Ship-based seabird and marine mammal surveys off Mauritania, Nov-Dec 2012

cruise report

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Adult light phase Pomarine Skua (CJC)

With contributions from Sandra Kloff & Ahmedou Ould Mohamed El Moustapha

Expedition on board the R/V “Al Awam” of the Mauritanian Institute for oceanographic research and fisheries - IMROP

The research presented in this cruise report on pelagic biodiversity of the shelf break was carried out in the framework of the Programme “Biodiversity Gaz et Pétrole, an initiative of the Mauritanian Ministry of Environment and Sustainable Development and sponsored by the United Nations Development Programme (UNDP), the German Agency for International Cooperation (GIZ), the World Conservation Union (IUCN) and WWF.

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Summary

The Mauritanian shelf-break area is targeted since the 1980s by an extensive industrial fleet of mostly foreign origin and since 2006 also by international oil and gas companies. Recent research on benthos has proven that this area hosts fragile ecosystems such as deep sea coral reefs. Rare oceanographic data and a handful of seabird and pelagic mega fauna assessments also indicate the occurrence of pelagic biodiversity hotspots at rather distinct zones along the shelf break. These concentrations of biodiversity and biomass are permanent in the north, around Cap Blanc, and seasonal further south.

In a context of dwindling fishery resources and intensified exploitation, the Mauritanian authorities are seeking to acquire a better understanding about the ecological vulnerability of their sea and that of the shelf break in particular. A series of ongoing research programmes should provide the government with sufficient data to make informed decisions about how to orchestra and manage different sea uses in better harmony with the protection of biodiversity, a prerequisite for sustainable development.

This scientific survey on pelagic biodiversity was conducted on board the IMROP research vessel *Al Awam* during November/December 2012. Avifauna and cetaceans were mapped by navigating a zigzag pattern along the shelf break. 36 species of seabirds, 11 cetaceans, two sea turtle species and one seal species were recorded. Of the seabirds, 26 species were Palaearctic (arctic regions, NW Europe and the Mediterranean), three were from Southern Hemisphere, and seven were from Macaronesia, Mauritania included. The total number of birds in the studied area was estimated at almost one million including 30% of the world population of Northern Gannets. Furthermore, significant numbers of the world populations of Grey Phalaropes, Cory's Shearwaters, Pomarine Skuas, and Band-rumped Petrels were recorded. A distinct north-south pattern in species abundance was detected. Habitat partitioning based on subtle differences in distribution patterns relative to the sea surface were observed. Floating sea grass and flotsam concentrated at fronts and these were of particular importance for phalaropes.

Cetaceans were composed of 4 baleen species (Blue, Fin, Bryde's and Humpback Whale), two toothed whales (Sperm Whale and unidentified beaked whales), and five species of dolphins (Common, Atlantic Spotted, Risso's and Bottlenosed Dolphins, Harbour Porpoise). While cetaceans were observed throughout the survey, an important hotspot was found at the deeper parts of the shelf break off Cap Tafarit coinciding with the underwater canyon "Timiris".

These results reconfirm the importance of the shelf break for marine biodiversity and notably as a wintering area for West Palaearctic and arctic seabirds as well as for migrating and resident cetaceans. The snapshot estimation of almost one million seabirds belonging to at least six species would therefore meet the criteria for "Important Bird Area" status of Birdlife and should also suffice for recognition as an "Ecologically or Biologically Significant Area", a special status for sensitive sea areas currently under development in the frame of the Convention on Biological Diversity.

The spectacular numbers of seabirds flocking around the shelf break in winter must be the result of large and predictable resources at many trophic levels. Our survey was carried out prior to the opening of the industrial fishing sector off Mauritania creating a unique opportunity to investigate the *natural* distribution of fish-eating seabirds. Massive feeding frenzies of Northern Gannets were observed south west of Cap Blanc, independent of any human fisheries. Their behaviour indicated high feeding success thanks to the presence of predatory dolphins and tuna fish chasing fish shoals towards the surface waters within reach of the seabirds.

Concerning recent developments with oil exploitation within this region, an assessment of the regional sensitivity to oil pollution following internationally accepted protocols is urgently required. Additional surveys are necessary to update and add data that describe patterns in seabird migration, abundance, age and composition in regional monthly sensitivity charts. Such an atlas would allow the Mauritanian state and companies to contain an oil spill more effectively and thereby reducing environmental impacts. Such data would also add value to Environmental Impact Assessments for seismic surveys and to the development of ecosystem based management plans for big and small pelagic fisheries.

Résumé

La zone du talus mauritanien est fréquenté, depuis les années 1980 par une vaste flottille de pêche industrielle (étrangère dans sa majorité) et depuis 2006 par des compagnies pétrolières. Des recherches récentes sur le benthos ont démontrées que cette zone abrite des écosystèmes vulnérables tels que les récifs coralliens d'eau profonde. De rares données océanographiques et une poignée de campagnes scientifiques sur les oiseaux de mer et la mégafaune pélagique indiquent que le talus abrite également des « hotspots » de biodiversité pélagique à des endroits bien précis. Ces concentrations de biodiversité et biomasse sont permanentes dans le nord, aux alentours du Cap Blanc et saisonnière plus au Sud.

Dans un contexte de diminution des stocks de ressources halieutiques d'une part et l'exploitation intensifiée d'autre part, les autorités mauritaniennes sont en quête d'une meilleure compréhension de la vulnérabilité écologique de leur zone maritime. Une série de programmes de recherches en cours devrait fournir au gouvernement des données suffisantes afin de leur permettre de prendre des décisions éclairées sur la meilleure façon d'orchestrer et de gérer ses usages économiques en harmonie avec la protection de la biodiversité, une condition préalable pour le développent durable.

C'est dans ce cadre qu'une étude scientifique sur la biodiversité pélagique a été réalisée à bord du navire de recherche de l'IMROP « Al Awam » durant la période novembre/décembre 2012. L'avifaune et les cétacés ont été cartographiés selon un trajet parcourant en zigzag le long du talus. 36 espèces d'oiseaux marins, 11 espèces de cétacés, ainsi que deux espèces de tortues de mer et une espèce de phoques ont été recensées. Parmi les oiseaux de mer, 26 espèces étaient Paléarctiques (région arctique, Nord West d'Europe et la Méditerranée) trois provenaient de l'Hémisphère Sud et sept de la région Macaronésie, dont la Mauritanie. Le nombre d'oiseaux a été estimé à environ un million avec des Fous de Bassan formant environ 30% des individus et 86 % de la biomasse aviaire. Les résultats de l'étude indiquent que près d'un tiers de cette population mondiale était présente dans les eaux mauritaniennes.

En outre, un nombre important de populations mondiales de Phalaropes à bec large, Puffins Cendres, les Labbes Pomarins et les Océanites de Castro a été enregistré. Un gradient marqué dans l'abondance et composition des espèces a été détecté en allant du nord vers le sud. Une répartition de niche entre les espèces basée sur des petites différences observées à la surface de l'eau. Des feuilles arrachées des herbiers marins de la zone côtière et d'autres matières flottantes à la surface au niveau des fronts étaient d'une importance particulière pour les phalaropes.

Les cétacés étaient composés de 4 espèces de mysticètes (la Baleine Bleu, le Rorqual Commun et la Baleine a Bosse), deux odontocètes (le grand Cachalot et des Ziphiides non identifiés) en plus de cinq espèces de dauphins (dauphin commun, le dauphin tacheté de l'Atlantique, les Tursiops, les dauphins de Risso et le Marsouin commun). Alors que les cétacés ont été observés tout au long de l'étude, un hotspot important a été observé dans les parties les plus profondes du talus au large du Cap Tafarit.

Ces résultats confirment l'importance du talus pour la biodiversité marine et notamment comme une zone d'hivernage pour les oiseaux marins de l'Ouest Paléarctique et arctiques ainsi que pour les cétacés migrateurs et sédentaires. L'estimation de presque 1 million d'oiseaux marins au niveau du talus appartenant à au moins 6 espèces suffiront donc à répondre aux critères d'identification du statut Birdlife "Zone Importante pour les Oiseaux" et devrait également suffire pour être reconnue comme ""aire marine d'importance écologique et biologique", un statut spécial en cours de développement dans le cadre de la Convention sur la Diversité Biologique.

Le nombre impressionnant d'oiseaux marins qui affluent autour du talus durant l'hiver est sans doute le résultat de ressources importantes et prévisibles sur plusieurs niveaux trophiques. Notre étude a été réalisée avant l'ouverture du secteur de la pèche industrielle au large de la Mauritanie créant ainsi une occasion unique d'étudier la répartition naturelle des oiseaux marins piscivores. Des frénésies alimentaires importantes des Fous de Bassan ont été observées au sud-ouest du Cap Blanc, indépendant de toute activité de pêche humaine. Leur comportement a démontré un grand taux de réussite de capture (high feeding success) grâce à la présence des

dauphins prédateurs et des thons poussant les bancs de poissons vers les eaux de surface dans le champs de vision des oiseaux marins.

Quant au récent développement pétrolier dans cette région, une évaluation suivant des protocoles internationaux reconnus de la vulnérabilité régionale vis-à-vis de la pollution par les hydrocarbures, s'impose d'urgence. Des études supplémentaires sont nécessaires pour permettre une mise à jour des données décrivant la migration des oiseaux de mer, l'abondance, l'âge, préférences habitat etc. Ces données sont à incorporer dans un atlas de vulnérabilité avec des cartes mensuelles qui permettraient aux compagnies et à l'Etat de riposter plus efficacement en cas de marée noire et de réduire ainsi les impacts environnementaux. Ces données ajouteraient également de la valeur aux Evaluations d'Impact Environnemental des études sismiques et à l'élaboration de plans de gestion écosystémique pour la pêche aux petits et grands pélagiques.

Cory's Shearwater in flat calm conditions (CJC)

Introduction

Coastal upwelling along eastern boundaries has fascinated oceanographers for decades (Chavez & Messié 2009). The coupling between atmospheric forcing, ocean circulation, biogeochemical cycling, and food web dynamics encouraged oceanographers, ecologists and fisheries biologists alike to conduct multidisciplinary scientific studies. Chavez & Messié (2009) followed an interdisciplinary approach is taken to highlight differences between the four major Eastern Boundary Upwelling Ecosystems (EBUE's), of which the Canary Current Upwelling Ecosystem is an example. Mauritanian waters, as part of the Canary EBUE, are well known for their rich fishing grounds. While these waters span almost 400 km offshore (Mauritanian EEZ), the bulk of the fishery biomass is caught along the shelf break. This relatively narrow stretch of sea, measuring 50 to 250 km wide, is situated in-between the continental shelf (0 to 100 meters) and the abyssal plain (1500 meters and beyond). It starts at about 70 to 150 km from the coast on the 100 meter depth contour and is formed by a steep drop off with a slope of 2,5 to 6° (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 this input of nutriments from the deep, provides perfect conditions for localized blooms of plankton – the foundation of extremely productive food webs.

The productive shelf seas are targeted since the 1960 with increased intensity by industrial fisheries. The local artisanal fleet is composed of relatively small vessels (pirogues) and occupy the shallower coastal waters of the continental shelf. While some pirogues also brave the deep waters of the shelf break, the area is mainly fished by large industrial trawlers from Europe and Asia. Pelagic and bottom trawlers with state of the art equipment on board capture large quantities of fish in one single trawl and target fishery resources at depths of 1000 meters and beyond.

Numerous studies have focused on population dynamics of the target fish species with the aim to regulate this highly effective fishing sector via a quota system. Even though commercial species are part of, and depend on, complicated food webs, non commercial species have gotten much less attention in research programmes. Dwindling fishery resources as well as the recent development of oil and gas have triggered a societal debate in Mauritania and amongst the international community, about the need to put in place: (a) a sound policy to limit collateral damage of the fishing industry (e.g. by-catch, habitat modification); and (b) an environmental policy for hydrocarbon development. As both hydrocarbon development and industrial fishing concentrate along the shelf break, more information about the ecological importance and functioning of this area is urgently required (Mauritanian Ministry of environment. Document du Programme Biodiversité Gaz et Pétrole 2012).

During these past years interesting discoveries about the marine ecology of the shelf break have been made: carbonate mud mounds were unveiled by an oil company, bivalves associated to “cold seep” ecosystems were caught as bycatch by bottom trawlers and the benthos community in marine canyon systems, on seamounts and mud slides has been partially mapped by several different research institutions (von Cosel, 2002; Karstel et al, 2004; Colman et al., 2005; Eisele et al, 2011; Ramos et al. in prep.).

The most spectacular findings of these recent discoveries were the Banda and Timiris carbonate mud mounds measuring 100 meters high and 400 km long. These biogenic structures were constructed by deep-sea corals during a succession of three distinct growth periods in the last glacial (Eisele *et al.* 2011). Today, life corals are growing on the summits of these mounds again and a thriving coral community has also been found in the deep trenches of canyon systems where they live alongside other fragile long living life forms such as giant oysters of 500 years old (Krastel *et al.* 2004, Westphal *et al.* 2007, Anon. 2010).

Distinct areas of rich biodiversity also exists in the water column. While the surface waters of the entire shelf break are very productive and rich in biodiversity, it is well established that the waters off the Cap Blanc form a special area. Upwelling occurs year-round, and “giant filaments” of relatively high phytoplankton concentrations develop and persist throughout the year with a seaward extension measuring several hundreds of

kilometers long (Lange et al, 1998; Meunier et al., 2012). High primary production has created ideal conditions for the formation of a pelagic biodiversity hotspot composed of dense fish schools, high seabird concentrations and other marine life including one of the last viable populations of the critically endangered species the Mediterranean Monk seal (Pinela et al. 2010).

Zones of enhanced productivity can also be detected further south along the area where upwelling is more seasonal (Oct-Jun). The location and drivers behind these temporary zones of intense upwelling are not well known. Seamounts, mud mounds, canyons and other underwater structures probably play a role. Oceanographic research in Mauritania has indeed shown that the Timiris canyon system facilitates upwelling and is creating localized blooms of plankton (Schulz et al., 1989).

Seabirds and cetaceans have proven to be good indicator species to map pelagic biodiversity hotspots. The avifauna off Western Africa is normally 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). In earlier studies, many seabirds were associated with the large trawlers around the shelf-break, but the exact importance of these fishing activities for seabirds is still unclear.

This research project aimed at mapping avifauna and cetaceans along the shelf break was carried out during a unique period of extremely low fishing activity of the industrial fleet. This allowed the researchers to describe the distribution and feeding ecology of wintering seabirds, marine mammals and other mega fauna in Mauritanian waters in an almost natural context. Other hydrographical patterns (e.g. sea surface temperature, upwelling, salinity, depth) were measured in order to relate these to avifauna and cetacean distribution.

This report presents the key results obtained during the ship-based seabird and marine mammal surveys conducted between 27 November and 8 December 2012 and must be seen as a preliminary analysis of the data. A formal publication will be submitted to a leading journal later in 2013. In this cruise report, following a short introduction of the methods and protocols used and a description of the methods chosen to analyse, map, present and illustrate the data, there are species accounts and short ecological interpretations of the collected material.

This research project was financed via the Programme “Biodiversity Gas and Oil” (BGO) which is spearheaded by the Mauritanian Ministry of environment and which is financially supported by the GIZ and UNDP/GEF. It was carried out by IMROP in co-operation with Dutch researchers (CJC, TMvS, HV). The project contributes to the aim of the Programme BGO to gain a better idea of the sensitivity of the area for oil pollution and of the ecological vulnerability of the area to oil and gas development in general.

Sandra Kloff

Observer effort

The ship *Al Awam* surveyed part of the Mauritanian Continental shelf and slope (shelf break) towards and from deeper oceanic waters between 27 November and 8 December 2012. Transects were designed to cross the slope preferably at a 90° angle and followed a zigzag pattern with 2-3 shelf-slope crosses each day (surveying from dawn to dusk; **Fig. 1**). Data were collected in 5-minute periods and for each period, the geographical position was recorded as well as the ship's speed, weather conditions, sea state, 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). Observations near Nouadhibou (off Cap Blanc), while sailing to or from pre-planned transect locations, are summarised under "A". The other transects were labelled B-G, labelling from north to south, to facilitate a grouped analysis of the data where needed (**Fig. 1**, **Table 1**).

Table 1. Observer effort per day (number of 5 minute counts, hours of observation, minimum and maximum latitude and longitude surveyed, area surveyed (km²), distance travelled (km), and overall speed during surveys (knots). The data can be summarised per leg (A-G) as in **Figure 1.**

Dd	Mm	Yy	Leg	Counts (n)	Hours (h)	MinLat °N	MaxLat °N	MinLong °W	MaxLong °W	Area (km²)	Dist (km)	Spd (kn)
28	11	2012	**A**	55	4.6	20.27	20.89	-17.19	-17.01	20.7	69.2	8.1
30	11	2012	**A**	36	3.0	20.34	20.61	-17.17	-17.06	10.2	33.8	6.1
3	12	2012	**A**	48	4.0	20.53	20.89	-17.34	-17.01	18.7	62.3	8.4
27	11	2012	**B**	138	11.5	20.34	20.50	-18.29	-17.34	53.7	179.1	8.4
3	12	2012	**B**	20	1.7	20.50	20.52	-17.60	-17.35	8.2	27.4	8.9
8	12	2012	**C**	133	11.1	19.87	20.20	-17.75	-17.25	49.6	165.4	8.1
4	12	2012	**D**	132	11.0	19.37	19.63	-17.25	-16.78	47.8	159.3	7.8
7	12	2012	**E**	98	8.2	18.88	19.00	-17.00	-16.50	35.8	119.4	7.9
5	12	2012	**F**	132	11.0	18.37	18.62	-16.83	-16.33	48.3	161.0	7.9
6	12	2012	**G**	129	10.8	17.87	18.13	-16.75	-16.33	47.5	158.5	8.0
				921	76.8					340.6	1135.3	8.0 ± 0.7 kn

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. 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 kriging techniques[1], 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 a 300m strip-transect to one side and ahead of the ship (with snap-shot for flying birds; Tasker *et al.* 1984, Camphuysen *et al.* 2004). The surveys included full behavioural observations using international procedures (Camphuysen & Garthe 2004). Of the 54 sub-sampled rectangles, mean coverage amounted to 6.3 ± 3.3 km² (*i.e.* 17.1 ± 9.2 5-minute counts or 1.8 ± 1.0% of the total surface area). Poor coverage was in three rectangles (light blue in **Fig. 2**; 1-2 5-minute counts in each, 0.4-0.9 km² surveyed, 0.1-0.2% of the entire rectangle surface area). In order to obtain estimates of total numbers within the studied area (that is within all sufficiently surveyed rectangles), a

[1] Geostatistical techniques to interpolate the value if a random field as a function of the geographical location at an unobserved location from observations of its value at nearby locations

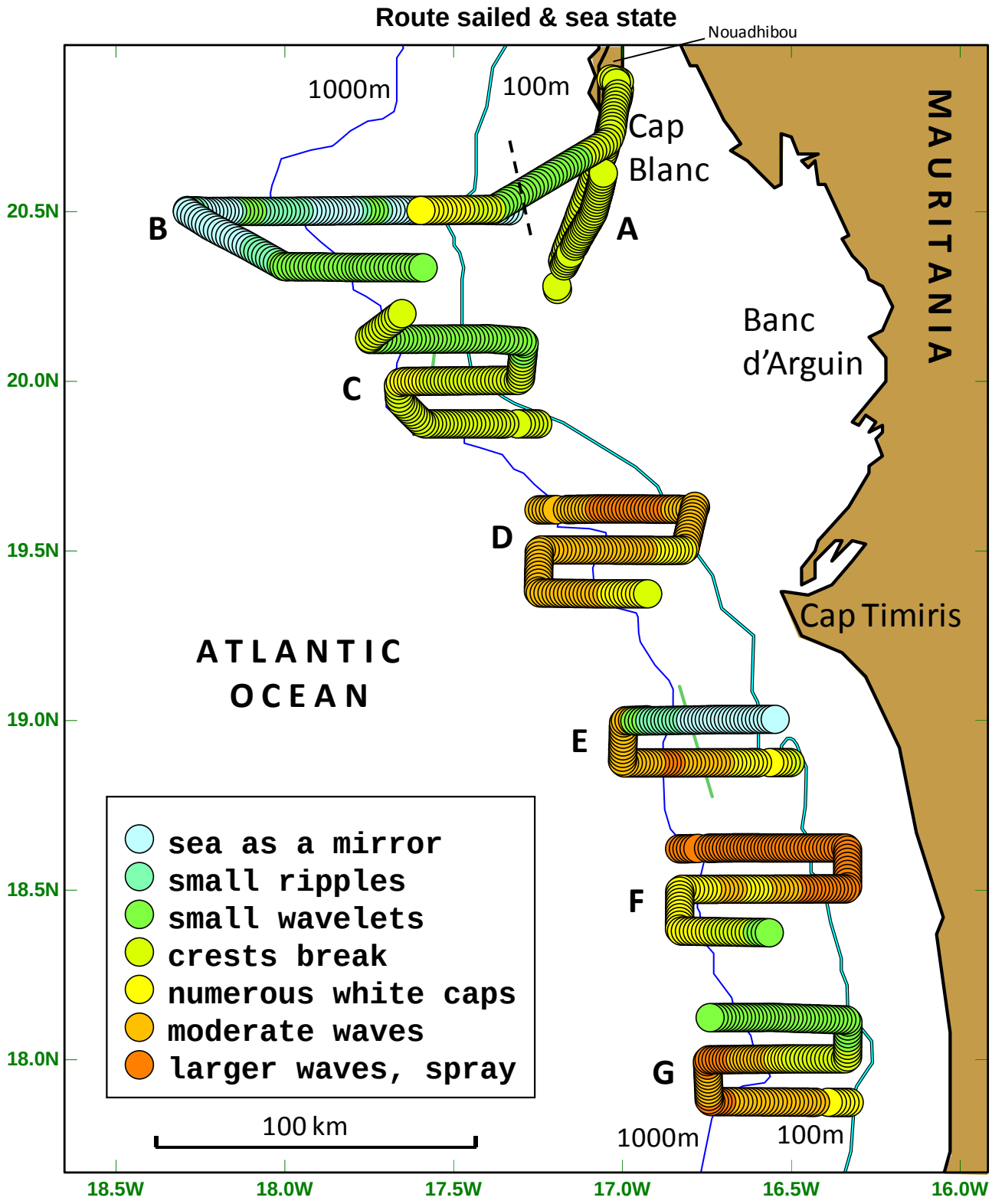


Fig. 1. Observer effort per day (plots of 5-minute counts, with colours indicating sea state (legend) during the survey). The shelf slope (100-1000m depth contours) is indicated. The data can be summarised per leg (A-G).

mean density ± SD was calculated over the numbers of birds per km² found in each of 51 rectangles. An extrapolated number was calculated by using the overall mean density found for all 86 10x10' rectangles covering similar areas around the shelf slope, as indicated in **Fig. 3** (unsurveyed blocks and poorly surveyed blocks included). As an example: an overall density of 2.2 ± 6.7 Cory's Shearwaters per km² calculated over 51 properly surveyed 10x10' rectangles would lead to an estimate of *c.* 38,500 individuals for studied blocks (green to red in **Fig. 1**) and an estimate of 65,000 individuals for all 86 rectangles drawn in **Fig. 2**. Slightly more complicated, small birds such as storm-petrels and phalaropes were easily missed and a species-specific correction factor was calculated based on assessments of densities (large flocks excluded) within 4 distance bands away from the ship (see Species Accounts). As a result, an uncorrected estimate for European Storm-petrels would arrive at 149,000 individuals within the studied rectangles (based on 8.5 ± 38.4 birds per km²; an estimate of 250,000 individuals for all 86 rectangles), but 166,000 individuals after corrections for animals missed in areas with small flocks and lower densities (280,000 individuals for the total of 86 rectangles).

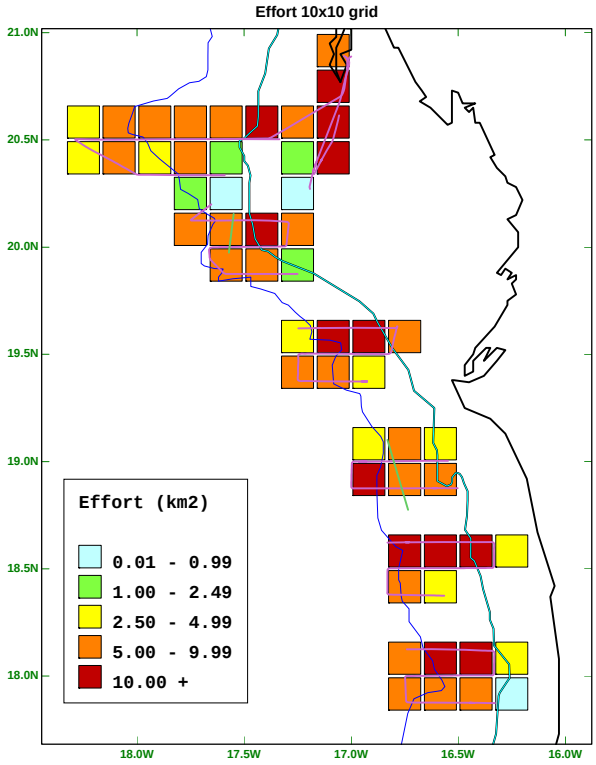


Fig. 2 Observer effort as km² surveyed per 10x10' grid (54 sub-sampled rectangles in total)

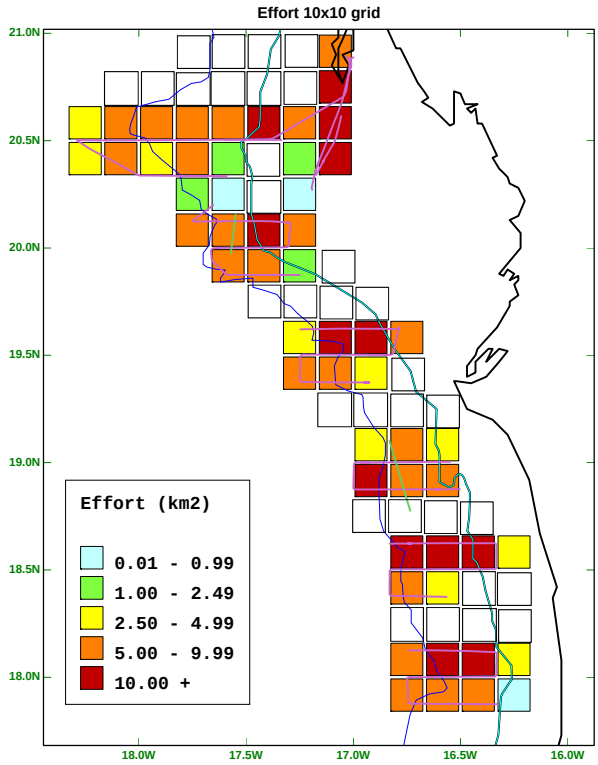


Fig. 3 Area used for extrapolation: 86 10x10' rectangles and the positioning of unsurveyed rectangles relative to the 54 surveyed grid cells.

Oceanographic characteristics

Sea surface temperatures (SST) and sea surface salinities (SSS) were measured onboard the ship at 15 min intervals during surveys between 3 and 9 December 2012. Measured sea surface temperature values (ranging from 16.4 – 21.2°C) are plotted in **Fig. 4**, sea surface salinities (ranging from 35.8-38.5‰) in **Fig. 5**. Seabird counts were at 5-minute intervals and missing values between the recorded temperatures and salinities were interpolated assuming linear trends. In order to relate seabird densities with surface water properties, all strip transect counts with SST and SSS values were used to calculate overall densities relative to these values, irrespective of the exact area where this was measured. Total observer effort with sea surface temperature and salinity values amounted to Leg A 10.9, B 8.3, C 35.0, D 25.5, E 26.4, F 39.6, and leg G 40.1 km². In line graphs in the species accounts, the observer effort (km²) is shown in blue, seabird densities (n per km²) in red. As

expected, higher SSTs were found westward of the 100m depth contour, and cooler waters were found over the shelf (**Fig. 4**). Salinity values varied more or less in concert, with higher salinities further offshore and lower SSS over the shelf, but the spatial trends were less consistent (**Fig. 5**).

