north (19-20°N), they were now more widespread and abundant (see map). Only one (2%) was seen within the Neritic zone (173m deep waters), five around the shelf-break (11%; 261-719m depth) and 41 (87%) in the Oceanic zone (824-1699m depth). Encounters with sea turtles were typically very brief and few notes could be made regarding their behaviour or any other features. At least three individuals (two Green turtles and one Loggerhead) were seen associated with marine litter (debris), one Loggerhead was surface seizing jellyfish (actively foraging; jellyfish are known prey for Loggerheads, Bustard 1972). Couples of turtles were seen twice and the interactions observed suggested that mating attempts were undertaken. On both occasions, one of the individuals flipped over and was seen swimming upside down at the surface apparently to get rid of the second. While copulations are known to occur at sea, this behaviour has not been adequately described to the best of our knowledge and it cannot therefore easily be explained.

Olive ridley *Lepidochelys olivacea*, large adult, 2 Nov 2016, 19.82°N, 17.72°W (2 pairs of prefrontals, hawk-like beak and greenish coloration). Photo Rob van Bemmelen, ID Kiki Dethmers.

Green turtle *Chelonia mydas*, 2 Nov 2016, 19.76°N, 17.57°W (3+ costals, smooth carapace), with floating litter. Photo Rob van Bemmelen, ID Kiki Dethmers.

Loggerhead *Caretta caretta*, 2 Nov 2016, 19.92°N, 17.70°W (clearly elongated shape, broad head, rugged coloration). Photo Rob van Bemmelen, ID Kiki Dethmers.

Loggerhead *Caretta caretta*, 5 Nov 2016, 16.93°N, 17.08°W (2 pair of pf, no 4 pos), with floating litter. Photo Rob van Bemmelen, ID Kiki Dethmers



Loggerhead *Caretta caretta*, 10 Nov 2016, 20.12°N, 17.72°W (very clear plastron; juvenile?), flipping over and finally belly up as a result of second individual interfering (sexual interactions?). Photo Rob van Bemmelen, ID Kees Camphuysen.

Acknowledgements to Kiki Dethmers for help with identifications.

Sharks, rays, and other apex predators

Predatory fish observed included sharks, mobula's, sun fish, undintified tuna (bontio's), and Swordfish, details of which are provided below. Most these predators were observed in relatively warm waters (SST 24.6 ± 1.6°C, range 21.6-27.7°C), often far offshore in deeper waters (796 ± 470m, range 41-1549m depth), but some exceptions have occurred

