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Marine mammals and seabirds in Mauritanian waters

pilot study April 2004

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Summary

The upwelling zones in Mauritanian coastal waters provide food-rich conditions for fish. Fish-stocks are exploited by a large international fleet of freeze-trawlers. Trawlers, fish and fish predators therefore congregate in a relatively narrow strip where the upwelling takes place. As an unwanted side-effect large animals, such as cetaceans, sharks and rays are accidentally caught in the nets.

To be able to estimate the effect of by-catches on local populations of these groups information on densities and occurrence in relation to season and environmental variables is needed. In April 2004 the Netherlands Institute for Fisheries Research (RIVO) and Alterra conducted a pilot survey of marine mammals and seabirds in cooperation with the Mauritanian Institute for Oceanographic and Fisheries Research (IMROP). As sea mammals often interact and form multi-species feeding associations with seabirds, the census included both sea mammals and seabirds.

The main aim of the project was to investigate the suitability of the combination of a survey of marine mammals and seabirds with an acoustic survey that is carried out twice per year to assess pelagic fish stocks. The ultimate goal is to set up a monitoring program with several surveys per year. If the combination with the acoustic survey is useful and successful, the monitoring program can be carried out at relatively low cost.

Between 16 and 28 April 2004 two observers joined the acoustic survey on board the Al Awam, the research vessel of IMROP. A total of 28 transects positioned East-West at distances of 10 nm apart were sampled, at depths varying from 20 m to 500 m. All marine mammals and seabirds encountered were noted, using standard seabirds at sea counting methods. Besides assessing numbers, also behaviour was recorded, following the observation protocol for ship-based seabird surveys in Europe. Observations were carried out when the ship was steaming. During fishing operations (2-5 times per day) observations were interrupted.

In this report a short overview of the results is presented. Cetaceans were only rarely encountered during the survey. In total, ten groups or singles were observed during 91.5 hours of counts. The sightings included two large whales (Fin Whale and Humpback Whale), three species of small whales (Killer Whale, Long- or Short-finned Pilot Whale and unidentified Beaked Whale) and two species of dolphin (Common and Bottlenose Dolphin).

In total 51.838 seabirds and 314 species were recorded of which Common/Arctic Tern, Black Tern, Wilson's Storm-petrel and Sabine's gull were the most abundant species. The general pattern can be characterised by a clear near shore-offshore gradient, with peak densities of most species at the drop-off of the continental shelf. The majority of birds was associated with trawlers.

The combination of the two surveys proved to be very successful. The prerequisites to arrive at realistic density estimates are that 1) the ship either sails along a random or a regular pattern 2) the ship is preferably not fishing 3) sailing speed is at least eight knots. The Al Awam fulfilled all these requirements. Standardised counts cannot be made from a commercial fishing vessel because these never follow a regular or random pattern. During fishing operations large numbers of birds are attracted to the ship, which greatly influences the 'natural' densities and distribution.

The relatively low numbers of especially dolphins (compared to another survey carried out at different time of year and the experience of the crew in different years) might be related to the water temperature that was much lower than normally at this time of year.

The acoustic survey is carried out twice per year (April and November). Given the relatively low cost (reduced to working hours and travel costs for a two person team) the marine mammal and seabird survey could be carried out at the same scheme with little extra logistical effort. Ideally the transects should extent further into deeper water as the probability of encountering dolphins is likely to be higher there. The survey should be carried out by skilled observers. Currently enough observers are available to cover two two-week surveys per year.

1 Introduction

1.1 General background

The Dutch pelagic freezer-trawler fleet in Mauritania targets small pelagic species such as Sardinella *Sardinella aurita*, Pilchard *Sardina pilchardus*, Mackerel *Scomber scombrus* and Horse Mackerel *Trachurus trachurus*. An unwanted side-effect is that large animals such as dolphins, sharks and rays are accidentally caught as well. To be able to estimate the effect on local populations of these groups information on densities and occurrence in relation to environmental variables is essential. With more information available on the occurrence of these animals in relation to for instance season and water temperature dedicated actions may be designed to reduce the by-catch. (Zeeberg *et al.* 2003; Zeeberg 2004).

The ecosystem in Mauritanian waters is characterised by a high primary and secondary production, caused by upwelling (Roy and Reason 2001). Fish forage in these plankton-rich waters. As a result the area also attracts fish consumers such as cetaceans, sharks and birds. All these different fish consumers interact in such a way that they often feed in multispecies feeding associations, either in combination with trawlers or independently.

Several surveys investigating the occurrence of marine mammals and seabirds have been carried out in this area and shown the importance of the area. In January 2000 a team on board the research vessel Pelagia cruised along the Mauritanian coast and recorded three species of dolphins and six whale species (Camphuysen 2000). In March 2003 a survey of the Chinguetti oilfield at the southern part of the Mauritanian shelf yielded six dolphin species and one whale (Burton & Camphuysen 2003, Camphuysen in press). During summer 1997-1998 and winter 1998 large numbers of three species of dolphins and four other whale species were recorded on the shelf and adjacent oceanic waters (Laptikhovskii 2001).

1.2 Aim of the study

The primary aim of the present study was to investigate the possibilities for a monitoring program linked up with existing echo surveys in Mauritanian shelf waters. Because of the interactions between marine mammals and seabirds and to gain maximum output from the survey both marine mammals and seabirds were studied.

Twice every year an acoustic survey is carried out by the Mauritanian Institute for Oceanographic and Fisheries Research (IMROP) from the research vessel, Al Awam. In April 2004 two observers joined this acoustic survey to count marine mammals and seabirds. During the two week survey the occurrence and abundance of marine mammals and seabird was described to assess whether sensible density estimates and or population estimates can be made based on observations from the research vessel.

The Al Awam

2 Methods

2.1 Organisation of the survey

Between 16 and 28 April 2004 we joined the acoustic survey carried out by the IMROP on board the Al Awam. The Al Awam is a Japanese built research vessel measuring 37 m by 7.80 m (maximum speed 12 knots). The survey is designed to assess stocks of commercially important species such as Sardinella, Sardine and Horse Mackerel. The whole shelf area of Mauritania between 20 and 500 m water depth and between the border with Western Sahara at 20° 40' N and the border with Senegal at 16° 10' (280 nm, 511 kilometer) is covered by this survey (Fig. 2.1). In this acoustic survey a total of 28 transects positioned East-West at distances of 10 nm apart are sampled. During the survey fish abundance is registered constantly using a Simrod transducer. When fish schools are encountered, hauls (lasting up to one hour) are made to investigate species composition. Of each haul total number and weight of every species is recorded. Because of prevailing northwesterly winds and the migration patterns of the fish the survey starts in the north and works southward from there. The width of the transects varies depending on the width of the shelf edge. The widest transects are situated in the north, off the Banc d' Arguin and are 40 nm, while the narrowest transects are situated off cape Timiris (10 nm).

At every latitudinal degree (and at 16°10N and 20°40'N) hydrographical data were collected at 25 m, 50 m, 100 m, 250 m and 500 m depth, using a CTD, measuring temperature and salinity at 1m depth intervals.

The scientific team consisted of the following people:

Ebaya ould Sydina (expedition leader)
Baba Achmedould Cheikh (captain)
Ahmed ould Mohamed El Moustapha (acoustics)
Wagué Abdoulaye (biologist)
Cheikh Diop (biologist)
Seikou Kidé (biologist)
Sall Mamadou Diallo (biologist)
Abdellah ould Samba (biologist and co-observer))
Mohamed Ahmed (electricien)
Sergei Alexsirov (oceanographist)
Ingrid Tulp (seabird/cetacean observer)
Mardik Leopold (seabird/cetacean observer)

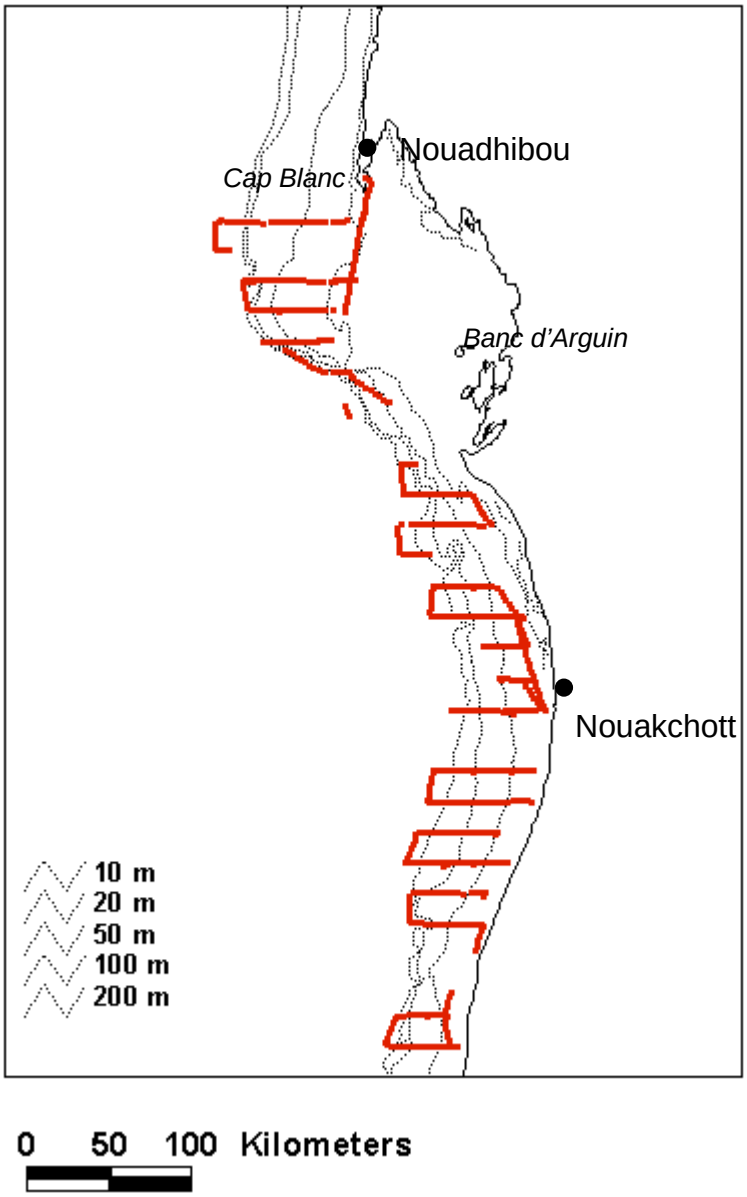

Figure 2.1 *Map of the study area. The red lines indicate the route taken, with individual dots representing subsequent 10 min counts.*

Observation platform on the top-deck

2.2 Observations

Dedicated seabird surveys were conducted from the Mauritanian fisheries research vessel Al Awam from 16-28 April 2004. All seabirds encountered were noted, using standard seabirds at sea counting methods (Tasker *et al.* 1984). For observations of cetaceans and seabirds an observation platform was constructed on top of the upper deck, at a height of 7 m above the water surface. The surveys were conducted from dawn to dusk (7:00 AM -19:15 PM), during full speed steaming (10 knots) by two observers working as a team. Occasionally, a third observer (AoS) joined this team.

Counts were conducted while the ship was on an echo survey for pelagic fish schools. When interesting schools were detected, a pelagic fish haul was done. During fishing (2-5 times per day) observations were stopped, because the speed was reduced and birds were attracted to the ship. Hauls lasted about one hour each. Also at the hydrographical stations observations were interrupted. Depending on the depth of the station these interruptions lasted between 10 and 30 minutes.

A 300 m wide band transect on one side and ahead of the ship was operated, in which birds were mostly discovered with the naked eye, but also through binocular scans used frequently to detect distant storm-petrels that would otherwise have been missed. Counting units were subsequent 10-minute periods and all birds on the water within transect plus the flying birds in regular 'snapshot counts' were used to calculate densities (n km^{-2}). Simultaneously, a 180° scan of the area ahead of the ship was used to enlarge the samples of scarcer species and of records of feeding birds of any species.

These data were not used to calculate densities. Besides assessing seabird numbers, we also noted their behaviour, following the observation protocol for ship-based seabird surveys in Europe of Camphuysen & Garthe (2001). A total of 1542 km of transects, running mainly from E to W, from the -20 to the -500 m isobaths, between Cap Blanc (20°50'N) and the border with Senegal (16°10'N) was sailed on effort.