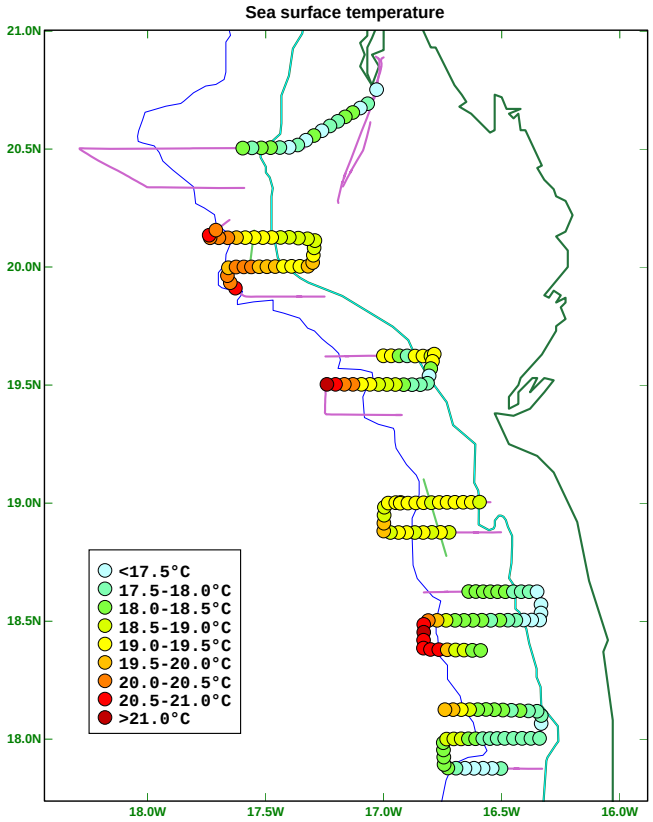


Fig. 4. Sea surface temperatures (°C) based on measurements every 15 minutes during surveys 3-8 December 2012

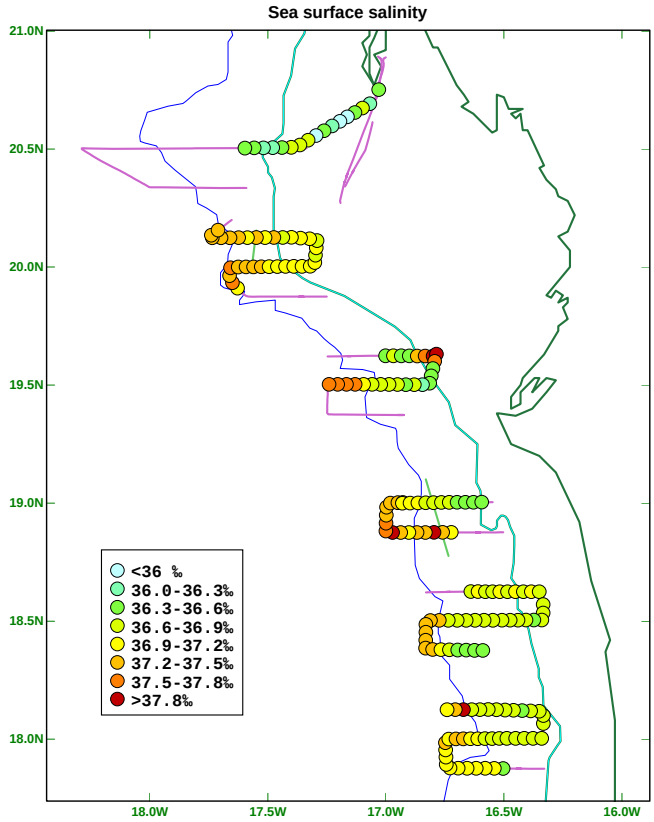


Fig. 5. Sea surface salinities (‰) based on measurements every 15 minutes during surveys 3-8 December 2012

Bathymetry and bio-acoustic information

Water depth (m) was measured every 5 minutes. The collected information was plotted on a map with 100m and 1000m isolines deduced from a sea chart in **Fig. 6**. Indices of fish abundance (quantity of fish, shoaling structures) and the (vertical) distribution of fish were monitored and post-processing with a Simrad EK 60 echo sounder operated with two transducer frequencies (38 kHz and 120 kHz) split beam, calibrated earlier in 2011. The sounding transect was carried out between 3 and 8 December 2012. All biomass abundance estimates were based on data from the 38 kHz transducer. The Bergen Integrator (BI) was used for analysis and allocation of integrated s_A-values (Nautical area scattering coefficient (NASC)) by 1 nautical mile intervals. Certainly these estimates should not be used to calculate or estimate quantities of fish or plankton in different water layers. They were used as general indices of biomass abundance and were be correlated with observations of seabirds and marine mammals. The acoustic system was operated, tuned, and interpreted by Ahmedou Ould Mohamed El Moustapha (IMROP). An overview of interpretations of the collected data (Sa), showing where acoustic data have been collected during our surveys, is provided in **Fig. 7**.

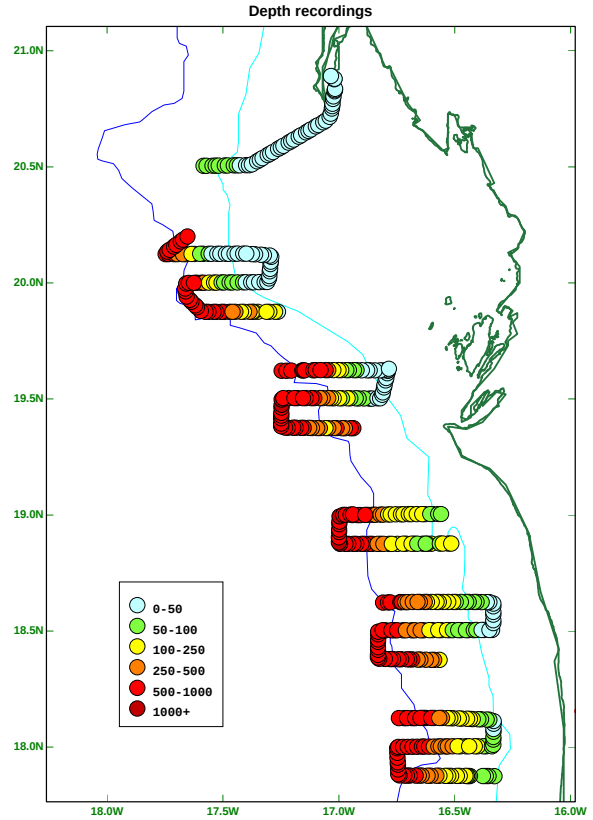


Fig. 6. Water depth (m) in 5-minute intervals based on measurements during surveys 3-8 December 2012

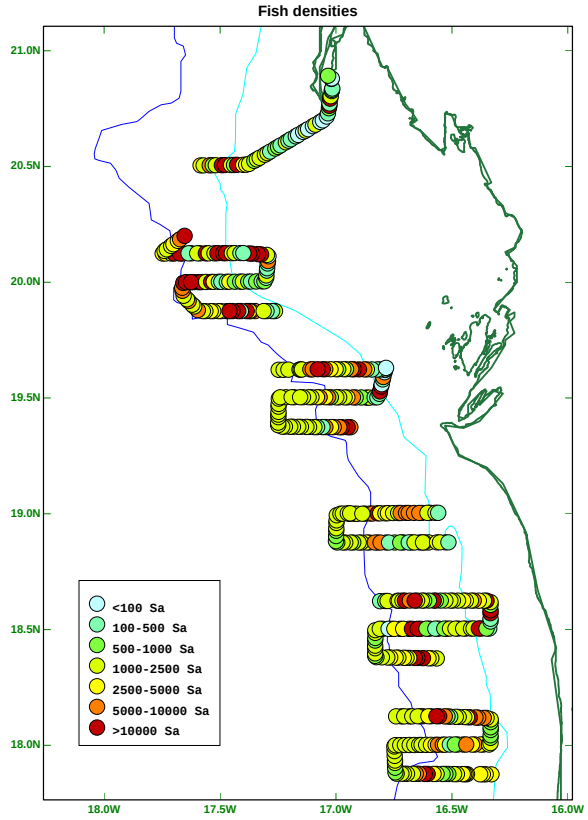


Fig. 7. Strength of the acoustic signal (Sa) in 5-minute intervals based on continuous recordings during surveys 3-8 December 2012

Observers on the top deck of Al Awam

Table 2. Seabirds, marine mammals, other megafauna and fisheries buoys observed during systematic surveys off Mauritania, 27 Nov-6 December 2012. The observations are organised per leg (**Fig. 1**) and include birds associated with the vessel.

Leg			**A**	**B**	**C**	**D**	**E**	**F**	**G**
Distance travelled (km)			165	206	165	159	119	161	158
Scopoli's Shearwater	Puffin cendré (Mediterannée)	*Calonectris diomedea*		2		2	1	3	
Scopoli's/Corys shearwater	Puffin cendré	*Calonectris* spec		8	810	5	1	36	79
Cory's Shearwater	Puffin cendré (Atlantique)	*Calonectris borealis*		340	525	92	66	116	898
Cape Verde Shearwater	Puffin du Cap-Vert	*Calonectris edwardsii*				4		4	
Great Shearwater	Puffin majeur	*Puffinus gravis*		81	1	2			1
Sooty Shearwater	Puffin fuligineux	*Puffinus griseus*		22	2	1	1		10
Manx Shearwater	Puffin des Anglais	*Puffinus puffinus*			1		1		1
European Storm-petrel	Océanite tempete	*Hydrobates pelagicus*	757	3170	107	9	149	58	29
unidentified storm-petrel	Océanite	*Oceanodroma/Hydrobates/Oceanitus*		9		3	1	1	
Wilson's Storm-petrel	Océanite de Wilson	*Oceanites oceanicus*		1					
Band-rumped Storm-petrel	Océanite de Castro	*Oceanodroma castro*	1	450	10	19	19	35	3
Leach's Storm-petrel	Océanite culblanc	*Oceanodroma leucorhoa*		24	3	2	7	9	
Eastern White Pelican	Pélican blanc	*Pelecanus onocrotalus*	6						
Northern Gannet	Fou de Bassan	*Morus bassanus*	1249	2002	14405	6244	2491	895	737
West-African Cormorant	Cormoran à poitrine blanche	*Phalacrocorax carbo lucidus*	1						
Grey Phalarope	Phalarope à bec large	*Phalaropus fulicarius*		105	791	198	1324	218	13
Long-tailed Skua	Labbe à longue queue	*Stercorarius longicaudus*				2	1		
Arctic Skua	Labbe parasite	*Stercorarius parasiticus*	6	1	3	3	8	10	3
Pomarine Skua	Labbe pomarin	*Stercorarius pomarinus*	55	104	170	197	1015	331	262
Great Skua	Grande Labbe	*Stercorarius skua*	31	12	36	16	80	16	11
Audouin's Gull	Goéland d'Audouin	*Larus audouinii*	4			1	3	2	1
Yellow-legged Gull	Goéland leucophée	*Larus michahellis*				4	1		1
Lesser Black-backed Gull	Goéland brun	*Larus fuscus*	363	64	1	480	255	32	111
Slender-billed Gull	Goéland railleur	*Larus genei*	1						
Mediterranean Gull	Mouette mélanocéphale	*Larus melanocephalus*	3						
Little Gull	Mouette pygmée	*Larus minutus*					2	1	
Black-headed Gull	Mouette rieuse	*Larus ridibundus*	10			1			
Sabine's Gull	Mouette de Sabine	*Larus sabini*		4		3		1	12
Black-legged Kittiwake	Mouette tridactyle	*Rissa tridactyla*		3	3	1	1	1	
Whiskered Tern	Guifette moustac	*Chlidonias hybridus*				2			
Black Tern	Guifette noire	*Chlidonias niger*		2			33	3	28
Common / Arctic tern	Sterne pierregarin/arctique	*S. hirundo / S. paradisaea*	1	1				31	
Caspian Tern	Sterne caspienne	*Sterna caspia*	19	1		1			
Roseate Tern	Sterne de Dougall	*Sterna dougallii*					2		
Common Tern	Sterne pierregarin	*Sterna hirundo*	157	52	180	126	143	68	130
Mauretanian Royal Tern	Sterne royale	*Sterna maxima albidorsalis*				151		2	2
Arctic Tern	Sterne arctique	*Sterna paradisaea*		1		1			
Sandwich Tern	Sterne caugek	*Sterna sandvicensis*	80	10	92	189	3	5	20
whale	baleine	whale			2		2	2	
Blue / Fin / Sei Whale	rorqual grande	large *Balaenoptera* spec.					1		2
Sei / Brydes Whale	rorqual petite	small *Balaenoptera* spec.					1		2
Bryde's Whale	Rorqual Tropical	*Balaenoptera edeni*					3		1
Blue Whale	Baleine Bleue	*Balaenoptera musculus*				1			1
Fin Whale	Rorqual commun	*Balaenoptera physalus*		2	2				
Humpback Whale	Baleine a bosse	*Megaptera novaeangliae*			2		2		
Sperm Whale	Cachalot	*Physeter macrocephalus*			18				
beaked whale	baleine a bec	*Mesoplodon* spec.		3					
Common Dolphin	Dauphin commun	*Delphinus delphis*			890	20			
Risso's Dolphin	Dauphin de Risso	*Grampus griseus*			11				9
Harbour Porpoise	Marsouin commun	*Phocoena phocoena*	3						
Atlantic Spotted Dolphin	Dauphin tacheté Atlantique	*Stenella frontalis*		21	70		45		2
unidentified Stenella's	Stenella dauphin esp	*Stenella* spec					150		
Bottlenose Dolphin	Grand dauphin	*Tursiops truncatus*		1	12	2			
unidentified dolphin	dauphin	unidentified dolphin		7	5	2			
Mediterranean Monk Seal	Phoques moines de Mauritanie	*Monachus monachus*	1						
sea turtle	Tortue	(unidentified) sea turtle		2					
Loggerhead Turtle	Tortue carette	*Caretta caretta*		4	3	1	1		
Hawksbill Turtle		*Eretmochelys imbricata*		1					
Smooth Hammerhead		*Sphyrna zygaena*			5				
unidentified shark	Requin	unidentified shark		2				2	
unidentified tuna					110				
Sailfish		*Istiophorus platypterus*		1					
Swordfish		*Xiphias gladius*		1					
fish net buoys, drift net		fish net buoys, drift net	301	1	81				

Species accounts - Birds

In this section, the observed species are reviewed and documented where needed. Each species, or each group of species, is indicated by a header indicating the number of recorded individuals during transect surveys (*i.e.* "on effort"), but regardless of the actual presence within a pre-defined strip transect width of 300m ahead and to one side of the ship (cf. Tasker *et al.* 1984). Species distribution maps are prepared for commoner taxa and these may include all records (plots) or densities (number of birds within transect expressed as birds km^{-2}).

Cape Verde Shearwater **Puffin du Cap-Vert** *Calonectris edwardsii* (8 records)

The Cape Verde Shearwater is endemic for the Cape Verde islands (Hazevoet 1997). Six sightings during the Nov-Dec surveys on board Al Awam:

4 Dec 2012 (1) 19°37.20'N, 17°14.2'W (ship-associated)
4 Dec 2012 (1) 19°37.20'N, 17°12.3'W (ship-associated)
4 Dec 2012 (2) 19°37.20'N, 17°05.4'W
5 Dec 2012 (1) 18°24.00'N, 16°49.9'W
5 Dec 2012 (1) 18°37.20'N, 16°47.3'W
5 Dec 2012 (2) 18°37.20'N, 16°47.3'W

Further Cape Verde Shearwaters may have been overlooked in frenzies of Scopoli's/Cory's Shearwaters seen during these surveys and for a more careful assessment of the abundance and distribution of this species, dedicated time would be required.

Scopoli's/Corys shearwater **Puffin cendré** *Calonectris spp.* (939 records)
Scopoli's Shearwater **Puffin cendré Mediterannée** *Calonectris diomedea* (8 records)
Cory's Shearwater **Puffin cendré Atlantique** *Calonectris borealis* (2037 records)

Cory's Shearwater (HV)

A group of seabirds, until recently considered a polytypic species with several subspecies; currently usually regarded as three separate species (Bourne 1955, 1998, 1999, Camphuysen & Reid 1999, Gomez-Diaz & González-Solís 2007, Heidrich *et al.* 1998, Hillcoat *et al.* 1997, Randi *et al.* 1989). Identification in the field is not always straightforward and particularly during wing-moult, Scopoli's and Cory's Shearwaters may be difficult to separate (Gutiérrez 1998). Scopoli's Shearwaters breed mainly within the Mediterranean Sea, Cory's Shearwater on Atlantic islands including the Selvagens, Madeira, and the Azores (Macaronesian region). Although the Mauritanian shelf is within the foraging range of the birds actively breeding in Macaronesia (Ramírez *et al.* 2008), the birds observed in December (off-season) were all non-breeders and the majority was in active post-nuptial moult.

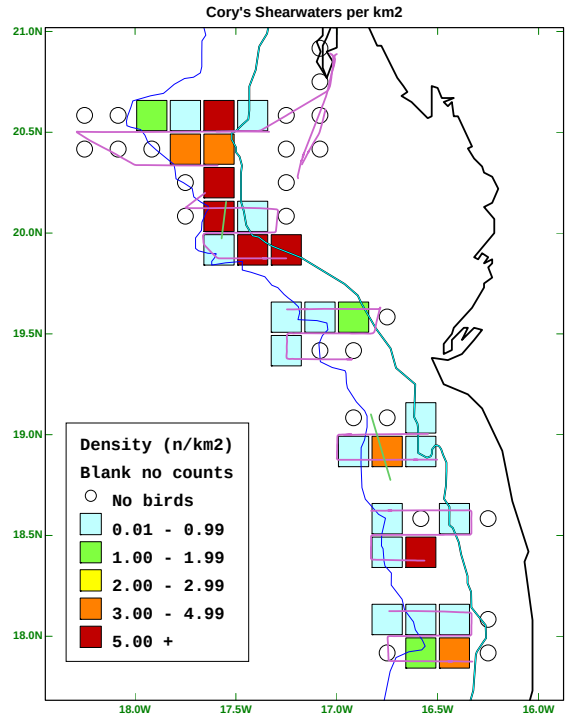


Fig. 8. Densities of Cory's or Scopoli's Shearwaters (n per km²), two taxa combined, Nov-Dec 2012.

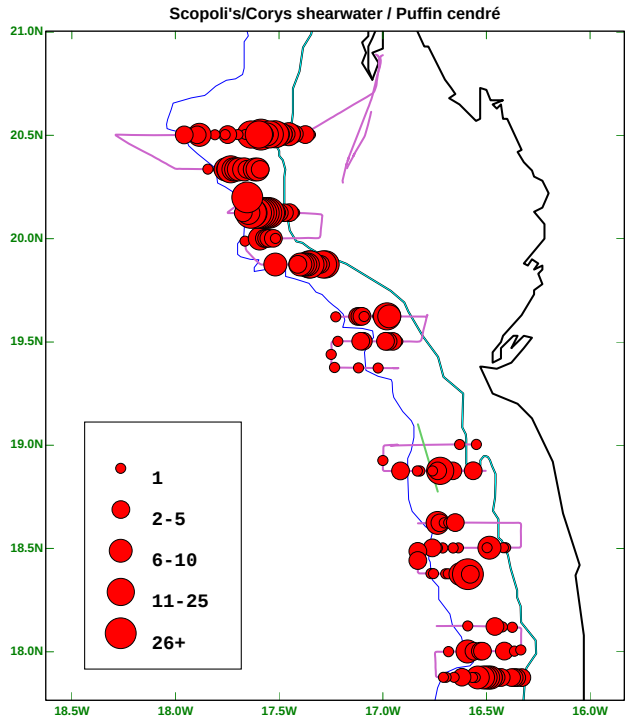


Fig. 9. All sightings of Cory's or Scopoli's Shearwaters (n), two taxa combined, Nov-Dec 2012.

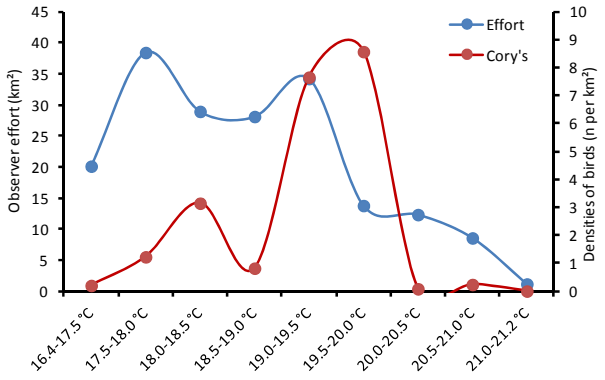


Fig. 10. Relative abundance (n km^{-2}) of Cory's Shearwaters in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

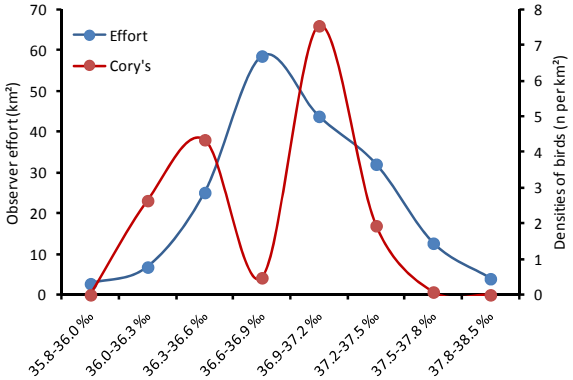


Fig. 11. Relative abundance (n km^{-2}) of Cory's Shearwaters in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

The observations in November and December 2012 indicated that the majority of the shearwaters of this complex in Mauritanian waters belonged to the Atlantic species, *C. borealis* (Cory's Shearwater). Sightings of either Cape Verde Shearwaters and Scopoli's Shearwaters were so infrequent, that all 2992 sightings were lumped for the present analysis (named "Cory's Shearwaters" below). Relatively high densities occurred in the shelf slope area to the SW of Cap Blanc (**Figs. 8-9**). Based on the strip-transect counts (only birds recorded within the 300m transect including the snapshot methods; **Fig. 8**), an estimate of total numbers present in all 51 properly studied 10'x10' rectangles would arrive at 38,000 individuals (2.2 ± 6.7 birds km^{-2}). For the entire area, all 86 rectangles in **Fig. 3**, an estimate of *c.* 65,000 individuals seems appropriate.

Cory's Shearwaters were particularly numerous within the frontal zone to the southwest of Cap Blanc. Both warm and saline pure oceanic waters and colder less saline shelf waters were more or less avoided by this species (**Figs. 10-11**), while the 'upper shelf' was seemingly preferred (**Fig. 12**). In all, 780 birds (36.8%, n= 2122) were recorded as "in flight", 141 (6.6%) were associated with cetaceans, 113 (5.3%) with visible fronts or

flotsam lines, 4 (0.2%) with fishing vessels and 24 individuals (1.1%) were participating in multi-species feeding frenzies. Birds in flight were recorded to move in all possible directions and this, plus the frequent observations of actively searching or foraging individuals underpins the importance of the Mauritanian shelf slope as a staging (wintering) area rather than as a area where passage migrants simply move through. Of 1062 Cory's Shearwaters not associated with the research vessel, 557 individuals (52.4%) were foraging (of which 4.3% shallow plunging, 50.4% pursuit plunging, 45.1% actively searching and 0.2% under attack of a kleptoparasite).

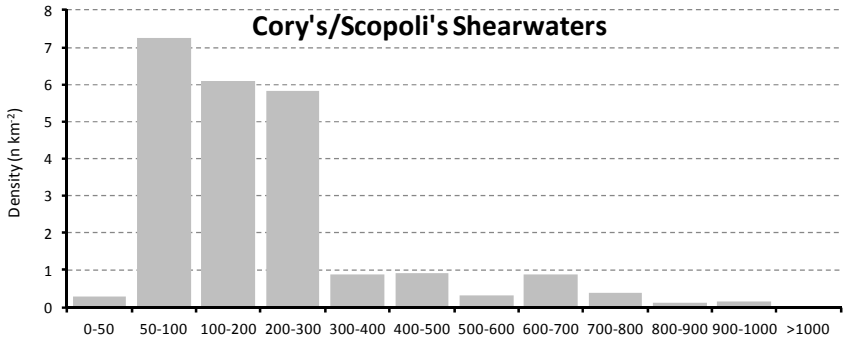
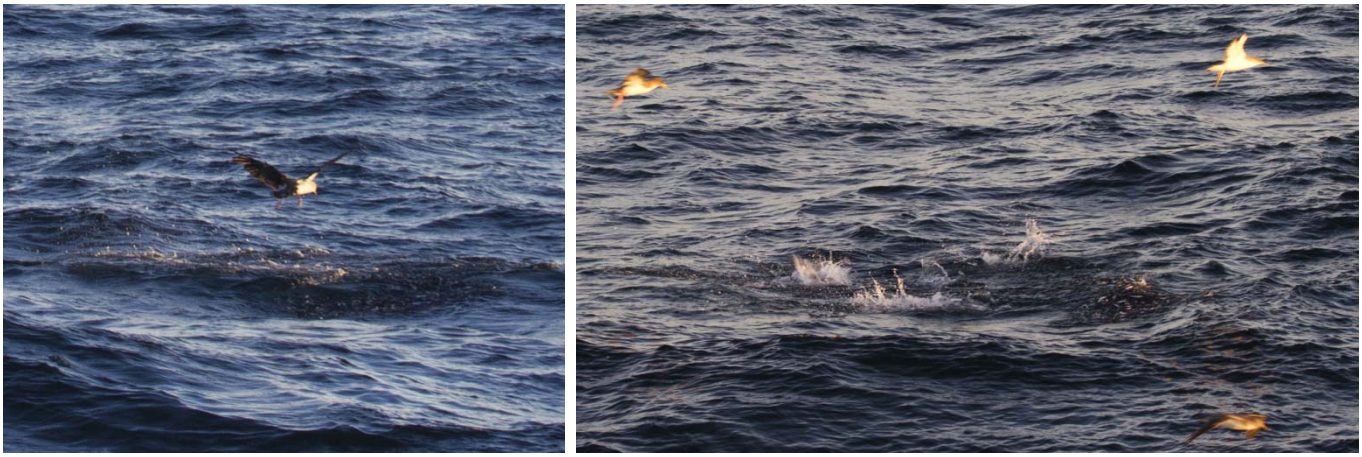


Fig. 12 Relative abundance (n km^{-2}) of Cory's, Scopoli's, and including Cape Verde Shearwaters (*Calonectris* spp) in areas of different water depth (m), 3-8 Dec 2012

Rafting Cory's Shearwaters associated with the research vessel, 6 Dec 2012 (CJC)

The research vessel itself was a considerable attraction to Cory's Shearwaters and 1060 (50%) of 2122 recorded individuals were logged as somehow associated (and by default not in transect. On 6 December 2012 (leg G), large flocks formed in association with the research vessel (gradually increasing from a dozen to 130, 220, and finally 400 individual birds). Accurate strip-transect censuses are hard to achieve on such days, because the birds tended to keep circling around the boat and assembled in large rafts on the track-line ahead of the ship (*photo*). The strong tendency to approach the research vessel, no matter how brief, will have influenced the strip-transect counts. Paradoxically, high numbers of ship-associated birds will have artificially lowered recorded densities at sea because relatively many birds are ignored by the observers because they are assumed to be ship-followers. In low density areas, recorded densities may be elevated, because distant shearwaters approach the ship that would otherwise have been "out of transect". This is a well known problem with oceanic seabirds that sometimes obtain food at vessels (even at non-fishing vessels) and it simply reduces the reliability of abundance estimates, no matter how hard the observers attempt to correct for this.

Cory's Shearwaters were recorded twice in multi-species foraging associations (flocks #250, and #360). The first group was encountered on 5 Dec 2012 (18°30'N, 16°29'W) and comprised deep plunging Northern



Cory's Shearwaters over fish ball during tuna attacks (HV); MSFA - flock #364

Cory's Shearwaters over fish ball during tuna attacks (HV) ; MSFA - flock #364

Northern Gannets, Pomarine Skuas, Common Terns and Cory's Shearwaters over fish ball during and after tuna attacks (HV) ; MSFA - flock #364

Surface driven fish ball during tuna attacks (HV) ; MSFA - flock #364, 8 December 2012 at 19°52'N, 17°21'W

Gannets (24 individuals), 6 shallow plunging Cory's Shearwaters and one Lesser Black-backed Gulls plus a searching Arctic Skua (potential kleptoparasites). The second feeding frenzy was triggered by at least several dozens of small tuna driving balls of small fish ("fish fry") towards the sea surface and this feeding frenzy was observed 8 December 2012 at 19°52'N, 17°21'W. This activated 18 shallow plunging Cory's Shearwaters, one Great Shearwater (*see below*) and 6 Common Terns, *c.* 425 actively searching Northern Gannets and 8 Pomarine Skuas. All birds were reluctant to enter the water when tuna were visible at the surface, and the Cory's Shearwaters were the more successful foragers on quiet moments.

Great Shearwater **Puffin majeur** *Puffinus gravis* (85 records)

Sooty Shearwater **Puffin fuligineux** *Puffinus griseus* (36 records)

Great Shearwaters (HV)

Great and Sooty Shearwaters are both migratory seabirds that breed in the South Atlantic Ocean (Tristan da Cunha complex, southern South America) that undertake a annual migration towards the Northern Hemisphere and back (Phillips 1963, Voous & Wattel 1963, Stresemann & Stresemann 1970, Cooper *et al.* 1991, Bourne 1995). During our surveys, adult breeding birds are expected to breed and the few observed birds were either non-breeders or juveniles from the previous breeding season. Wing moult has not been observed in Great Shearwaters during our survey, suggesting that a majority of the birds in November/December may have been juveniles. Wing moult has been observed in three out of 36 Sooty Shearwaters, suggesting that at least some older individuals were involved. Again, juveniles were likely prevailing.

Most sightings were on the northernmost legs (**Figs. 13-14**), where also Cory's Shearwaters occurred in highest densities. Some Sooty Shearwaters were encountered on the southernmost leg, when Cory's Shearwaters assembled around the ship in large numbers. Sooty Shearwaters were typically visiting shortly, if at all, and most moved on without interruptions.

