


NIOZ REPORT

NIOZ Report 2022-04

Vulnerable wildlife concentrations at the Mauritanian Shelf

Atlas of area sensitivity to surface pollutants

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Front cover: Northern Gannet Morus bassanus, off Mauritania, 19 Feb 2022,
Atlantic Spotted Dolphins Stenella frontalis, 17 Feb 2022 (both Kees Camphuysen)

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Please cite as:
Camphuysen C.J. (2022). Vulnerable wildlife concentrations at the Mauritanian Shelf - Atlas of area sensitivity to surface pollutants. NIOZ Report 2022-04, Royal Netherlands Institute for Sea Research, Texel. 48 pp. https://doi.org/10.25850/nioz/7b.b.nd

This atlas was produced with financial support of and on request by GTA partners

Cover photos

Northern Gannet *Morus bassanus*, off Mauritania, 19 Feb 2022,

Common Dolphins *Delphinus delphis*, 20 Feb 2022 (both Kees Camphuysen)

Summary

- The Grand Tortue Ahmeyim (GTA) gas development project is the first project to develop >15 trillion cubic feet (tcf) from a major and new African natural gas province that has an estimated potential between 50 and 100 tcf. The project is a technological challenge and involves a pipeline of ~125 km long transporting vast volumes of gas, water with oil and condensates from a deep-water field (~2700m depth) to a Floating Production and Storage Offloading unit anchored on the upper slope (~130 m depth) closer to shore (~40 km) and an LNG hub situated in 30 meters depth. Water is removed and discharged to sea from the FPSO, after the lowering oil content, whereas the condensates are extracted and prepared for export. Dry gas will continue its route from the FPSO towards a nearby modular LNG hub, protected by a solid breakwater where the gas is further treated, liquefied and prepared for reception by large LNG tankers.
- Maritime transport associated with the GTA project will increase risks of the existing threat for accidental spills by international maritime transport. Condensate spills due to a rupture of the wet gas pipeline by dense demersal fishing activity of the world's largest fleets but also sabotage in a war situation where the commerce of gas plays central role, should be considered carefully.
- Besides managing risks for accidents to As Low As Possible (ALAP), decision makers also require an authoritative and frequently updated array of information and planning documents for effective emergency response. They need to assess the potential impacts of an accident, improve preparedness and gain an *a priori* understanding of the value of one of the most biodiverse and sensitive pelagic sea areas of the Atlantic Ocean. Considering the longstanding practice of one of the most important industrial fishing fleets, knowledge and awareness about the societal importance to preserve offshore ecosystems remained poor.
- When an accidental spill occurs, this vulnerability atlas will provide decision makers with easy to digest information, enabling them to see, at a glance, and even before anything happened, when and where sea areas are at risk and where to prioritise clean-up/containment efforts in a crisis situation to protect marine wildlife and fishery resources. This atlas will also provide information when to plan risky and temporary operations.
- The vulnerability of seabirds to oil (or hydrocarbon) pollution in Mauritania was assessed by parameterising an Oil Vulnerability Index (OVI), used in combination with area specific spatial information on the distribution and density of marine birds (estimates of relative abundance based on state of the art, effort-corrected survey data). The resulting maps predict which areas are most at risk from oil spills when they occur.
- Base material are the results of systematic strip-transect surveys, conducted in nine years, most of which since 2000. The data were split into four, representing quarters of the year (Jan-Mar, Apr-Jun, Jul-Sep, and Oct-Nov).
- Traditionally, vulnerability atlases for hydrocarbon pollution are based solely on (sensitive) seabird abundance data, while the presence and abundance of other megafauna is often put aside. Given the global importance of the Mauritanian slope and shelf area, sightings of cetaceans are added as exact plots, to integrate data and to highlight particular biodiversity hotspot areas.

- The **key product** with this atlas are the **seasonal vulnerability maps in Fig. 9A-D**. All intermediate steps to reach the conclusions shown on these maps are discussed in the text, and illustrated in maps, tables, diagrams, and Appendices, and this includes the underlying observer effort, the species-specific OVI assessments, any intermediate results and additional sources of information used in comparison.
- Vulnerable seabirds and cetaceans occupied overlapping, but locally slightly different areas, with considerable changes through the year. For all wildlife, the shelf-break and areas of cold-water upwelling stood out most prominently Jul-Dec, while seabirds had a somewhat more Neritic (Shelf), less clustered, distribution in Apr-Jun, when cetaceans were comparatively scarce. Large baleen whales were particularly numerous in late winter, and mostly rather far south, at considerable distance from the upwelling area near Cap Blanc, but close to the operational area of the Grand Tortue Ahmeyim (GTA) gas development project.