Smooth Hammerhead	1	Nov	2016	1	ind	20.50	°N	-17.84	°W	23.6	°C SST	553	m depth	Shelf-break
	2	Nov	2016	1	ind	19.92	°N	-17.26	°W	21.6	°C SST	41	m depth	Neritic
	7	Nov	2016	1	ind	17.62	°N	-16.77	°W	25.0	°C SST	970	m depth	Oceanic
	10	Nov	2016	1	ind	20.01	°N	-17.65	°W	22.1	°C SST	559	m depth	Shelf-break
unidentified shark	1	Nov	2016	1	ind	20.51	°N	-17.75	°W	22.8	°C SST	301	m depth	Shelf-break
	2	Nov	2016	1	ind	19.93	°N	-17.54	°W	24.1	°C SST	462	m depth	Shelf-break
	3	Nov	2016	1	ind	19.04	°N	-16.91	°W	26.1	°C SST	691	m depth	Shelf-break
	9	Nov	2016	1	ind	19.46	°N	-16.99	°W	23.7	°C SST	328	m depth	Shelf-break
Lesser Guinean Mobula	2	Nov	2016	1	ind	19.92	°N	-17.70	°W	23.3	°C SST	1245	m depth	Oceanic
	2	Nov	2016	2	ind	19.92	°N	-17.68	°W	23.9	°C SST	1072	m depth	Oceanic
	2	Nov	2016	1	ind	19.92	°N	-17.65	°W	24.3	°C SST	896	m depth	Oceanic
	3	Nov	2016	1	ind	18.87	°N	-16.82	°W	25.6	°C SST	431	m depth	Shelf-break
	3	Nov	2016	1	ind	18.87	°N	-16.83	°W	25.7	°C SST	474	m depth	Shelf-break
	5	Nov	2016	1	ind	17.04	°N	-16.86	°W	27.7	°C SST	1055	m depth	Oceanic
	8	Nov	2016	1	ind	18.58	°N	-16.96	°W	26.0	°C SST	1434	m depth	Oceanic
Lesser Guinean Mobula	8	Nov	2016	2	ind	18.60	°N	-16.96	°W	26.0	°C SST	1425	m depth	Oceanic
(cont.)	9	Nov	2016	1	ind	19.46	°N	-17.19	°W	24.9	°C SST	1038	m depth	Oceanic
	10	Nov	2016	1	ind	20.12	°N	-17.83	°W	23.7	°C SST	1549	m depth	Oceanic
	10	Nov	2016	2	ind	20.12	°N	-17.82	°W	23.6	°C SST	1521	m depth	Oceanic
	10	Nov	2016	1	ind	20.12	°N	-17.65	°W	23.6	°C SST	305	m depth	Shelf-break
Sun-fish	2	Nov	2016	1	ind	19.92	°N	-17.40	°W	22.9	°C SST	162	m depth	Neritic
	8	Nov	2016	1	ind	18.62	°N	-16.77	°W	25.5	°C SST	648	m depth	Shelf-break
Unidentified tuna	3	Nov	2016	55	ind	18.99	°N	-17.08	°W	25.9	°C SST	1499	m depth	Oceanic
	5	Nov	2016	10	ind	17.04	°N	-16.77	°W	27.7	°C SST	416	m depth	Shelf-break
Swordfish	3	Nov	2016	1	ind	19.04	°N	-17.01	°W	26.1	°C SST	1245	m depth	Oceanic
	4	Nov	2016	1	ind	17.87	°N	-16.61	°W	25.1	°C SST	381	m depth	Shelf-break

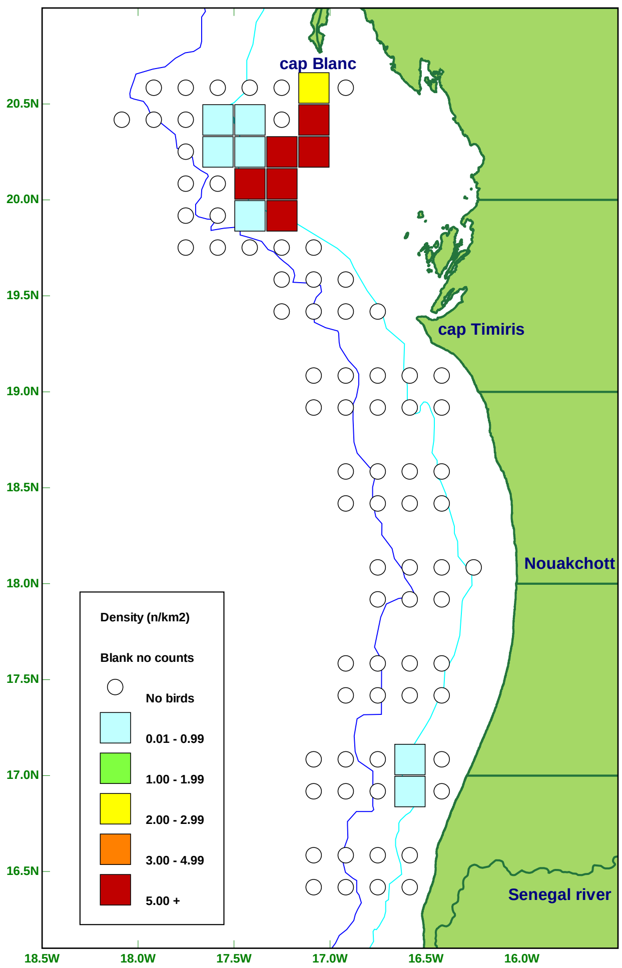
unidentified flying fish, Exocet, poisson volant