The large numbers of birds that congregated during the fish hauls were counted when the ship resumed steaming at full speed, but these figures were not used to calculate seabird densities and all such birds were coded as 'associated with our own vessel'. Likewise, birds associated with other (commercial) fishing vessels were noted as such, as were birds associated with other visible features, such as fish schools, dolphins or fronts. The resulting observer effort was distributed quite evenly over the whole area (Fig. 2.2) totalled 91.5 hours traveling and covered 463 km^2 of band transects.

At every cetacean sighting, distance and angle to the group (relative to the track of the ship) were recorded immediately. The combination of distance and angle allows later identification of the exact position of the group. Since especially dolphins tend to be attracted to vessels, an early and exact position is necessary to estimate densities correctly. Also the number of animals, behaviour and if possible age or sex were recorded. Apart from observations on birds other variables such as the presence of trawlers, piroques or sudden transitions in the water were also recorded at 10 min intervals.

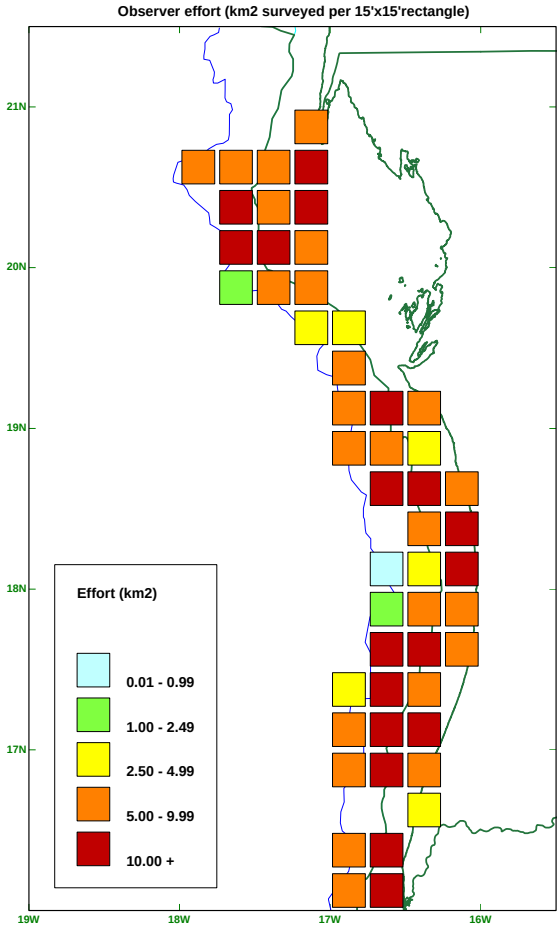

Figure. 2.2. *Observer effort per 15'x15' rectangle.*

3 Results

3.1 Weather and observation conditions

The weather was rather constant, with northerly to northwesterly winds on all days (fig. 3.1). Observation conditions were good on most days. The general pattern was characterized by strong winds in the morning, calmer weather during midday and increasing wind later in the afternoon. Sea sate varied between 2 and 6 Bf. Cloud cover varied between complete clear and overcast with a thin layer of clouds. On most days the vision was clear, on a few days only a slight haziness reduced visibility somewhat.

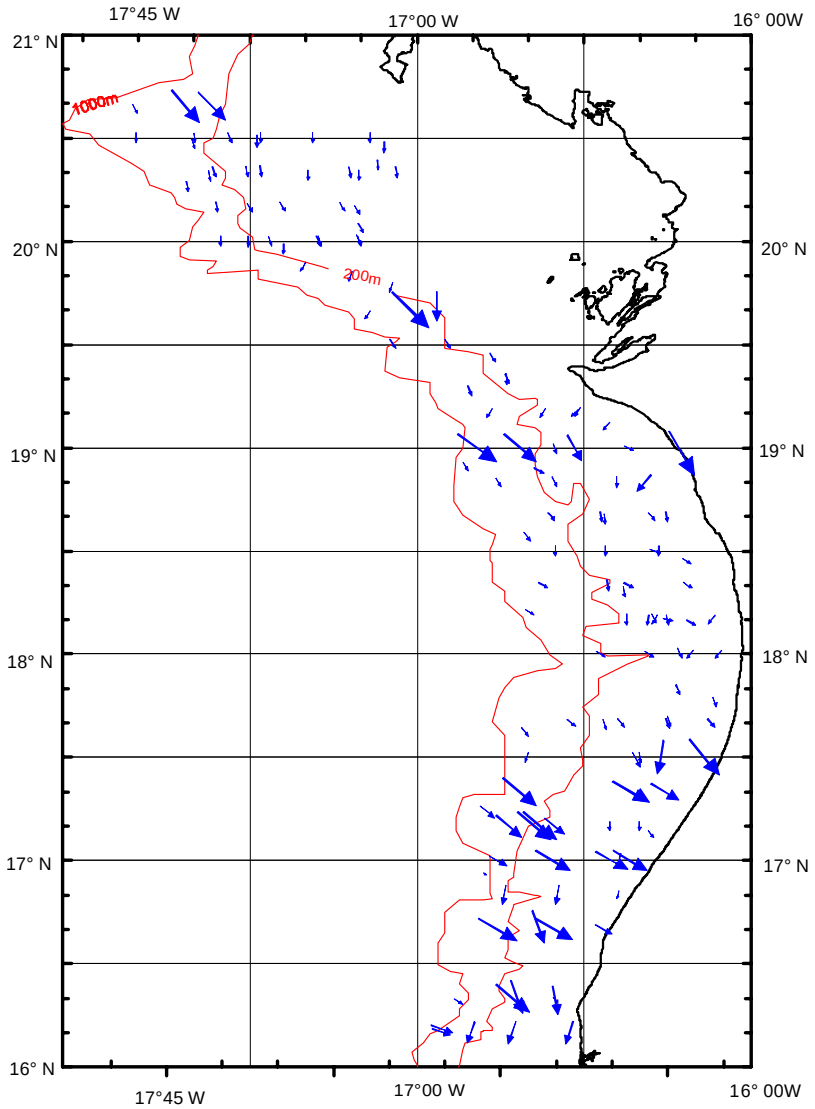

Figure 3.1 *Wind speed and direction in the study period. Wind speed and direction was measured by an anemometer mounted in the top mast (data collected by S. Alexsirov). Wind speed ranged from 1 to 12 ms^{-1} (scale linear).*

3.2 General observations

Detailed descriptions of daily observations are presented in Appendix 1 and summarised here. Most birds were encountered at the shelf edge. This is also the area where most of the trawlers congregate (Fig. 3.2). By far the highest densities of fishing trawlers were seen in the north, West and southwest off Cap Blanc. At the time these where the areas were upwelling took place. In total seven species of cetaceans and 34 seabird species were recorded (Table 3.1). The cetaceans were seen on ten occasions. Apart form these groups also migrating waders, landbirds, one turtle, Ocean Sunfish and Portuguese Man of War were recorded. Here we present species accounts for the cetaceans, seabirds and other marine life. Scientific names are given in tables 3.2 and 3.3.

***Table 3.1**. Total number of species and total number per group.*

group	n species	number
cetaceans	7	123 (excluding one night group)
seabirds	34	51838
migrating waders	8	171
landbirds	2	2
turtles	1	1
Ocean Sunfish	1	1
Portuguese Man of War	1	7

Humpback Whale

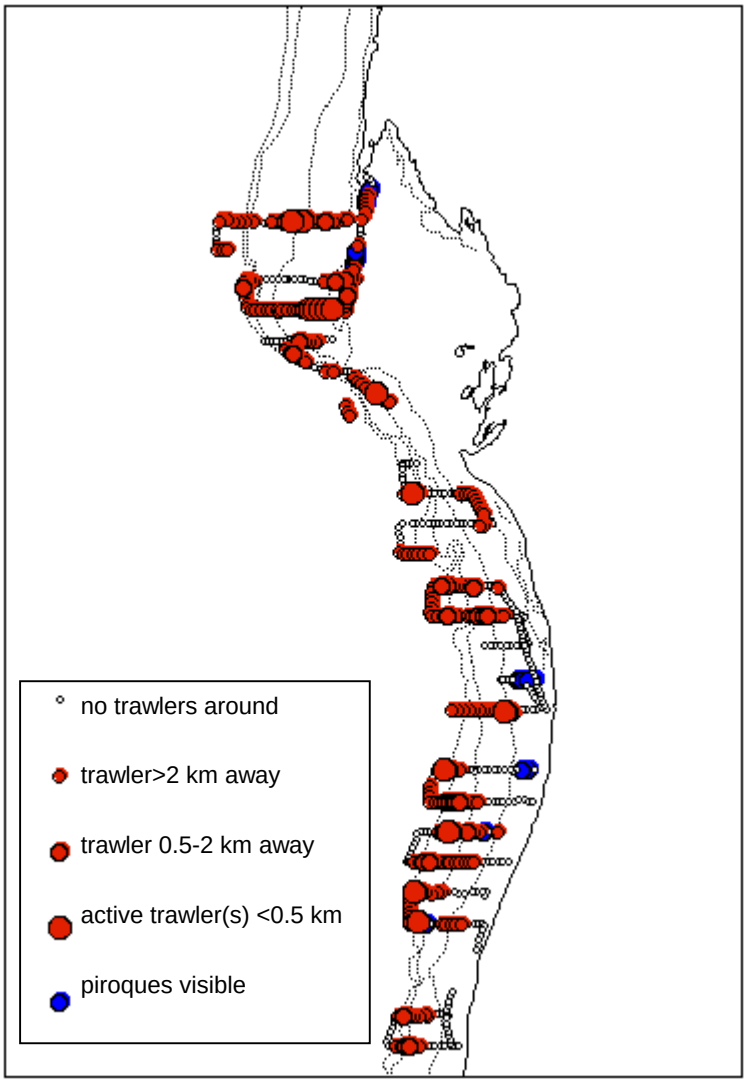

Figure 3.2 *The occurrence of fishing vessels in the area during the survey.*

3.3 Sightings of cetaceans and other marine life

Cetaceans were only rarely encountered during the survey. In total, ten groups or singletons were observed during 91.5 hours of counts (Table 3.2). The sightings included two large whales (Fin Whale and Humpback Whale), three species of small whales (Killer Whale, Long- or Short-finned Pilot Whale and unidentified Beaked Whale) and two species of dolphin (Common and Bottlenose Dolphin). Other large animals seen were an adult Leathery Turtle and an immature Ocean Sunfish. Adult Portuguese Men of War (7 sightings) were also noted when spotted floating at the surface. The locations of all sightings of megafauna are presented in figure 3.4. Most of the dolphins and all of the smaller whales were seen in relatively deep waters (200-500 m, the maximum reached during this survey). Both the Fin Whale and the Humpback Whale were seen in shallow (< 50 m) waters, as were the single Leathery Turtle and Ocean Sunfish.

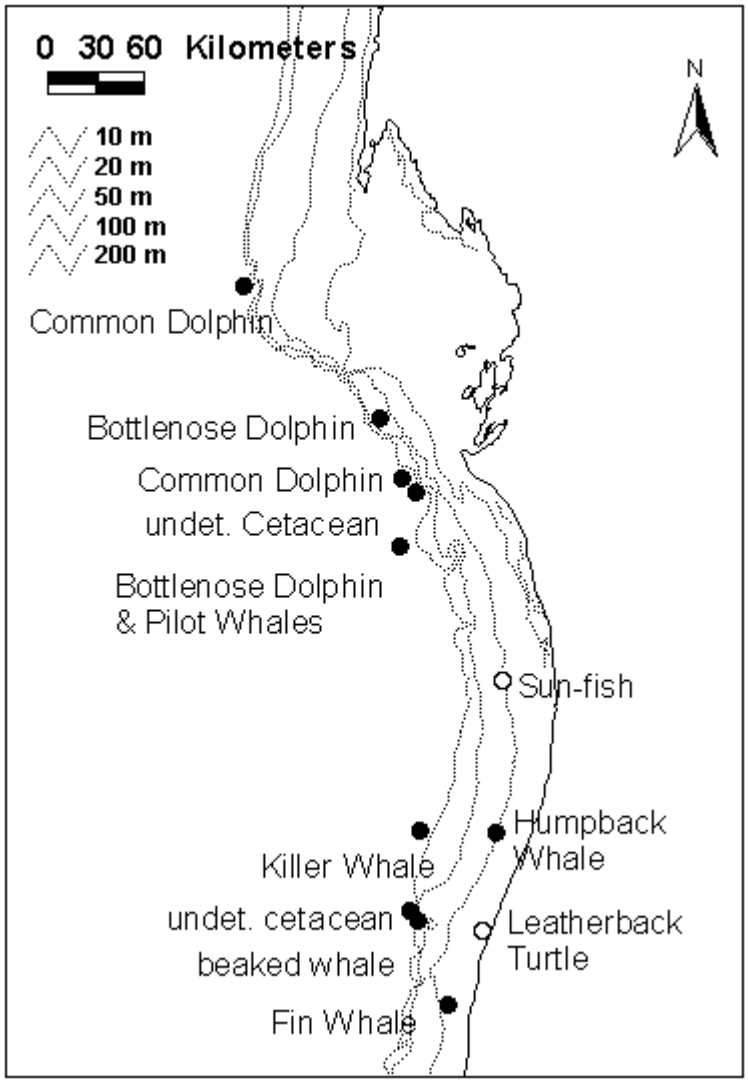

Figure 3.4. *Locations of sightings of cetaceans and other megafauna.*

Fin Whale

On 25 April a single (large) animal was seen swimming steadily SE, while blowing repeatedly, in quite shallow waters (<50m). The animal was seen at distances from about 1200 to 500 m ahead and abeam of the ship in rather rough seas, but the blows and long, dark back with tall, falcate dorsal fin set well back were clearly visible. The blows were powerful and several meters high and always occurred well before the dorsal fin surfaced. No seabirds accompanied this animal.