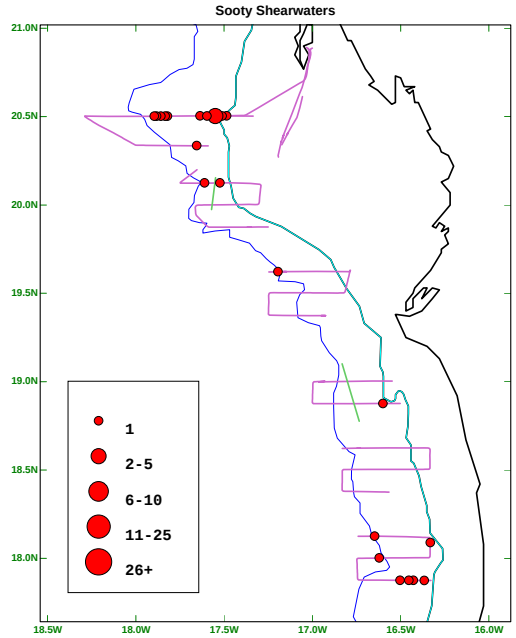


Fig. 13. All sightings of Sooty Shearwaters (n), Nov-Dec 2012.

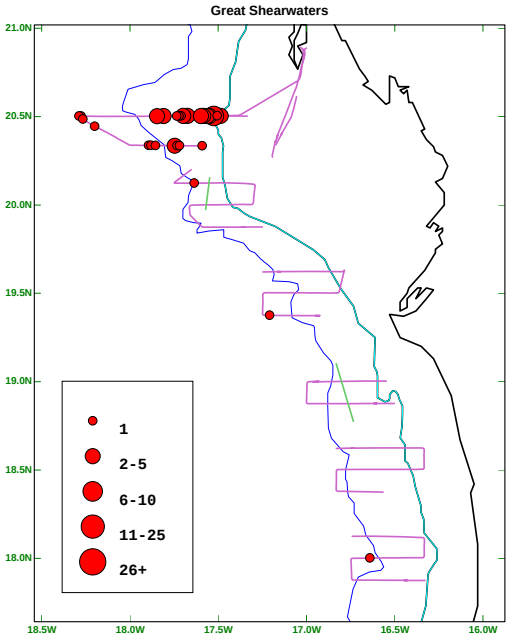


Fig. 14. All sightings of Great Shearwaters (n), Nov-Dec 2012.

One Great Shearwater, overlooked during the censuses onboard Al Awam, participated in a MSFA observed on 8 December 2012 that had developed over dense fish shoals driven towards the surface by several dozens of small tuna (see Species Account if Cory's Shearwater for further details.

Overlooked Great Shearwater (third bird from the left)with Northern Gannets and Cory's Shearwaters foraging at a surface driven fish ball after tuna attacks (HV) ; MSFA - flock #364, 8 December 2012 at 19°52'N, 17°21'W

Manx Shearwater **Puffin des Anglais** *Puffinus puffinus* (3 records)

Northern Hemisphere breeding birds, with large breeding populations in the UK and smaller numbers nesting in Iceland, France, and Macaronesia. Almost all winter off South America (Bergkamp 1995). In Mauritanian waters this species is probably a passage migrant, earlier in autumn. Three sightings of solitary individuals in pristine plumage (likely juveniles):

6 Dec 2012 (1) 17 ° 52.6 'N, 16 ° 40.8 'W
7 Dec 2012 (1) 19 ° 0.0 'N, 16 ° 54.5 'W
8 Dec 2012 (1) 20 ° 11.5 'N, 17 ° 39.8 'W

European Storm-petrel **Océanite tempete**
Hydrobates pelagicus (4279 records)

Part of dense European Storm-petrel concentration (CJC)

European Storm Petrels breed on remote islands throughout NW Europe, within the Mediterranean and locally in Macaronesia (Selvages). European Storm Petrels were abundant during our surveys and some particularly large concentrations were encountered on 27-28 November 2012 just to the southwest of Cap Blanc:

27 Nov 2012	20.50°N, 17.52°W	1,000 individuals
27 Nov 2012	20.50°N, 17.52°W	661 individuals*count corrected with photo
28 Nov 2012	20.49°N, 17.12°W	350 individuals
27 Nov 2012	20.50°N, 17.52°W	305 individuals*count corrected with photo
27 Nov 2012	20.50°N, 17.55°W	180 individuals
28 Nov 2012	20.51°N, 17.15°W	150 individuals

Just over 300 European Storm Petrels in one dense concentration, reflected in the water during flat calm conditions on 27 November 2012 (CJC)

Just as in the January surveys of 2000, European storm-petrels *Hydrobates pelagicus* peaked at the shelf edge and around upper the shelf break (**Figs 15-**19; Camphuysen & Van der Meer 2005), while the majority of the larger storm petrels (mostly *Oceanodroma castro* or *monteiroi*) were encountered further offshore over deeper waters (see below). An uncorrected estimate of the total numbers of birds within the studied 10'x10' rectangles arrived at 150,000 individuals (8.5 ± 38.4 individuals km^{-2}). The result is influenced by some of the very large groups mentioned earlier: hundreds to low thousands within the band transect, and the standard error of the abundance estimate is huge as a result. Low densities were to be corrected by a factor 1.77 for birds apparently missed in distance bands C (100-200m) and D (200-300m) based on densities within A (0-50) and B (50-100m from the ship). Correcting abundance estimates with this species-specific correction factor for low density rectangles (<30 birds km^{-2}) would result into an overall abundance estimate of some 166,000 European Storm Petrels within the studied area. For the entire area, 86 rectangles in all, after correction for missed individuals, an estimate of *c.* 280,000 individuals was found.

The distribution was patchy and numbers were highest in the northernmost areas (maps). Of the largest of flocks, behaviour was unclear. The observed birds away from the larger concentrations (205 individuals in all) were actively foraging (pattering and surface pecking) or searching for prey. Of these 65% were not associated with other birds or any obvious surface features, 8% were associated with a multi-species feeding frenzy, 22% with an oil slick (likely fish oil), 1% with a clearly visible oceanic front and 4% with cetaceans.

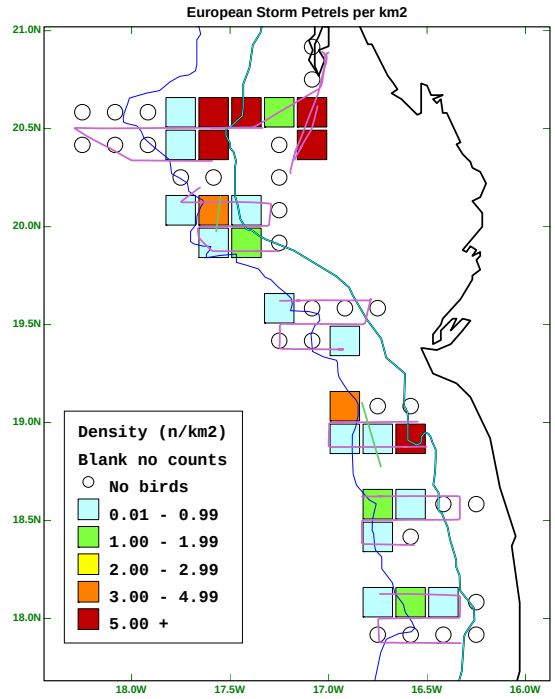


Fig. 15. Densities of European Storm-Petrels (n per km²), Nov-Dec 2012.

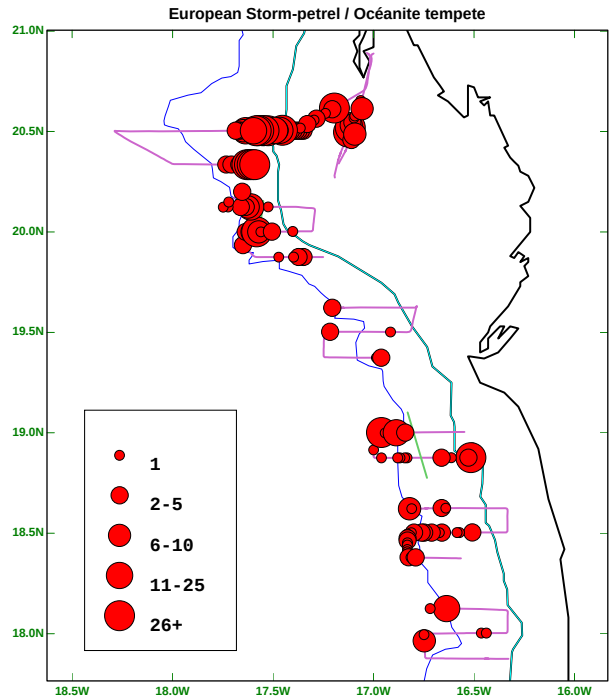


Fig. 16. All sightings of European Storm-Petrels (n), Nov-Dec 2012.

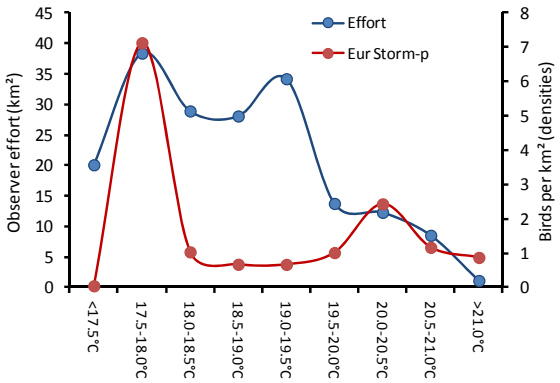


Fig. 17. Relative abundance (n km^{-2}) of European Storm-petrels in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

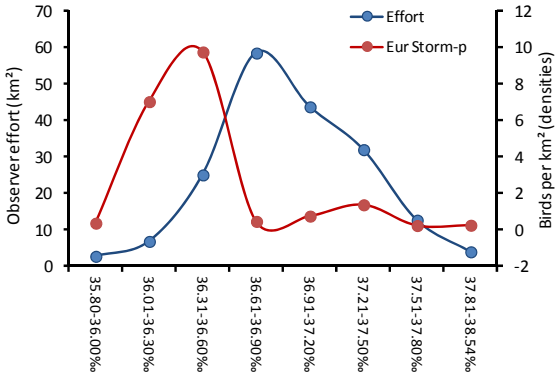


Fig. 18. Relative abundance (n km^{-2}) of European Storm-petrels in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

European Storm Petrels are thought to winter in strength off South Africa, as discovered by van Oordt and Kruijt (1953). Substantial northward passage offshore from West Africa has been observed in March and April (BWP*i* 2004). Numbers in the earlier January survey in 2000 (Camphuysen & Van der Meer 2005) were rather lower than the numbers encountered in the present survey. However, both results indicate that the Mauritanian shelf and shelf slope is an important wintering area for this species. Apparently only part of the petrels move on to South Africa. We have not found an association with free floating sea-grasses during this survey (according to our own sampling rich in potential storm petrel prey: tiny juvenile fish and zooplankton). Densities peaked at sea surface salinities (SSS) of 35-36 ‰ and at sea surface temperature (SST) of *c.* 18°C were much reduced in warm waters of higher salinity (*i.e.* further offshore).

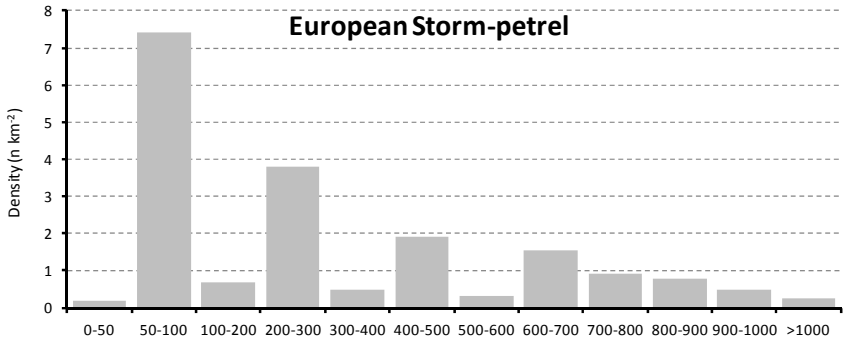


Fig. 19 Relative abundance (n km^{-2}) of European Storm-petrels in areas of different water depth (m), 3-8 Dec 2012

Wilson's Storm-petrel **Océanite de Wilson** *Oceanites oceanicus* (1 record)

A single record of a bird breeding on the Southern Hemisphere that is very abundant in the northern summer off Mauritania (Leopold 1993, Wynn & Krastel 2012)):

27 Nov 2012 (1) 20°20.1'N, 17°44.7'W

Band-rumped Storm-petrel **Océanite de Castro**
Oceanodroma castro (537 records)
Leach's Storm-petrel **Océanite culblanc**
Oceanodroma leucorhoa (45 records)

Band-rumped Storm-petrel (HV)

Band-rumped and Leach's Storm-petrels were not always easy to separate and 14 further but unidentified storm petrels were likely *Oceanodroma* petrels. The majority of the birds had clear characteristics of Band-rumped Storm-petrels *Oceanodroma castro.* Evidence indicates that there are at least three population lineages in the Western Palearctic which are best treated as species (Sangster *et al.* 2012).

- Cape Verde Storm Petrel *O. jabejabe* (monotypic; endemic to the Cape Verde Islands)
- Madeiran Storm Petrel *O. castro* (monotypic; hot-season breeders Madeira and Selvagens; provisionally also includes cool-season breeders in the Azores, Madeira, the Selvagens, and islands off Portugal)
- Monteiro's Storm Petrel *O. monteiroi* (monotypic; hot-season breeders in the Azores)

Birds breeding in the cool season in Madeira, the Selvagens, the Azores and islands off Portugal are sympatric with hot-season breeders in Madeira and the Selvagens, but differ from these in vocalizations (Robb *et al.* 2008) and morphology. However, DNA differences are less clear than those among Azorean populations (Friesen *et al.* 2007, Bolton *et al.* 2008). Although potentially a fourth species, this unnamed taxon is provisionally included in *O. castro* pending further study. Leach's Storm-petrels breed in the North Atlantic from NE USA and E Canada to Iceland, the Faeroe Islands North Scotland and NW Norway (Del Hoyo *et al.* 1992) and migrates south to winter in regions of tropical convergences (BWP*i* 2004).

Band-rumped Storm-petrels of the complex described above are considered inseparable at sea, even though the timing of moult and their different breeding strategies could provide some clues. Many individuals showed active primary moult and both observers noted independently that many individuals had remarkably deeply forked tails (at times reminding of Leach's Storm-petrels *O. leucorhoa;* confusion cannot always be excluded). Some suggested differences is structure and plumage aspect for the proposed 3-4 species in the *O. castro* complex include the longer and more deeply forked tail and short particularly thin bill in *O. monteiroi* (Bolton *et al.* 2008, Robb *et al.* 2008, Flood & Fisher 2011). Several of the photographed individuals showed exactly these features in at least some of the Band-rumped Storm-Petrels observed (see below), as well as advanced primary moult (primary moult in *O. monteiroi* is expected to take place between August and February; Flood & Fisher 2011).

Presumed Monteiro's Storm-petrels (left and centre) and Leach's Storm Petrel (right). Note deeply forked tail in all three, relatively short white rump and thin bill in presumed Monteiro's Storm-petrels. (HV)

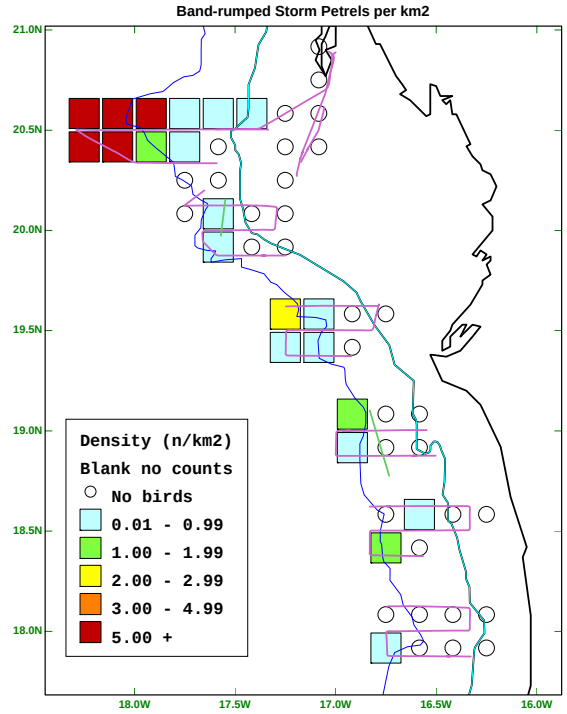


Fig. 20. Densities of Band-rumped Storm-petrels (n per km²), Nov-Dec 2012.

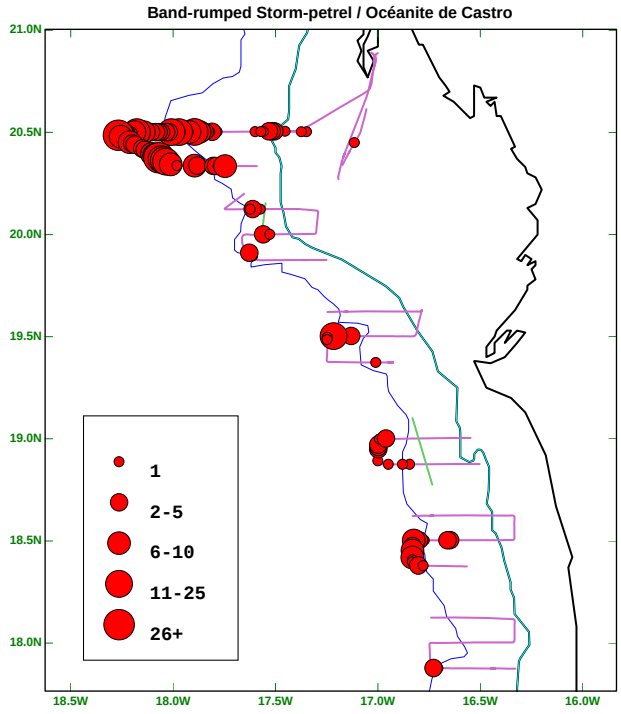


Fig. 21. All sightings of Band-rumped Storm-Petrels (n), Nov-Dec 2012.

Without jumping onto conclusions, and while the presence of at least some Monteiro's Storm-petrels is far from unlikely, the differences in structure, moult stage and plumage aspects added to the confusion at times when individual storm-petrels needed to be identified. All sightings of Band-rumped Storm-petrels have been lumped for the analysis below.

Band-rumped Petrels were characteristic species at the lower shelf and in true oceanic conditions (**Figs. 22-24**). An estimate of total numbers of Band-rumped Storm-petrels in the studied 10'x10' rectangles arrived at 22,000 (1.2 ± 3.5 km^{-2}). Densities had to be corrected by a factor 1.79 for birds apparently missed in distance bands C (100-200m) and D (200-300m) based on densities within A (0-50) and B (50-100m from the ship). Correcting resulted into an overall abundance estimate of *c.* 39,000 European Storm Petrels within the studied area. For the entire area, 86 rectangles in all, and including the correction for missed individuals, an estimate of *c.* 66,000 individuals was found. Leach's Storm-petrels were relatively rare and were encountered in the same (oceanic) areas as Band-rumped Storm-petrels .

In sharp contrast to the findings for European Storm Petrels did the densities of Band-rumped Petrels (and Leach's Storm-petrels) peak in areas with higher surface salinities (>37 ‰): deeper waters, mostly beyond the 1000m depth contour (**Figs. 22-24**). Densities peaked at SSTs of around 20°C; distinctly higher water temperatures than recorded for peak densities of European Storm Petrels. Sightings of Band-rumped Storm-petrels were rather rare in cooler waters of lower salinity (upper slope and shelf; **Fig. 24**). The habitat characteristics were slightly more extreme than Grey Phalaropes (see below), planktivorous waders that were found to occupy a mid-position between European Storm-petrels and Band-rumped Petrels in the area.

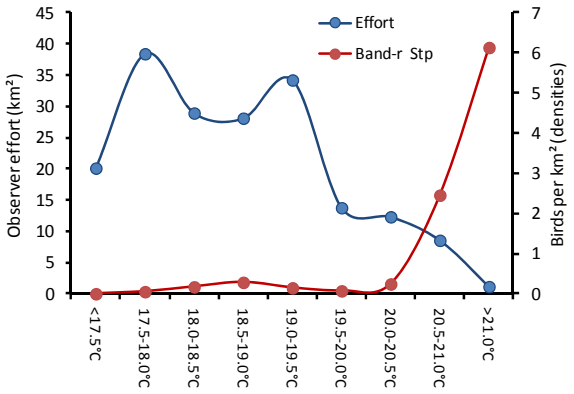


Fig. 22. Relative abundance (n km^{-2}) of Band-rumped Storm-petrels in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

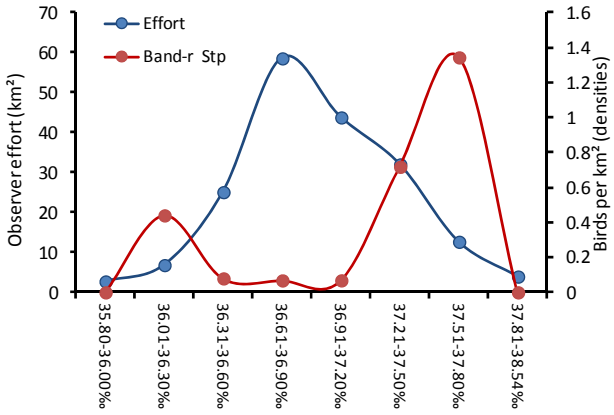


Fig. 23. Relative abundance (n km^{-2}) of Band-rumped Storm-petrels in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

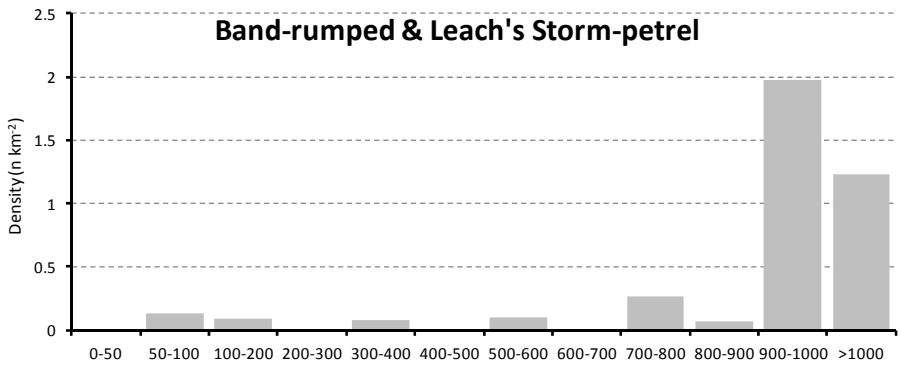


Fig. 24 Relative abundance (n km^{-2}) of Leach's and Band-rumped Storm-petrels (*Oceanodroma* spp) in areas of different water depth (m), 3-8 Dec 2012

Eastern White Pelican **Pélican blanc** *Pelecanus onocrotalus* (6 records)

Resident species. Four sightings of in total 6 pelicans, all near Cap Blanc and Nouadhibou (leg A):

28 Nov 2012 (1), 20°46.6'N, 17°1.8'W.
28 Nov 2012 (3), 20°49.8'N, 17°0.8'W.
3 Dec 2012 (1), 20°46.3'N, 17°1.6'W.
3 Dec 2012 (1), 20°48.2'N, 17°1.4'W.

West-African Cormorant **Cormoran à poitrine blanche** *Phalacrocorax carbo lucidus* (1 record)

West-African Cormorant iuvenile (HV)

Resident species. Common in Nouadhibou, but only a single sighting at sea during the surveys (leg A):

28 Nov 2012 (1), 20°49.8'N, 17°0.8'W.

Northern Gannet **Fou de Bassan** *Morus bassanus* (28023 records)

Northern Gannet with Cory's Shearwater (HV)

Northern Gannets breed in Europe and in Canada. Del Hoyo *et al.* (1992) estimated the global population of Northern Gannets to number 526,000 individuals. In Europe, however, the breeding population is estimated to number 300,000-310,000 breeding pairs, equating to 900,000-930,000 individuals (BirdLife International 2004). Europe forms 75-94% of the global range, so a revised estimate of the global population size is 950,000-1,200,000 individuals, although further validation of this estimate is needed (BirdLife International 2012). From our strip-transect surveys, an estimate of total numbers in studied 10'x10' rectangles arrived at 190,000 individuals (11.0 ± 21.5 km^{-2}). For the entire Mauritanian slope area, 86 rectangles, an estimate of *c.* 325,000 individuals or *c.* 30% of the world population seems appropriate. This estimate is well in accordance with an estimate based on the distribution of birds carrying geolocators (Kubetzki *et al.* 2009) and this would make this one of the most important wintering areas for this species in the North Atlantic.

Fragment of a spectacular, mono-species feeding frenzy of Northern Gannets, 8 December 2012 (CJC)

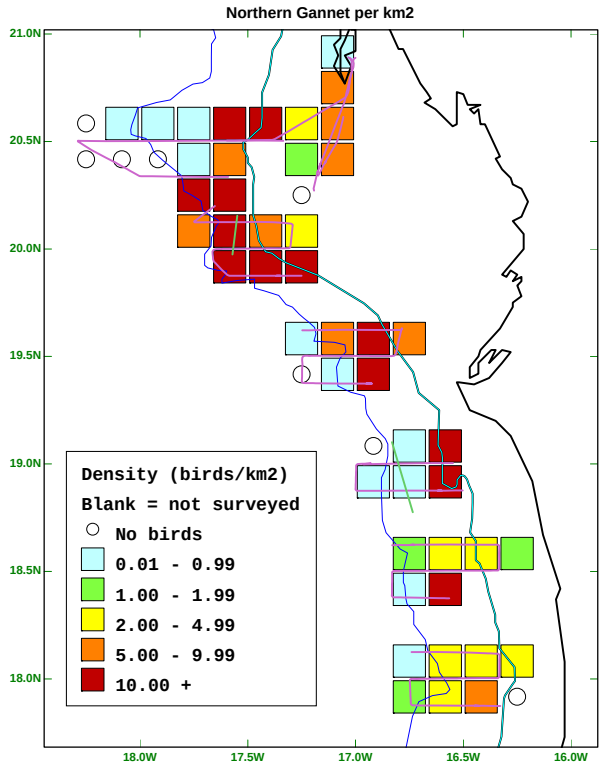


Fig. 25. Densities of Northern Gannets (n per km²), Nov-Dec 2012.

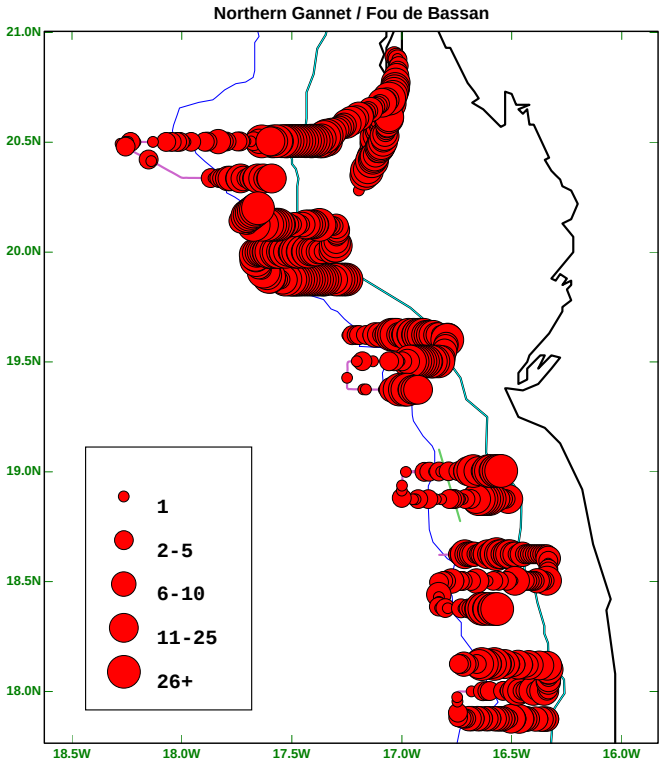


Fig. 26. All sightings of Northern Gannets (n), Nov-Dec 2012.