Unidentified flying fish Exocoetidae

The Exocoetidae are a family of marine fish known as flying fish. About 64 species are grouped in seven to nine genera. Flying fish can make powerful, self-propelled leaps out of water into air, where their long, wing-like fins enable gliding flight for considerable distances above the water's surface (Wikipedia). Numerous flying fish were seen during the Nov 2016 survey, and species-specific identification proved to be impossible. Several types were seen, but only a distinction was made between individuals with dark, blackish wings (fins) and individuals with fully transparent, more silvery wings. Several transparent winged types were seen as well as dark-winged varieties, and both were more abundant in Oceanic waters than further inshore. Of the light winged type, 92% were seen in deep waters (*n*= 609), 2% over the Shelf-break and 6% within the Neritic zone (G_{adj}= 450.3, df=2, P< 0.001). Of dark-winged flying fish, 81% were seen in Oceanic waters, 8% over the Shelf-break and 11% within the Neritic zone (G_{adj}= 46.8, df=2, P< 0.01).

Artisanal fleets and floats

Artisanal fish floats (indicative for pod or set-net fisheries) were highly concentrated in the northern part of the study area (see density map above), where particularly large fleets of pirogues were encountered. The numbers of seabirds attracted were usually rather small, also because much of the fisheries is a night activity.



5. Discussion

Common Terns *Sterna hirundo*

Table 5.1. Commoner seabirds in transect and abundance estimates based on overall densities extrapolated over the entire research area (**Fig. 3.2** right image). Shown are species name, number of individuals recorded in transect, overall density, area extrapolations and overall densities within the Oceanic, Shelf-break and Neritic zones.

English name	Scientific name	In transect	Effort 483.2 km² Density	Area 38073 km² Extrapolation	Oceanic (171.9 Oceanic	Shelf-break 103.6 Shelf-break	Neritic 207.7) Neritic
Scopoli's Shearwater	*Calonectris diomedea*	4	0.008	320	0.006	0.010	0.010
Scopoli's/Corys shearwater	*Calonectris spp.*	73	0.151	5800	0	0.039	0.332
Cory's Shearwater	*Calonectris borealis*	926	1.916	73000	1.076	0.676	3.231
Cape Verde Shearwater	*Calonectris edwardsii*	13	0.027	1020	0	0.039	0.043
Great Shearwater	*Ardenna gravis*	1	0.002	80	0	0.010	0
Sooty Shearwater	*Ardenna grisea*	11	0.023	870	0.006	0.010	0.043
Balearic Shearwater	*Puffinus mauretanicus*	1	0.002	80	0	0	0.005
European Storm Petrel	*Hydrobates pelagicus*	2017	4.174	193600	0.535	0.734	8.903
Wilson's Storm-petrel	*Oceanites oceanicus*	259	0.536	24900	0.308	0.589	0.698
Band-rumped Storm Petrel	*Oceanodroma castro*	2	0.004	200	0.006	0.010	0
Leach's Storm Petrel	*Oceanodroma leucorhoa*	859	1.778	82500	4.229	1.158	0.058
White-faced Storm-petrel	*Pelagodroma marina*	3	0.006	300	0.012	0.010	0
Northern Gannet	*Morus bassanus*	1000	2.070	78800	0.081	0.357	4.570
Red Phalarope	*Phalaropus fulicarius*	364	0.753	33300	0.332	0.106	1.425
Long-tailed Jaeger	*Stercorarius longicaudus*	102	0.211	8040	0.128	0.125	0.323
Parasitic Jaeger	*Stercorarius parasiticus*	1	0.002	80	0	0	0.005
Pomarine Skua	*Stercorarius pomarinus*	686	1.420	54100	0.273	0.705	2.725
Great Skua	*Stercorarius skua*	3	0.006	240	0	0	0.014
Lesser Black-backed Gull	*Larus fuscus*	13	0.027	1020	0	0	0.063
Sabine's Gull	*Xema sabini*	42	0.087	3310	0.081	0.077	0.096
Black Tern	*Chlidonias niger*	1142	2.363	90000	4.252	2.345	0.809
Caspian Tern	*Hydroprogne caspia*	1	0.002	80	0	0	0.005
Common Tern	*Sterna hirundo*	694	1.436	54700	0.966	1.313	1.888
Sandwich Tern	*Thalasseus sandvicensis*	6	0.012	470	0.006	0.010	0.019
sea turtle	(unidentified) sea turtle	33	0.068	2600	0.169	0.029	0.0048
fish net buoys, drift net	fish net buoys, drift net	416	0.861	44700	0	0	2.003