Humpbacked Whale

A flipper-slapping animal surfaced close to the ship (<200 m away) on 23 April, while the ship was stationary (off effort) in very calm seas in shallow waters (<50m). A long flipper was repeatedly lifted upright, completely out of the water, to be forcefully slapped down again. After about 10 such events, the animal swam away, arching its back but without lifting its tail out of the water. Flipper and back length suggested that this animal was not adult.

Beaked Whale

A large dolphin or small whale was seen breaching clear out of the water for four or five times at a distance of about 2.5 km abeam in good light, but too far to be specifically identified. The splashes were large, the body of the animal seemed considerably larger than that of Bottlenose Dolphin *Tursiops truncatus*, but smaller than that of Minke Whale *Balaenoptera acutorostrata*. On the basis of size, location (deep water), behaviour and because the animal appeared to be alone, it was tentatively identified as a beaked whale (unidentified Mesoplodon). Two other single animals were seen briefly in deep water that possibly also were Mesoplodons, but these two were seen too briefly to be identified further, and are labeled in figure 3.4 as undetermined cetaceans.

Killer Whale

On 23 April, in moderate seas at a depth of circa 500 m, a group of four Killer Whales surfaced at about 275 m abeam of the ship. The animals, believed to be a female and three immature males on the basis of the shapes and sizes of their dorsal fins, remained at the surface for about 2 minutes, blowing repeatedly, before descending again.

Pilot Whale

On 19 April, a mixed herd of about 20 Pilot Whales and 10 Bottlenose Dolphins were seen at ca. 1800 m abeam of the ship, accompanied by 8 circling Northern Gannets *Morus bassanus*. All animals were swimming fast, the Pilot Whales with visible blows, the dolphins sometimes leaping completely out of the water. The dolphins were leading, swimming at first in a formation with all animals next to each other and the pod of Pilot Whales was following at some 50-100 meters. The animals took no notice of our passing ship. The animals were swimming at the sunny side of our course line, and the resulting sharp contrasts made that the blunt heads of the Pilot Whales could clearly be seen, as well as several dorsal fins. Based on the location of the sighting, at 18°.52' N, the whales were tentatively identified as Short-finned Pilot Whales *Globicephala macrorhynchus* (c.f. Reeves *et al.* 2002).

Bottlenose Dolphin

Apart from the mixed herd of Bottlenose Dolphins and Pilot Whales described above, one other pod of Bottlenose Dolphins was observed. In the evening of 18 April one (off effort) group of four animals came to the bow of the ship and remained there for about one minute. All animals within this pod were of the same (adult) size.

Common Dolphin

The Common Dolphin is reportedly the most abundant species observed off Mauritania and according to the ship's crew, this species is observed on most days at sea in the study area, particularly in the southern third. However, during the present survey, only two groups were found during the daily watches and another group got at the bow during a night. All were seen in waters over 200 m deep. The first group was swimming near another (fishing) boat on 17 April, that was hauling its nets at the time. When our ship passed the scene at about 500 m distance, the dolphins came over to our bow and small parties swam there for short periods of time. The total pod size was estimated at 50 animals, subdivided into many smaller groups of

4-10. The animals at the bow were identified as Short-beaked Common Dolphins *Dephinus delphis.*

A second group of 30 'Common' Dolphins was found under a mixed group of 120 plunge-diving Northern Gannets and 10 pursuit-diving Cory's/Scopoli's Shearwaters *Calonectris borealis/diomedea* on 19 April, again in deep waters. The dolphins were apparently feeding, but as their location was more or less on our transect line, some came briefly over to our bow. Specific identity however, could not be assessed and it cannot be excluded that these animals were Long-beaked Common Dolphins *Delphinus capensis*.

Finally, during the late evening (22.00h local time) of 24 April, parties of up to 15 small dolphins swam at the bow, barely visible in the moonlight. According to the crew, this lasted for over an hour (on and off). Animals were not seen to breach out of the water and this, together with their small size and persistent bow-riding suggests that they were Common Dolphins (of either species) as well.

Leatherback Turtle

A single full-sized (ca 2 m long) animal was seen surfacing directly in front of the bow, at a distance of about 25 m on 24 April in nearshore waters. It remained at the surface for maybe 20 seconds, trying to get out the ship's way and displaying its huge head and longitudinal ridges running over its back.

Ocean Sunfish

A single, half meter long animal was seen in nearshore waters on 21 April, the animal was apparently basking, laying on its side, with one of its pectoral fins breaking the surface ("waving"), within 50 m of the ship's trackline.

Portuguese Men of War

On seven occasions the inflated sails of large (circa 20 cm length) of Portuguese Men of War were seen. The sails were bulgy, transparent with a sheen of purple particularly at the upper rim. These animals were only seen at close range, within 100 of the track line, indicating that detection of these transparent animals was difficult. Despite this, no animals were seen in the central section of the study area, where wind conditions were relatively favourable (Fig. 3.1). Portuguese Men of War were seen both in the northern and southern third of the study area, usually in deep offshore waters, with one exception (near shore sighting) in the south.

Mediterranean Monk Seal

One individual was observed at the entrance of the Baie du Lévrier. It was swimming at the surface and recognized by its very dark colour and lack of dorsal fin.

Harbour porpoise

After the survey on 30 April we observed up to 11 animals at the same time from Cap Blanc, occurring from about 500 m from the shore to some 2 km offshore. Three groups of two individuals were seen, of which one was clearly smaller than the other, so these were probably mother-calf pairs. Several porpoises were apparently feeding, swimming fast in ever changing directions and breaching almost clear out of the water. Large schools of fish were visible at and just below the surface in many places around Cap Blanc and besides porpoises several species of terns (Aves, Sternidae) were mass-feeding here.

Harbour porpoise off Cap Blanc

3.4 Seabirds

In total 51.838 seabirds and 31 species were recorded of which Common/Arctic Tern, Black Tern and Wilson's Storm-petrel were the most abundant species. The general pattern can be characterised by a clear near shore-offshore gradient, with peak densities of most species at the drop-off of the continental shelf. For a selection of the most common species distribution maps are presented (Figs. 3.5 to 3.11). In the calculated densities only birds observed within the 300 m transect are included (excluding ship followers).

Along the transects close to the shore (ca 10 nm offshore) few birds were seen. Only low densities of terns (Common, Arctic, Sandwich, Royal and Black), Arctic Skua, Great Skua and Eastern White Pelicans were observed here. Most birds aggregated on the shelf edge. Especially Pomarine Skuas and Wilson's Storm-petrels were very abundant at the drop-off. European Storm-petrels were more confined to near shore areas where they were often encountered in dense swimming groups. Common, Arctic and Black terns were seen migrating in northwesterly directions on many days. Most of the feeding seems to take place at trawlers, although gannets, storm-petrels, shearwaters and terns fed independently as well. The proportion of ship followers varied per species, but was generally high (Table 3.4). Hereafter we give a more detailed account for every species(group).

Shearwaters

Cory' s Shearwater were present throughout the area. The majority were Scopoli's *Calonectris diomedea* Shearwaters (the Mediterranean Cory's Shearwater) with only few Cory's Shearwaters C. *borealis.* A proportion of the shearwaters were actively feeding near trawlers, but the majority seemed to be feeding independently. Sooty Shearwaters were only seen in the southern part. Manx Shearwater and Balearic Shearwater were recorded very rarely and only in the south as well.

Table 3.2. *Summary of sightings of cetaceans and megafauna. The night observation of dolphins and the observations of Harbour Porpoises after the survey on 30 April are not included.*

date	Dutch name	English name French name	scientific name	number	accompanied by	behaviour
cetaceans						
17 Apr	Gewone Dolfijn	Common Dolphin Dauphin commun	*Delphinus delphis*	50	unclear	crossing over from fishing vessel
18 Apr	Tuimelaar	Bottlenose Dolphin Grand dauphin	*Tursiops truncatus*	4	none	coming to bow, briefly there
19 Apr	Gewone Dolfijn	Common Dolphin Dauphin commun	*Delphinus delphis*	30	120 Gannet 10 Cory's spec	apparently feeding
19 Apr	walvis of dolfijn	cetacean rorqual ou dauphin	whale or dolphin	1	none	only one time back, dorsal and splash seen at close range
19 Apr	Tuimelaar	Bottlenose Dolphin Dauphin commun	*Tursiops truncatus*	10	20 Pilot Whales 8 Gannets	swimming fast in formation
19 Apr	Griend/ Indische Griend	Long/short-finned Pilot Whale Globicephale noir/tropical	*Globicephala melaena/* *G. Macrorhynchus*	20	10 Bottlenose Dolphins 8 Gannets	swimming fast in formation
23 Apr	Bultrug	Humpback Whale Mégaptère	*Megaptera novaeangliae*	1	none	flipper slapping
23 Apr	Orca	Killer Whale Orque	*Orcinus orca*	4	none	surfacing
24 Apr	walvis of dolfijn	cetacean rorqual ou dauphin	whale or dolphin	1	none	only one time back and dorsal seen at close range
24 Apr	spitssnuitdolfijn	beaked whale Mésoplodon spec.	*Mesoplodon* spec.	1	none	breaching
25 Apr	Gewone Vinvis	Fin Whale Rorqual commun	*Balaenoptera physalus*	1	none	swimming steadily
Other marine life						
21 Apr	Maanvis	Sun-fish Môle	*Mola mola*	1	none	basking, fin out of water
24 Apr	Lederschildpad	Leatherback Turtle Tortue luth	*Dermochelys coriacea*	1	none	surfacing right in front of our
28 Apr	Monniksrob	Mediterranean Monk Seal	*Monachus monachus*	1	none	swimming at surface