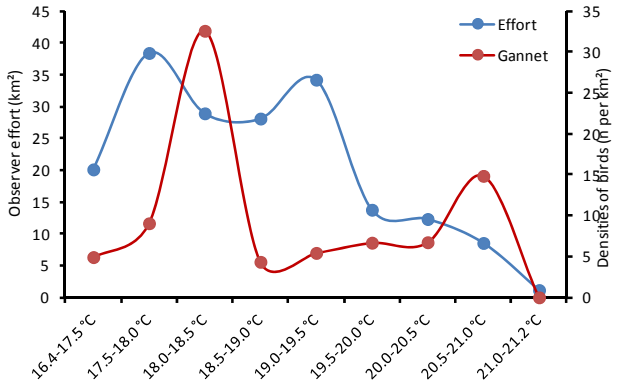


Fig. 27. Relative abundance (n km^{-2}) of Northern Gannets in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

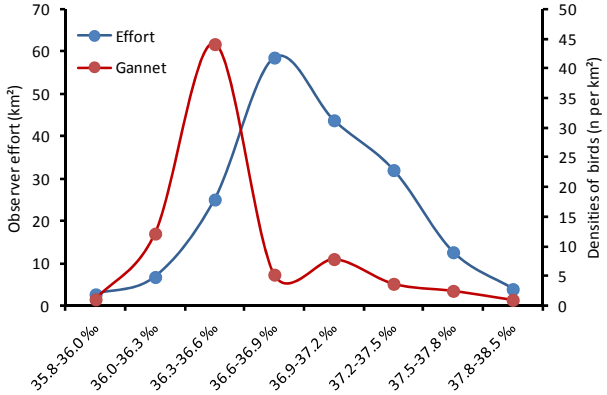


Fig. 28. Relative abundance (n km^{-2}) of Northern Gannets in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

Patchy distribution with local (often large) foraging concentrations. Higher densities on the upper slope, mostly in cooler waters of lower salinity. Particularly high densities on legs C and D (shelf break south of Cap Blanc, NW of Cap Timiris. Adults predominated in the northernmost legs (A-C, 70-80% adults), while around 50% of the birds in the 4 southernmost legs (D-G) were immatures or juveniles. A similar north → south trend in age composition was found in January 2000 (Camphuysen & Van der Meer 2005).

Around the frontal zones along the shelf slope, massive feeding frenzies of naturally foraging Northern Gannets (*i.e.* not associated with fishing fleets) have been seen. Particularly large flocks of up to several thousands of individuals were seen within a wide range around the ship on 6 December 2012, just before sunset, and most these gannets joined into long lines of birds moving north and north-east (to roost at sea or otherwise), following more or less the exact same track line as the surveying vessel. Around half (51%) of all recorded Northern Gannets were foraging or searching for prey when recorded. In all, only 6.2% of these (n= 14,318) were foraging in association with commercial fishing vessels. All others were seen under natural conditions. Very large fishing flocks, sometimes numbering several thousands of individuals, were seen foraging on fish shoals with no other seabirds (or dolphins) involved. A minority (2.7%; in all nearly 400 Northern Gannets) were associated with fast moving or herding dolphins (Common Dolphins *Delphinus delphis* and Atlantic Spotted Dolphins *Stenella frontalis*). Northern Gannets were associated with the tuna-driven fish balls described earlier (see Cory's Shearwater), but the birds were more reluctant to enter the feeding frenzy than shearwaters for as long as the tuna attacked the fish fry. Recorded associations of foraging or searching Northern Gannets included

Associated with cetaceans	379	individuals
Associated with (visible) front or foam line	69	individuals
Associated with oil slick	10	individuals
Associated with floating sea grass	37	individuals
Associated with observation base	808	individuals
Sitting on observation base	2	individuals
Associated with fishing vessel	1469	individuals
MSFA participant (natural feeding frenzies)	485	individuals

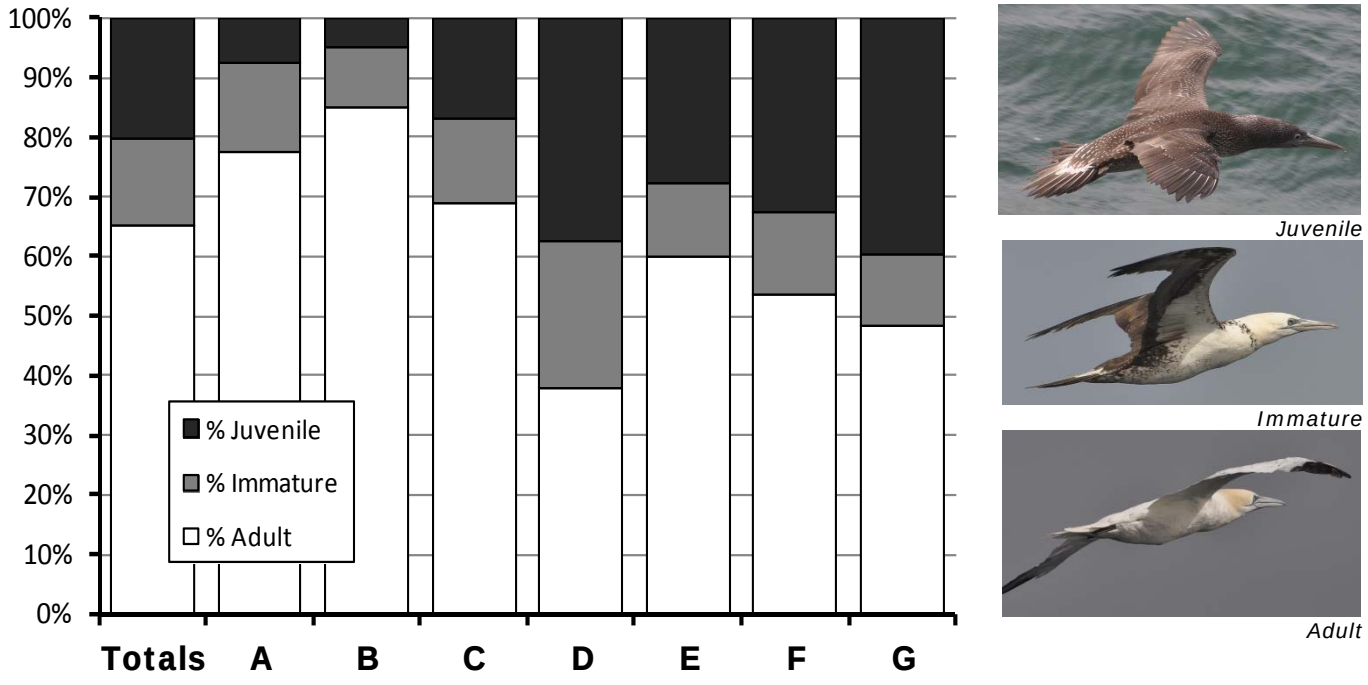


Fig. 29. Age composition of Northern Gannets in different legs of the surveys Nov-Dec 2012 (photo's CJC).

The observations have confirmed the status of the shelf break as a very important wintering foraging ground of Northern Gannets and, more importantly, thanks to the low number of fishing vessels operating in the area during our surveys, the study has confirmed that natural resources are accessible and apparently plentiful for these deep plunge diving seabirds even in the absence of fisheries.

In total, 1469 Northern Gannets were seen in association with fishing vessels. Substantial flocks near fishing vessels (34% actively foraging individuals and 30% searching birds near active trawlers plus 36% resting and/or preening individuals in a trawlers wake) were observed on 7 Dec 2012:

07 Dec 2012 18°52.6'N, 16°38.2'W (372 individuals).
07 Dec 2012 18°52.6'N, 16°37.5'W (37 individuals).
07 Dec 2012 18°52.6'N, 16°37.1'W (480 individuals).
07 Dec 2012 18°52.6'N, 16°37.1'W (40 individuals).
07 Dec 2012 18°52.6'N, 16°36.8'W (368 individuals).
07 Dec 2012 18°52.6'N, 16°36.0'W (99 individuals).

Fragment of a spectacular feeding frenzy of Northern Gannets, 8 December 2012 (CJC)

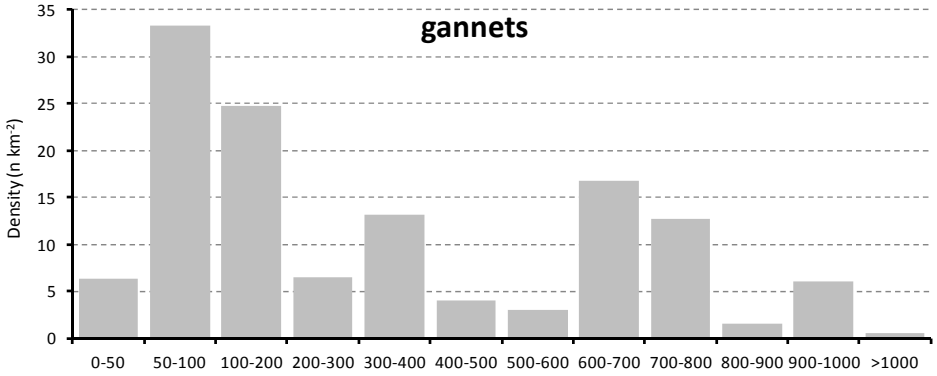


Fig. 30 Relative abundance (n km^{-2}) of Northern Gannets in areas of different water depth (m), 3-8 Dec 2012

Prior to our surveys, several dead and dying Northern Gannets were found on the Mauritanian shoreline (WC Mullié pers. comm.). During the surveys, 8 dead Northern Gannets were seen floating, 2 birds were oiled, and 23 individuals had nylon ropes or nylon line dangling from their beak or plumage (entanglements in fishing gear). Worldwide, entanglements in fishing gear are among the most serious causes of unnatural death in this species (Schrey & Vauk 1987, Camphuysen 1990, Montevecchi 1991, Schneider 1991, Camphuysen 2001a, 2008, Votier *et al.* 2011).

Grey Phalarope **Phalarope à bec large**

Phalaropus fulicarius (2649 records)

Grey Phalaropes (HV)

Grey Phalaropes are high-arctic breeding birds, nesting on tundra's but wintering pelagic off coasts of Chile (Pacific) and W and SW Africa. The NW African wintering population is thought to originate mostly from high arctic Canada, Greenland and Iceland (*c.* 1 million breeding pairs in all) and the 1% level is set at 10,000 individuals (Delany & Scott 2006).

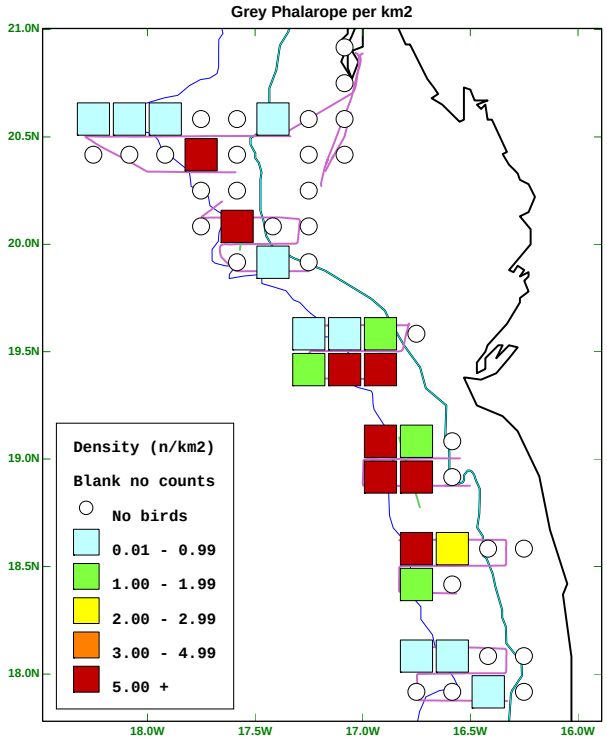


Fig. 31. Densities of Grey Phalaropes(n per km²), Nov-Dec 2012.

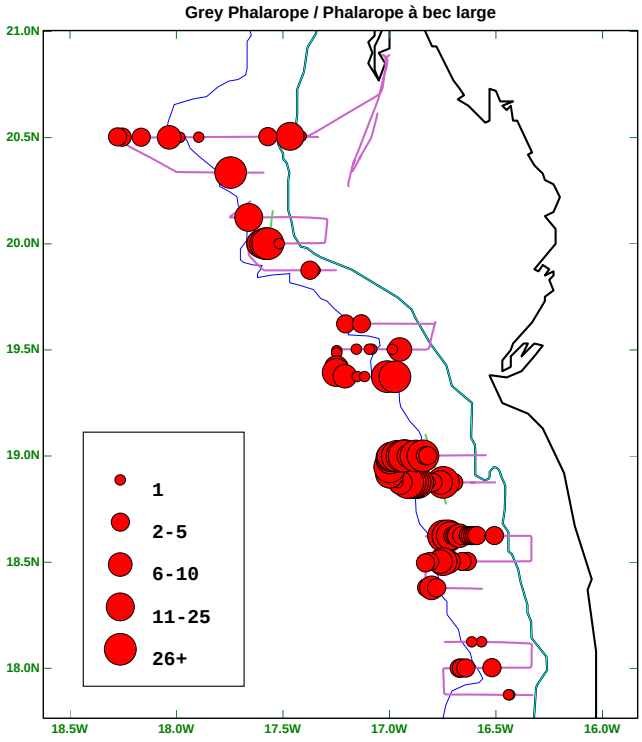


Fig. 32. All sightings of Grey Phalaropes (n), Nov-Dec 2012.

Grey Phalaropes were encountered throughout the study area, albeit in highly variable densities (**Figs 31-32**). Relatively high densities were encountered in leg E (7 Dec 2012), *i.e.* just SW of Cap Timiris. Densities peaked in waters with a combination of relatively high sea surface temperatures and high salinity (high ocean), and peak densities occurred closer to the 1000m depth line than higher onto the shelf slope. Among the planktivorous birds in the area (phalaropes and storm-petrels), Grey Phalaropes seem to occupy a mid-position between the more shelf-orientated European Storm Petrels and the more pelagic *Oceanodroma* species (Band-rumped and Leach's Storm-petrels; **Figs. 33-35**). All recorded phalaropes were recorded as either actively

foraging (surface pecking) or searching for prey, and a great majority were associated with visible fronts, flotsam lines, or other foam lines (76.1%). Nearly a quarter of the birds (23.8%) were associated with free-floating patches of seagrass (often mixed with flotsam), and samples of seagrass picked up from the sea surface were found to contain high densities of zooplankton including numerous species of fish larvae.

The estimate of total numbers within studied 10'x10' rectangles off Mauritania in December 2012 arrived at 67,000 (3.9 ± 12.3 km²) individuals, or 7x the 1% level. Low densities were to be corrected by a factor 1.43 for birds apparently missed in distance bands C (100-200m) and D (200-300m) based on densities within A (0-50) and B (50-100m from the ship). Correcting abundance estimates with this species-specific correction factor for low density rectangles (<10 birds km^{-2}) would result into an overall abundance estimate of some 72,000 Grey Phalaropes within the studied area. The distribution was patchy and while the SD in overall densities were large, after interpolating the data for non-surveyed areas between legs A-G, an overall estimate of at least 122,000 individuals is not unrealistic (12x the 1% level), confirming the status of the area as a highly important wintering ground for this species.

Their pelagic orientation, dense concentrations, and general behaviour at sea makes Grey Phalaropes highly vulnerable for surface pollutants such as mineral oil. Given recent developments in oil exploration off NW Africa and with a very large proportion of the world population wintering between Morocco/Western Sahara (Camphuysen & Van der Meer 2005) and Senegal (Brown 1979), and assessment of the key parameters affecting offshore distribution patterns and oil vulnerability indices of these areas is now urgently required. Further to the south, Grey Phalaropes were the only seabirds associated with an oceanic 'front' offshore and Brown (1979) suggested that this and similar boundary zones are important feeding areas during the pelagic phase of this species' annual cycle. In Mauritania, just as in the Senegal upwelling, phalaropes may take advantage of the arrival of young fish in the surface waters, spawned off the African coast and drifted offshore.

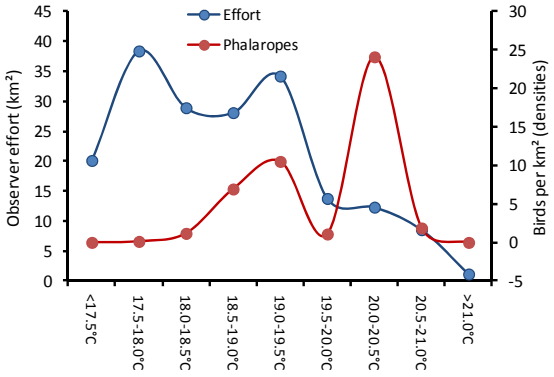


Fig. 33. Relative abundance (n km^{-2}) of Grey Phalaropes in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

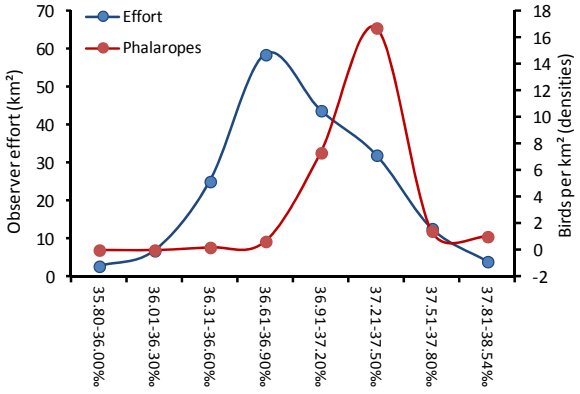


Fig. 34. Relative abundance (n km^{-2}) of Grey Phalaropes in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

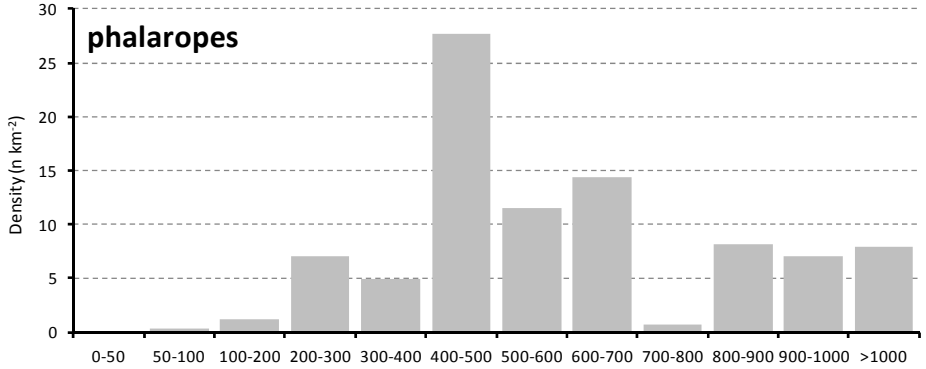


Fig. 35 Relative abundance (n km^{-2}) of Grey Phalaropes in areas of different water depth (m), 3-8 Dec 2012

Long-tailed Skua **Labbe à longue queue** *Stercorarius longicaudus* (3 records)
Arctic Skua **Labbe parasite** *Stercorarius parasiticus* (34 records)

Arctic and Long-tailed Skuas are circumpolar holarctic breeding birds nesting in tundra and boreal climatic zones (Voous 1960). Both species are long-distance migrants that winter mostly in the South Atlantic (Africa and South America; Olsen & Larsson 1997). Long-tailed Skuas were remarkably rare during the 2012 surveys, certainly in comparison to the surveys in January 2000 (Camphuysen 2003). Three sightings:

4 Dec 2012 (1), 19°22.4'N, 16°59.8'W.
4 Dec 2012 (1), 19°30.2'N, 17°11.5'W.
7 Dec 2012 (1), 18°59.9'N, 16°57.1'W.

In Jan 2000, the Long-tailed Skuas showed a more homogeneous distribution over the shelf and shelf break, with considerable densities over deeper waters and the species had a tendency to form flocks over specific areas with concentrated flotsam where tiny material was pecked from the surface, sometimes in association with storm petrels (Camphuysen 2003). None of this has been seen during the 2012 surveys.

Arctic Skuas were seen occasionally, mostly along the southernmost legs, without a clear 'preference for' or link with certain water characteristics (SST or SSS). Most nearby birds were adults (28 adults, 2 subadults) and light phase birds predominated (28 light phase, 6 dark phase). Aerial pursuit was recorded three times (attempts to kleptoparasitise Common Terns *Sterna hirundo*). Two birds were joining a multi-species foraging association (MSFA), likely as kleptoparasites.

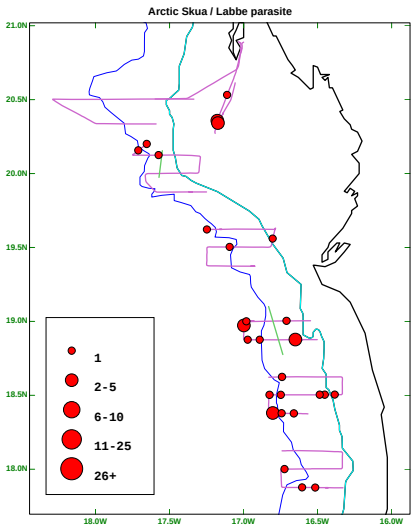


Fig. 36. All sightings of Arctic Skuas (n), Nov-Dec 2012.

Pomarine Skua **Labbe pomarin** *Stercorarius pomarinus* (2134 records)

Pomarine Skua adult light phase (CJC)

As in earlier winter surveys, Pomarine Skuas were the most common species of skua. NW Africa is one of the key wintering sites of this species that breeds almost circumpolarly holarctic and virtually exclusively in the tundra climatic zone (Voous 1960). Pomarine Skuas in Mauritania probably mostly originate from the Russian breeding population (Novaya Zemlya and further to the east), although the presence of birds from arctic Canada (as in Grey Phalaropes) cannot be excluded.

On some days, large flocks of Pomarine Skuas formed in association with the research vessel. Accurate strip-transect censuses were very hard to achieve on such days, because the birds tended to keep circling around

the boat or even assembled in small flocks on the track-line ahead of the ship. The largest associated flocks (based on peak counts) were observed on the southernmost legs (E-G), notably on 5 December (80 individuals, leg F), 7 Dec (79, leg E), and 6 Dec 2012 (46, leg G). From our strip-transect surveys, an estimate of total numbers in studied 10'x10' rectangles arrived at 31,000 Pomarine Skuas (1.8 ± 5.3 km^{-2}). For the entire Mauritanian slope area, 86 rectangles, an estimate of *c.* 52,500 individuals seems appropriate.

Of 1387 individuals of which the colour phase was recorded (adults and immatures combined), 92.4% were light phase birds. Nearly every single individual was in active (post-nuptial) moult. The age composition was highly remarkable: juveniles were near-absent (2.6%, n= 970) and an overwhelming 95.8% were recorded as fully mature (black legs, unbarred underwing coverts). Some older immatures (3rd year plumage) may have been overlooked, but younger birds (1cy and 2cy) were rare. The results suggest that the breeding season of 2012 and possibly also 2011 in the areas of origin must have been disastrous.

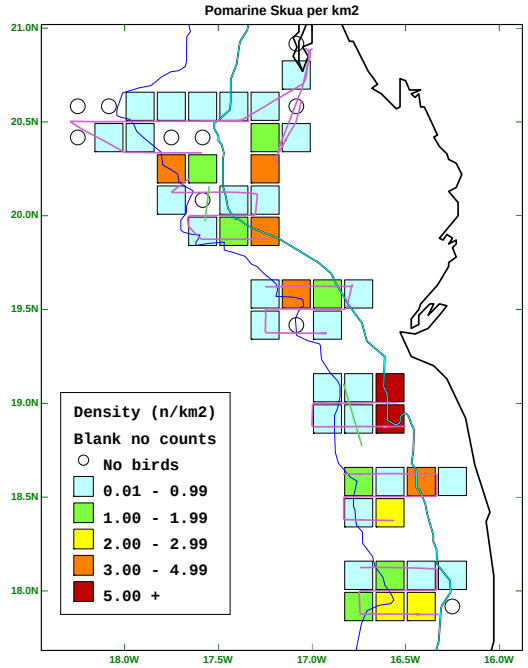


Fig. 37. Densities of Pomarine Skuas (n per km²), Nov-Dec 2012.

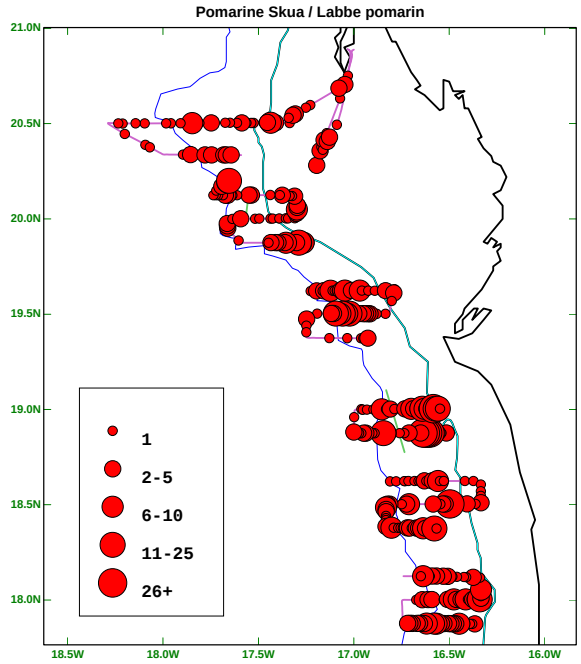


Fig. 38. All sightings of Pomarine Skuas(n), Nov-Dec 2012.

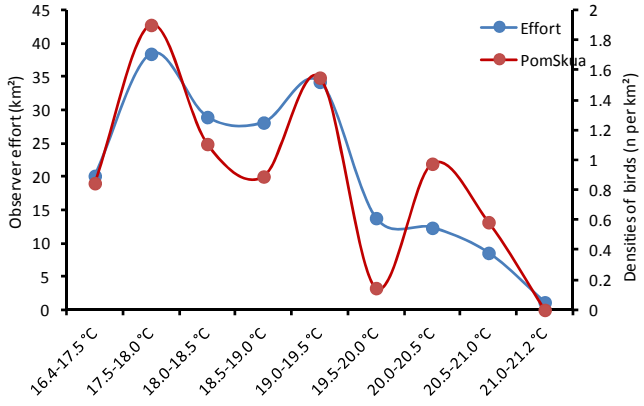


Fig. 39. Relative abundance (n km-2) of Pomarine Skuas in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

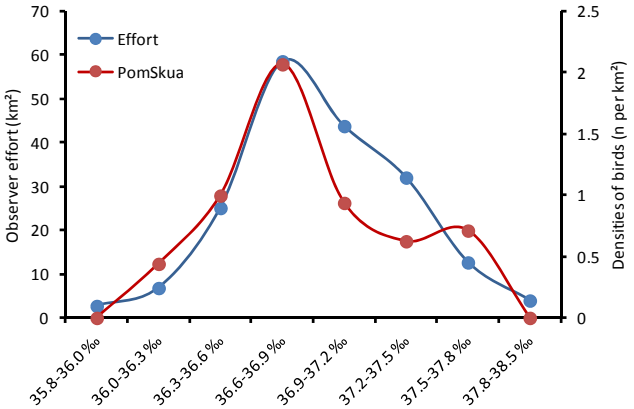


Fig. 40. Relative abundance (n km-2) of Pomarine Skuas in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

Pomarine skua associated with the ship (CJC)

Pomarine Skuas were seen everywhere within the studied area, except near Cap Blanc and near the harbour of Nouadhibou. Pomarine Skuas were seen over the shelf, over the shelf-break and slope, and over oceanic waters in waters with cool and warm SST and with higher or lower SSS (no obvious habitat preferences; **Figs. 39-40**). There were no 'preferences' regarding water depth either in any species of skua observed (**Fig. 41**).

As in January 2000 (Camphuysen 2003), Pomarine Skuas were generally so inactive during the daytime surveys, that fairly little was learned about their foraging ecology in these winter quarters. Active trawlers were scarce, but a fairly large actively foraging flock was seen near one ship. Otherwise, Pomarine Skuas had a tendency to form resting flocks at sea rather than to actively feed. Aerial pursuits were recorded 17x, 88 birds were searching for prey, 1 was surface pecking, 5 were shallow plunging, and 60 individuals were associated with and foraging at a commercial fishing vessel. Six species were seen to be the subject of aerial pursuit by Pomarine Skuas: Cory's Shearwater (1x), Grey Phalarope (1x), Great Skua (1x), Lesser Black-backed Gull (2x), Sandwich Tern (1x), and Common Tern (4). Only the Grey Phalarope was attacked as in an attempt to kill (failed). The Great Skua was attacked by a particularly bold juvenile Pomarine Skua. Normally, the arrival of a Great Skua would trigger an avoidance response of Pomarine Skuas nearby. One particular individual "attacked" the observers on board and was easily hand-fed. One leucistic individual was recorded.