Based on the fairly crude extrapolations made, approximately three quarter of a million seabirds were present within the offshore study area as outlined in **Fig. 3.2**. Most abundant were Cory's Shearwater, European Storm-petrel, Leach's Storm-petrel, Northern Gannet, Pomarine Skua, Black Tern, and Common Tern. While some species may have been "at strength" as Northern Hemisphere winter residents, it is clear that several key players were still arriving (notably Northern Gannet, Great Skua, Lesser Black-backed Gull, and Sandwich Tern. It was interesting to note that Black Terns were still abundant, but that their foraging opportunities and targets had changed. Bonito-driven feeding frenzies were by no means as common as in September 2015.

5.1 Offshore key habitats

Sandwich Tern *Sterna sandvicensis*

In earlier surveys, the shelf-break was the area of most significance to seabirds and cetaceans alike (**Table 6.2** to give an example based on 2005 data, but see Camphuysen & Van der Meer 2005). This was not the case in November 2016! While many species (and the overall biodiversity) peaked in the northern part of the study area, where cool water reached the surface and where foraging opportunities (including fishing operations) were clearly most diverse and attractive, it was the Neritic zone where the largest numbers of seabirds were seen. For terns, all three zones were of significance, but with a bias towards the Oceanic zone for Black Terns and a bias to shallower waters for Common Terns.

On the map of overall *actively foraging* seabird densities, arguably the areas that matter most to marine birdlife (**Fig. 5.1**), a rather patchy distribution of important areas can be found. The northernmost area is a mix of mostly storm-petrels, shearwaters, gannets and phalaropes, apparently attracted by the cooler, nutrient rich waters of the more or less permanent upwelling in the northernmost area. Further south, the mostly deep water patches with high numbers of foraging seabirds are dominated by Black Terns and to a lesser extent Common Terns.

Table 5.2. Species diversity (*n*) and overall densities (*n* km^{-2}) for groups of seabirds and other visible aspects over the Neritic zone, the Shelf-break and in deep waters (Oceanic) in **September 2015**. Peak densities in **bold**.

	Species diversity (*n*)			**Overall densities** (*n* km^{-2})		
Group	Oceanic	Shelf-break	Neritic	Oceanic	Shelf-break	Neritic
storm-petrels	4	5	4	0.13	**1.75**	1.20
shearwaters	7	7	6	0.15	**0.19**	0.10
pelicans *(no gannets!)*			1			0.02
phalaropes	1	1	1	0.03	**0.69**	0.40
skuas	3	3	4	0.11	**0.72**	0.55
gulls	1	1	3	0.01	**0.09**	0.04
terns	4	5	7	**8.40**	3.42	2.89
cetaceans	10	9	6	1.78	**6.68**	0.04
turtles	1			0.01	0	0
sharks	2	2	1	0.01	0.01	0.01
various visible fish	3	2	1	**1.84**	0.43	0.73
fishnets	+	+	+	0	0.01	**0.39**

Table 5.3. Species diversity (*n*) and overall densities (*n* km^{-2}) for groups of seabirds and other visible aspects over the Neritic zone, the Shelf-break and in deep waters (Oceanic) in **November 2016**. Peak densities in **bold**.