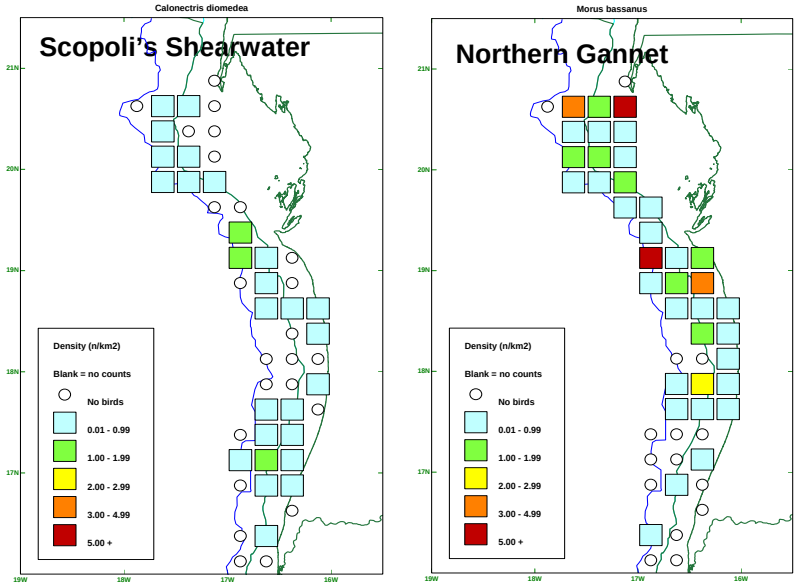

Figure 3.5. *Distribution of Scopoli's Shearwater and Northern Gannet.*

Table 3.3. *Summary of sightings of seabirds and other birds.*

English name	French name	Scientific name	n
seabirds			
Northern Fulmar	Fulmar boréal	*Fulmarus glacialis*	1
Bulwer's Petrel	Pétrel de Bulwe	*Bulweria bulwerii*	1
Cory's Shearwater (undet)	Puffin Scopoli/candré	*Calonectris diomedea/borealis*	124
Scopoli's Shearwater	Puffin Scopoli	*Calonectris diomedea*	338
Cory's Shearwater	Puffin candré	*Calonectris borealis*	14
Sooty Shearwater	Puffin fuligineux	*Puffinus griseus*	17
Manx Shearwater	Puffin des Anglais	*Puffinus puffinus*	2
Balearic Shearwater		*Puffinus puffinus mauretanicus*	3
Wilson's Storm-petrel	Océanite de Wilson	*Oceanites oceanicus*	5657
European Storm-petrel	Océanite tempete	*Hydrobates pelagicus*	2383
Northern Gannet	Fou de Bassan	*Sula bassana*	1406
West African Great Cormorant	Grand Cormoran	*Phalacrocorax carbo lucidus*	2
Eastern White Pelican	Goéland	*Pelecanus onocrotalus*	69
Grey Phalarope	Phalarope a bec large	*Phalaropus fulicarius*	1
Pomarine Skua	Labbe pomarine	*Stercorarius pomarinus*	3432
Arctic Skua	Labbe parasite	*Stercorarius parasiticus*	531
Long-tailed Skua	Labbe à longue queue	*Stercorarius longicaudus*	315
Great Skua	Grande labbe	*Stercorarius skua*	17
Sabine's Gull	Mouette de Sabine	*Larus sabini*	5229
Slender-billed Gull	Goéland railleur	*Larus genei*	23
Lesser Black-backed Gull	Goéland brun	*Larus fuscus*	1289
Yellow-legged Gull	Goéland leucophee	*Larus michahellis*	44
LBB/YL-Gull	G. brun/G. leucophee	*Larus* spec.	492
Caspian Tern	Sterne Caspienne	*Sterna caspia*	36
Royal Tern	Sterne royale	*Sterna maxima*	1502
Lesser Crested Tern	Sterne voyageuse	*Sterna bengalensis*	20
Sandwich Tern	Sterne caugek	*Sterna sandvicensis*	679
Roseate Tern	Sterne de Dougall	*Sterna dougallii*	17
Common Tern	Sterne pierregarin	*Sterna hirundo*	1940
Arctic Tern	Sterne arctique	*Sterna paradisaea*	550
Common / Arctic tern	S. pierregarin/S. arctique	*S. hirundo / S. paradisaea*	20318
Bridled Tern	Sterne bridée	*Sterna anaethetus*	1
Little Tern	Sterne naine	*Sterna albifrons*	5
Black Tern	Guifette noire	*Chlidonias niger*	5380
total			*51838*
waders			
Grey Plover	Pluvier argenté	Pluvialis squatarola	5
Golden Plover	Pluvier doré	Pluvialis apricaria	3
Red Knot	Bécasseau maubêche	Calidris canutus	18
Dunlin	Becassau variable	Calidris alpina	20
Bar-tailed Godwit	Barge rousse	Limosa lapponica	55
Whimbrel	Courlis corlieu	Numenius phaeopus	66
Eurasian Curlew	Courlis Cendré	Numenius arquata	2
Common Redshank	Chevalier gambtete	Tringa totanus	2
total			*171*
passerines			
Swift (undet)	Gierzwaluw (undet)	Apus spec.	1
Sudan Golden Sparrow	Bruinruggoudmus	Passer luteus	1
total			*2*

Table 3.4. *Percentage of birds that were associated with a trawler or our own ship. Numbers represent all birds recorded.*

	n	% associated with fishing vessel (trawler or own ship)
Cory's Shearwater	14	14
Scopoli's Shearwater	338	34
Cory's Shearwater (undet)	124	29
Sooty Shearwater	17	47
Wilson's Storm-petrel	5641	70
European Storm-petrel	2383	20
Northern Gannet	1406	32
Eastern White Pelican	69	35
Pomarine Skua	3432	69
Arctic Skua	531	40
Long-tailed Skua	315	40
Great Skua	17	18
Sabine's Gull	5229	72
Lesser Black-backed Gull	1289	82
Yellow-legged Gull	44	75
large gull	492	69
Caspian Tern	36	36
Royal Tern	1502	82
Lesser Crested Tern	20	50
Sandwich Tern	679	68
Common Tern	1940	60
Arctic Tern	550	20
Common / Arctic Tern	20318	38
Black Tern	5380	11

Storm-petrels

European Storm-petrel occurred mainly in the north and the middle of the study area. Further south they were largely replaced by Wilson's Storm-petrels (Fig. 3.6). Wilson's Storm-petrels had a far more offshore distribution compared to European Storm-petrels. Large numbers (up to several thousands) could build up in the wake of trawlers were they were feeding on small particles. European Storm-petrels in the middle area were often seen swimming in large tight groups (up to several tens) relatively close to the shore. A large proportion (55%) of Wilson's Storm-petrels was visibly in active wing moult.

None of the other Storm-petrels that have been recorded in this area before (Band-rumped Storm-petrel, and Leach's Storm-petrel, Camphuysen 2000) could be identified positively.

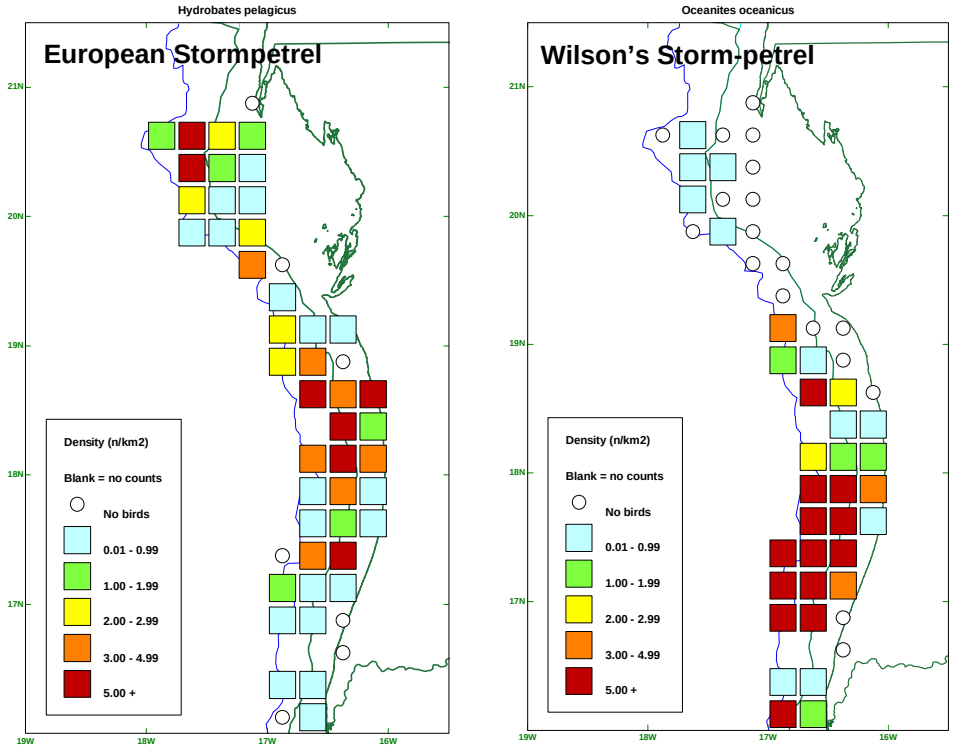

Figure 3.6. *Distribution of European and Wilson's Storm-petrel.*

Northern Gannets

Northern gannets occurred mostly in the north and middle (Fig. 3.5). Especially the area near Cap Blanc held high densities. Nearly all of these birds (96%) were immature. Given the time of year, most of the adults had probably left the area to the breeding colonies. In January the proportion of adults was much higher (Camphuysen 2000). A considerable number (3%) of Northern Gannets were entangled in fishing gear or plastic. Some of the cetacean groups (Common Dolphin, Bottle-nosed Dolphin/Pilot Whale) were discovered by the flocks of actively feeding Northern Gannets hovering (Table 3.2). At several other occasions we encountered groups of Northern Gannets behaving in the same way, obviously following something in the water. However we could not detect any dolphins or other cetaceans here.

Waders

Small groups of waders (Grey Plover, Golden Plover, Red Knot, Dunlin, Bar-tailed Godwit, Whimbrel, Eurasian Curlew, Common Redshank) were seen migrating almost every day, but only early in the mornings. They all headed in a northwesterly direction and were mostly single-species.

Skuas

The three smaller skuas were abundant throughout the area (Fig. 3.7). Great Skuas were only rarely observed and mostly confined to the shelf, a distribution which is similar to that described earlier (Camphysen 2000, Wynn & Knefelkamp 2004)). The distribution of Pomarine Skuas was concentrated in the north and south and less so in the middle. Usually Pomarine Skuas started to appear near the shelf edge and stayed with the ship until we reached depths of >200 m, where most ship followers left the ship. Of all skuas only Arctic Skuas kleptoparasitised other birds, especially terns. The other skua species seemed to be feeding by themselves or scavenging in the wake of trawlers.

Adults of all species were almost all in a well-advanced breeding plumage, which facilitated identification a great deal. The proportion of immature birds was similar in the species (Long-tailed Skua 29%, Pomarine Skua 39% , Arctic Skua 29%). All Great Skuas were classed as adults. Pomarine Skuas often congregated in large flocks. Especially during fishing operations large groups would sit on the water and only start flying when the ship continued steaming. However we did not see the flocks of Long-tailed Skuas feeding away from vessels as described by Camphuysen (2000).

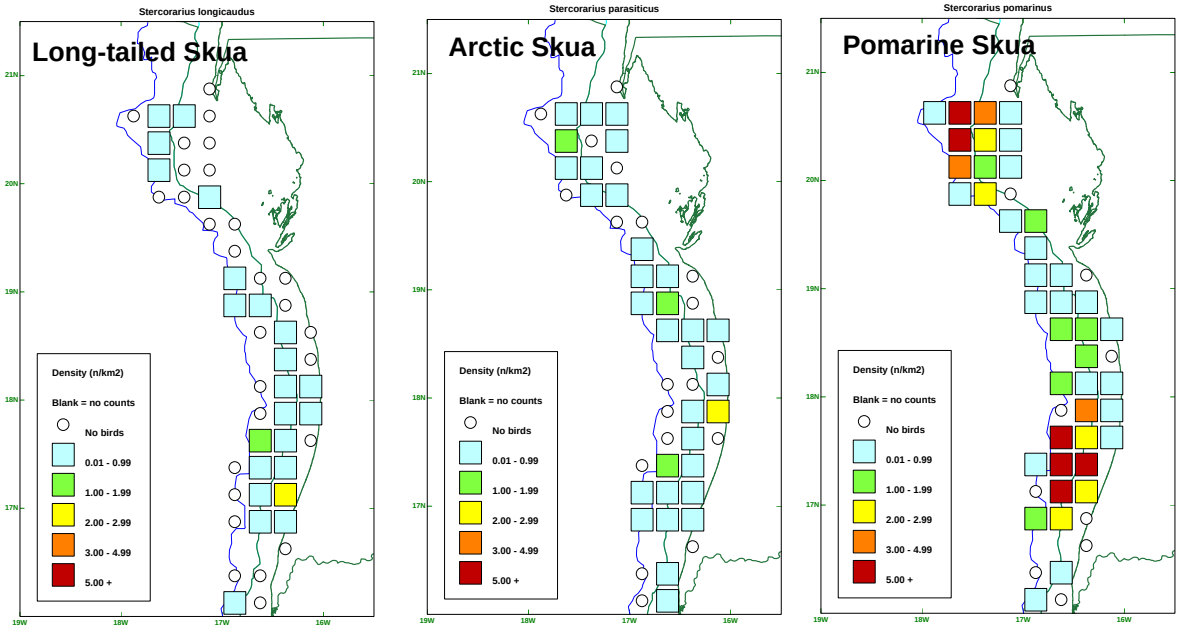

Figure 3.7. *Distribution of Long-tailed, Arctic and Pomarine Skua's.*

Gulls

The majority of the larger gulls, Lesser Black-backed Gulls and Yellow-legged Gulls, was immature (81% and 93% respectively), which made identification difficult. Lesser Black-backed Gulls were far more abundant than Yellow-legged Gulls. Both species were confined to the shelf and slope (Fig. 3.8). Audouin's Gulls were completely absent. Sabine's Gull occurred mainly in large groups and often associated with trawlers and our own ship, either scavenging behind the ship or resting in large groups on the water. They were most abundant on the shelf slope and edge (Fig. 3.8). Nearly all individuals were adults. Compared to the survey carried out in January (Camphuysen 2000) Sabine's Gulls were far more abundant, suggesting that the birds in the April survey were passing through towards their high arctic breeding areas.