Introduction

Over the last decades, several NW African countries have attracted strong and sometimes renewed interest from international oil and gas companies. The Grand Tortue Ahmeyim (GTA) gas development project is a good example. The project is based on a partnership between Mauritania and Senegal and two oil companies (BP and Kosmos Energy) and will be conducted in a potentially new African natural gas province. The focus of the GTA gas development project is a floating, liquefied, natural gas (FLNG) export project. This would make natural gas supplies not only available for exports, but also for the domestic energy markets of Mauritania and Senegal. The Grand Tortue Ahmeyim (GTA) gas development project is the first project to develop > 15 trillion cubic feet (tcf) from a major and new African natural gas province that has an estimated potential between 50 and 100 tcf (Looney 2017).

The project is a technological challenge and involves for the first development phase a pipeline of ~125 km long transporting vast volumes of gas, water with oil and condensates from a deep-water field (~2700m depth) to a Floating Production and Storage Offloading unit anchored on the upper slope (~130 m depth) closer to shore (~40 km) and an LNG hub situated in 30 meters depth. Water is removed and discharged to sea from the FPSO, after the lowering oil content, whereas the condensates are extracted and prepared for export. Dry gas will continue its route from the FPSO towards a nearby modular LNG hub, protected by a solid breakwater where the gas is further treated, liquefied and prepared for reception by large LNG tankers.

With the projected offshore, deep-water hydrocarbon extraction off the coast of NW Africa comes an increased risk to marine habitats and organisms, whether from accidents, pipeline leaks, sub-surface well-blowouts or otherwise. With the emerging risk for accidents or leakages comes the urgent need for preparedness and a priori understanding of the most sensitive areas. Accidental hydrocarbon spills require a technical response (depending on the kind of accident or leakage with an intention to stop further damage or associated marine pollution), but accidents also require an adequate wildlife response, so that additional or prolonged environmental damage can at least be minimized. Pre-planning is essential for an effective response, and to provide valuable wildlife orientated advice during spills or during subsequent clean-up operations, up to date and tailor-made information on the most vulnerable sea areas is required.

Seabirds are particularly vulnerable to oil pollution, and accidental spills often result into mass mortality events. Assessing the vulnerability of seabirds to oil is generally achieved through a species-specific index for the sensitivity of seabirds to oil: an **Oil Vulnerability Index** (OVI; King & Sanger 1979, Williams *et al.* 1995). With sensitivity to hydrocarbon pollution being different between marine species (considering their life-history, population size, distribution area, behaviour, marine exposure, and at-sea mortality factors other than oiling), the OVI, combined with spatial information on distribution and density of marine birds, is used to predict which areas are most at risk from oil spills when they occur. Systematic ship-based surveys, during which spatial patterns in charismatic megafauna abundance have been assessed, have been conducted since 1988 and these data have been made available for a sensitivity atlas to evaluate spatial patterns in vulnerability to oil pollution off Mauritania. Surveys have been conducted almost year-round, but data coverage has thus far been weak in the first quarter of the year.

Due to the Covid-19 pandemic, the commissioning of the first phase of the GTA project, which was initially planned for 2022, has been delayed to 2023. The Covid-19 pandemic also meant that the survey needed to at least partly fill the data gap in that first quarter had to be postponed. While it felt important to combine and analyse all existing data, collected in earlier decades (1988-2018) according to state-of-the-art at-sea survey techniques, so that BP would at least be largely prepared when the GTA gas development project actually starts its offshore operations, a first, preliminary, vulnerability atlas was published (Camphuysen 2021). This was seen as an important step in the risk assessment, by for the first time evaluating spatial and temporal patterns in the vulnerability to oil pollution of sea areas off Mauritania based on seabird densities, and while awaiting sufficient coverage for the first quarter of the year. Following a successful cruise conducted in February-March 2022 (Camphuysen *et al.* 2022), major remaining data gaps have been filled in, which led to a full update, as presented in this report.