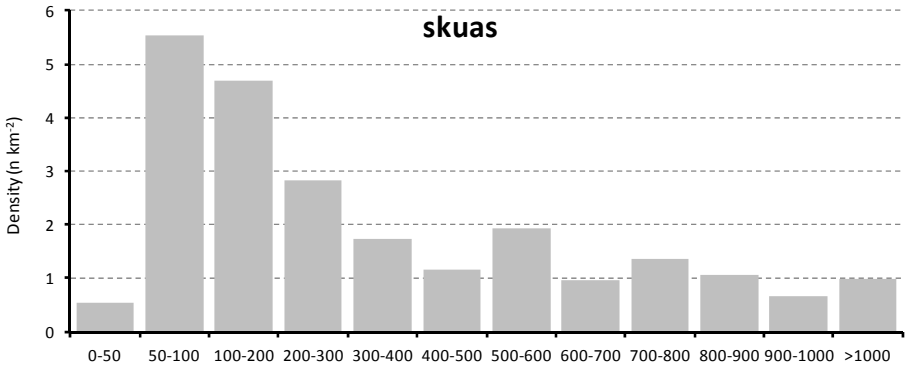


Fig. 41 Relative abundance (n km^{-2}) of skuas (Catharacta and Stercorarius spp) in areas of different water depth (m), 3-8 Dec 2012

Great Skua **Grande Labbe** *Stercorarius skua* (202 records)

Colour-ringed Great Skua (HV)

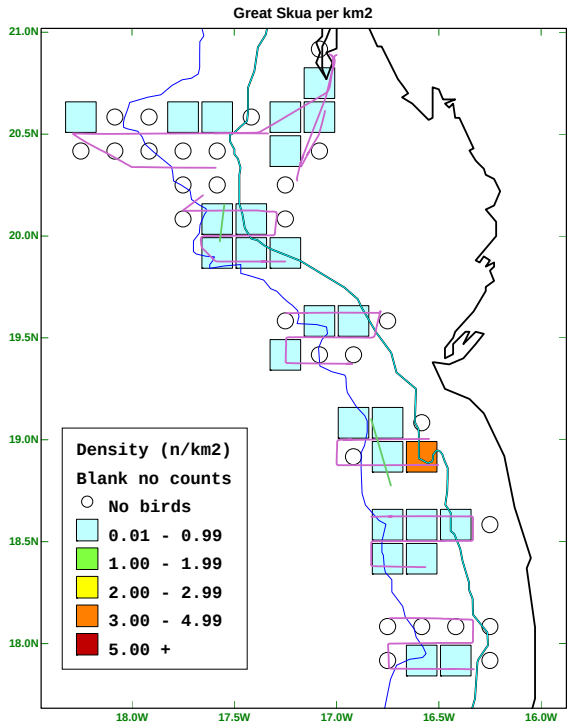


Fig. 42. Densities of Great Skuas (n per km²), Nov-Dec 2012.

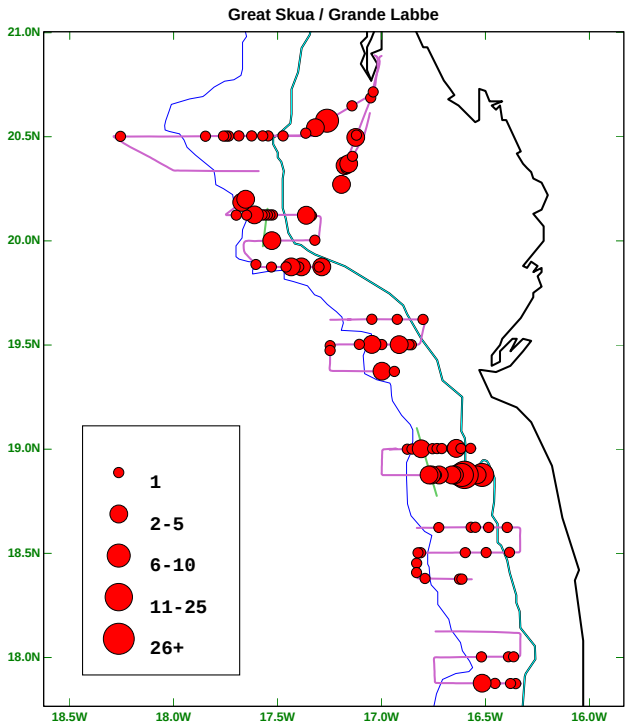


Fig. 43. All sightings of Great Skuas(n), Nov-Dec 2012.

The Great Skua was the second most numerous skua during these surveys. Great Skuas breed in NW Europe (Scotland, Faeroe Islands, Iceland) and have recently colonised Greenland, northern Norway and Svalbard. A colour-ringed (dark green) individual seen during the 2012 surveys most probably originated from a Scottish population (R.W. Furness *pers. comm.*).

Great Skuas rarely approached the research vessel and certainly did not stay in association for any length of time. A large flock of ship-following seabirds did attract Great Skuas, however, and rather strong avoidance responses were recorded from Cory's Shearwaters, Pomarine Skuas, gulls and terns. "Distant association" is a well known phenomenon in this species, however, and the tendency to alight on the water well ahead of the approaching vessel may have artificially elevated the recorded densities at sea. From our strip-transect surveys, however, an estimate of total numbers in studied 10'x10' rectangles arrived at 3500 Great Skuas (0.2 ± 0.5 km^{-2}). For the entire Mauritanian slope area, 86 rectangles, an estimate of *c.* 6000 individuals seems appropriate.

As in Pomarine Skuas, a majority of the birds were recognised as adults (or, in this case, older immatures); only 4 juveniles (3%, n= 136) were found. Ten birds were seen scavenging near a fishing vessel. Six individuals performed an aerial pursuit, targeting Lesser Black-backed Gulls and Cory's Shearwaters.

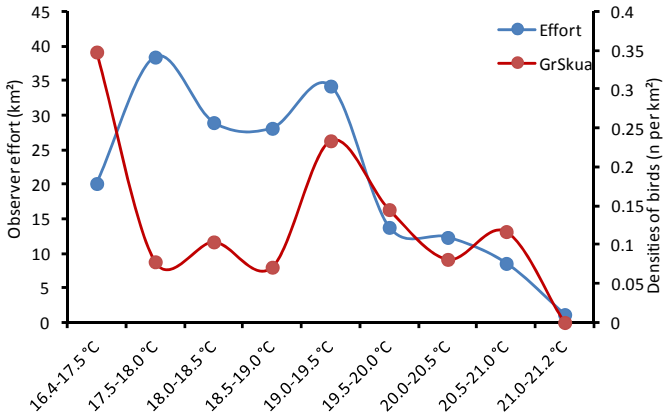


Fig. 44. Relative abundance (n km^{-2}) of Great Skuas in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

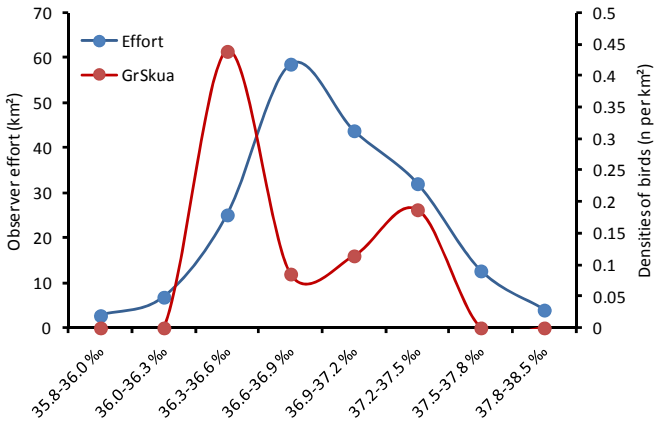


Fig. 45. Relative abundance (n km^{-2}) of Great Skuas in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

Yellow-legged Gull **Goéland leucophée**
Larus michahellis (6 records)
Lesser Black-backed Gull **Goéland brun**
Larus fuscus (1306 records)

Lesser Black-backed Gull (HV)

Lesser Black-backed Gulls are winter visitors that originate from NW Europe. Colour-ring readings in Nouadhibou and Nouakchott during this expedition confirmed the presence of birds originating from Iceland (2x), Norway (27x), Denmark (3x), Germany (3x), The Netherlands (19x), Belgium (7x), the UK (4x) and France (2x). Yellow-legged Gulls most likely originate from Spanish, Portuguese or Moroccan colonies. Only six individuals were seen during the ship-based surveys off Mauritania in 2012 and the species was rather rare in coastal resorts. Yellow-legged Gulls:

4 Dec 2012 (1), 19°22.4'N, 17°5.6'W.
4 Dec 2012 (1), 19°37.4'N, 16°48.6'W.
4 Dec 2012 (1), 19°37.4'N, 16°50.7'W.
4 Dec 2012 (1), 19°37.4'N, 17°2.7'W.
6 Dec 2012 (1), 18°7.1'N, 16°21.0'W.
7 Dec 2012 (1), 18°52.5'N, 16°40.4'W.

Lesser Black-backed Gulls were most common off Nouadhibou and Cap Blanc (leg A) and off Nouakchott (leg G) in relatively shallow waters (**Figs. 46-47**). From strip-transect counts, an estimate of total numbers in studied

10'x10' rectangles arrived at 8600 individuals (0.5 ± 2.0 km^{-2}). Within the entire area (all 86 rectangles) perhaps 13,500 individuals could be expected, but note that Lesser Black-backed Gulls roost onshore and may reach higher densities in nearshore fisheries (outside the survey area) than many other species. The massive overnight roosts onshore leave little doubt about the importance of Mauritania as a wintering area for this species.

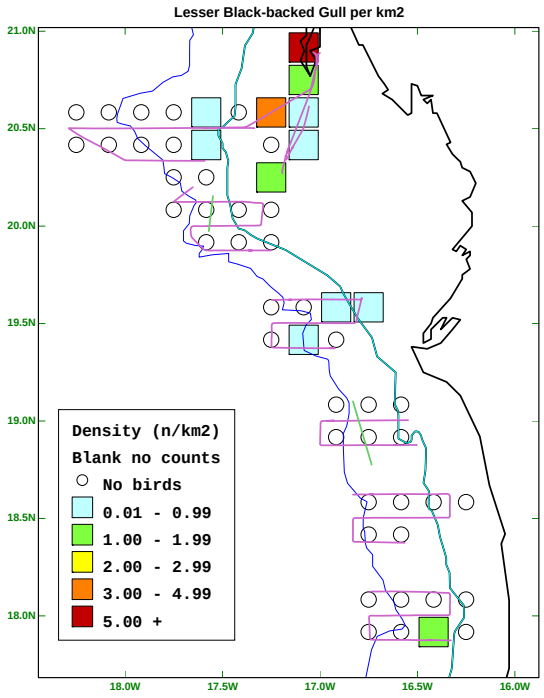


Fig. 46. Densities of Lesser Black-backed Gulls (n per km²), Nov-Dec 2012.

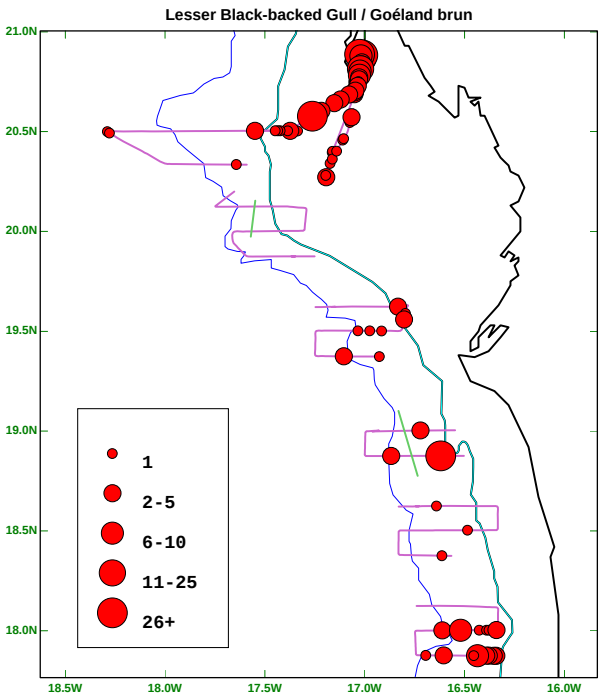


Fig. 47. All sightings of Lesser Black-backed Gulls (n), Nov-Dec 2012.

As expected from a coastal species, higher densities were found in cooler waters of low salinity (**Figs. 48-49**). The absence of large trawlers offshore will have influenced the actual distribution of this species. In January 2000, when numerous large fishing vessels occurred at the shelf-break, large flocks of gulls were observed at great distances from the coast.

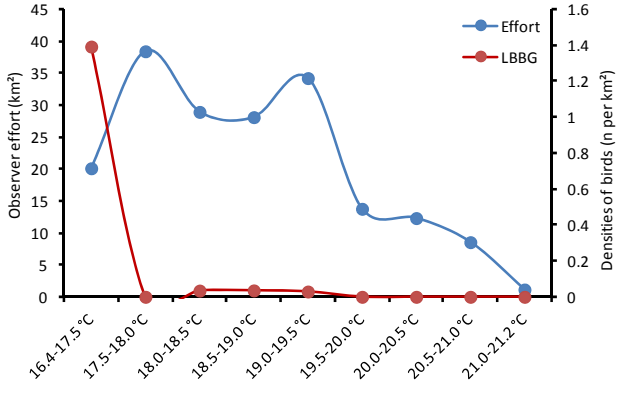


Fig. 48. Relative abundance (n km^{-2}) of Lesser Black-backed Gulls in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

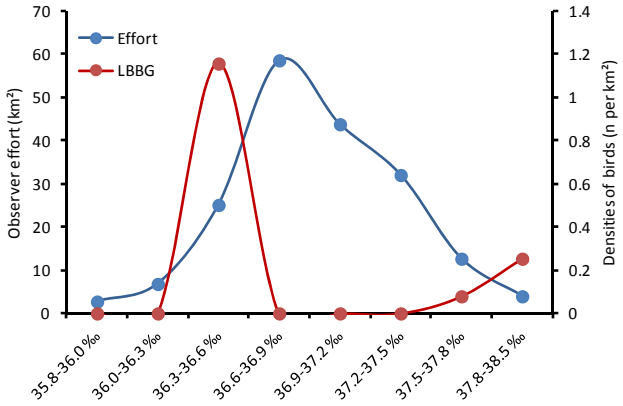


Fig. 49. Relative abundance (n km^{-2}) of Lesser Black-backed Gulls in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

The age composition of Lesser Black-backed Gulls in 1016 individuals of which the plumage has been recorded was 93.5% adult, 0.5% 4cy, 1.4% 3cy, 0.6% 2cy, and 4.0% juveniles. Birds in adult plumage also numerically predominated the onshore roosts in Nouadhibou and Nouakchott. Recorded (foraging) behaviour included aerial pursuit (5x), scavenging (4x), scavenging for discards at a fishing vessel (120x), dipping (1x), surface seizing (1x), shallow plunging (3x), actively searching (54x), and under attack by a kleptoparasite (30x, including one group of 28 birds under attack from 4 adult Great Skuas). The results seem to emphasise the significance of commercial fisheries for these birds and rather few birds were engaged in natural feeding frenzies. However, a rather unexpected (but non-quantified) result of the survey were the frequent sightings of night-feeding terns and Lesser Black-backed Gulls (with Common Dolphins and Cory's Shearwaters) around the steaming research vessel in pitch darkness. Night feeding is an aspect that will require more attention in future projects, since this could explain the low levels of foraging activity of several species of birds during day time.

Night feeding Common Terns (left) and Lesser Black-backed Gulls (centre and right) following the steaming research vessel (CJC). Feeding frenzies around the ship were recorded in several nights and often also included Common Dolphins and Cory's Shearwaters. Occasionally, small fish as prey could be seen.

Audouin's Gull **Goéland d'Audouin** *Larus audouinii* (11 records)

Adult Audouin's Gull (CJC)

A winter visitor from the Mediterranean region. Colour-ring readings in Nouadhibou and Nouakchott during this expedition confirmed the presence of birds originating from Italy (3x), Spain (12x) and Portugal (5x). While Audouin's Gulls were common in Nouakchott, in Nouadhibou and at Cap Blanc, there were only 11 individuals recorded during the ship-based surveys at sea (7 adults, 1 juvenile, 3 immatures). Of these, six were associated with fishing vessels and 4 birds were associated with the research vessel.

Slender-billed Gull **Goéland railleur** *Larus genei* (1 record)
Mediterranean Gull **Mouette mélanocéphale** *Larus melanocephalus* (3 records)
Little Gull **Mouette pygmée** *Larus minutus* (3 records)
Black-headed Gull **Mouette rieuse** *Larus ridibundus* (11 records)
Sabine's Gull **Mouette de Sabine** *Larus sabini* (20 records)
Black-legged Kittiwake **Mouette tridactyle** *Rissa tridactyla* (9 records)

Black-legged Kittiwake (HV)

A group of smaller gulls, all of which seen only occasionally during the offshore surveys on board the Al Awam in Nov-Dec 2012. The origin of these species is rather diverse, ranging from the Canadian high arctic (Sabine's Gull) to the Mediterranean (Slender-billed Gull and Mediterranean Gull). Little Gulls (disintegratedly transpalaearctic), and Black-headed Gulls (transpalaearctic in boreal and temperate climatic zones) are inland breeding birds in Europa and Asia. Black-legged Kittiwakes are cliff-nesting seabirds breeding mostly in temperate to arctic regions of NW Europe.

Slender-billed Gulls have local breeding populations, but birds from the Mediterranean winter in NW Africa. Colour-ring readings in Nouadhibou and Nouakchott during this expedition confirmed the presence of birds originating from Spain (7x). Encountered in small numbers in Nouadhibou and at Cap Blanc, but only a single record at sea:

3 Dec 2012 (1), 20°46.9'N, 17°1.6'W (leg A).

Mediterranean Gulls are Palearctic migrants reach Mauritanian waters only in very small numbers (BWP*i* 2004, Isenmann 2007). Two records only, involving three birds (one adult winter, two juveniles):

28 Nov 2012 (2), 20°47.8'N, 17°1.5'W (leg A)
3 Dec 2012 (1), 20°47.6'N, 17°1.5'W (leg A).

The same holds for Little Gulls: most birds winter off the coast of SW Europe and small numbers reach Morocco (BWP*i* 2004). One adult winter plumage individual and two juveniles were seen during our surveys, well offshore and rather far south (SW of Cap Timiris):

5 Dec 2012 (1), 18°37.4'N, 16°44.4'W.
7 Dec 2012 (2), 19°0.2'N, 16°37.7'W.

Sabine's Gulls are passage migrants that winter further off SW Africa, but that may be seen in large numbers during migration. These are pelagic seabirds in winter, that should be expected offshore rather than over the shelf. All birds seen were adults in winter plumage and most were seen on 6 December 2012 on leg G (the southernmost leg during these surveys). The mean SST and SSS of areas where Sabine's Gulls were seen (18.1°C, 37.0 ‰) did not differ significantly from the overall mean (18.6°C, 36.9 ‰) during these surveys, but the number of birds seen is simply too small to draw any conclusions. Sabine's Gulls were only slightly more common than during surveys in January 2000 (Camphuysen & Van der Meer 2005), indicating that the majority of the birds has already passed by the area in late November.

The pelagic waters off Mauritania are slightly beyond the southern limits of the wintering range of Black-legged Kittiwakes (Camphuysen & Van der Meer 2005, Isenmann 2007). Sightings included 5 adults and four juvenile birds, all attracted to the research vessel, scattered throughout the study period and research area.

Whiskered Tern **Guifette moustac** *Chlidonias hybridus* (2 records)

Black Tern **Guifette noire** *Chlidonias niger* (66 records)

Black Terns (HV)

Black Terns are marsh terns that breed in continental and maritime middle latitudes, mainly in well-watered lowlands of the in western Palearctic (BWP*i* 2004). In African wintering areas Black Terns are marine birds that feed far offshore (Glutz von Blotzheim & Bauer 1982). Mauritanian waters are visited by large flocks of Black Terns in autumn (Aug-Sep) and spring (Apr-May; Bourne & Dixon 1973, Leopold 1993), but the region is well north of the main wintering grounds. In the Guinea Gulf large mixed tern flocks (dominated by Black Terns) feed in Aug-Oct when a seasonal shift of the upwelling system reaches coastal waters, with migratory surface shoaling sardines. Mid-December at 0°N (equator), 10°W (*i.e.* 500 km SSE of Liberia many large flocks of Black Terns (up to 1000 individuals) have been observed fishing, also at night.

Whiskered Terns in winter frequent habitats that are similar to the inland breeding habitats, but mainly in the tropics (BWP*i* 2004). The single sighting of two individuals is unexpected and misidentification cannot fully be excluded:

4 Dec 2012 (2), 19°22.4'N, 17°0.6'W.

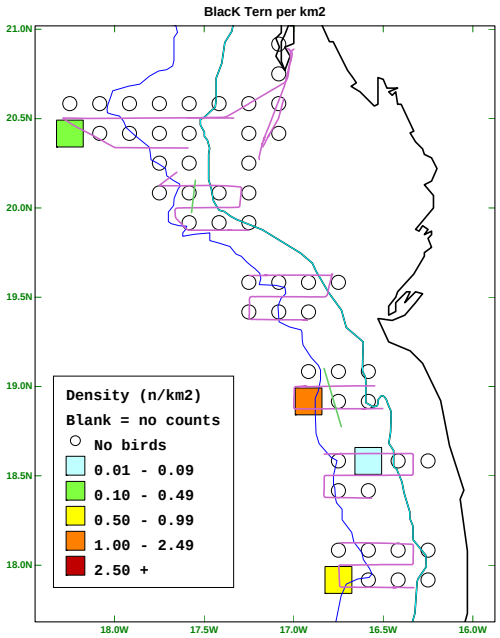


Fig. 50. Densities of Black Terns (n per km²), Nov-Dec 2012.

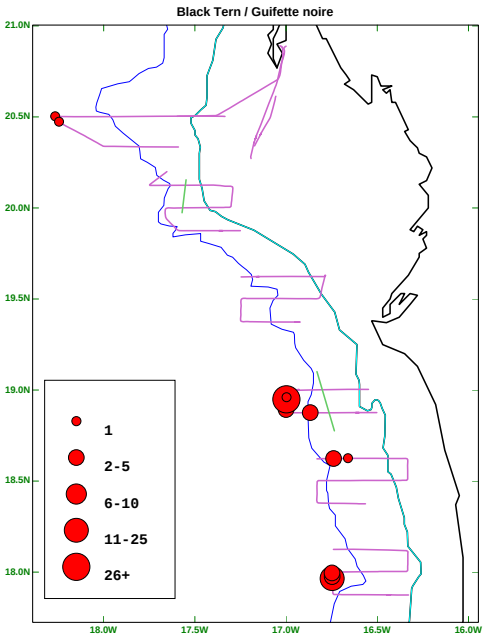


Fig. 51. All sightings of Black Terns (n), Nov-Dec 2012.

Black Terns occurred, more or less as expected, in very low numbers in the true pelagic zone (beyond the 1000m depth contour). An estimate of total numbers of Black Terns in studied 10'x10' rectangles arrived at 1100 individuals (0.1 ± 0.3 km^{-2}). An estimate for the total area (all 86 rectangles) was 1850 individuals. As can be seen on the maps, however, the value of these estimates is rather limited, given that all sightings were at the extreme westernmost tips of the trajectories. Larger numbers may have occurred at greater distances from land.

Common / Arctic tern **Sterne pierregarin / arctique** *S. hirundo / S. paradisaea* (33 records)

Common Tern **Sterne pierregarin** *Sterna hirundo* (856 records)

Arctic Tern **Sterne arctique** *Sterna paradisaea* (2 records)

Roseate Tern **Sterne de Dougall** *Sterna dougallii* (2 records)

Common Terns on deck (CJC)

All species if terns in this group ('commic terns') are Palaearctic migrants that are either winter visitors or migratory in Mauritanian waters. Arctic Terns winter in Antarctic and sub-Antarctic waters and move through this area in spring and autumn. Roseate Terns breed on the Canaries and Azores, but are rarely recorded in Mauritanian waters (Isenmann 2007). British Roseate Terns spend their winter further to the south (Ratcliffe & Merne 2002). Four individuals in all have been recorded of these rarer terns.

Roseate Tern:

7 Dec 2012 (2), 18°59.9'N, 16°57.8'W.

Arctic Tern:

27 Nov 2012 (1), 20°30.2'N, 18°15.9'W.
4 Dec 2012 (1), 19°37.4'N, 16°50.0'W.

The fast majority of the unidentified 'commic terns' will have been Common Terns, just as the majority of the identified individuals. The estimate of total numbers of Common Terns in studied 10'x10' rectangles arrived at 5600 individuals (0.3 ± 0.9 km^{-2}), or 9500 individuals in the area at large (all 86 rectangles). 'Commic' terns were attracted by the ship and many individuals would alight on the superstructure of the ship. Corrections for ship-attractions are difficult to achieve reliably with such species, especially so because substantial groups appeared to materialise "out of the blue" at times. The estimates must be treated with caution.

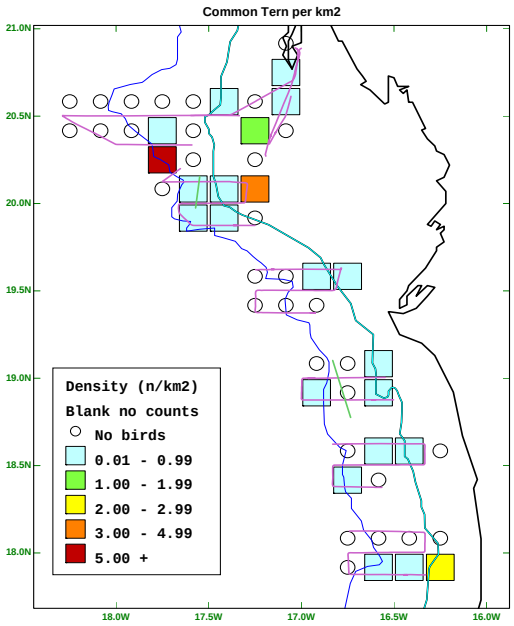


Fig. 52. Densities of Common Terns (n per km²), Nov-Dec 2012.

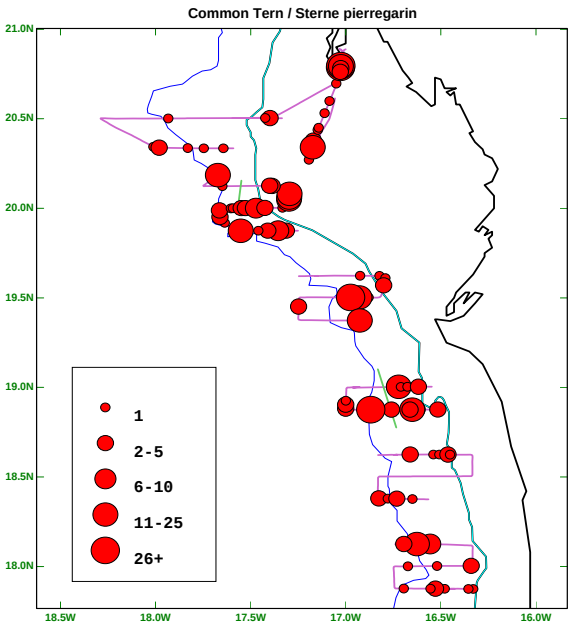


Fig. 53. All sightings of Common Terns (n), Nov-Dec 2012.

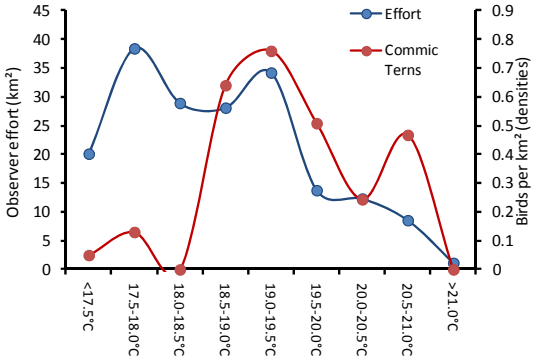


Fig. 54. Relative abundance (n km^{-2}) of 'commic terns' in areas differing in sea surface temperatures (SST, °C). The observer effort is provided as km² surveyed, 3-8 Dec 2012.

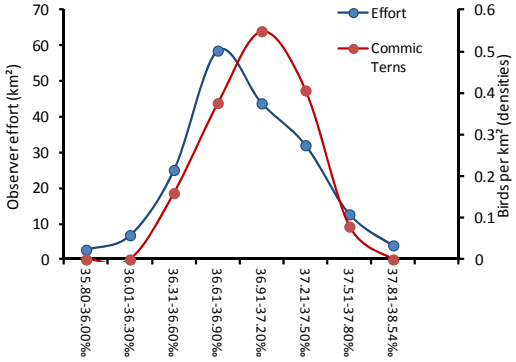


Fig. 55. Relative abundance (n km^{-2}) of 'commic terns' in areas differing in sea surface salinity (SSS, ‰). The observer effort is provided as km² surveyed, 3-8 Dec 2012

Preferred habitats of these terns seem to be characterised by relatively high sea surface temperatures (SST) and slightly higher than average sea surface salinities (SSS), indicating a preference for the slope rather than the shelf itself. Truly pelagic conditions (as in Black Terns) were mostly avoided by these species.

As described under Lesser Black-backed Gull, an interesting and underexplored phenomenon were the night-feeding activities of comic terns associated with the research vessel. Most terns were inactive during daytime and night feeding could be an important foraging technique for these species. Small fish prey were targeted and it is unclear of the (few) lights of the ship attracted these fish closer to the surface. The feeding frenzies were numerically dominated by Common Terns, but unknown numbers of Common Dolphins, Cory's Shearwaters and small numbers of Lesser Black-backed Gulls participated.

Caspian Tern **Sterne caspienne** *Sterna caspia* (21 records)

Mauretanian Royal Tern **Sterne royale** *Sterna maxima albidorsalis* (155 records)

Mauretanian Royal Tern (HV)

Most, if not all of the observed Caspian Terns and Mauritanian Royal Terns are assumed to have been local resident birds. With regard to the Caspian Terns observed, we have no evidence from the ring-reading activities that birds from Northern Europe were involved, but their presence cannot be fully excluded.