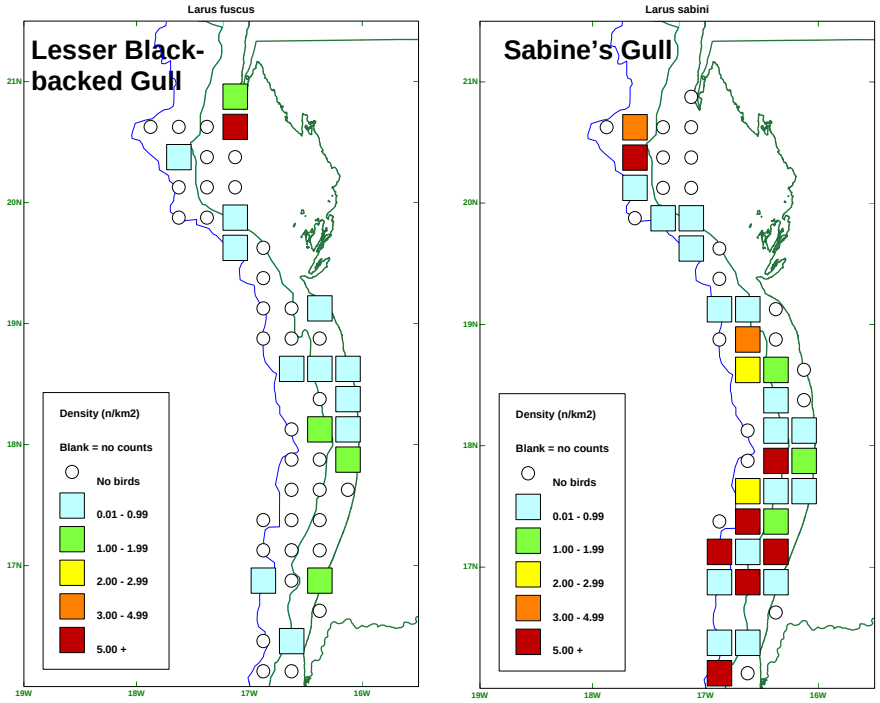

Figure 3.8. *Distribution of Lesser Black-backed and Sabine's Gull.*

Terns

Arctic Terns and Common Terns are often difficult to distinguish in the field, particularly in large, distant, mixed groups. Only at close range they can be told apart. Both species were present all over the shelf, with Arctic Terns more common in the north (Fig. 3.9). Both species were seen migrating in northwesterly direction. These movements mainly took place in the mornings. The proportion of juvenile Common Terns was large and increased towards the south. This might be a result of adults migrating out of the area as well as a latitudinal gradient in age ratio. A large proportion (up to 10%) of all birds resting on the ship was ringed. A few attempts to catch these birds with a sweepnet, yielded a recovery of a Common Tern, ringed as chick in The Netherlands the year before (Ketelmeer). In the wake of the ship all tern species engaged in feeding frenzies over the discarded or escaped fish from the fishing nets.

Black Terns were found all over the Mauritanian shelf, with an exception of the northwestern part, where the shelf is at its widest (Fig. 3.10). Background densities were low, at less than 1 bird per km^2 but both in the north, at Cap Blanc, and in the south, near the border with Senegal, densities were much higher. In both these areas, groups of up to 1000 birds were encountered that were mass-feeding (without trawlers present). In between, birds were generally seen singly or in pairs. All but very few were in full adult breeding plumage. Of the birds not feeding or engaged in any other behaviour, the majority was flying into northerly directions. Birds were often seen diving towards the water's surface from 1-3 m altitude, pecking at something very small from or just above the surface. Pursued prey were always too small to be seen by us and the birds would at most touch the water's surface with their bill tip.

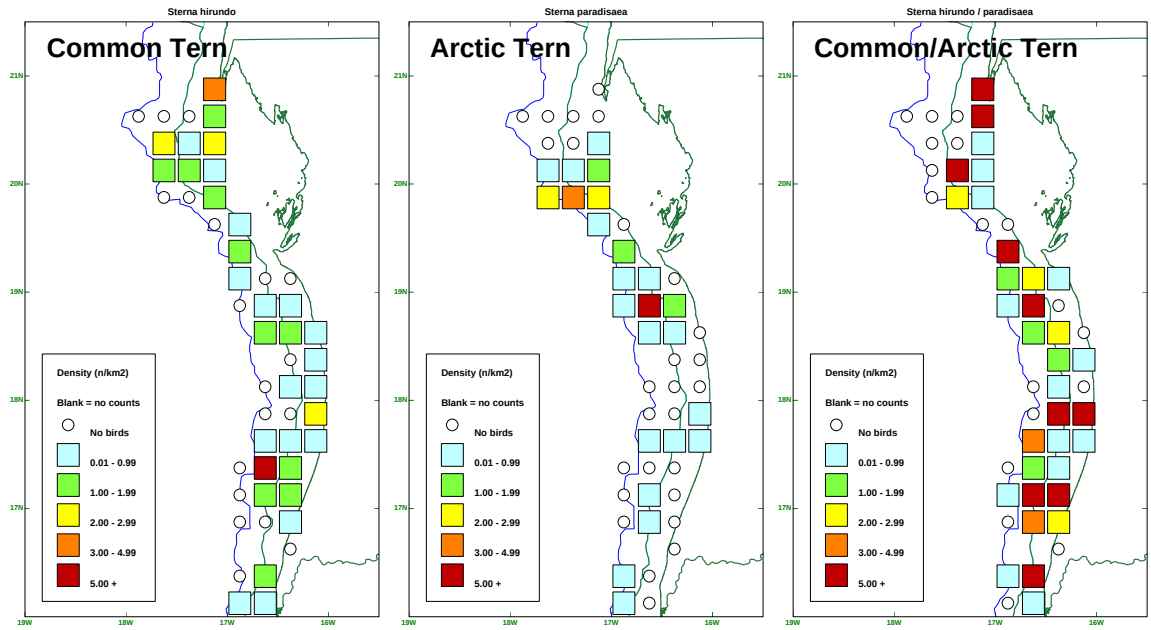

Figure 3.9. *Distribution of Common, Arctic and Common/Arctic Tern.*

Actual diving for prey (fish) was mainly seen in the north (near Cap Blanc) and south (near Senegal) of the study area. Nowhere did Black Terns, like the *Sterna* terns, dive deeply into the water. Mass feeding was restricted to these two areas, in the north and south of the study area. In the south, we noted many tight groups of tens to hundreds of Black Terns feeding by diving for small, schooling fish. These were driven to the surface by larger (40 cm to circa 1 m long) predatory fish, later identified as *Campogramma glaycos*. Observations were stopped to make a surface haul for the chased fish and their chasers in order to see what fish the terns were dealing with. Their prey turned out to be small (4-10 cm long) Anchovy *Engraulis encrasicolus*. Near Cap Blanc, where mass-feeding was also observed, groups of feeding Black Terns were of similar size and also largely mono-specific, but the identity of the prey could not be determined here.

Royal Terns were found in the northern part in low densities (Fig. 3.10). In the middle area they were completely absent but reoccurred in the south. Most were adults and many were flying in pairs, often engaged in what looked like display behaviour. At one instant a pair was actually seen courtship feeding. Given the close distance to breeding colonies and the time of year this could indicate that Royal Terns use this area before they commence breeding.

Caspian Terns were largely confined to the coast and only observed during sailing in and out of the harbour of Nouadhibou. They were never observed at open sea. Lesser Crested Terns were seen occasionally in singles or pairs, were rare in the north but started to appear in the middle of the survey.

Sandwich Terns were evenly distributed in low densities over the whole area and did not show a clear gradient perpendicular to the coast (Fig. 3.11). The majority of Sandwich Terns were adults or immatures, only 17% were first winter birds.

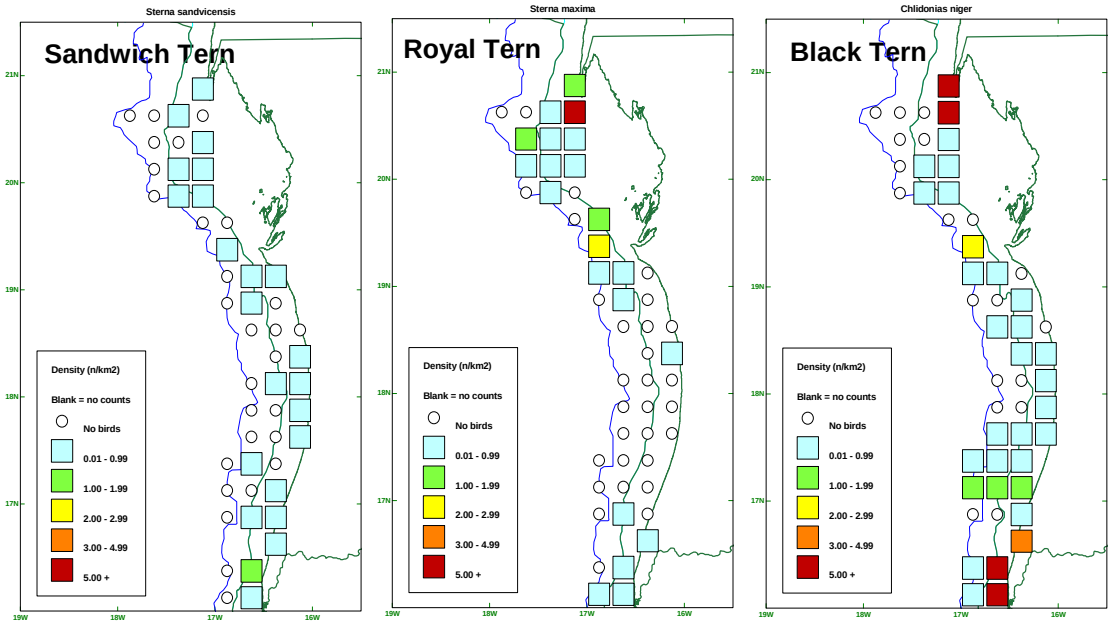

Figure 3.10. *Distribution of Sandwich Tern, Royal Tern and Black Tern.*

Black Terns and Common Terns aboard the Al Awam

4 Discussion

4.1 Suitability of the acoustic survey for observations of marine mammals and seabirds

In order to estimate the feasibility of a monitoring project based on a research vessel such as the Al Awam we will discuss the pros and cons and compare it with alternative options. Alternatives could be a survey based from a fishing vessel or an aerial survey.

The prerequisites for an unbiased survey of sea mammals and seabirds are:

A random or regular design of transects
In the acoustic survey carried out twice per year (April and November) by the Al Awam sampling takes place along a regular pattern of transects. The disadvantage of observing from a fishing vessel would be that routes sailed are not random neither regular. Fishing vessels steam from one fish school to the next, therefore not covering a random area, but sampling the areas with highest fish abundance. As a result densities of both marine mammals and seabirds would be overestimated. Correction for this overestimation is difficult because the degree to which species are attracted to trawlers is species-specific. From this point of view it is not advisable to conduct surveys from an actively fishing trawler.

No fishing, because of attraction of birds to ship
During the acoustic survey every day 2-5 hauls were made. During and immediately after these hauls many birds were attracted to the ship. Mostly it took some time before it is possible to distinguish 'new' birds from ship followers. The consequence is that densities are underestimated because there is a tendency that new birds are not detected in the cloud of ship followers. Our experience is that with the number of hauls taken during the acoustic survey enough steaming time remains (91.5 hour in twelve days) to allow for a useful survey. This is also the reason why the monitoring program cannot be carried from a ship engaged in a demersal survey, when many more fishing hauls are conducted.