	Species diversity (*n*)			**Overall densities** (*n* km^{-2})		
Group	Oceanic	Shelf-break	Neritic	Oceanic	Shelf-break	Neritic
storm-petrels	5	5	3	5.09	2.50	**9.66**
shearwaters	6	6	8	1.09	0.78	**3.66**
gannets	1	1	1	0.08	0.36	**4.57**
phalaropes	1	1	1	0.33	0.11	**1.43**
skuas	4	4	4	0.40	0.83	**3.07**
gulls	1	3	3	0.08	0.08	**0.16**
terns	4	3	5	**5.22**	3.67	2.72
cetaceans[incl. unid. groups]	13	9	4	2.47	**3.15**	0.01
turtles	4	3	1	**0.17**	0.03	0.00
sharks	1	2	1	0	**0.02**	0.00
rays	1	1		**0.05**	0.01	0
various visible fish	4	5	3	**3.34**	0.21	0.15
fishnets		1	1	0	0	**2.00**

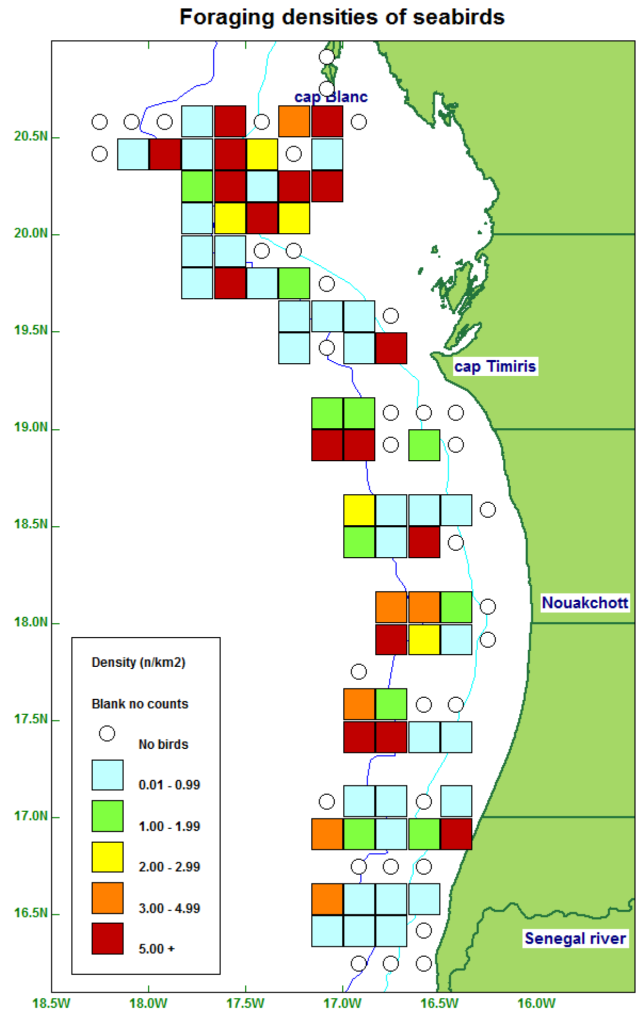


Fig. 5.1. Densities of foraging (actively searching and/or feeding) seabirds, all species combined (*n* km^{-2}), 1-12 Nov 2016.