The distribution of sightings of Caspian and Royal Terns was strikingly different. Caspian Terns were seen almost exclusively off Cap Blanc, where large roosts were seen onshore earlier during this expedition. Royal Terns were common only to the NW of Cap Timiris (off SW Banc d'Arguin) and numerous birds were seen to alight on the survey vessel together with numerous other terns. Only for Royal Terns has an estimate of total numbers within the study area been made: total numbers of Royal Terns in studied 10'x10' rectangles amounted to *c.* 975 individuals (0.1 ± 0.3 km^{-2}); 1650 individuals may be assumed to occur in the area at large. As in Black Terns, however, it is clear that the main area for Royal Terns was outside the surveyed area (probably closer inshore) and these estimates have therefore rather limited value.

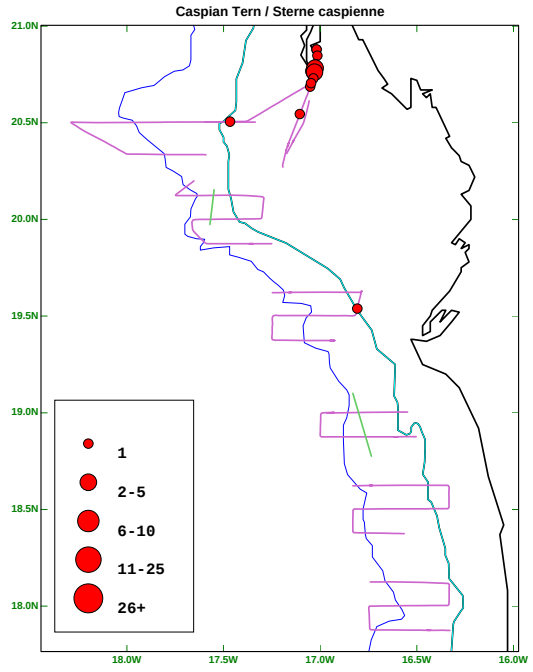


Fig. 56. All sightings of Caspian Terns (n), Nov-Dec 2012.

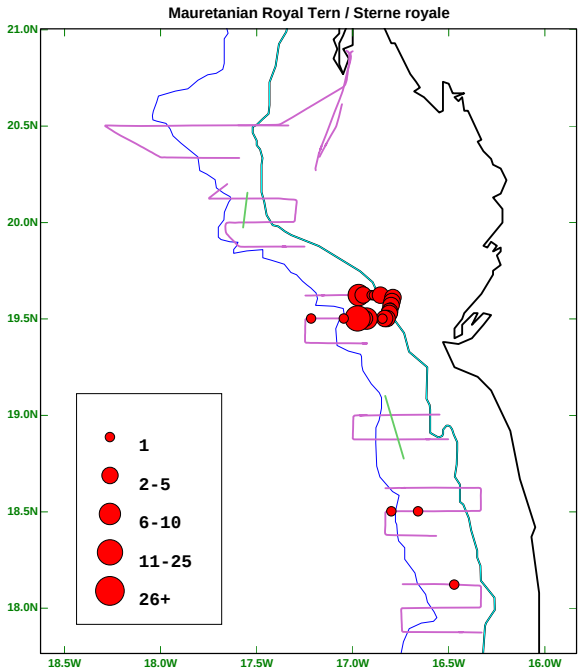


Fig. 57. All sightings of Royal Terns (n), Nov-Dec 2012.

Roosting Caspian Terns and some Sandwich Terns, Cap Blanc (CJC)

Sandwich Tern **Sterne caugek** *Sterna sandvicensis* (399 records)

Colour-ringed Sandwich Tern onboard (H.V.)

Sandwich Terns are Palaearctic migrants that can be found wintering from SW Portugal and Spain all the way south to South Africa and into the Indian Ocean. An estimate of the total numbers of Sandwich Terns within the

studied 10'x10' rectangles arrived at 1400 individuals (0.1 ± 0.3 km^{-2}). For the larger area (86 rectangles) around 2300 individuals were thought to occur. As with so many terns, Sandwich Terns were readily attracted to the research vessel and strip-transect count results may be considered inaccurate. Colour-ring sightings indicated the presence of birds originating from the UK and from Italy.

Most sightings of Sandwich Terns were over the upper slope and shelf, confirming the coastal orientation of this species (night roosts on land). Relatively high numbers were recorded off the Banc d'Arguin. Rather lower numbers were seen on the southernmost legs. Surface waters were most Sandwich Terns occurred characterised by relatively low temperatures and salinity (typical upper slope/shelf conditions).

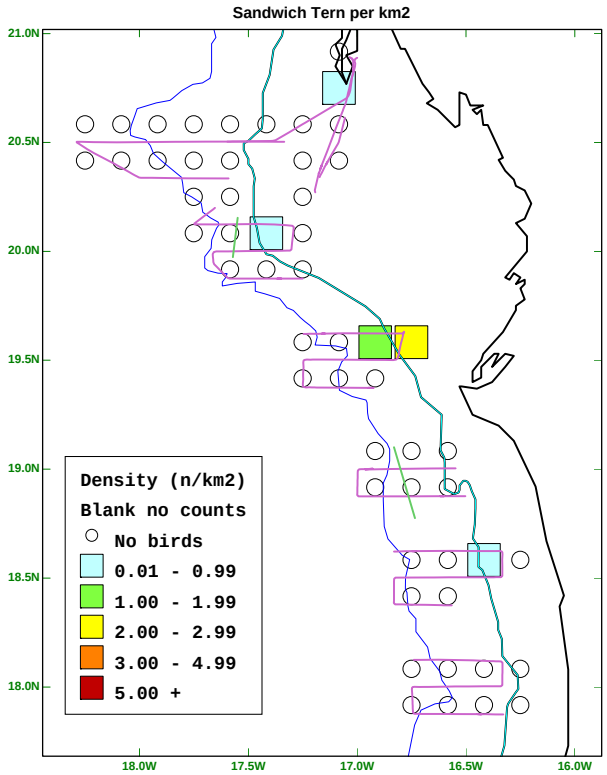


Fig. 58. Densities of Sandwich Terns (n per km²), Nov-Dec 2012.

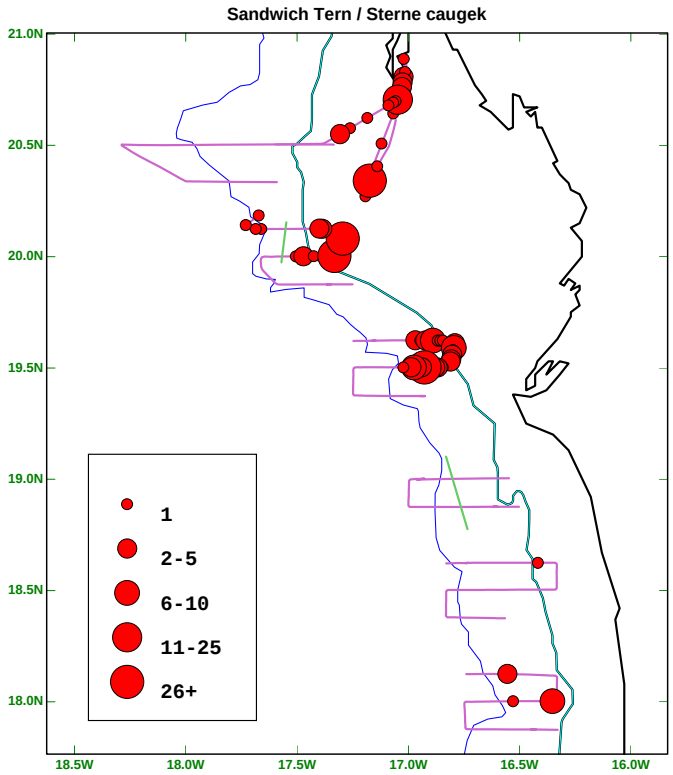


Fig. 59. All sightings of Sandwich Terns (n), Nov-Dec 2012.

Whales and dolphins

At least 11 different species of cetaceans have been recorded during these surveys, including at least 4 different species of baleen whales (Blue, Fin, Bryde's and Humpback Whale), two toothed whales (Sperm Whale and unidentified beaked whales), and five species of dolphins (Common, Atlantic Spotted, Risso's and Bottlenosed Dolphins, Harbour Porpoise). Bryde's Whales and some dolphins may be residents in the area, but most other species will have a strong seasonal variation in occurrence ("wintering", perhaps even breeding species).

For seabirds, a strip-transect count served as an accurate mechanism to obtain abundance information (densities). For cetaceans, line-transect techniques would have been more appropriate (Buckland *et al.* 1993). With insufficient trained staff, we refrained from line-sampling techniques and cannot therefore produce abundance estimates for cetaceans based on this survey. The abundance of cetaceans in this winter survey was such, however, that the use of line-transect techniques (and at least the presence of a third trained observer) must be considered in future surveys. All sightings are listed in this cruise report, with annotations regarding behaviour and criteria used for identification.

Cetaceans were observed regularly throughout the survey, but certain hot-spots were found, different for each of the major groups, that will be described below. One important hot-spot was found over the lower slope (close to deep oceanic waters) on leg C (around 20°N). Large whales (including all Sperm Whales) and large groups of dolphins were encountered beyond and oceanic front separating shelf seas (cooler SST, less saline SSS) from oceanic conditions (warmer SST, higher salinity). During our surveys, and slightly affecting our trajectories, we encountered a seismic survey in progress with plenty whales and dolphins around. If whale observers have been on board these vessels, they must have considered the abundance of whales and dolphins less important than the progress of that seismic survey.

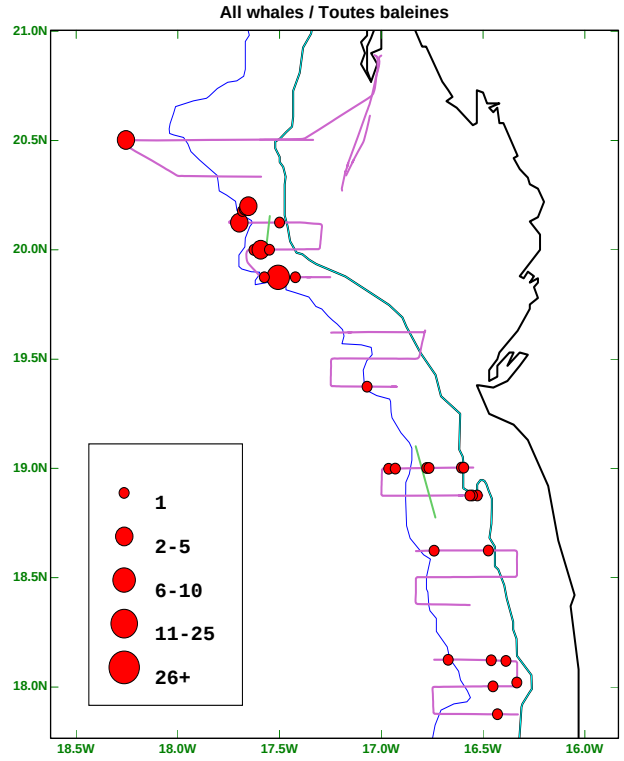


Fig. 60. All sightings of large whales (n), Nov-Dec 2012.

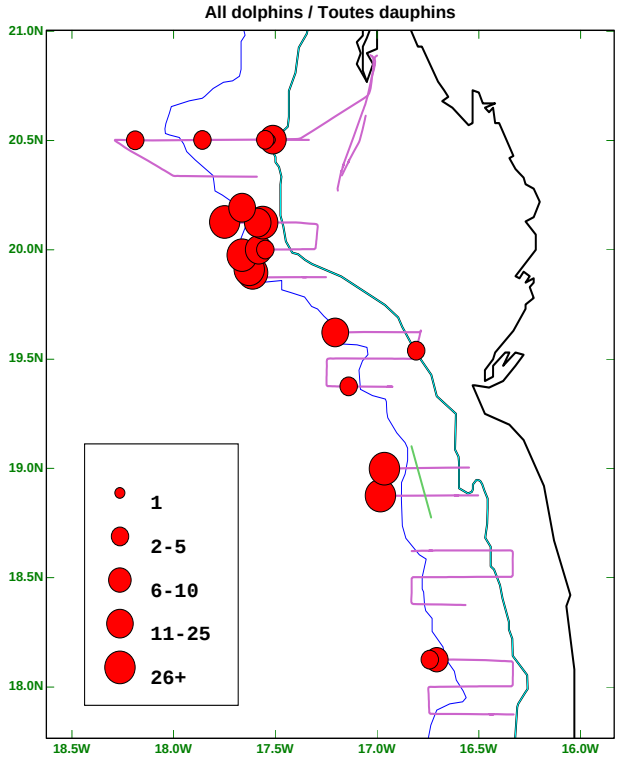


Fig. 61. Sightings of dolphins (n), Nov-Dec 2012.

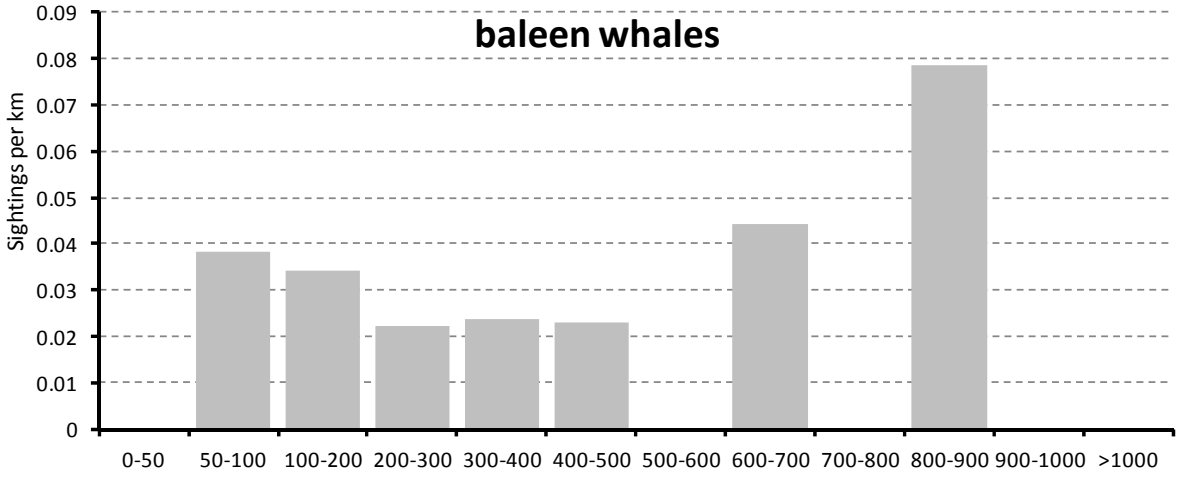


Fig. 62. Relative abundance (n km^{-1}) of baleen whales in areas of different water depth (m), 3-8 Dec 2012

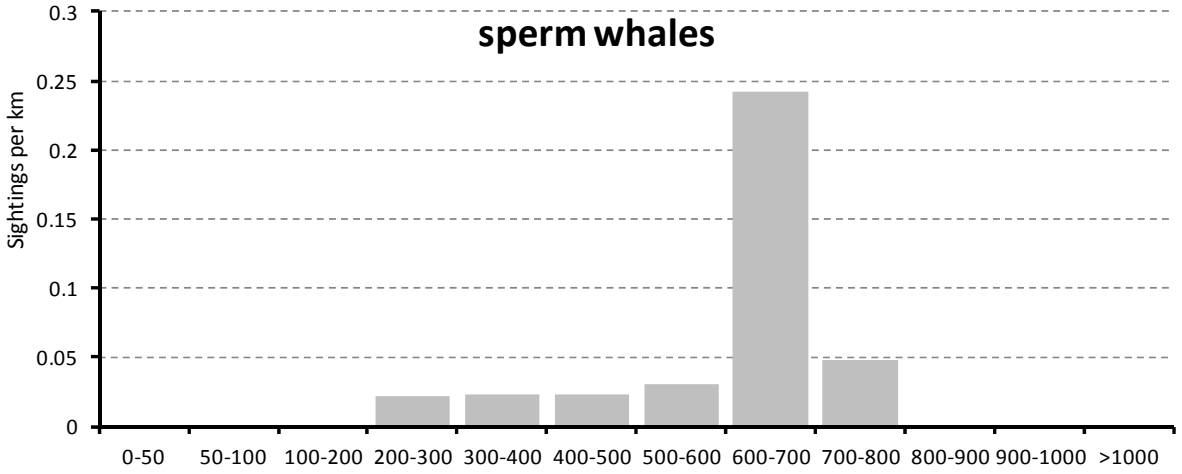


Fig. 63. Relative abundance (n km^{-1}) of Sperm Whales *Physeter macrocephalus* in areas of different water depth (m), 3-8 Dec 2012

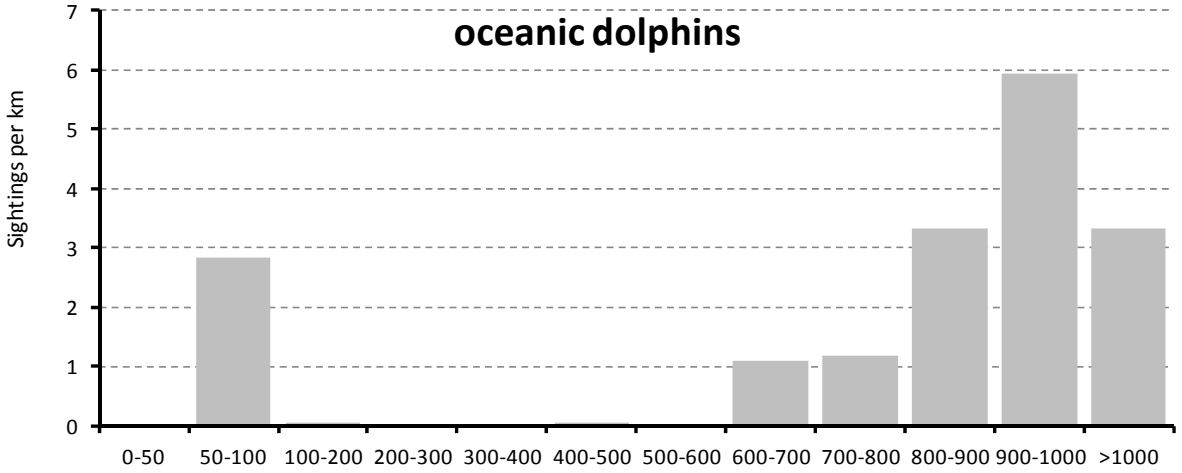


Fig. 64. Relative abundance (n km^{-1}) of oceanic dolphins (*Delphinus*, *Stenella* spp) in areas of different water depth (m), 3-8 Dec 2012

Blue Whale (H.V.)

Bryde's Whale **Rorqual Tropical** *Balaenoptera edeni* (4 records)
Blue Whale **Baleine Bleue** *Balaenoptera musculus* (2 records)
Fin Whale **Rorqual commun** *Balaenoptera physalus* (4 records)
Humpback Whale **Baleine a bosse** *Megaptera novaeangliae* (4 records)
Sei / Brydes Whale *small Balaenoptera spec.* (3 records)
Blue / Fin / Sei Whale *large Balaenoptera spec.* (3 records)
whale Baleine *whale* (6 records)

Blue Whale (HV)

Large balaenopterid and Humpback Whales (light blue symbols in **Fig. 65**) were most numerous on the southernmost legs (E, F, G). These whales were often impossible to identify, because a single or an infrequently repeated, tall vertical blow was all that could be seen. Most animals moved very slowly and spent remarkably little time at the surface (both observers had extensive experience with baleen whales elsewhere on the planet and in African waters). Only in two Humpback Whales (leg C) were foraging activities obvious (lunge feeding at the surface); most other sightings involved rather slow moving, seemingly inactive individuals.

By far the most spectacular sightings were two Blue Whales, one of which could be carefully documented and details are now included in the East Atlantic Blue Whale catalogue (R. Sears *pers. comm.* 16 Dec 2012). One individual surfaced several times and very close to the research vessel, allowing numerous photo's to be taken. Another, apparently much larger individual was recorded as a 'probable' sighting (typical colour, very powerful and prolonged blows, but no dorsal fin seen to confirm specific

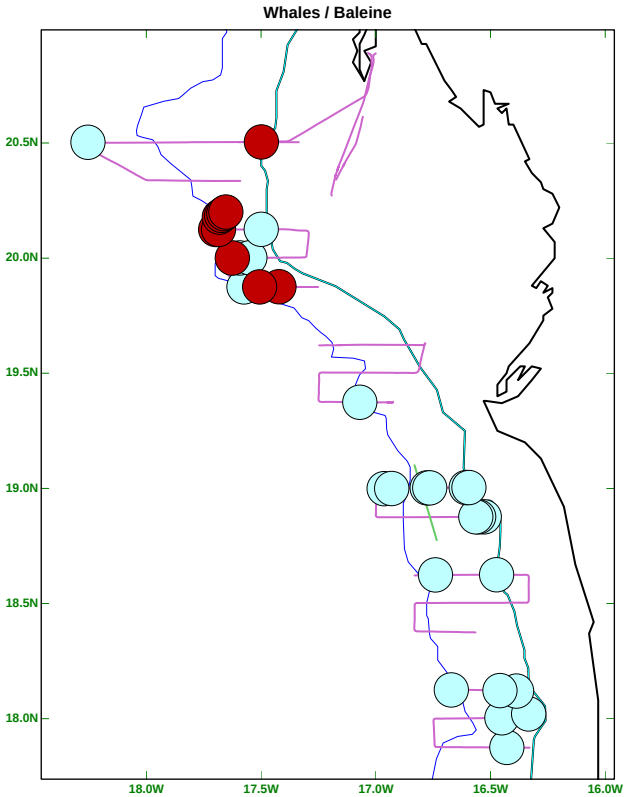


Fig. 65. Sightings baleen whales (blue) and deep-diving toothed whales (red; n), Nov-Dec 2012.

identity). Blue Whales have been observed fro probably the first time in recent history in 2002, when during visual monitoring associated with the 3D seismic survey conducted by Woodside (an Australian oil company) at least two Blue Whales were recorded (Woodside 2003).

The baleen whales seemed to utilise the slope rather than the upper shelf, with some individuals in deeper (oceanic) waters (**Fig. 62**). An overview al all sightings is provided below (**Table 3**).

Blue Whale (HV)

Sperm Whale **Cachalot** *Physeter macrocephalus* (18 records)
beaked whale **Baleine a bec** *Mesoplodon spec.* (3 records)

Two deep-diving species of cetaceans were recorded: Sperm Whales and unidentified beaked whales *Mesopodon* spp., representatives of the Ziphiid family. Sperm Whales are sexually dimorph (adult males much larger than adult females) and the sexes segregate in the Northern Hemisphere summer (males move towards the poles, females and calves remain in (sub-) tropical waters. In winter, the schools of females in warm waters are visited by males for mating.

Three unidentified beak whales were observed just ahead of the ship in the upper slope area of leg B. Features visible during this sighting were confusing enough to prevent identification, but photo's taken during the encounter confirmed the identity of (not specifically identified) beaked whales. One individual had a remarkable hooked, probably damaged dorsal fin.

All Sperm Whales were seen on 8 December 2012 along leg C and sightings comprised 11 solitary individuals and a pod of 7 animals. The calm weather and light breeze made the shape and angle of the blows useful identification criteria. On several occasions identifications could be confirmed when the head, dorsal or flukes (sounding animals) became well visible. All sightings were in a rather small area at the 1000m depth contour (lower slope). Most animals stayed considerable length of time at the surface, frequently 'ventilating' suggesting that most animals were recovering from rather deep dives (Clarke 1976, Gordon & Steiner 1992).

Animals that disappeared did so with an almost vertical tail movement. All Sperm Whales observed must have been exposed to the seismic survey pulses in the area (a seismic survey took place at the time of our survey). Madsen *et al.* (2002) did not detect observable avoidance behaviour of foraging Sperm Whales stayed under such conditions in polar waters. We were unable to obtain useful photographs of flukes for possible photo-identification, nor could be establish the group composition of the observed pod of Sperm Whales (but some smaller blows suggested that at least some young animals were involved. An overview al all sightings of toothed whales is provided below (**Table 3**).

Common Dolphin **Dauphin commun** *Delphinus delphis* (910 records)
Atlantic Spotted Dolphin **Dauphin tacheté Atlantique** *Stenella frontalis* (138 records)
unidentified Stenella's ***Stenella* dauphin esp** *Stenella sp* (150 records)
unidentified dolphin **dauphin** *dolphin* (14 records)

Common Dolphin (HV)

Of the smaller, more agile dolphins, often occurring in large aggregations, two species were identified: Common Dolphins and Atlantic Spotted Dolphins. Common Dolphins are abundant and widespread in warm-temperate or subtropical waters and many populations undertake seasonal migrations (Shirihai & Jarrett 2006). This species can aggregate in thousands of animals. Atlantic Spotted Dolphins are widespread in warm temperate and tropical waters from the Atlantic, from Cape Cod (USA) and the Azores south to Rio Grande (Brazil), Gabon and St Helena (Shirihai & Jarrett 2006). In many parts of their range Atlantic Dolphins occur in waters 20-250m deep, but "regionally much deeper". Occur as residents in some parts of their range. Normally, Atlantic Spotted Dolphins occur in groups of less than 50 individuals (5-15, occasionally to over 200), and schools may segregate by age or sex (Shirihai & Jarrett 2006).

Atlantic Spotted Dolphin (HV)

During daytime surveys, 11 pods of identified dolphins were detected. Common Dolphin pods varied from 20 to *c.* 400 individuals (mean 182 ± 178, n= 5), Atlantic Spotted Dolphins occurred in smaller pods (2-50 individuals, mean 23 ± 20, n= 6). One herd of 150 dolphins could not be identified, but these were rather slender *Stenella* type dolphins that performed particularly acrobatic leaps. All larger groups occurred around the lower slope, over deep oceanic waters, and most were seen on 7 and 8 December (legs E and G; **Fig. 61**). Several of these large groups were travelling fast, some were evidently herding prey. Large groups of dolphins almost always attracted at least some seabirds, including Cory's Shearwater, Sooty Shearwater, European Storm-petrel, Band-rumped Storm-petrel, Leach's Storm-petrel, Northern Gannet, and Pomarine Skua. Observed MSFAs driven by groups of dolphins as beaters (Camphuysen & Webb 1999) include the following sightings:

1 Bottlenose Dolphin, 18 Atlantic Spotted Dolphin, 1 Sooty Shearwater, 3 Northern Gannet, 4 Cory's Shearwater, 8 European Storm-petrel (27 Nov 2012, 20°30.2'N, 17°30.7'W)

50 Atlantic Spotted Dolphin, 15 Northern Gannet (8 Dec 2012, 19°53.7'N, 17°36.7'W)

400 Common Dolphin, 2 Band-rumped Storm-petrel, 3 Leach's Storm-petrel, 122 Northern Gannet (8 Dec 2012, 19°54.6'N, 17°37.7'W)

80 Common Dolphin, 22 Northern Gannet, 2 Pomarine Skua (8 Dec 2012, 19°58.5'N, 17°39.8'W)

350 Common Dolphin, 115 Northern Gannet (8 Dec 2012, 20°7.5'N, 17°33.7'W)

20 Atlantic Spotted Dolphin, 35 Northern Gannet, 130 Scopoli's/Corys shearwater (8 Dec 2012, 20°7.5'N, 17°35.0'W)

The encounters were generally too short to be able to observe any details on species-specific behaviour, other than seabird foraging techniques deployed (if any). In all cases, however, the dolphins attracted seabirds rather than vice versa. Future researchers may wish to evaluate and assess the importance of these foraging opportunities for seabirds wintering offshore in Mauritania in more depth.

Risso's Dolphin **Dauphin de Risso** *Grampus griseus* (20 records)

Risso's Dolphin (HV)

Risso's Dolphins are probably abundant and occur worldwide between 60°N and 60°S usually seaward of continental shelfs (Shirihai & Jarrett 2006). Two sightings involving 20 animals during the Nov-Dec surveys on board Al Awam, both over the lower slope/deep oceanic waters (leg C, leg G; **Table 3**)

Harbour Porpoise **Marsouin commun** *Phocoena phocoena* (3 records)

The distribution of Harbour Porpoises in southern Europe and along the Atlantic African coast is poorly understood, with tentative assessments suggesting a discrete West African population with a northern limit around the Straits of Gibraltar (Smeenk *et al.* 1992, Boisseau *et al.* 2007). Three sightings of solitary animals during the Nov-Dec surveys on board Al Awam, all near Cap Blanc (**Table 3**). One sighting (off effort) at Cap Blanc.