Skilled observers
In order to identify marine mammals and seabirds observers need to be well-trained in identification. Marine mammals are often only seen briefly, in bad light and partly surfacing. Characteristics of all possible species need to be memorized to know to what one needs to pay attention to at every sighting. The variation in plumage and ages of the seabirds is large, especially in different seasons.

The alternative of an aerial survey would be the best to study densities of marine mammals, but the high cost of such a survey is a large drawback. Also the availability of a suitable aircraft in Mauritania is questionable, and flying in such a remote area with a small aircraft with no airports to divert to might be hazardous.

4.2 Application of the data: are density estimates possible?

Sightings of cetaceans were not very common during the survey. During another survey carried out in January 2000 more groups of dolphins were observed. Compared to the April survey the weather was much calmer resulting in better observer conditions. Also the area covered differed, with more observation time in deeper areas in the January survey. However, according to the crew many more dolphins were seen on previous surveys, carried out at the same time of year. A possible explanation for the low numbers seen can be found in the water temperature that was much lower (2-4°C) compared to other years (Fig. 4.1 and 4.2). Upwelling takes place mainly early in the year and by June-July when the water generally gets warmer the number of by-catch incidents increases (Zeeberg *et al.* 2003; Zeeberg 2004; ter Hofstede *et al.* 2004). Therefore surveys should ideally be carried out at different times of year to describe the year round pattern and to understand the relationship between occurrence of cetaceans and upwelling and temperature patterns better. Sightings of sea mammals can be used to derive density estimates using a program (*distance*) designed for animal abundance estimates based on line-transect counts (Buckland *et al.* 2001, Borchers *et al.* 2002), but more observations than those collected in this survey are needed to do so.

Bird numbers were high and for most species we were able to calculate densities. For explicit ship followers such as Wilson's Storm-petrels, Common Tern, Arctic Tern, Pomarine Skua and Sabine' Gull densities are likely to be overestimated because these species are attracted from a large area towards our own ship. On the other hand, very large mixed-species groups were seen around trawlers usually at distances beyond our 300 m band transects. Such birds were largely unavailable for density estimations, and this may result in underestimates. For species such as Scopoli's and Cory's Shearwater, Black Terns, European Storm-petrel, Arctic, Long-tailed and Great Skua densities are probably realistic.

Royal Terns

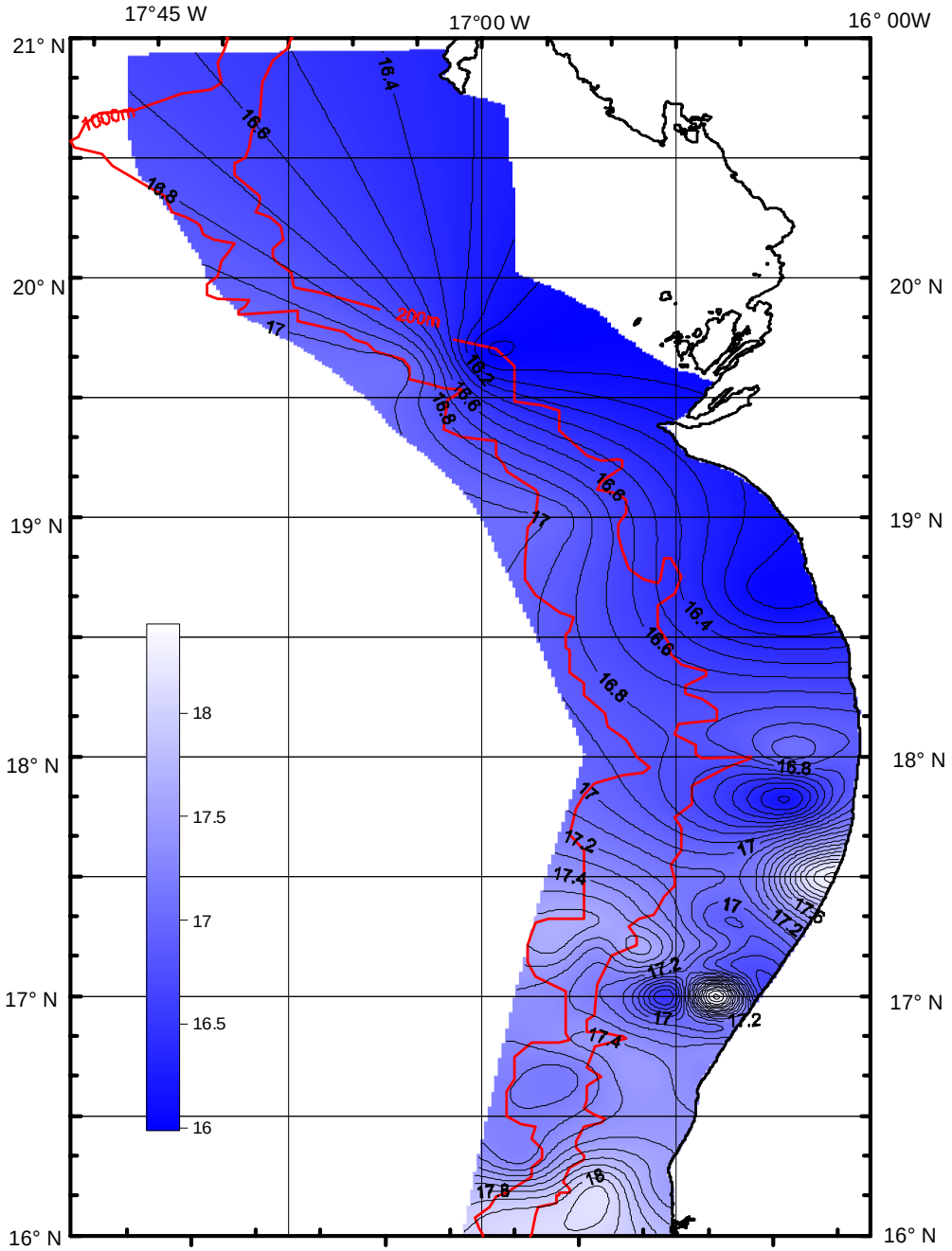

Figure 4.1. *Sea surface temperature in the study period. Data from CTD measurements and interpolate (data collected by S. Alexsirov).*

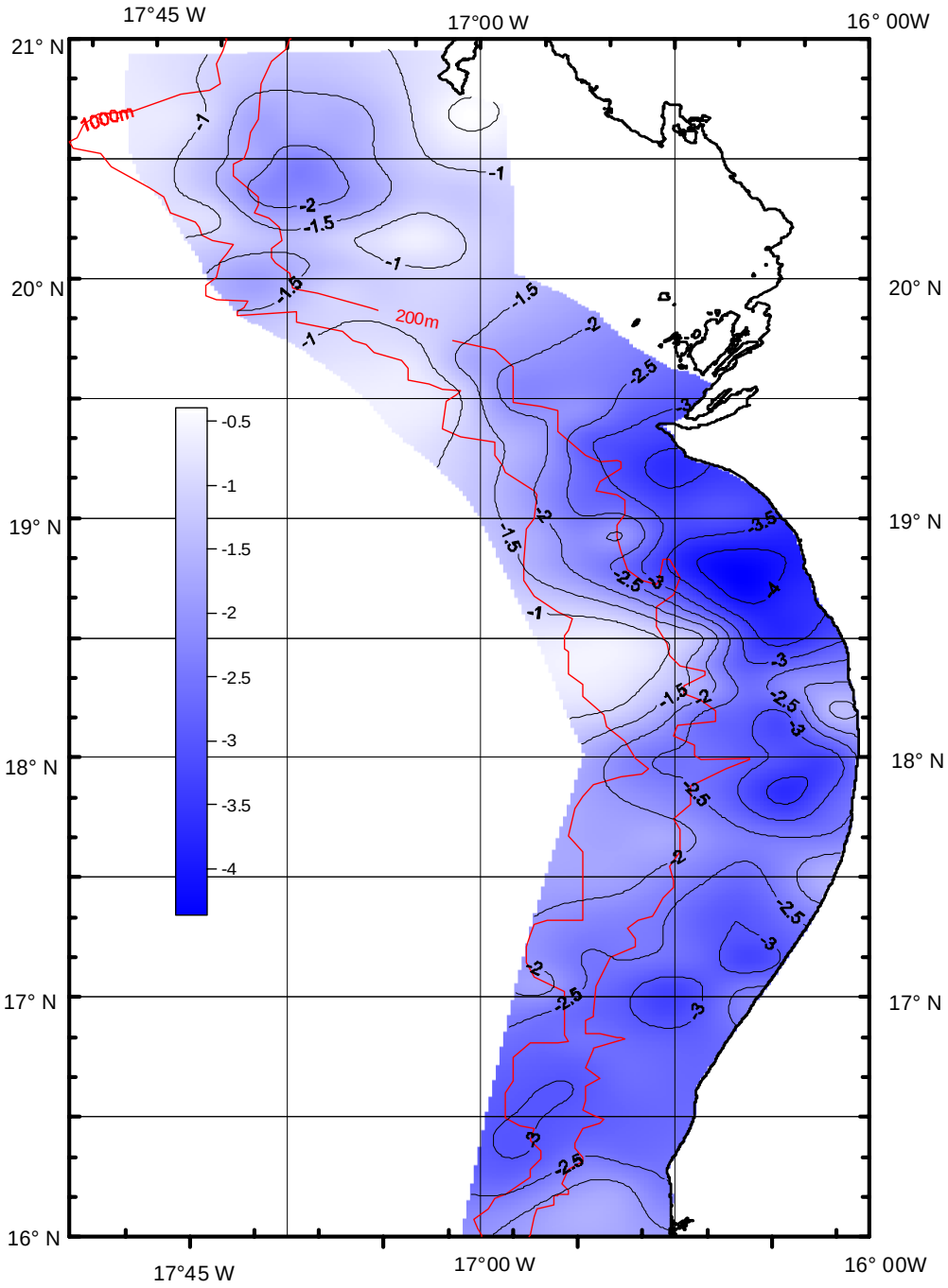

Figure 4.2. *Sea surface temperature anomalies in the study period (data collected by S. Alexsirov).*

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Pomarine Skua

References

Borchers, D.L., Buckland, S.T., Zucchini, W. 2002. Estimating Animal Abundance. Springer Verlag.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press.

Burton, C. & C.J. Camphuysen. 2003. Etude de la faune marine dans les eaux mauritaniennes, mars 2003.

Camphuysen, C.J. 2000. Seabirds and marine mammals off West Africa. Responses 2000 cruise report. NIOZ report.

Camphuysen, C.J. & S. Garthe. 2001. Recording foraging seabirds at sea: standardized recording and coding of foraging behaviour and multi-species foraging associations. IMPRESS report 2001-001.

Camphuysen C.J. (in press). Seabirds. In: J. Colman, F.K. Aidibe & J. Heap (eds). Draft Environmental Impact Statement, November 2003. Chinguettidevelopment@woodside.com.au.

ter Hofstede, R., J.J. Zeeberg, D. de Haan, B. Couperus & I. Mantingh. 2004. Incidental catches of pelagic megafauna by the Dutch pelagic fleet in the Mauritanian Exclusive Economic Zone during the years 1999-2003. RIVO report C032/04.

Laptikhovskii, V.V. 2001. Distribution and numbers of cetaceans in waters off north-eastern Africa and their role in ecosystem. Zoologicheskii Zhurnal 80: 358-363.

Leopold, M.F. 1993. Seabirds in the shelf edge waters bordering the Banc 'd Arguin, Mauritania, in May. Hydrobiologia 258: 197-210.

Reeves, R.R., B.S. Stewart, P.J. Clapham & J.A. Powell. 2002. Sea mammals of the world. New York.

Roy, C. & C. Reason. 2001. ENSO related modulation of coastal upwelling in the eastern Atlantic. Progress in Oceanography 49: 245-255.

Tasker M.L., P.H. Jones, T.J. Dixon & B.F. Blake. 1984. Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardized approach. Auk 101: 567-577.

Wynn, R.B. & B. Knefelkamp. 2004. Seabird distribution and oceanic upwelling off northwest Africa. British Birds 97: 323-335.

Zeeberg, J.J., Mantingh, I., Ter Hofstede, R., & Corten, A. 2003. The remote sensing research missions of 2002: use of satellite imagery and analysis of the fluctuation of sardinella stock in the Mauritanian EEZ since 1996. RIVO Contract Report C008/03 and (internal) 03.005. Ministry of Agriculture, Nature Management and Fisheries, The Hague.