5.2 Multi-species foraging associations (MSFAs)

Studies of communities typically focus on counting and identifying member species and then address their interactions and mechanisms for coexistence (Ballance *et al.* 1997, Ballance 2002). In contrast with many terrestrial species, almost nothing is known about this aspect of the ecology of cetaceans. There are regularly occurring species assemblages. For example, Pantropical Spotted and Spinner Dolphins in the eastern tropical Pacific are frequently found in mixed-species schools in association with yellowfin tuna *Thunnus albacares* accompanied by large and speciose flocks of seabirds. There are variations in typical co-occurrence patterns elsewhere in the world (Harrison *et al.* 1991, Camphuysen *et al.* 1995, Clua & Grosvalet 2001, Vaughn *et al.* 2007, O'Donoghue *et al.* 2010, Vaughn *et al.* 2011), but the nature of the interactions between species in these assemblages, why they associate, and the reasons for variations in community membership patterns are almost completely unknown (Ballance 2002). Coexisting species, particularly those that are closely related or have similar ecological roles, potentially compete for resources. Ecological theory states that stable communities of coexisting species must differ in resource utilization in some way: prey species or size specialization, differential habitat use, or diel pattern. To understand community structure, the mechanism by which species partition resources are of principal interest. This is an area that remains almost completely unexplored for cetaceans and the communities in which they are found (Balance 2002).

Table 5.4. Numbers of birds observed, number seen feeding or foraging (*n,* %) and the fraction of those foraging or feeding within a MSFA (*n,* %). Al Awam surveys, 1-12 November 2016.

		Observed	Foraging	%	in MSFA	%
880	Scopoli's Shearwater	42		0		
885	Scopoli's/Corys shearwater	567	170	30	95	56
890	Cory's Shearwater	5049	873	17	99	11
900	Cape Verde Shearwater	580	56	10	1	2
1560	Great Shearwater	9				
1570	Sooty Shearwater	84	1	1	1	
1680	Manx Shearwater	5				
1690	Balearic Shearwater	2				
1880	European Storm Petrel	2858	2056	72	29	1
1920	Wilson's Storm-petrel	475	312	66	24	8
1930	Band-rumped Storm Petrel	2	1	50		0
1970	Leach's Storm Petrel	1329	657	49	18	3
2070	White-faced Storm-petrel	3	3			0
2280	Northern Gannet	4024	649	16	217	33
7230	Osprey	2				
7260	Kestrel	2	1			
8880	Red Phalarope	516	288	56		0
9020	Long-tailed Jaeger	397	122	31	4	3
9040	Parasitic Jaeger	19	5	26		0
9050	Pomarine Skua	3520	653	19	50	8
9060	Great Skua	16	1	6		0
9250	Audouin's Gull	4				
9490	Lesser Black-backed Gull	232	24	10		0
9830	Sabine's Gull	204	84	41	18	21
9980	Black-legged Kittiwake	1				
10120	Black Tern	3118	2697	86	46	2
10310	Bridled Tern	3	3			0
10380	Caspian Tern	1	1			0
10440	Common Tern	2604	1691	65	262	15
10480	Royal Tern	6				
10520	Sandwich Tern	165	26	16	2	8

In Mauritanian waters, MSFA drivers potentially facilitating aerial (skuas), plunge diving (gannets and terns) and pursuit plunging (shearwaters) seabirds are various species of Oceanic dolphins (*Stenella* spp., *Delphinus delphis*) and fish, notably tuna Scombridae, that drive small prey fish and possibly zooplankton towards the surface and within reach of seabirds (Camphuysen & Webb 1999). This mechanism of facilitation and resource sharing is characteristic for numerous tropical seabird and cetacean communities (Ballance *et al.* 1997, Clua & Grosvalet 2001). A study in the Azores showed that the encircling of prey initiated by common dolphins, often mixed with spotted dolphins *Stenella frontalis*, resulted in the formation of a bait ball of several thousands of prey fish close to the surface (Clua & Grosvalet 2001). Seabirds were always present throughout the few minutes during which the entire collective food hunt took place. North Sea MSFAs were similarly short-lived and the roles of each of the seabird species of seabirds in the speciose flocks could be documented and turned out to be particularly consistent (Camphuysen & Webb 1999). Knowing that short-lived MSFAs are an important foraging mechanism for tropical seabirds, the observation team was on a constant lookout for indications that MSFAs would be formed, had been formed, or were just disintegrated during a passage. All behavioural characteristics of MSFA participants were computer coded and can thus be easily quantified.