The OVI principle and area sensitivity

Decision makers require an authoritative and frequently updated array of information and planning documents for environmental impact assessments. The information should consider effects of certain activities or likely accidents on animals, on animal habitats, or on the environment that is overseen. The need for a system to evaluate relative vulnerabilities of certain animal species, or animal populations has historically been particularly great to assess the effects of marine oil pollution (Baker 1983, Clark 1984, Burger & Gochfield 2002, Camphuysen *et al.* 2005). A simple system was devised as early as in the late 1970s, to present and evaluate avian data such that those interested in birds, whether trained or not, could easily grasp the implications of some proposed action, or even forecast the effect of an accidental spill (King & Sanger 1979). Despite the early development of this system, the lack of preparedness by authorities and oil spill responders regarding the impact on marine wildlife has been prominent, not only during historical spills (e.g. Torrey Canyon in 1967 and Amoco Cadiz in 1978), but was still a major problem in 1989 (Exxon Valdez, Alaska), 1991 (Persian Gulf War oil spill), 1999 (Erika, Bay of Biscay), in 2002 (Prestige, Galicia, Spain) and particularly in 2010 (Deepwater Horizon oil spill). What was learnt over time, is that it isn’t the spilled volume of oil that matters most, but the sensitivity of the area where the oil or condensates is released (Camphuysen *et al.* 2005, Camphuysen 2007).

It was evident, that biologists had to devise ways of presenting their knowledge such that it could easily and effectively be used by decision makers, who are often less informed, if not completely ignorant, of any vulnerable wildlife at risk. The Oil Vulnerability Index (OVI) has been designed to fulfil this informational need on the avifauna (seabirds) in any given sea area, but needed improvement. The OVI is designed as an aid in assessing the vulnerability of concentrations of birds to surface pollutants, especially oil (Skov & Durinck 1992, Carter et al. 1993, Webb et al. 1995, Begg et al. 1997, Skov et al. 2002, Garthe 2006), but similar indices have more recently been designed also for windfarms (Garthe & Hüppop 2004). The method has now been successfully applied to the Pacific, the high Arctic, North Sea, the Baltic and NW Europe, and can be used for other areas, give or take some area-specific modifications.

OVI scores for individual species serve only to rank the relative vulnerability of them (see specifications below), but are of no use on their own in assessing the sensitivity of sea areas. That is, because no allowance is made *within* the OVI score for variable use of an area. This requires knowledge of the relative importance of the area for each species in each month or period and the total number of species using that area. In this atlas, a density is calculated for each seabird species for each 10' of latitude by 10' of longitude rectangle[1] for which data were available, using survey data held in the NW Africa Seabirds at Sea database. This dataset, certainly when split in half or in quarters to describe seasonal patterns, is still too small, and most species are simply not recorded frequently enough, to warrant a more refined spatial analysis using for example more advanced kriging techniques. It is currently the best available dataset to achieve our goal, however. So, in order to assess total vulnerability of offshore areas, the density values were combined with the species OVI scores using the formula area vulnerability score =

$$\sum_{species} \ln(p + 1) * OVI$$

where *p* is the density calculated for a species in the area and OVI is the oil vulnerability index score for that species (Begg *et al.* 1997). The area vulnerability, or sensitivity, is thus a combination of the numbers of each species present in each area and their respective OVI scores. Natural logarithms are used to transform each density into an order of magnitude. This smoothed out variations in the number of birds seen in a survey but still highlights large-scale variations. One will be added to each density to avoid negative logarithm values. The value for each 10'x 10' rectangle is then placed into one of eight categories of vulnerability (ranging from very high to very low), by dividing the range of values into eight equal-sized groups. A map for each month of the year or for each season would have been plotted if sufficient data would have been available (cf. Carter *et al.* 1993, Webb *et al.* 1995).

The idea of a vulnerability atlas that is based on a combination of seabird densities (estimates of relative abundance based on effort-corrected survey data) and the species-specific OVI assessed a priori is, that decision makers can see at a glance when and where sea areas are most sensitive with respect to any surface pollutants (usually hydrocarbons such as gas condensates or mineral oil, but also vegetable oils, fish oil, or any other hydrophobic and insoluble chemicals dumped from ships or otherwise released into marine ecosystems; Camphuysen & De Leeuw 2011). Given any choice, this information could be used to minimize any further damage, whenever this would be possible. For example, clean-up operations could be prioritized for areas of particular sensitivity over areas where the effect on wildlife would be smaller. When risky operations are planned, an evaluation of periods and areas of high sensitivity could help set the agenda to reduce the likelihood of wildlife mortality in case of incidents during the work.