Zeeberg, J.J. 2004. The use of satellite imagery in sardinella and sardine fisheries in the Mauritanian EEZ – Annual report 2003 with daily observations during freezer-trawler missions. RIVO Contract Report C029/04. Ministry of Agriculture, Nature Management and Fisheries, The Hague.

Appendix 1 Daily summaries

Because GMT is used as a standard in The ESAS routine we will refer to times in GMT. In Mauritania at this time of year this means that GMT is –2 hours local time: 7:00 am local time equals 5:00 GMT.

15 April

Upon arrival in Nouadhibou we were picked up from the airport by Kees Goudswaard and brought to the Al Awam immediately. The table and bench that was meant for the observations had been picked up from the carpenter and went on board. After our observation platform was set up and the bench fixed to the upper deck, it was too late to sail. At dark it is difficult to navigate out of the port of Nouadhibou because of the 555 shipwrecks, leaving only a narrow channel. Therefore the captain decided to sail at first light the next morning.

16 April

At 5:00 GMT in the morning the Al Awam left the harbour of Nouadhibou and sailed westward towards the start of the first transect. Observations started at 5:52 GMT sailing out from Nouadhibou. Large flocks of Common, Arctic terns and Black terns were seen feeding. Royal, Caspian and Little Terns were observed as well as Lesser Black-backed and Yellow-legged Gull and European Storm-petrels. After one hour we reached the start of transect 1 (at 20°40'N). As the first transect was a hydrography transect, observations were interrupted five times at the different stations. Sailing westward along transect 1 we encountered mainly Gannets, terns (Common and Arctic), Arctic Skuas and Pomarine Skuas. Early in the morning we saw a group of 30 Whimbrels migrating northeast. The first haul was taken in the shallow area (up to 50 m) and consisted largely of Sardinella and Mackerel. Approaching the shelf edge Cory's Shearwaters notably *Calonectris diomedea* (Scopoli Shearwater), Sabine's Gulls and Wilsons Storm-petrels became more abundant. At 15:42 we reached the end of the first transect and headed south for an hour. Along this stretch birds were not numerous, apart from the occasional Pomarine Skua and Stormpetrel and a Great Skua. We encountered a Portuegese Man of War in front of the ship. After an hour we started the second transect (20°30N) sailing eastward towards the coast. By dusk we had not reached the shelf edge yet. Observations stopped when it was too dark to see at 17:27 GMT.

17 April

During the night the second transect was finished and in the morning we started the observations on transect 3 (20°20'N) at 5:15 GMT. Sea state varied between 4 and 5 and was rather constant over the day. Many Arctic and Common Terns were seen migrating northward in small groups. Gannets were common on the shelf, but decreased on the shelf edge. Approaching the shelf edge Arctic and Pomarine Skua petrels and Sabine's Gull became more abundant. European Storm-petrels were slowly replaced by Wilson's Strom-petrels. The first haul contained Sardines and Anchovy. During the second haul many Royal terns were observed with a orange-pink type of sandeel of ca 10-15 cm. The third haul yielded few fish, mainly Sardinella. Transect 3 was finished at 12:39 GMT and we continued our observations on the southward stretch heading for transect 4 (20°20'N). After passing a trawler at close range, a group of 30 Common Dolphins suddenly showed up near the bow. They likely transversed from

the trawler to our ship. Apart from the dolphins also many Pomarine Skuas, Arctic Skuas, Sabine's Gulls and Common Terns changed ships. Although in deep sea, Royal Terns were still around. The number of Pomarine Skuas did not decrease along this stretch. Other species did not occur in large numbers. The onset of transect 4 was reached at 13:47 GMT. After one hour we stopped for fishing. Upon reaching the shelf edge fishing vessels were all around (a total of 27 visible concurrently). At the west side of transect 4 many Gannets were seen plunging, but this did not indicated the presence of dolphins. As new species Mediterranean Shearwater, Leach's Storm-petrel and Wilson's Storm-petrel. A Portuegese Man of War was sighted twice in front of the ship. Because up to now these were only detected in front of the ship the detection probability is probably very low.

18 April

During the night transect 4 was finished. Along transect 5 (20°00'N) four hydrological stations should be sampled. Because these measurements could not be collected during the night the ship stayed anchored at the start of transect 5. For the observations this was favourable, because we could start sailing westward in the morning, the sight not being hampered by the sun. During the whole day wind was strong, 5-6 Bf and in the morning and late afternoon rather cloudy. The observations were started at first light at 5:20 GMT, but interrupted after half an hour for the first haul and recommenced at 6:50 GMT. Between 6:50 GMT and 9:13 GMT the observations were discontinued three times for the hydrography stations. At 9:51 GMT the second haul was taken after which we proceeded to transect 6 (19°'50'N) along a south-easterly transect. Transect 6 was finished within one hour and we continued in a southerly direction towards the west point of transect 7 (19°40'N). Because of the strong northern wind and the position of the sun observations were hampered by spray and bad light. Only at the end of transect 7 at 16:45 GMT we could start our observations again and continued till 17:20 GMT when it became too dark. So in all we carried out transect 5, transect 6 and the intermediate stretches between 5-6, 6-7 and 7-8. Only one group of sea mammals (4 bottlenose dolphins) was observed right after we stopped our observations in the evening. Two new bird species were observed: Cory's Shearwater and Bridled Tern. Again storm-petrels (notably European Storm-petrel) and Sabine's Gull occurred mainly over the deepest parts of the transects. Scopoli Shearwaters were observed several times, but also mostly in deeper areas. Arctic Terns and Black Terns seemed to be migrating northwards. On two occasions large groups of terns in combination with Northern Gannets were observed feeding at a large distance, giving the impression that they were aggregating over a group of dolphins. However, the distance was too large to be able to check this. Arctic Skuas were the only skuas that were seen actively chasing other birds (mainly terns). Royal terns mostly operated in duo's again. Royal Terns were observed eating the thin orange-pinkish type of smelt again. The first haul contained large fish (>50 cm Bonito's) as well as small (ideal birdfood type) Anchovy. The second haul contained less fish (mainly Sardinella). Apart from scavenging from the discards Arctic Terns were observed catching smelt-like prey independently.

19 april

Because the vessel anchored for the night we started off with transect 9 (19°20'N) sailing eastward at 5:07 GMT. On this stretch Royal Terns were observed taking the orange sandeel type of prey again. At 5:40 GMT this transect was ended and we proceeded southward along the shelf edge to the start of transect 10. Contrary to other transects at this depth few storm-petrels were seen and Sabine's Gulls were absent. Scopoli's Shearwater however were very abundant. A group of 30 Common Dolphins was discovered due to a large flock of Gannets hovering over the herd. Common Tern and Arctic Terns caught a smaller version of the orange sandeel type. Both terns were seen migrating northward in a nearly discontinuous flow.

At 6:43 GMT we started on transect 10 (19°10'N) sailing eastward. Because of the sun and wind conditions for observations were poor on this stretch. At 7:00 GMT one single dolphin was observed but it could not be identified. A splash and the back were seen once shortly. Sandwich Terns and Royal Terns were observed taking a dark sandeel type of fish. Strikingly the proportion of juvenile terns (all species) was much larger than observed on earlier transects. Because there were very few schools visible on the echosounder, fishing on this transect was restricted to one haul that yielded only a few large (> 1m) fish and a small amount of Anchovy. Skuas were rare and Sabine's Gulls again absent. At the end of transect 10 (10:02 GMT) the Mauritanian coast was visible. The wind had dropped and observation conditions became much better. Sailing southward over the shelf towards transect 11 (19°00'N) very few birds were seen, apart from an occasional Northern Gannet and some terns (mostly ship associated). Common Terns were seen preying on insects. An unexpected and rare sighting (and new species for the trip) was a Fulmar that was obviously not in good condition. At 11:50 GMT we started transect 11. Observations were interrupted at four stations for hydrological measurements. Contrary to transects 9 and 10 many storm-petrels and Sabine's Gulls were seen in the deeper part. Large numbers of Common and Arctic Terns were migrating in northwesterly direction. Also on the stretch sailing form transect 11 to 12 both groups were present in large numbers. Along this stretch a group of 10 Bottlenose Dolphins and twenty Long-finned Pilot Whales was observed at a large (1800 m) distance. As before this group was also discovered because of hovering and plunging Northern Gannets. The Pilot Whales could be distinguished from the dolphins because they produced blows. Transect 12 (18°50'N) was reached at 16:28 GMT. Observations were continued until sunset at 17:28 GMT. Storm-petrels were the most abundant species. Two passerines were seen on board the ship, one small brown unidentified *Phylloscopus* and a Sudan Golden Sparrow.

20 April

During the night the remainder of transect 12 was finished. Observations started at 5:15 GMT at the start of transect 13 (18°40'N), working our way westwards. It was cloudy at first but became sunny a few hours later. Like yesterday sea state varied between 3 and 5 BF, with the strongest winds in the morning and late afternoon and calmer weather in the middle of the day. The first haul was taken at 5:50 GMT and consisted of Mackerel and Horse Mackerel. Although the echosounder gave very strong echoes the catch was small.

After an hour the observations were continued. A group of gulls and Northern Gannets were seen hovering and searching as if they were flying over a group of dolphins but none were seen. Contrary to the days before Wilson's Storm-petrel occurred at close distance form the coast.

As noted before the proportion of dark phase Pomarine and Arctic Skua were large (about 1:3). When passing a trawler a large group of 320 European Storm-petrels were seen flying towards the ship. Sabine's Gulls were very abundant along this stretch, especially over the shelf edge. At 10:24 transect 13 was ended and we headed southward towards transect 14 (18°30'N). Wilson's Storm-petrels were very abundant here and Northern Gannets were completely absent. At 9:25 GMT we reached transect 14 and headed eastward. In the second haul at 12:00 GMT mainly large sized Sardines (25 cm) were caught. At 12:45 GMT the observations were started again and along the easterly part of transect 14 many groups of European Storm-petrels occurred. Gannets reappeared but terns were few. At 12:57 GMT we reached the end of this transect, with the Mauritanian coast in view. Similar to the southward coastal stretch yesterday the stretch connecting transects 14 and 15 was very quiet, apart from the occasional European Storm-petrel and Gannet. At 14:45 GMT the ship reached transect 15 (18°20'N). Observations were hampered by the sun (sailing in a westward direction) and were stopped when the third haul of the day was taken at 16:15 GMT. During the whole day Royal Terns were very sparse. A number of new wader species were seen migrating northward: Redshank (1), Whimbrel (1, and 8), Bar-tailed Godwits (45) and Grey Plover (4). New seabird species were Manx Shearwater (1), at the shelf edge and Roseate Tern (2). The latter were perched on one of the lines on the ship.

21 April

Transect 15 was finished during the night and in the morning we started our observations at 2/3 of transect 16 (18°10'N). The sea state showed the same patterns as the previous days: strong northerly winds (4-5 Bf) in the morning and late afternoon and calmer weather (state 3) in the middle of the day. At 5:30 GMT we did one count in between the first two hauls. In both hauls very little fish was caught. Observations were continued at 6:52 GMT. European Storm-petrels were the only abundant species in this coastal area, swimming in small dense groups. Many piroques (up to 37 at the same time) were active in this area. On board the ship we observed the first Lesser Crested Tern, considerably smaller than the Royal Tern next to which it was sitting. At 8:15 GMT we reached the end of transect 16 but turned back along the same line for a last haul (mainly Anchovy). At 9:45 GMT we headed south to transect 17 (18°00'N), meanwhile passing Nouakchott. Amongst the European Storm-petrels were many Wilson's Storm-petrel amongst which a considerable number was in primary moult (showing wing gaps). Along transect 17, positioned at 18°00' five hydrographical stations are positioned. It took the rest of the afternoon to finish this transect, because of the many interruptions (stations and two hauls). The echosounder showed schools of fish close to the sea bottom and as expected these hauls consisted of Mackerel and Horse Mackerel. Northern Gannets seem to occur not close to the coast and at the deepest part inhabit the waters in between. Like the day before Royal Terns were practically absent. Common Terns was again more prominent than Arctic Tern. Terns were not migrating like the previous days. Roseate Tern and Sooty Shearwaters were each observed twice (one of the shearwaters was in wing moult). On the shelf edge our ship was accompanied by large number (80) Pomarine Skuas, 99% adults and light phase (only 2 were dark phase). This is quite unlike to the phase and age ratio observed up to now. Observations were ended at 16:45 when we reached the deepest part of the transect and the final station. In the evening another haul was made that yielded a large catch of Anchovy and Hairfish.