Bottlenose Dolphin **Grand dauphin** *Tursiops truncatus* (15 records)

Bottlenose Dolphins (HV)

A cosmopolitan species, in the Atlantic north to Iceland and south to Patagonia. Many populations segregate into smaller inshore and larger offshore populations (Shirihai & Jarrett 2006). Common in nearshore waters of the Banc d'Arguin where in the past, artisanal fishermen and dolphins co-operated during mullet fisheries (Campredon 2000). During the offshore surveys, one sighting of a solitary animal associated with Atlantic Spotted Dolphins (27 Nov 2012, leg B), two individuals 4 Dec 2012 on the upper slope and a slow moving larger group of 12 individuals 8 Dec 2012 over the lower slope in truly oceanic conditions in an area rich in Sperm Whales (**Table 3**). Only the first sighting involved a feeding frenzy, but the Atlantic Spotted Dolphins were clearly the drivers in this event:

> 1 Bottlenose Dolphin, 18 Atlantic Spotted Dolphin, 1 Sooty Shearwater, 3 Northern Gannet, 4 Cory's Shearwater, 8 European Storm-petrel (27 Nov 2012, 20°30.2'N, 17°30.7'W)

The other sightings involved dolphins that didn't generate an interest by seabirds and that were apparently cruising or travelling.

Mauritanian Monk Seal **Phoques moines de Mauritanie** *Monachus monachus* (1 record)

Foraging Mauritanian Monk Seal with associated Lesser Black-backed Gull (HV)

The Mediterranean monk seal is categorized as Critically Endangered on the IUCN Red List and is in urgent need of effective conservation measures (Pires *et al.* 2008). The largest aggregation of this species is currently found on the Cap Blanc, Mauritania (Gazo *et al.* 2000). One sighting of a solitary animal during the Nov-Dec surveys on board Al Awam near Cap Blanc on 28 Nov 2012 in an area rich in artisanal fisheries. One sighting (off effort) at Cap Blanc, 2 Dec 2012. All sightings are, together with all sightings of cetaceans, summarised and annotated in **Table 3**.

Table 3. All sightings of seals and cetaceans, Nov-Dec 2012 (including some off effort records at Cap Blanc and at sea).

Species	Poskey	Dd	Mn	Yy	Hr	Min	Latitude	Longitude
3 beaked whale	180,001,958	27	11	2012	8	15	20.504	-17.498
Identification from photo; confusing features during sighting (colour, one with hooked dorsal, other with triangular dorsdal, slow movements); beak and brown body colour (photo's) diagnostic								
18 Atlantic Spotted Dolphin	180,001,959	27	11	2012	8	20	20.504	-17.511
1 Bottlenose Dolphin	180,001,959	27	11	2012	8	20	20.504	-17.511
1 unpatterned dolphin	180,001,960	27	11	2012	8	25	20.504	-17.524
3 unidentified dolphin	180,001,962	27	11	2012	8	35	20.503	-17.549
3 Atlantic Spotted Dolphin	180,001,987	27	11	2012	10	40	20.503	-17.858
3 unidentified dolphin	180,002,014	27	11	2012	12	55	20.501	-18.188
2 Fin Whale	180,002,020	27	11	2012	13	25	20.502	-18.255
1 Mediterranean Monk Seal	180,002,115	28	11	2012	13	30	20.665	-17.059
1 Mediterranean Monk Seal	off effort	2	12	2012			20.767	-17.050
1 Harbour Porpoise	off effort	2	12	2012			20.767	-17.050
1 Harbour Porpoise	180,002,184	3	12	2012	13	25	20.814	-17.020
1 Harbour Porpoise	180,002,185	3	12	2012	13	30	20.803	-17.023
1 Harbour Porpoise	180,002,188	3	12	2012	13	45	20.772	-17.027
20 Common Dolphin	180,002,246	4	12	2012	7	40	19.622	-17.205
2 Bottlenose Dolphin	180,002,295	4	12	2012	11	45	19.539	-16.807
2 unidentified dolphin	180,002,355	4	12	2012	16	45	19.375	-17.139
1 Blue Whale	180,002,361	4	12	2012	17	15	19.374	-17.070
Confirmed sighting, photo's show diagnostic characteristics, identification conclusive during sighting								
40 Common Dolphin	off effort	4	12	2012	23	0	18.535	-16.481
1 whale	180,002,380	5	12	2012	7	45	18.624	-16.740
Balaenoptera spec, conspicuous blow								
1 whale	180,002,408	5	12	2012	10	5	18.625	-16.473
Balaenoptera spec, conspicuous blow								
1 Blue Whale	180,002,514	6	12	2012	8	0	17.875	-16.428
Probable; very large, powerful and particularly prolonged blow, large part of back but no dorsal seen, characteristic greyish/blueish colour on Photo								
1 Blue / Fin / Sei Whale	180,002,580	6	12	2012	13	30	18.003	-16.450
Powerfull blow, no further details on fin								
1 Sei / Brydes Whale	180,002,591	6	12	2012	14	25	18.020	-16.333
Clear and fairly tall but thin blow, no confirming details								
1 Bryde's Whale	180,002,604	6	12	2012	15	30	18.119	-16.386
Clear and fairly tall but thin blow, sickle shaped dorsal, not as tall and 'nicked' as in Sei Whale								
1 Blue / Fin / Sei Whale	180,002,610	6	12	2012	16	0	18.122	-16.459
Powerfull blow, no further details on fin								
1 Sei / Brydes Whale	180,002,628	6	12	2012	17	30	18.125	-16.671
Clear and fairly tall but thin blow, tall dorsal, great distance								
9 Risso's Dolphin	180,002,631	6	12	2012	17	45	18.125	-16.706
Slow swimming compact herd, one individual tail slapping								
2 Atlantic Spotted Dolphin	180,002,633	6	12	2012	17	55	18.125	-16.729
Shortly some immatures at the bow, possibly part of larger pod								
2 Common Dolphin	off effort	6	12	2012	21	10	18.334	-16.688
30 Common Dolphin	off effort	6	12	2012	23	0	18.433	-16.653
All night (?) attending ship in large numbers with night feeding gulls and terns and shearwaters following the boat								
1 whale	180,002,637	7	12	2012	7	25	18.876	-16.527
1 Humpback Whale	180,002,639	7	12	2012	7	35	18.876	-16.552
Bushy blow 4x, typical dorsal 1x very clear, once not very well visible								
1 Sei / Brydes Whale	180,002,640	7	12	2012	7	40	18.876	-16.564
45 Atlantic Spotted Dolphin	180,002,675	7	12	2012	10	35	18.875	-16.983
Splitting herd, small portion at the bow, some in the wake, most older animals passed on; all								

Species	Poskey	Dd	Mn	Yy	Hr	Min	Latitude	Longitude
characteristics well documented (photo & film)								
1 Humpback Whale	180,002,695	7	12	2012	15	15	18.999	-16.963
Swimming fairly steady, blow missed, typical dorsal twice								
150 unidentified *Stenella* dolphins	180,002,695	7	12	2012	15	15	18.999	-16.963
Very distant broad front herd, acrobatic (spinning) leaps and porpoising, massive splashes, *Stenella* body shape, no colour details								
1 Blue / Fin / Sei Whale	180,002,698	7	12	2012	15	30	18.999	-16.930
Just very large and powerful, towering 'rorqual' blow twice, no body details								
1 Bryde's Whale	180,002,712	7	12	2012	16	40	19.002	-16.776
Probably (unconfirmed sighting); Swimming as a Minke Whale, no visible blow, but dorsal as Brydes (not Sei)								
1 whale	180,002,713	7	12	2012	16	45	19.002	-16.765
Just a blow by one of the observers								
1 Bryde's Whale	180,002,727	7	12	2012	17	55	19.004	-16.605
Probably (unconfirmed sighting); Very slow and superficial surfacing, no visible blow, blowhole at the same time as prominent dorsal								
1 Bryde's Whale	180,002,728	7	12	2012	18	0	19.004	-16.594
Probably (unconfirmed sighting); Very slow and superficial surfacing, no visible blow, blowhole at the same time as prominent dorsal								
1 Sperm Whale	180,002,747	8	12	2012	8	25	19.875	-17.422
Frequent forward blows								
7 Sperm Whale	180,002,754	8	12	2012	9	0	19.875	-17.506
Estimated 6-8 animals, frequent bushy blows under angle, confirmation from dorsals, tailstocks and raised flukes indicating deeper dives								
1 Fin Whale	180,002,760	8	12	2012	9	30	19.875	-17.574
Tall vertical blows; a glimpse of the dorsal fin confirmed identity; seen at fairly long range								
50 Atlantic Spotted Dolphin	180,002,764	8	12	2012	9	50	19.895	-17.611
With associated Northern Gannets; did not approach research vessel; spectacular acrobatic leaps by some (younger) individuals								
400 Common Dolphin	180,002,766	8	12	2012	10	0	19.911	-17.628
Large herd, travelling fast with associated Northern Gannets; herd splits up near vessel (a few dozens approach the ship, rest continues). Numerous slides								
80 Common Dolphin	180,002,773	8	12	2012	10	35	19.975	-17.663
Apparently foraging herd of dolphins, does not approach ship, numerous associated Northern Gannets								
1 Sperm Whale	180,002,778	8	12	2012	11	0	20.000	-17.625
Frequent forward blows								
2 Humpback Whale	180,002,781	8	12	2012	11	15	20.000	-17.592
Evidently feeding; lobtailing, frequent blows, surfacing sideways at times (showing flippers); apparently lunge-feeding								
11 Risso's Dolphin	180,002,782	8	12	2012	11	20	20.000	-17.582
Pod of at least 11 animals including at least 1 young calf, 2 older (whitish) individuals, rest scarred/grey Photo's available								
5 unidentified dolphin	180,002,785	8	12	2012	11	35	20.001	-17.549
Little more that distant splashesof leaping dolphins; no details								
1 whale	180,002,785	8	12	2012	11	35	20.001	-17.549
vertical blows, 3x, long intervals								
1 whale	180,002,834	8	12	2012	15	40	20.125	-17.499
faint vertical blow, small species or small individual								
350 Common Dolphin	180,002,839	8	12	2012	16	5	20.125	-17.561
Fast moving large herd along flotsam front, a least 115 associated Northern Gannets								
20 Atlantic Spotted Dolphin	180,002,841	8	12	2012	16	15	20.125	-17.586
Dark and large individuals difficult to identify at first; photo's confirmed identification; apparently feeding with big group of pursuit plunging Cory's Shearwaters								
1 Sperm Whale	180,002,849	8	12	2012	16	55	20.124	-17.685
Shows flukes for deep dive; characteristic frequent forward blows								
1 Fin Whale	180,002,850	8	12	2012	17	0	20.124	-17.698
Not very tall but vertical blows; dorsal fin seen twice provides opportunity for identification								

Species	Poskey	Dd	Mn	Yy	Hr	Min	Latitude	Longitude
1 Sperm Whale	180,002,850	8	12	2012	17	0	20.124	-17.698
Characteristic blows								
60 Common Dolphin	180,002,855	8	12	2012	17	25	20.127	-17.749
Distant rapidly porpoising group, does not approach ship, powerful bins reveal characteristic side patterns for ID								
1 Sperm Whale	180,002,862	8	12	2012	18	0	20.178	-17.682
1 Sperm Whale	180,002,863	8	12	2012	18	5	20.185	-17.672
1 Sperm Whale	180,002,864	8	12	2012	18	10	20.192	-17.663
All three solitary, frequent characteristic blows								
12 Bottlenose Dolphin	180,002,864	8	12	2012	18	10	20.192	-17.663
Slow moving group, large individuals, numerous photo's								
1 Sperm Whale	180,002,865	8	12	2012	18	15	20.200	-17.653
Raised flukes for deep dive; characteristic blows								

Other charismatic megafauna

sea turtle **Tortue** *(unidentified) sea turtle* (2 records)
Loggerhead Turtle **Tortue carette** *Caretta caretta* (9 records)
Hawksbill Turtle **Tortue imbriquée** *Eretmochelys imbricate* (1 record)

Loggerhead Turtle (HV)

Sea turtles are under threat around the world. Six of the world's seven species of sea turtles occur in Mauritanian waters (Brongersma 1995, Fretey 2001). The commonest species are the Green Turtle *Chelonia mydas* and the Loggerhead *Caretta caretta.* The latter *species* is not well studied, but Mauritania constitutes probably the most northern breeding limit on the Atlantic coast of the African Continent. Nesting has been documented on the southern half of the Mauritanian coast.

Identification in the field is far from easy for as far as hard-shelled turtles are concerned and we used characteristics such as shell contours and facial plates whenever possible. Most animals were thought to be Loggerhead Turtles, but only two sightings could be confirmed using photographs. Turtles were exclusively seen in oceanic waters (lower slope and deep ocean waters (**Fig. 66**). Few (3) turtles were seen when SST and SSS were recorded on board, but most sightings were in areas with relatively high values for both. Legs B and C produced the most sightings, including two of animals at a frontal zone mid-slope (leg C).

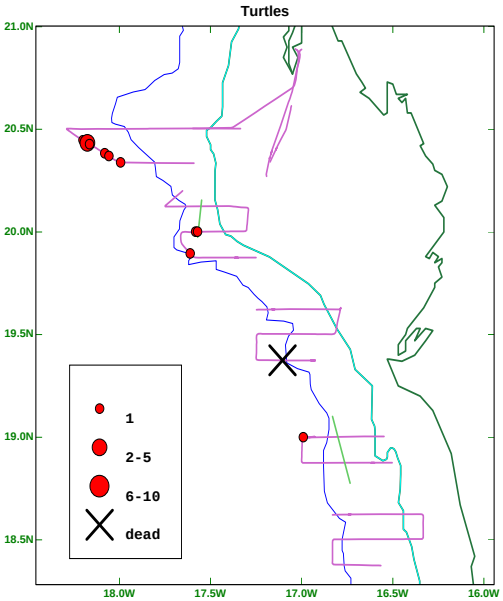


Fig. 66. Sightings of turtles (red, n) and location of a floating carcass of an unidentified individual, Nov-Dec 2012.

One sighting was re-identified later and this involved the critically endangered Hawksbill Turtle, an extremely rare species in Mauritanian waters (see image; observed 27 Nov 2012, 14:26 h, 20°18'N, 18°12'W). Human fishing practices currently threaten *E. imbricata* populations with extinction (World Conservation Union).

Hawksbill Turtle (H. Verdaat)

Smooth Hammerhead Shark *Sphyrna zygaena*
(5 records)
unidentified shark Requin *unidentified shark*
(4 records)
Sailfish *Istiophorus platypterus* (1 record)
Swordfish *Xiphias gladius* (1 record)

Smooth Hammerhead Shark (HV)

Most sharks, rays and fish remain hidden for ship-based observers, but every now and then a glimpse of their presence can be recorded. Sharks are usually the more prominent 'large fish' with dorsal and tail fins breaking the surface, rays and large "game fish" normally pass by unseen.

Nine sharks were recorded, several of which were Smooth Hammerhead sharks. None of these were photographed and the photo of a dorsal fin of a Smooth Hammerhead in the header of this paragraph was taken by chance: a shark was apparently present in the periphery of the tuna driven fish school described under Cory's Shearwater. The animal was either just attracted by the spectacle or participated in the frenzy.

The surface sightings of large fish are useless to quantify their relative abundance in a given area. Over time, further records in given habitats could provide insight in their offshore habitat preferences. Both big "game fish" were seen over deep water oceanic conditions. Sharks and rays were seen mostly in the slope area.

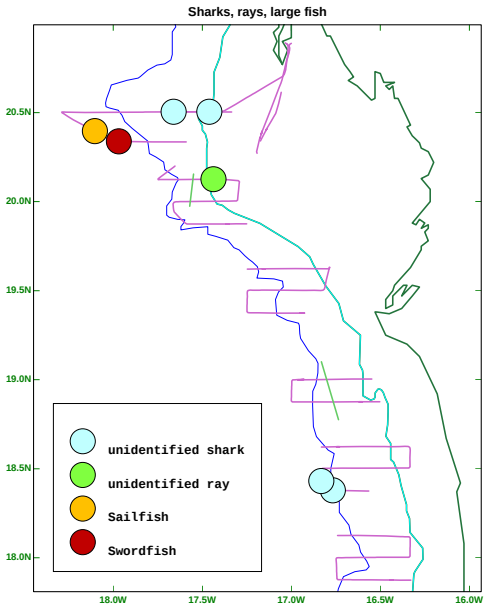


Fig. 67. Sightings sharks, rays and large fish at the surface, Nov-Dec 2012.

Fishery activities

Pirogue in rough weather far out at sea; type 2 Northern Gannet in foreground (CJC)

Earlier seabird surveys, worldwide, have demonstrated the importance of commercial fisheries for seabirds, or at least provided evidence for mass occurrences of certain species of seabirds in areas where fishing fleets operated (Bailey & Hislop 1978, Abrams 1983, Burger & Cooper 1984, Bailey 1989, Camphuysen & Garthe 2000, Arcos 2001, Camphuysen 2001b, Camphuysen & Van der Meer 2005). In order to investigate these relationships, during ship-based seabird surveys, part of the protocol is to systematically record the presence of fisheries (as a "habitat characteristic"). For every 5-minute period, any fishing vessels within reasonable view have been logged. A small deviation from the standard protocol in Mauritania was that trawlers were separated from Pirogues. Moreover, net floats at the surface (used to mark the presence of drift nets, set-nets or octopus pods) were recorded as if they were seabirds on water: numbers of floats within the 300m transect and outside have been noted.

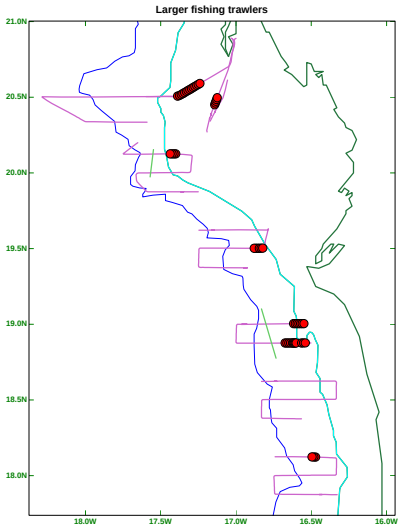


Fig. 68. Presence of commercial fishing trawlers during surveys, 27 Nov-8 Dec 2012 (any boats visible)

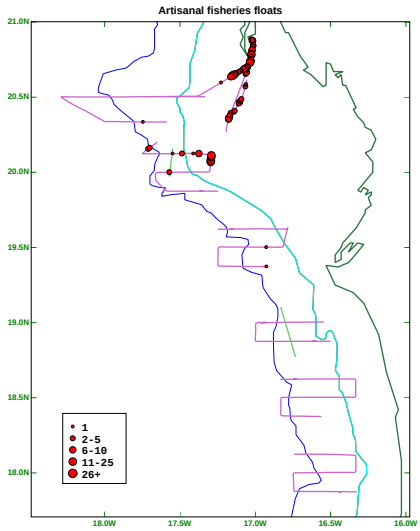


Fig. 69. Artisanal fisheries plastic floats within 300m on either side of the ship indicating set-nets, lines or octopus pods.

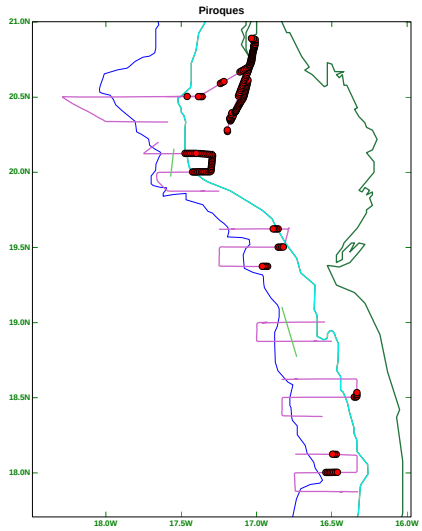


Fig. 70. Presence of artisanal Pirogues during surveys, 27 Nov-8 Dec 2012 (any boats visible)

(Trawler) fisheries opened on 1 December 2012, and only Pirogues had been encountered at sea before that date. The occurrence of fisheries was highly clumped (**Figs. 68-70**), with some trawler fisheries at the upper slope and over the shelf just to the south of Cap Blanc. Artisanal fisheries were abundantly represented south of Nouadhibou and close to the shelf break at leg C. To the south of 20°N Pirogues were rather rare and floats were

only occasionally encountered. Large freezer trawlers (common in earlier surveys over the slope, e.g. Camphuysen & Van der Meer 2005) were not seen anywhere during our surveys.

In total, 341 km² (1135 km) has been surveyed, of which 262 km² (873 km), or 77% of the total strip-transects, without any fishing vessels visible. Some 15% of the time (125 of 921 5-minute periods), however, either some Pirogues or trawlers, occasionally both, were within visible range (79 km², or 262 km transect work). There are some indications that Pomarine Skuas and Lesser Black-backed Gulls occurred in considerably higher densities with commercial fisheries nearby (**Table 4**). The reverse was true for Cory's Shearwaters and for Northern Gannets commercial fisheries nearby did not seem to have an effect on recorded densities.

Table 4. Recorded densities (n km^{-2}) of some seabirds with and without commercial fisheries within visible range, Nov-Dec 2012.

	Cory's Shearw	Gannets	Pom Skuas	L Bl Gulls
trawlers and Pirogues visible	0.04	9.36	0.33	0.50
no fisheries visible	38.21	12.52	0.09	0.07

Though fisheries were within during only 15% of the survey time, 38% of all Pomarine Skuas (n= 1714, own ship followers excluded) and 55% of all Lesser Black-backed Gulls (n= 526) were seen with at least some commercial fisheries around. These results seem to confirm a strong reliance on fisheries activities in the area for at least two species of seabirds.

Discussion

The surveys conducted on board Al Awam produced sightings of 36 species of seabirds, 11 cetaceans, one seal and one sea turtle. Of the seabirds, three comparatively scarce species were from Southern Hemisphere origin, 26 species were Palaearctic (arctic regions, NW Europe and the Mediterranean) and only seven species were more or less local species (Macaronesian region, Mauritania included). The cetaceans included 5 species of whales, 5 dolphins and unidentified beaked whales.

As in earlier surveys, a distinct north-south pattern in species abundance was found. Whether based on all seabirds seen around the ship (n km^{-1}) or on birds within the strip-transect densities, n km^{-2}), the storm-petrel family was most abundant along the northernmost trajectories (legs A-B, **Figs. 71-72**), shearwaters peaked just south of this area (leg C) and Northern Gannets, albeit widespread, reached particularly high densities in legs C-D. Grey Phalaropes and Pomarine Skuas were next in line with peak densities southwest of Cap Timiris (leg E). Lesser Black-backed Gulls were encountered in high numbers only near Nouadhibou and off

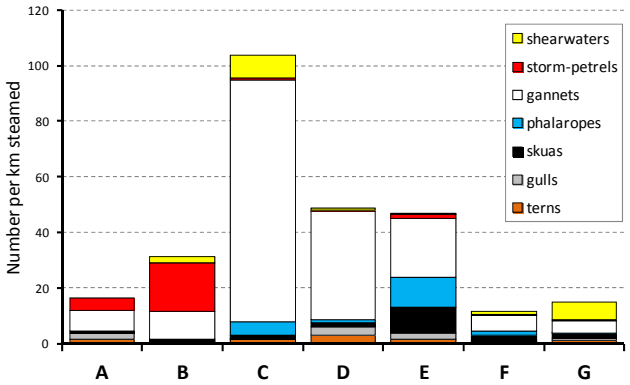


Fig. 71. Total number of birds per km steamed, 27 Nov-8 Dec 2012 (ship-followers excluded)

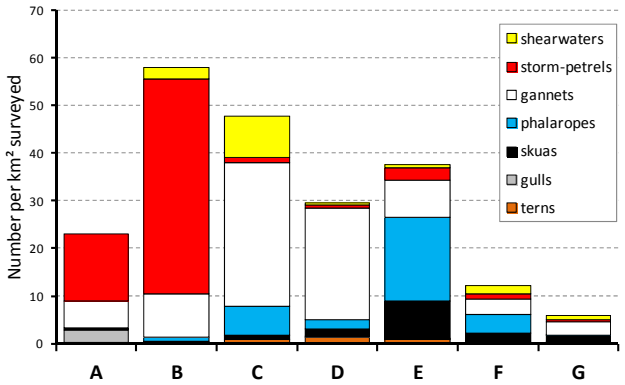


Fig. 72. Density of birds (n km^{-2}) based on strip-transect counts, 27 Nov-8 Dec 2012

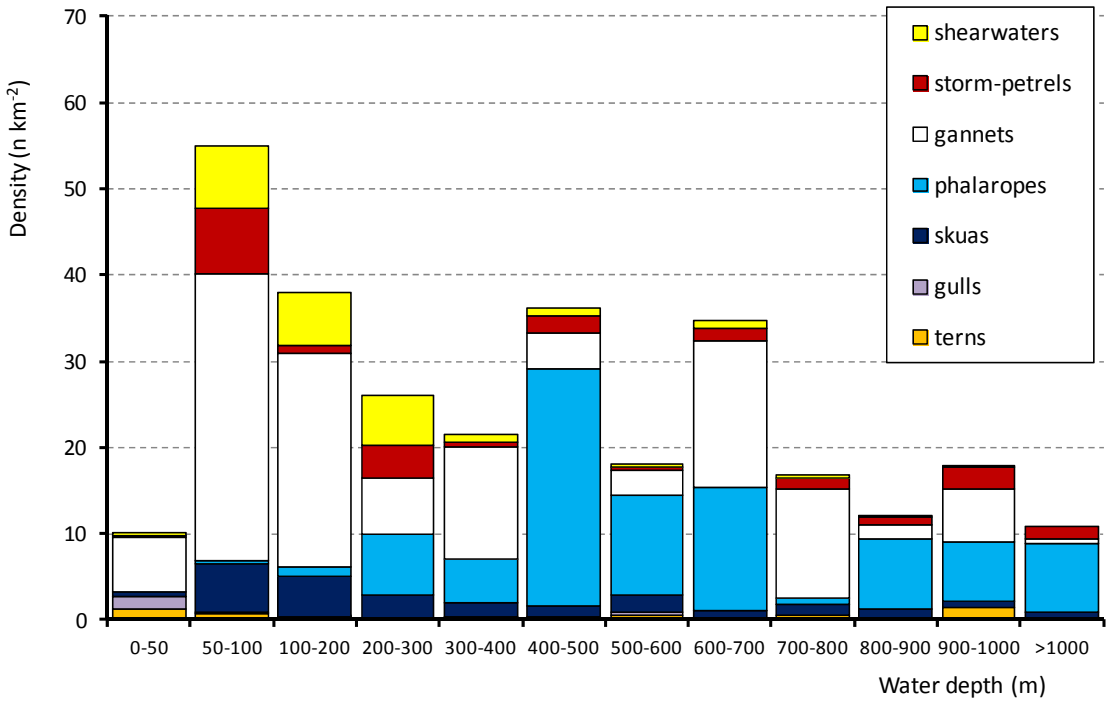


Fig. 73. Density of birds (n km^{-2}) based on strip-transect counts in waters of different depth (m), IMROP echo-sounding data, 3-8 Dec 2012.

Cap Blanc (leg A), while terns reached their highest densities off the Banc d'Arguin and Cap Timiris (legs C-E). Just as in the January surveys in 2000 (Camphuysen & Van der Meer 2005), did the species composition vary from leg to leg.

A summary of sightings data over waters of different depth shows that relatively low densities were found in the shallowest regions, rather high densities around the upper slope (50-200m depth), and variable densities further down the shelf break (**Fig. 73**). Species composition is clearly different from shallow to deep waters, further underpinning the species-specific habitat characteristics that will be revealed when larger numbers of data can be merged and analysed, using the exact same or highly similar survey techniques.

Table 5. Habitat characteristics of three surface foraging, planktivorous seabirds off Mauritania: densities (n km^{-2}) of Grey Phalaropes, Band-rumped Storm-petrels and European Storm-petrels relative to sea surface temperature (SST, °C, vertical axis) and sea surface salinity (SSS, ‰, horizontal axis), 3-8 Dec 2012 (legs B-G).

Observer effort (km²)					
°C\‰	35	36	37	38	
16		3.9	0.4		
17	0.8	50.4			
18	1.6	40.4	16.0	1.1	
19		13.2	35.4		
20			21.3		
21			1.1		

Grey Phalaropes (n km^{-2})					
°C\‰	35	36	37	38	
16		0.0	0.0		
17	0.0	0.1			
18	0.0	1.3	11.2	0.0	
19		9.6	7.0		
20			14.7		
21			0.0		

Band-rumped Petrels (n km^{-2})					
°C\‰	35	36	37	38	
16		0.0	0.0		
17	0.0	0.0			
18	0.0	0.2	0.4	0.0	
19		0.0	0.2		
20			1.1		
21			6.1		

Europ Storm Petrels (n km^{-2})					
°C\‰	35	36	37	38	
16		0.0	0.0		
17	0.0	5.0			
18	0.6	1.7	0.1	0.0	
19		0.2	0.9		
20			2.0		
21			0.9		

Three of the commoner species can be ranked as planktivorous seabirds and the results in **Fig. 72** suggest that storm-petrels and phalaropes concentrate on different areas off Mauritania. Further, more subtle evidence for resource partitioning can be derived from the observed differences in exact habitat characteristics based on SST and SSS (**Table 5**). Grey Phalaropes seem to occupy a mid-position between the more oceanic

Band-rumped Storm-petrels and more shelf-orientated European Storm Petrels, by concentrating their efforts of surface waters with intermediate values of both temperature and salinity. Communal feeding of phalaropes and storm-petrels has indeed never been observed during these surveys.