A major flaw is the fact that area sensitivity is based on (sensitive) seabird abundance, as in virtually all earlier studies, while the presence and abundance of cetaceans and marine turtles should be considered as well, certainly in a biodiverse region as that off Mauritania (e.g. Scales *et al.* 2015). Also, shorebirds were excluded from the analysis, while such groups must be considered in case of an impact assessment of intertidal areas and estuaries. In an attempt to compensate for the current lack of techniques, I have superimposed sightings of cetaceans as plots, in a further attempt to integrate data and highlight particular hotspot areas.

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[1] [1]Or any size rectangle or polygon that is preferred given the resolution of available data

Oil vulnerability scores for each seabird species

Following earlier examples (King & Sanger 1979, Camphuysen 1989), each species has been scored on 20 factors affecting its likelihood of survival using point scores ranging from 1, 3, or 5, indicating no, low, medium, of high importance, respectively, in their biology or habits, throughout their life-cycle. The potential range of the OVI for each species ranges theoretically from 20 to 100 (in practice ~25-80). High and very high OVI scores should point at species that are both vulnerable at the behaviour level, as a result of their life-style, as a result of their range (restricted being more sensitive than widespread), and as a result of their overall population, not as a result of the abundance or exposure in the area concerned here. Areas where species with high OVI's occur in high densities should show up as particularly sensitive areas.

All OVI scores for species where indices have been assessed before have been redone, using updated information, and for all Mauritanian seabird species where OVIs were missing the 20 factors were scored now. The resulting list of indices has been reviewed by an independent reviewer with expert knowledge of seabird demography, population biology, and seabird ecology (M.F. Leopold, Wageningen Marine Research, The Netherlands).

The following aspects are observed:

Range	1	3	5
Breeding range	Large	Medium	Small
Migration distance	Long	Medium	Short
Winter range	Large	Medium	Small
Marine orientation	Marginal	Estuarine	Neritic-Pelagic

The aspects breeding range, distance covered in migratory pathways, and wintering range all apply to the biogeographical population of the species or subspecies under consideration (using Cramp & Simmons 1977, 1983, Brown *et al.* 1982, Urban *et al.* 1986, Del Hoyo *et al.* 1992, 1996, and the most recent online version of the Handbook of the Bird of the World https://birdsofthe world.org/ (Accessed April-May 2021)). Under marine orientation (the preferred or principle habitat of the species under consideration away from its nest site), the intertidal zone is included in the estuarine areas, while birds that typically occur at sea to forage (coastal, neritic zone, shelfbreak or pelagic) score high. The Neritic zone refers to waters up to the shelf break and some species that utilize these waters roost on land during the night (see under Behaviour and Habits). Pelagic seabirds reside at sea 24/7.

Biogeographical population	1	3	5
Population size	Large	Medium	Small
Reproductive potential	High	Medium	Low

Population size is 'large' if estimated at over a million pairs, small if less than 100,000 pairs. The most recent estimates are taken from Del Hoyo *et al.* (1992, 1996), updated at https://birdsoftheworld.org/ (Accessed April-May 2021). Reproductive potential is a combination of life-history strategy (K- or r-selected) and clutch size, all based on the classic handbooks. So, long-lived Procellariiforms (small clutches, late maturity) score higher than relatively short-lived species with large clutches such as seaduck, that breed within a few years from fledging. The idea being, that a high reproductive potential should lead to a relatively quick recovery of the population after a crisis or a mass mortality event.

Behaviour and Habits	1	3	5
Roosting	Land	Intertidal	Neritic/Pelagic
Foraging	Aerial	Plunge-diving	Swimming/diving
Escape	Flying	Swimming	Diving
Flocking	Solitary	Small	Gregarious
Nesting density	Low	Medium	High/colonial
Specialization	Low	Medium	High

Species specific, behavioural characteristics that makes them more, or less, vulnerable to floating hydrocarbons at sea. Birds that typically roost on land are relatively safe in periods of rest, certainly more so than birds that roost and sleep at sea. Seabirds with a more aerial life-style, or species that plunge dive into the water from flight tend to be better capable to avoid patches of oil than birds that swim and dive from swimming. Escape behaviour from oil slicks (or any threat) is assumed to be a relatively safe strategy when birds tend to take off and leave an area in comparison with species that continue to swim or (worse) dive to escape. Nesting density is used in this analysis to score high for birds in nearshore colonies of high numbers with expected foraging movements and feeding activities at sea as central place foragers. Specialization refers to 'options' given a resource is unavailable as a result of pollution or otherwise. Colonial birds that breed elsewhere score low. Highly specialized species (prey type, habitat) are foreseen to be restricted in options, while versatile species, such as large gulls (foraging and roosting options in multiple habitats) score lower.