One of the crewmembers caught a Common Tern by hand (by approaching it from the back and taking it by hand). Many terns (Common, Sandwich and Arctic, often 1 out of 10) are ringed. A new species today was Dunlin (20), migrating northward. Strangely these were seen at the deepest part of the transect 25 mile offshore. A rare sighting for today was a complete dark phase Long-tailed Skua.

22 April

Transect 18 (17°50'N) was carried out during the night and in the morning we started our observations at the eastside of transect 19 (17°40'N) at 5:12 GMT. The sea state was 4Bf in the morning increasing to 4 and decreasing to 2 at midday, whereafter the wind picked up again. Sailing westward in the morning and eastward in the afternoon conditions were rather favourable for observations. Although we were close to the coast no groups of European Storm-petrels, as observed the days before in this zone, were seen. Several small groups of waders (1 Redshank, 20 Golden Plover and 20 Knots) passed in a northerly direction early in the morning. Up to now wader migration always took place at this time of day. After an half hour the first haul was taken, which comprised mainly large Sardines. The morning session was interrupted once more at 9:00 GMT for the second haul, also consisting of large Sardines. Observations were hampered greatly by a huge group of Pomarine Skua (80) and Wilson's Storm-petrel that were obviously associated to our vessel and made it difficult to judge which were new birds. Unlike before also Scopoli Shearwaters showed this behaviour. Sooty Shearwater was observed here as well. Especially at the shelf edge large numbers of Pomarine Skua occur. Identical to yesterday the great majority was adult and light phase. At 10:45 GMT the end of the transect was reached and we sailed southward. At 11:50 GMT the ship reached the start of transect 20 (17°30'N). Wilson's Storm-petrels and Black terns were very abundant, the latter flying mostly in duo's. Again very large numbers of Pomarine Skua, Arctic and Common Terns and Sabine's Gulls aggregated behind a fishing vessel. Passing the shelf edge Wilson's Storm-petrels occurred mixed with European Storm-petrels. This zone was again very rich in skuas (mainly Pomarine) small terns (few Sandwich) and European Storm-petrels. Observations were stopped for the third haul at 14:10 GMT. The catch was small with some Horse Mackerel. In the meantime 250 Sabine's Gulls, 90 Pomarine Skuas, 25 Wilson's Storm-petrels and 90 small terns congregated near the vessel. For the first time since 17 April Great Skuas showed up once more: one adult far offshore on the stretch connecting transects 19 and 20 and three adults at the westend of transect 20. Because Wilson's Storm-petrels were observed in wing moult yesterday we started to score of wing moult (absence or presence) for a sample of the individuals passing close enough to be able to distinguish it. Larus Gulls were absent during the whole day, in coastal and offshore area as well as at the shelf edge. Only at the very last count at the westside of transect 20 a few individuals were recorded. By 17:00 GMT transect 20 was finished and a last haul was made in this shallow area. This catch was very diverse, with Hairfish and Horse Mackerel as the most common species.

A European Storm-petrel was found on board the ship, obviously in poor condition. Lesser-crested Terns were seen again.

23 April

The night was spent anchored and early in the morning we started on transect 21 (17°20'N), sailing in a westerly direction. The sea state in early morning was calm 2 Bf and increased to 4 later in the day. In total 6 hauls were made. Observations were started at 7:13 GMT but interrupted after 5 minutes for the first haul at 5:18 GMT (consisting mainly of Sardinella). After the haul we crossed a clear transition between two types of water. Here in relatively shallow water (50 m) a 'carpet' of European Storm-petrels (75 per minute passing by) moved in a northwesterly direction along the edge of the transition. Although it is not clear what caused this line, we got the impression that it was caused by upwelling. Just after we started sailing again a large flipper of a Humpback Whale showed up in front of the ship. It showed its flippers a few times, then its back two times where after it dove, not showing its fluke. This was a rather unexpected sighting, so close to the coast. Among the terns on board (of which still a relatively large proportion is ringed) was a colour-ringed Sandwich Tern (left leg: metal; right leg: green over red). As in previous early mornings we saw groups of waders (30 Whimbrel and 2/2 Whimbrel/Curlew) moving north. Large gulls were again absent, the rest of the transect showed the usual picture: most birds, notably Pomarine Skuas, Wilson's Storm-petrel shelf edge and terns mainly associated with our own or other vessels. Numbers decreased quickly when approaching deeper water. Although Arctic and Long-tailed Skuas were present, Pomarine Skuas were again the most common skuas. At 9:06 GMT the end of transect 21 was reached. Just after turning south a herd of 4 Killer Whales showed up. We saw one male and three females surfacing about 7-8 times after which they dove at 300 m from the ship. Along the southward stretch we encountered many migrating Black terns, flying mostly in duos. They seemed to be foraging underway, diving towards the surface but never touching the water, as if they were preying on insect prey. Along this stretch a few skuas were present.

At 10:30 GMT transect 22 (17°10'N) was reached. Huge numbers of Wilson's Storm-petrels (1200) and terns followed in the wake of a trawler. The observations were interrupted 4 times on this transect for fishing. The first catch was small and contained Hairfish and Sardinella. The second haul was rather diverse with Horse Mackerel as the dominant species. We passed two more trawlers with large numbers of birds. At 14:10 GMT two other hauls were made. Upon departure after the fishing large numbers of Sabine's Gulls, Pomarine Skuas surrounded the ship, making counting very difficult. Getting close to the shore the number of Arctic Skuas increased and similar to yesterday several Great Skuas appeared here. A few times we saw multispecies groups congregating, consisting of terns (Common and Arctic), Pomarine and Arctic Skuas, but never associated with dolphins. At dusk we reached the end of transect 22 and spend the night anchored here. The last haul was taken after dark in shallow water and was very diverse with ca 10 species.

24 April

Observations started at 5:00 GMT at the start of transect 23 (17°00'N, in westward direction) but where already interrupted after 5 minutes for the first haul. The sea state was calm, but increased quickly to 4 and 5 midday after which it decreased again in the afternoon. Terns were migrating northward and a Great Skua appeared. The haul yielded a few large fish and some small fish like Anchovy and Sardines. Again the proportion of juvenile Common Terns on board the ship was very high: 2/3. For the first time in many days we encountered a group of Lesser Black-backed Gulls.

A multispecies feeding association of terns and Arctic Skua was observed but it was not related to a dolphin group. Few European Storm-petrels were seen close to the coast. As noted before only Arctic Skuas and Great Skuas klepto-parasitised other birds, Pomarine and Long-tailed Skuas seem to be feeding for themselves. Observations on this transect were interrupted 4 times for hydrogeographical observations. Pomarine Skuas and Wilson Petrels started to appear in large numbers around the 100 m depth contour. Amongst the terns again two Roseate Terns showed up. Because of their extreme white appearance and very long tail they are easily recognized.
At 9:37 GMT the end of the transect was reached and we turned south. Apart from Pomarine Skuas, Wilson's Storm-petrel and Black Terns few birds occurred here. The sighting of two Great Skuas along this stretch did not confirm our impression that this species mainly occurs in the coastal zone. A dorsal fin of a solitary dolphin was seen once but could not be identified. At 10:37 GMT we reached the westside of transect 24 (16°50'N), where we headed eastward. Still in the deep zone one large dolphin was seen at a large distance breaching twice. Also this individual was alone. The species could not be determined but it appeared larger than a Bottlenose Dolphin. Black Terns were still numerous here and Arctic Terns were seen migrating. Approaching the shelf edge Pomarine Skuas and Sabines Gull increased in numbers. A trawler in our vicinity caused a lot of movement from Sabines Gulls, skuas and Arctic Skuas. During the next haul another juvenile Common Tern (105 g) was caught by one of the crew. We caught two Common Terns with a sweepnet from our observation post, of which one was ringed with a Dutch ring (L214053, 135 g, ringed at Ketelmeer, The Netherlands). This bird threw up a Sardine. At 13:46 GMT we reached the end of the transect and were back at the coast. Here we encountered the first Pelican flying from land westward. A Leatherbback Turtle (about 2m) appeared just in front of the ship. At the stretch parallel to the coast Black, Royal and Caspian terns were the only species. At 15:00 GMT transect 25 (16°40'N) was started. The haul in the shallow part consisted of small fish: Sardines and Anchovy. Pelicans were seen more often up to the shelf edge, often associated with our or another vessel. The next haul consisted of Horse Mackerel and many jellyfish. This might explain the occurrence of the Leatherback Turtle, that largely feeds on jellyfish. The end of the transect was not reached by dusk. After dark at 20:00 GMT many dolphins (possibly Common or Striped) were seen bow-riding repeatedly and for long periods (16°40'03N, 16°26'76W). The species and number could not be confirmed.

25 April

Transect 25 and 26 (16°30'N) were finished during the night. At the start of the transect a first haul was taken with many large demersal fish. Pelicans were attracted by the ship (or other vessels) unto the shelf edge. On the shelf several groups of foraging terns (Common, Arctic and Black) occurred. Roseate Terns were seen a few times. A group of three Whimbrels migrated north. The second haul again contained many jellyfish and Horse Mackerel. Different form the last days was the reoccurrence of Lesser Black-backed Gulls. Portuegese Man of War were seen twice. On the shelf edge Sabine's Gulls appeared but the large numbers of Pomarine Skuas and Wilson's Storm-petrels found on previous transects were practically absent here. Several Sooty Shearwaters were recorded. At 12:55 GMT the end of the transect was reached. A Swift showed up and Bulwer's Petrel was observed for the first time. Along the southward stretch Royal Terns were an unexpected sighting, as before these were only seen in the shallower parts. Furthermore few birds were seen along this deep water stretch.

One hour later we headed eastward along the last transect (28, 16°10'N). Pomarine Skuas were still absent, but Sabine's Gulls, Common Terns and Wilson's Storm-petrels were abundant. On the shelf Black Terns were again very abundant and for the first time were seen feeding and actually plunging. Several dense flocks (of tens of birds) were seen, with a few Common/Arctic Terns. Sandwich Terns were feeding separate form these groups. European Storm-petrels were again absent and also Pelicans were not around. After having finished the transect we returned a short distance along transect 28 to fish a final haul. Here numbers of Black Terns had built up in the meantime and feeding groups of up to1000 birds were seen. It was obvious that feeding took place at very short intense periods, when large fish could be seen splashing at the surface, likely chasing smaller fish within the Black terns reach. During this haul we tried to fish right through the feeding groups. The catch consisted of large numbers of very small Anchovy (ranging in size from 3 cm to 10 cm) and the 'hunters': *Sphyrnea sphyrnea*. After this last haul, the acoustic survey had ended en we headed northward towards Nouakchott. We continued our observations at 15:00 GMT. Black Terns were still seen in large numbers, most of them heading southeast. The second most common species was Cory's Shearwater, both *Calonectris diomedea* and *C. borealis* were present. Half an hour before sunset we saw the blow and later also the back of a Fin Whale at 500 m from the ship in relatively shallow water (<50m). It blew and surfaced ca 10 times. At 17:10 GMT observations were finished. We sailed on during the night.

26 April

At 3:00 GMT we arrived in Nouakchott where we spend the day in the harbour.

27 April

We sailed form Nouakchott at 12:30 and commenced observations shortly after. The ship headed Northwest along the most coastal ends of the transects. Because we headed towards the wind waves were strong (sea state 4). This shallow stretch was very poor in birds, similar to our earlier observations in this area. Only Northern Gannets, Arctic and Common Terns, occasionally a Pomarine or Arctic Skua and some Cory's Shearwater were seen. We encountered a group of diving Northern Gannets two times, but never accompanied by dolphins. Observations were ended at dusk (5:10 GMT).

28 April

Counting started at dawn and ended when we entered the harbour of Nouadhibou at 13:00 GMT. Apart form Black Terns Common, Arctic and Royal Terns few birds (skuas and shearwaters) were observed. At the entrance of the Baie du Lévrier the first groups of Black Terns were encountered. As observed near the Senegalese border Black Terns were mass feeding here, mostly in single-species groups, sometimes mixed with Common and Arctic Terns. Many tight groups of tens to hundreds of Black Terns were feeding by diving for small, schooling fish. Fish, of which we do not which species were seen jumping out of the water and at times the water surface seemed to be 'boiling' with fish. Most feeding groups were seen at the transition between two types of water, different by colour.