A further difference between these planktivorous seabirds were tendencies to concentrate at flotsam accumulations (surface fronts). Only 0.5% of all storm-petrels observed (n= 4876) were associated with clear lines and flotsam accumulations at the sea surface. By contrast, 40% of all phalaropes were recorded as associated with flotsam (floating sea grass included) or clear foam lines.

Red tide (algal bloom), 27 Nov 2012, 20°30'N, 18°02'W – 18°16'W, and associated Grey Phalaropes (bottom image; CJC).

A striking but otherwise rather unusual example was observed on 27 November 2012, when over deep oceanic waters (beyond the 1000m depth contour) numerous red lines were encountered; reddish foam resulting from an algal bloom (dead and dying algae) mixed with small quantities of flotsam attracted Grey Phalaropes. This area was otherwise a key habitat for Band-rumped Storm-petrels (high SST, high SSS), birds that indeed reached peak densities in exactly this area, but none of these birds occurred in association with the "red tides". This striking difference between two plankton specialists could have resulted from different searching techniques or different prey preferences. Storm-petrels are known to use olfactory cues while foraging (Grubb 1972). Phalaropes are typically observed slowly swimming forward while foraging on marine neuston concentrated in surface convergence zones (using visual cues; DiGiacomoa *et al.* 2002).

Associations of phalaropes with free-floating seagrass have been seen before (CJC *pers. observ.*), but for the first time have we been able to sample flotsam from the seagrass. Numerous fish larvae, small juvenile and several crustaceans including copepods and Idoteidae.



Floating seagrass samples: (left) sampling, (right) fish larvae, unidentified juvenile fish and crustaceans collected, and (right) free-floating seagrass (TvS, HV, CJC)

Small-scale coastal ocean fronts, eddies and internal waves capable of generating convergences at the surface are common, albeit ephemeral, in Senegalese, Mauritanian and West Saharan waters (Brown 1979, Camphuysen 2003). Apparently, these features are particularly important for phalaropes and their general location is probable quite predictable. A striking example of the visibility of a mid-slope front passage was photographed on 7 Dec 2012, around 16:10 local time (photograph below). In rough seas, a front passage goes undetected, except for the instruments measuring water properties. In calm conditions, a marked change in the avifauna can be predicted when such fronts are crossed and relatively rich and diverse bird life can be expected at or near the boundary zone. In the illustrated case below, SST was similar on either side of the front, but SSS dropped markedly on the east side (steaming towards the shelf).

Front passage, 7 Dec 2012, 16:10, 19°00'N, 16°51'W, steaming eastward, towards the shelf. Grey Phalaropes were abundant and associated with floating sea grass on this side to the front, but completely absent beyond the visible dark line (CJC).

Fish, zooplankton and phytoplankton in the study area are usually concentrated along the shelf edge and upper slope where relatively cool, nutrient-rich, upwelled waters are brought to the surface (Camphuysen 2003, Wynn & Knefelkamp 2004). Except around, the deeper waters further offshore along most of the shelf break, with higher SSTs and SSSs, are not influenced by the upwelling and are therefore less attractive to most seabirds. A most productive area off Northwest Africa is around Cap Blanc (21°N), where the upwelling is particularly strong in winter and summer and where long "filaments" of 200 km long with high plankton concentrations enter the oligotroph ocean environment (Dec-Mar; Jones & Halpern 1981, Grall *et al.* 1982, Postel 1982, Weikert 1984, Lange et al., 1998; Hagen 2001). The reason that so many seabirds gather in these waters throughout the year

must be the large and predictable resources at many trophic levels (phytoplankton, zooplankton, fish). Camphuysen & Van der Meer (2005) and several other authors found high concentrations of piscivorous seabirds in this area, and the surveys in Nov-Dec 2012 have confirmed these earlier observations. While many seabirds can be seen to gather around fishing vessels (if present), the offshore waters of Mauritania must have attracted seabirds for many centuries, well before human offshore fisheries occurred at any significant scale.

Trawler at the horizon and resting artisanal Pirogues on the foreground, shelf break, 8 Dec 2012, 20°07.5'N, 17°23.6'E (CJC)

The surveys in November 2012 were prior to the opening of the trawler fisheries off Mauritania and fleets were still rather small in the first week of December 2012. This offered a fairly unique opportunity to investigate the *natural* distribution of fish-eating seabirds. Natural MSFAs have indeed been encountered, but because these frenzies are rather short-lived (Camphuysen & Webb 1999), more effort is required to fully understand the interspecific interactions and the driving forces within this area. Particularly impressive, however, were the massive feeding frenzies of Northern Gannets, totally independent of any human fisheries, fishing in large flocks in certain areas southwest of Cap Blanc and beyond. Given the fact that individual gannets immediately alighted on the sea to preen after only a few plunge dives, the foraging success rates must have been high in these situations (Northern Gannets often try to feed until they are too heavy to fly, and sit their digestion out on the spot while preening or sleeping; Camphuysen *et al.* 1995).

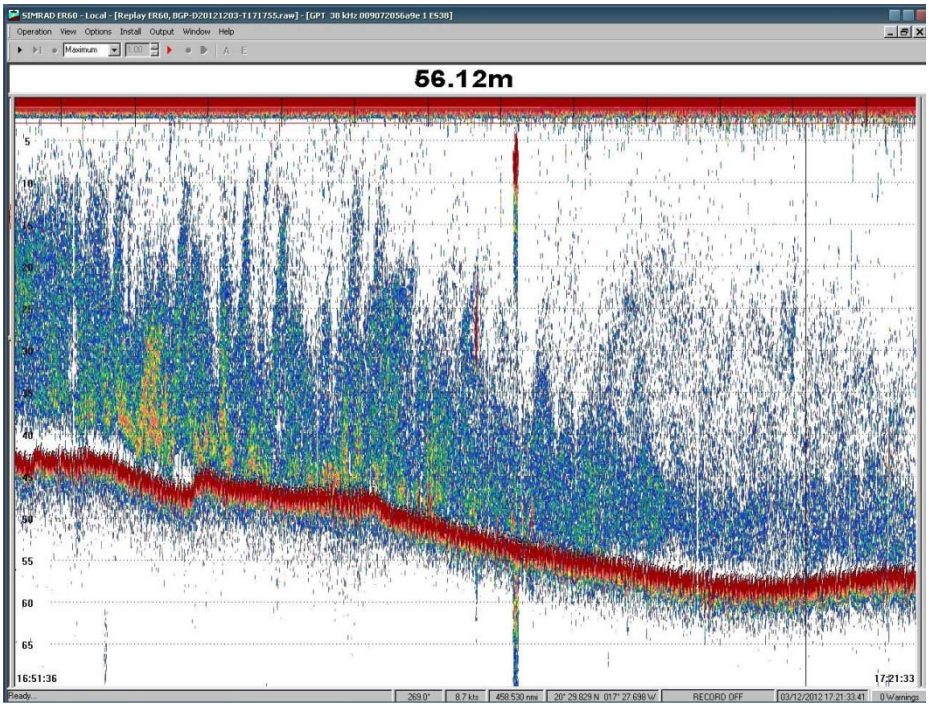


Fig. 74. Near-surface detections of large fish school (red) in an area with 30 plunge diving Northern Gannets. Poskey 180002228, 3 Dec 16:50-17:20 → 3000, 2000, 19000, and 1000 Sa (m/mn^2).

Acoustic recordings and foraging Northern Gannets – All feeding activities of Northern Gannets have been logged throughout the survey and all substantial groups (>25 individuals) of actively foraging Northern Gannets logged between 3 and 8 December were listed to be compared with the results of the acoustic monitoring. As

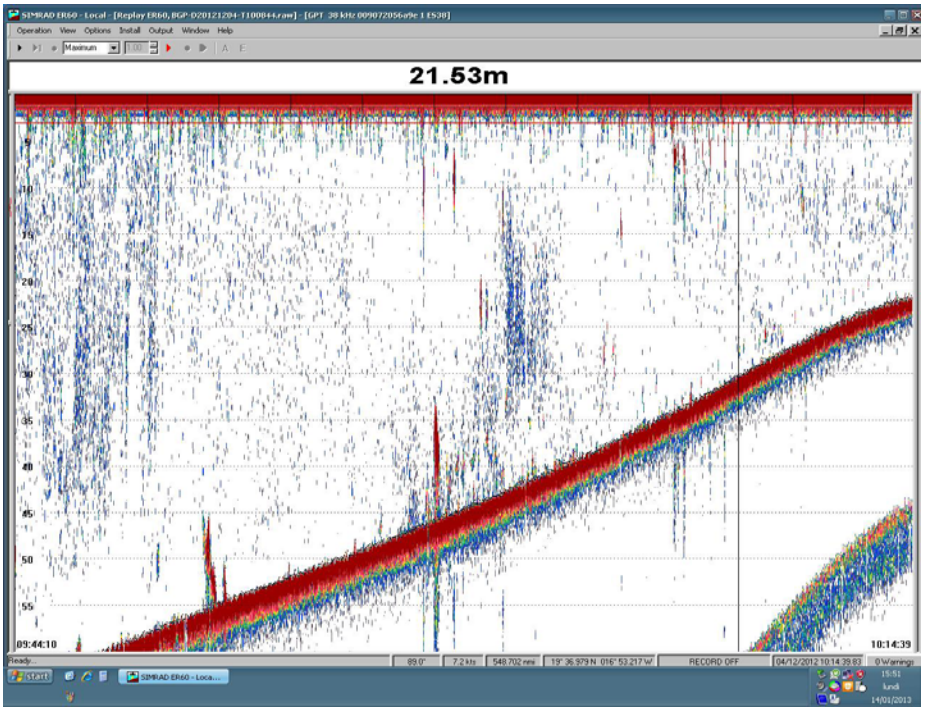


Fig. 75. Near-surface detections of fish (red) or plankton (blue), possibly within reach of birds. Poskeys 180002271-5 foraging frenzies including Northern Gannet (151), Pomarine Skua (2), Great Skua (1), Common Tern (1), Mauretanian Royal Tern (2), Sandwich Tern (10). 4 Dec 09:45-10:15 → 6400, 39200, 14100, 8500, and 2200 Sa (m/mn^2)

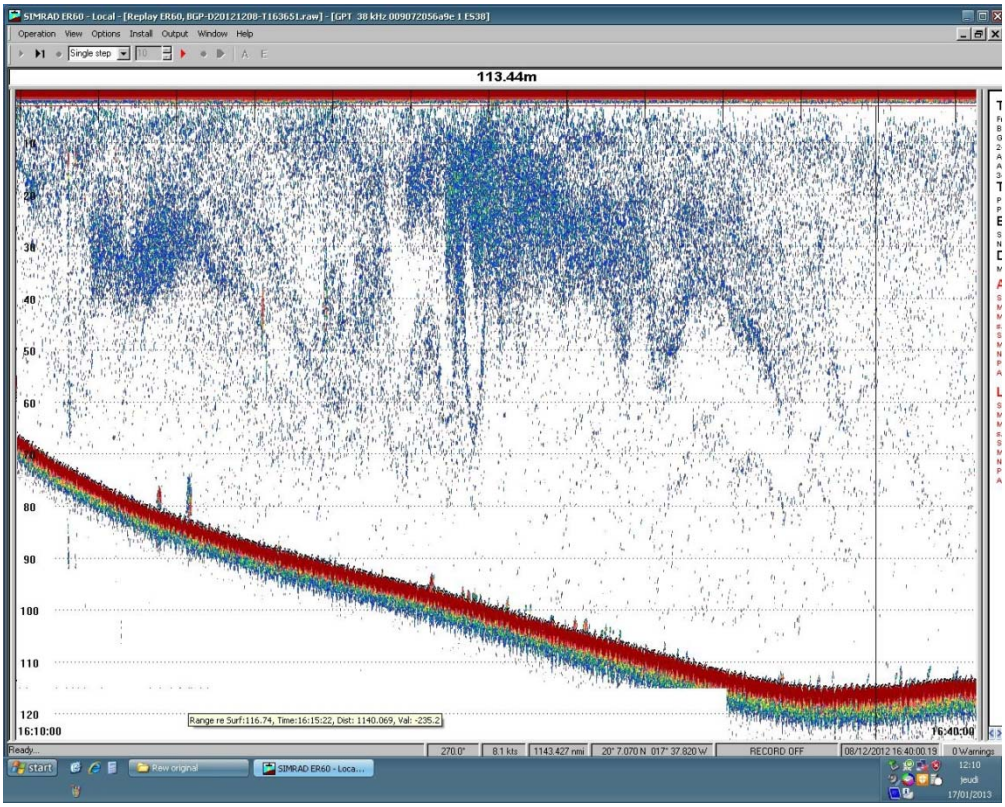


Fig. 76. Near-surface detections of fish (red) or plankton (blue), in an area with very large feeding frenzies of Northern Ganets. Poskeys 180002843-foraging frenzy including 2600 Northern Gannet (16:25). 8 Dec 16:10-16:40 → 670, 1000, 300, and 130 Sa (m/mn^2).

usual, not unexpected given the highly patchy nature of predators and prey, few clear indications of high, accessible fish abundances were found in areas with plunge diving gannets: both the birds and the fish needed to be exactly on the trackline in order to be recorded simultaneously. Some positive examples are illustrated below, the first showing a large and compact (clupeoid?) fish school where 30 Northern Gannets were actively plunge diving (**Fig. 75**). A second example shows small fish schools near the surface in an area where numerous Northern Gannets and other seabirds were foraging (**Fig. 76**).

Some very large feeding flocks of Northern Gannets occurred in areas where large fish schools occurred at or near the sea floor, but where the water column underneath the ship did not seem to hold particularly vast quantities of schooling fish (**Figs. 77-78**).

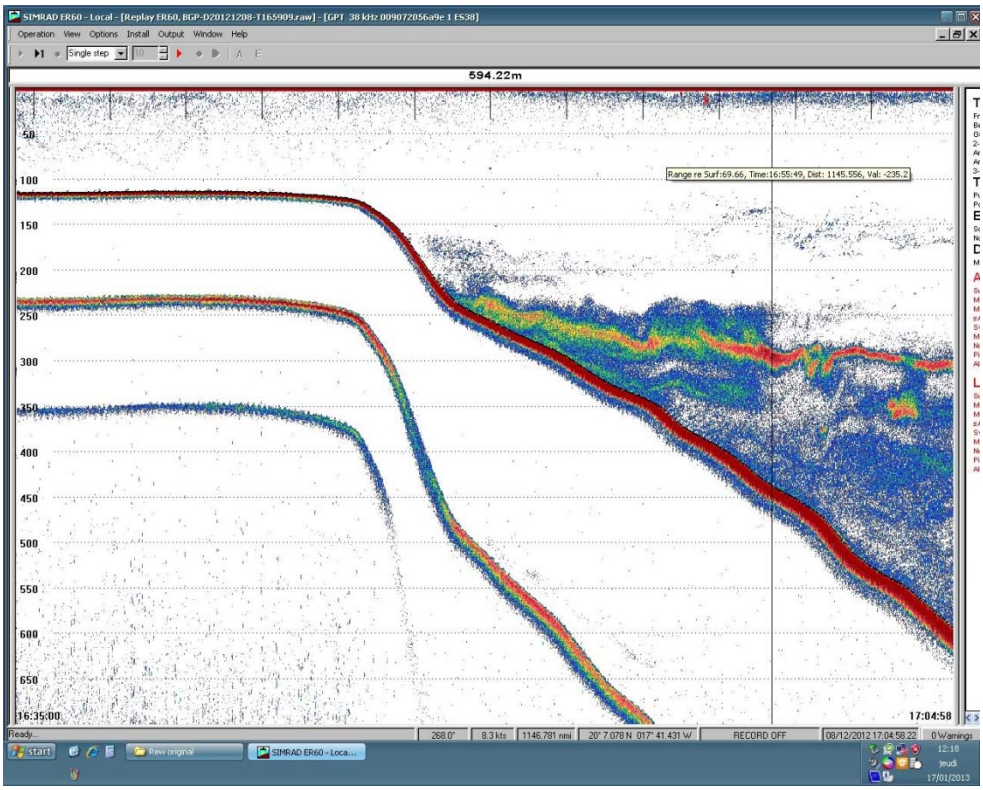


Fig. 77. Detections of fish (red) or plankton (blue), in an area with very large feeding frenzies of Northern Ganets. Poskeys 180002845-foraging frenzy including 1700 Northern Gannet (16:35). 8 Dec 16:10-16:40 → 130, 3000, 24000, and 18000 Sa (m/mn^2).

The significance of the area for marine mammals – The Monk Seal population at Cap Blanc is one of the last strongholds of a critically endangered population of marine mammals (Gazo *et al.* 2000, Pires *et al.* 2008, Shirihai & Jarrett 2006). With regard to cetaceans, the significance of these waters is less clear, but there is mounting evidence that the rich resources in the Canary Current, Mauritanian waters included, attract a large variety of cetaceans, even including critically endangered species such as Blue Whales (Burton & Camphuysen 2003, Camphuysen 2003, Van Waerebeek *et al.* 2003, Boisseau *et al.* 2007, Morissette *et al.* 2010, Pinela *et al.* 2010, Sears *et al.* 2012, Van Waerebeek *et al.* 2012). With the slowly recovering North East Atlantic stocks of the great whales, the significance of Mauritanian waters is easily underestimated and in line with Brown (1979), the upwelling may currently "underexploited" by cetaceans, in contrast to comparable upwelling systems elsewhere, because the stocks are still very small (overharvested in earlier centuries) and fragile. Further studies are urgently required to assess the abundance and species composition of whales and dolphins off Mauritania (using line-distance techniques) and to deepen our knowledge of trophic interactions between all predators in the area (human fisheries included; Gascuel *et al.* 2007) and their prey.

The analysis of fish abundance (quantity of fish, shoaling structures) with the Simrad ER 60 echo integration system was performed "double blind". The operator had not been at sea and the analysis was conducted without any previous knowledge of the observations of megafauna onboard the Al Awam. One screenshot was presented as "échos mammifère", thought to represent echo's of marine mammals under the keel (**Fig. 79**). If the echo's indeed represented marine mammals, numerous individuals occurred around a termocline at 300-350 m depth. At the time of these recordings, at least 400 common Dolphins travelled through the area, and approached and surrounded the research vessel.

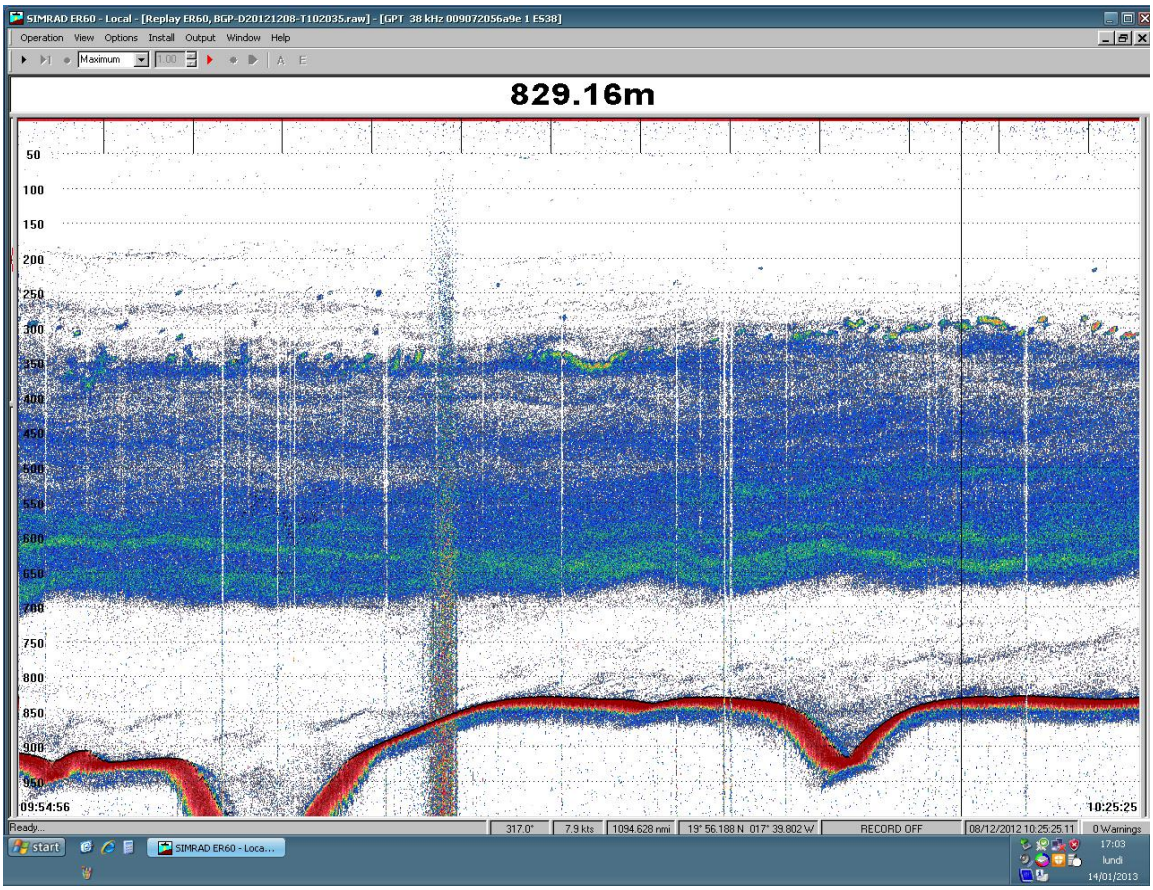


Fig. 78. *"échos mammifère.jpg"* Poskey 180002766, 19.9108°N, 17.628°W, 400 *Delphinus delphis* around the ship, 8 Dec 2012, 10:00h 8 Dec 09:55-10:25 → 1400, 6700, 2200, and 2200 Sa (m/mn^2).

Sensitivity of the area to oil pollution – This report, in line with a slowly increasing number of publications, many of which cited in this report, discussed the significance of Mauritanian waters for seabirds of two Hemispheres, breeding in Antarctic as well as in Arctic regions, in temperate and boreal zones of the Western Palaearctic, in the subtropics and in the tropics. In addition to the breeding and wintering seabirds, large numbers of migratory seabirds move through the area, on their way to and from breeding and wintering areas elsewhere. Recent developments with the oil exploration within this region are therefore a cause of immediate concern. Sooner or later, oil incidents are bound to happen and for as far as currently understood, important concentrations of seabirds occur in all seasons. An assessment of the regional sensitivity to oil pollution, using techniques and Oil Sensitivity Indices (OVIs) following internationally accepted protocols are now urgently required (King & Sanger 1979, Seip *et al.* 1991, IPIECA 1994, Williams *et al.* 1995, Begg *et al.* 1997). Additional surveys are urgently required to update and add data (most urgently to cover also the Northern Hemisphere autumn, *i.e.* Aug-Nov) that describe patterns in seabird abundance and species and age composition of birds occurring within this region. The next step, equally urgent, is to translate observed densities in regional,

monthly, sensitivity charts (cf. Carter *et al.* 1993, Vaitkus & Vinskas 1993, Webb *et al.* 1995). Only with such information at hand could oil responders take wildlife issues seriously into account in case of an oil spill (Heubeck *et al.* 2003, Camphuysen *et al.* 2007). A further analysis of the data will enable us to describe the natural habitat of several of the commoner fish-eating seabirds in more detail than ever before.

Pomarine skua associated with the ship (CJC)

Qualifications of the area as a marine IBA and EBSA

The most numerous seabirds and marine mammals recorded in Nov-Dec 2012 are listed in **Table 6**. Based on strip-transect counts (non-ship-associated seabirds recorded within a 300m strip transect including a snap-shot for flying birds, *cf.* Tasker *et al.* 1984), by far the most numerous seabirds were Northern Gannets. Incidentally, this is one of the very few seabirds for which a fairly accurate estimate of the total population size is available (BirdLife International 2012). Our crude assessments of total numbers in Mauritanian waters would suggest that around one third of that world population would be present. Shine *et al.* (2001) did not even consider the Mauritanian Continental shelf as an important area for seabirds and this simple fact alone shows that this is a serious omission. European IBA categories and criteria have been developed for the selection of IBAs. These allow the identification of IBAs, based on a site's international importance for threatened bird species, congregatory bird species, assemblages of restricted-range bird species, or assemblages of biome-restricted bird species. The study area worked in 2012 is now known to hold at least 20,000 (migratory) seabirds of at least six species in December (**Table 6**) and this area would therefore easily qualify for an IBA status.

Northern Gannets were the most numerous seabirds recorded, immediately followed by European Storm Petrels. Even though for European Storm-petrels this estimate is particularly crude (high standard deviations due to a highly clumped distribution), there is little doubt about the general importance of this wintering area for that species (see also Camphuysen & Van der Meer 2005). Highly significant numbers of Grey Phalaropes, Cory's Shearwaters, Pomarine Skuas, and Band-rumped Petrels were also found (**Table 6**). If our suggestion of the regular presence of *Oceanodroma monteiroi* during our surveys is true, this could be a key site for this recently described species, thought to be confined to the Azores archipelago, where it is currently known to nest on just two small islets. The total population size was estimated at only 250-300 pairs in 1999 (Bolton *et al.* 2008).

The numerical abundance of seabirds based on strip-transect counts is provided in **Table 6**, indicating that Northern Gannets (38.1%), European Storm-petrels (31.8%), and Grey Phalaropes (12.1%) together have accounted for 82% of the birds observed. Northern Gannets (body mass *c.* 2kg) and European Storm-petrels

Table 6. Most numerous seabirds and marine mammals recorded within the 300m strip-transect (n, n km^{-2}), the numerical percentage of each species relative to the total number of (common) seabirds observed, and the percentage according to biomass relative to the total biomass of common seabirds recorded within the strip-transect. The final column repeats the estimate of total numbers of birds within the area at large (extrapolation of recorded densities over 86 rectangles as in **Fig. 3**), and dietary preferences (or guild) for as far as known for Mauritanian waters.

Species		n	n km^{-2}	% numeric	% biomass	Estimate	Guild
Northern Gannet	Fou de Bassan	4017	11.79	38.1%	86.0%	325000	piscivore
European Storm-petrel	Océanite tempete	3351	9.84	31.8%	0.7%	280000	planktivore
Grey Phalarope	Phalarope à bec large	1274	3.74	12.1%	1.4%	122000	planktivore
Cory's Shearwater	Puffin cendré	729	2.14	6.9%	5.5%	65000	piscivore
Pomarine Skua	Labbe pomarin	538	1.58	5.1%	4.0%	52500	omnivore
Band-rumped Storm-petrel	Océanite de Castro	344	1.01	3.3%	0.1%	66000	planktivore
Lesser Black-backed Gull	Goéland brun	143	0.42	1.4%	1.2%	13500	omnivore
Common Tern	Sterne pierregarin	86	0.25	0.8%	0.4%	9500	piscivore
Great Skua	Grande Labbe	60	0.18	0.6%	0.6%	6000	omnivore
Common Dolphin	Dauphin commun	500	1.47			n.d.	piscivore
Atlantic Spotted Dolphin	Dauphin tacheté Atlantique	43	0.13			n.d.	piscivore

(25-30g) differ considerably is size and biomass. For ecological studies, a re-arrangement of the most important species based on biomass results in a rather different "relative abundance" (% biomass in **Table 6**), with Northern Gannets alone now comprising 86% of the seabird biomass within the studied areas. European Storm-petrels fall back to a meagre 0.7% of the total, while Cory's Shearwaters (6%) and Pomarine Skuas (4%) gain importance.

In the online BirdLife Marine e-Atlas (BirdLife Global Seabird Programme; accessed in Jan 2013), the offshore waters off Mauritania are listed, or proposed rather, on the basis of tracking data for Cory's Shearwaters only. Earlier censuses as well as the present survey have highlighted the utmost importance of the area for a whole variety of non-breeding seabirds, including birds from Antarctic and Arctic breeding origin, as well as for local birds. The results have re-confirmed the importance of NW African waters for marine wildlife, and in this case notably as a wintering area for West Palaearctic and arctic seabirds (cf. Holmes 1939, Rooth 1963, Chilman 1974, Bourne & Dixon 1975, Brown 1979, Chapman 1982, 1982, Bourne 1983, 1985, Hazevoet 1985, Bourne 1989, Cheshire 1991, 1992, Marr & Porter 1992, Marr *et al.* 1998, Camphuysen 2003, Wynn 2003, Camphuysen 2004, Wynn & Knefelkamp 2004, Camphuysen & Van der Meer 2005). Systematic surveys of these waters are unfortunately still quite rare and the results produced during this expedition should add to our knowledge and hopefully stimulate further and deeper (ecological) investigations in years to come. A re-assessment of the conservation status of the area is urgently required. And, as the other results indicate, not just from a seabird perspective.

Together with fragile benthic ecosystems such as the Lophelia coral reefs described in canyons, on carbonate mud mounds and seamounts, the surface waters of the shelf break would also meet the preliminary criteria to be nominated as "Ecologically and Biologically Significant Area" (EBSA) by the Convention on Biological Diversity (CBD).

Pomarine skua associated with the ship (CJC)

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Pirogue in rough weather far out at sea (CJC)

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