Mortality	0	1	3	5
Hunted by man		Low	Medium	High
Susceptibility to wrecks		Unknown	Medium	High
Entanglements, bycatch		Low	Medium	High
History of oiling		Low	Medium	High

Mortality relates to key factors known to lead to mortality in each species, specifically while at sea or when coastal, and these factors deliver point to species that have multiple stressors in the marine environment, even though most these stressors have nothing to do with oil pollution.

Marine exposure	1	3	5
Jan-Mar	Low	Medium	High
Apr-Jun	Low	Medium	High
Jul-Sep	Low	Medium	High
Oct-Dec	Low	Medium	High

Marine exposure relates to the marine environment as a principle habitat in each season, anywhere within the range of the species under consideration. For many Northern Hemisphere birds from the temperate, subarctic or arctic zones, Apr-Sep refers to the breeding season, while for many Southern Hemisphere birds it is Oct-Mar. Birds that are rare at sea during breeding and mostly forage on land or on freshwater have been given a low score for these periods.

The conservation status of a species could have been another factor to consider, but for the present analysis (as in earlier Sensitivity Atlases) I have refrained from using this information. Status codes refer to Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW), Extinct (EX). Using the IUCN status categories as indicate above, would lead to slightly higher OVIs for a few species (Stattersfield & Capper 2000/2021). Examples are passage migrant Balearic Shearwater *Puffinus mauritanicus* (CR), the in this region rather common Cape Verde Shearwater *Calonectris edwardsii* (NT), and the wintering Audouin's Gull *Ichthyaetus audouinii* (VU), all already with a high to very high OVI score. The IUCN does not consider subspecies and, hence, the Little Shearwater complex and the Band-rumped Storm-petrel complex are both considered Least Concern (LC) as a species, even though these complexes include quite rare and endemic taxa in Macaronesian (and Mauritanian) waters.

Conservation status

IUCN status	0	1	3	5
Categories	LC	DD/NT/VU	EN	CR/EW

Methods and material

Systematic surveys were conducted in nine years, and most of these were conducted since 2000 (**Table 1**). Only strip-transect surveys were selected for the OVI analysis, since accurate seabird densities are part of the equation. Observer effort is expressed as km² surveyed and seabird densities as numbers per km squared (n km^{-2}). For sightings of cetaceans, however, a 180° scan forward was deployed, and for that, observer effort is expressed as km travelled and cetaceans observed as number of sightings per km steamed within each rectangle (n km^{-1}). In 2004, the second quarter of the year, 96 counts were conducted without the use of a strip transect, covering 231 km of sea area with a 180° scan as only observation technique. Spatial patterns in observer effort, expressed as km² surveyed (based on strip-transect counts), are shown in **Fig. 1**. The timing of these surveys is shown in **Table 1** and **Fig. 2**. Distance traveller (km) per rectangle is presented as a background of cetacean sightings in **Fig. 4**.

As discussed in the previous chapter, in order to assess total vulnerability of offshore areas, the seabird densities found were combined with species-specific OVI scores, as

$$\sum \text{species} \ \ln(p + 1) * \text{OVI}$$

where p is the density calculated for a species in the area and OVI is the oil vulnerability index score for that species (Begg *et al.* 1997). The area vulnerability, or sensitivity, is thus a combination of the numbers of each species present in each area and their respective OVI scores.