During our surveys in 2016, MSFAs were not the more prominent feature as we would have expected from other studies within the tropics or based on our own findings within these waters. Most notably is the disinterest expressed by most seabirds towards pods of dolphins travelling or even herding prey. In comparison with the 2015 September surveys, even the tuna-driven frenzies offshore were much less prominent as a phenomenon, even though frenzies did occur. The highest biodiversity (multi-species attention) was found around fishing vessels, but there, different taxa utilised highly different resources, ranging from fish oil slicks to discarded fish or relying on kleptoparasitism (notably skuas and gulls).

5.3 Sensitivity to oil pollution

Atwood Oceanics' ultra-deepwater drillship Atwood Achiever

Environmental perturbations such as oil spills occurring within the main foraging areas of the seabirds and marine mammals that depend on Mauritanian waters have the potential to negatively impact seabird populations within and outside NW Africa. To understand why certain oil spills have been more devastating than others in terms of their effect on marine wildlife, it is important to consider that different species and different geographical areas vary in terms of their sensitivity to oil (Camphuysen 2007b). The sensitivity of seabirds depends largely on behavioural characteristics and species-specific differences in the exposure to oil pollution. The sensitivity of sea areas depends mainly on the numbers and behaviour (e.g., feeding, roosting, passage) of sensitive seabird species occurring there in combination with the likely persistence of hydrocarbons in the marine environment. The sensitivity of seabirds has been examined by ranking multiple factors affecting their survival and to translate these values into so-called Oil Vulnerability Indices (OVIs). The first publication to systematically address this issue for seabirds was that by King & Sanger (1979), but others have followed. Anon. (2002) compared the various oil vulnerability indices and significant relationships between OVIs calculated for the same species in different parts of the world were found. Factors leading to a higher sensitivity for oil spills include (see Camphuysen 1989):

- lifestyle (largely aerial is low risk, commonly roosting or sleeping at sea is high risk)
- marine orientation (from low in the coastal zone, via intertidal to high for open sea)
- foraging behaviour (dipping or aerial is low risk, diving is high risk)
- flocking behaviour (widespread is low risk, highly concentrated is high risk)
- proportion of biogeographical population at risk (low is low risk, large is high risk)
- population size (if small a higher risk, if large a lower risk)
- reproductive potential (larger clutches leads to lower, single egg clutches to higher OVIs)
- seasonal exposure (low if strictly seasonal, high if year-round)
- other unnatural causes of death

A dedicated OVI assignment for species wintering and breeding in Mauritania could now be undertaken, while using the species lists provided by the offshore surveys in combination with more regional (near-shore) information on seabirds and coastal species. These OVIs could be used to recalculate observed offshore seabird densities and transfer the data into oil/gas-pollution-sensitivity charts.

In conclusion

High numbers of seabirds and marine mammals were encountered, but the wintering population was clearly in a build-up stage and some Antarctic birds were still in the area. Contrary to earlier surveys were the most important foraging areas not concentrated at the shelf-break, but rather in shallower (and often cooler) waters or further offshore. Based on foraging distribution, the advice that could be given to safeguard particular areas at the expense of others (for example during a hydrocarbon blow-out or a spill) would be less clear-cut than in earlier surveys, but the rich area just to the south of Cap Blanc would deserve special attention (~19°45'N-20°45'N, 17°45-16°45'W). MSFAs and marine mammal driven feeding frenzies were much less important than in other surveys, while commercial fisheries were widespread and attractive to many birds. With the completion of this survey, in combination with earlier surveys, a fairly comprehensive overview of the species composition, age-ratio, the abundance and distribution of seabirds and marine mammals can be provided for the entire autumn and winter. Additional data need be collected in late spring (e.g. May-Jun, when survey data are old or according to faulty protocols) and mid-summer (Jul-Aug) to complete the annual cycle for the first time.

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