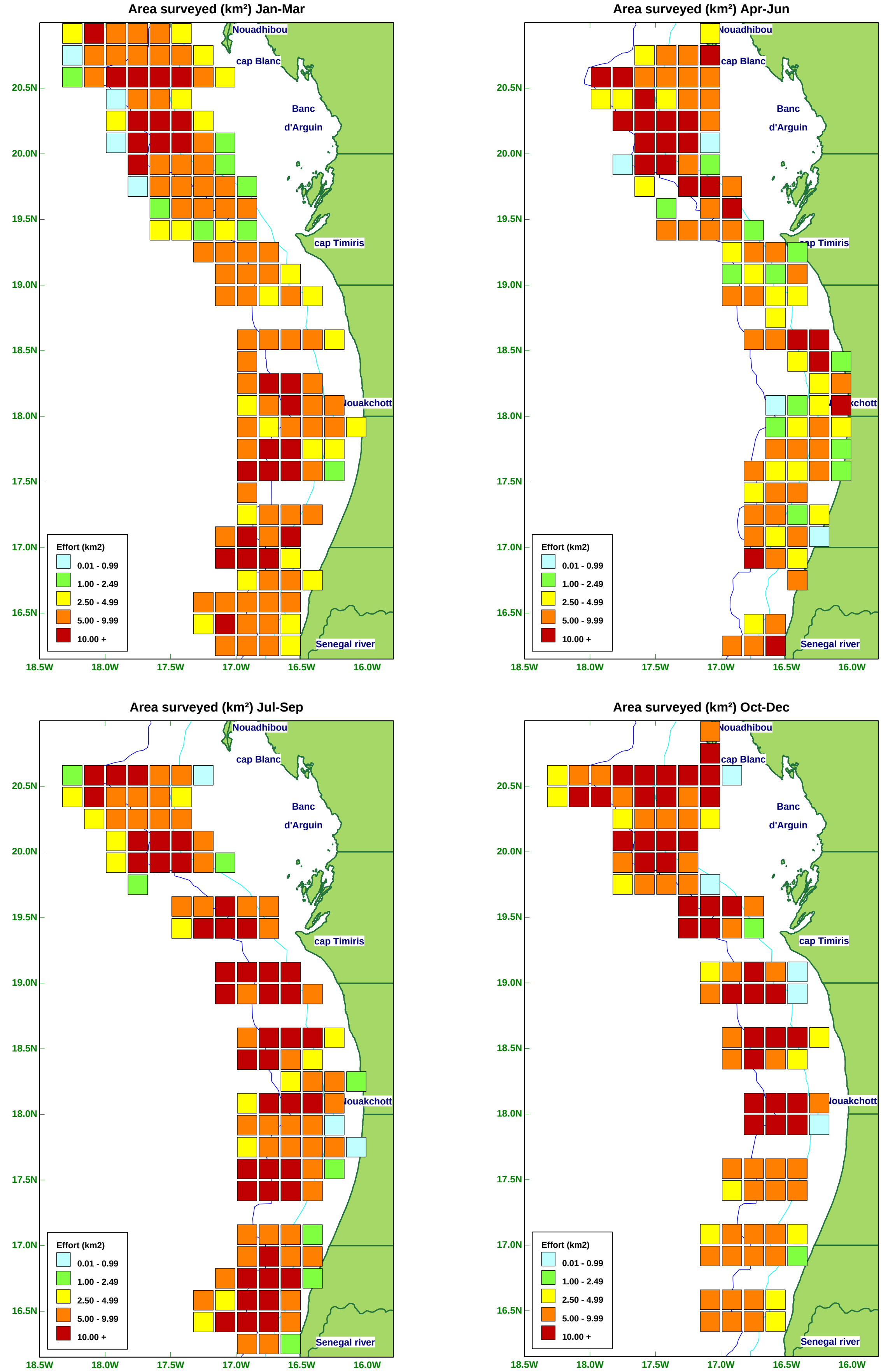

Figure 1. Observer effort (km² surveyed) in Mauritanian waters per quarter, expressed per 10' Lat. x 10' Long. rectangle, based on systematic ship-based surveys, 1988-2022, at more or less constant speed (8.1 ± 0.7 knots), using a 300m wide strip-transect technique (to assess densities as *n* km^{-2}). **Source:** NW African Seabirds at Sea Database.

Table 1. Expeditions to Mauritanian waters during which state of the art strip-transect survey data were collected covering larger parts of the Continental Shelf, the Shelf break, and parts of the deeper waters bordering the Continental Shelf (1988-2022). **Source:** NW African Seabirds at Sea Database, maintained at NIOZ, Texel.

Year	Quarter		strip	km²	10'x10'sq	scan	km	10'x10'sq	Source
1988	2	Apr-Jun	275	237.9	39	275	793.1	39	Leopold 1993
2000	1	Jan-Mar	186	147.7	39	172	491.9	35	Camphuysen & Van der Meer 2005
2003	1	Jan-Mar	1080	296.8	10	1080	989.2	10	Burton & Camphuysen 2003
2004	2	Apr-Jun	645	462.7	67	741	2004.1	101	Tulp, Leopold & Winter 2004
2012	4	Oct-Dec	921	340.6	54	921	1135.3	54	Camphuysen *et al.* 2013
2015	3	Jul-Sep	1478	540.6	85	1477	1802.1	85	Camphuysen 2015
2016	4	Oct-Dec	1340	484.7	90	1339	1615.7	90	Camphuysen *et al.* 2016
2018	3	Jul-Sep	1028	414.5	86	1028	1381.6	86	Unpubl. data CJ Camphuysen
2022	1	Feb-Mar	1497	625.6	117	1028	2087.4	117	Camphuysen *et al.* 2022

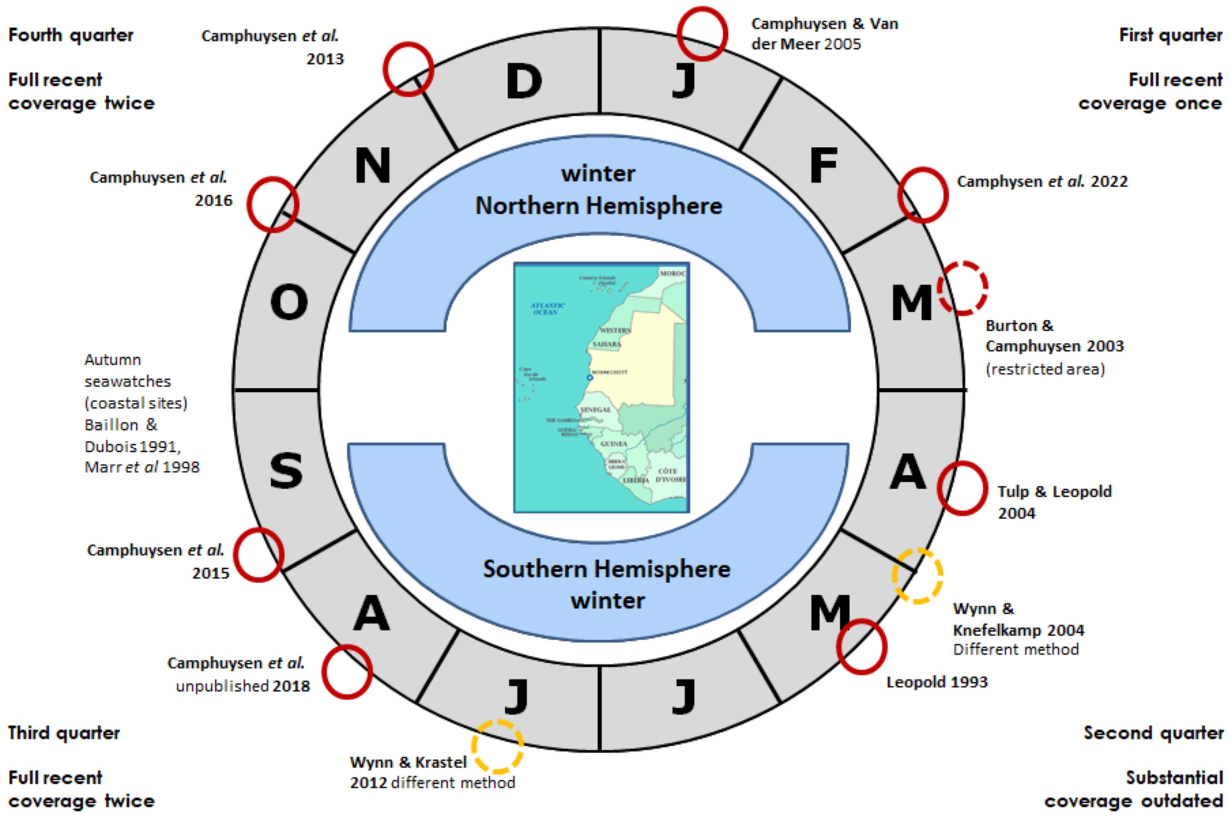

Figure 2. Ship-based seabird observations in Mauritanian waters, for as far as available in a published format, or in the NW African Seabirds at Sea Database maintained at NIOZ Texel (see Table 1). Data collected while using more opportunistic or different methods or in neighbouring sea areas (orange broken circles) can be used to highlight particular areas or seasons of importance in addition to the data that were analysed. Autumn (shore-based) seawatches have rather limited value, as have roost counts or colony censuses of the Mauritanian coast and estuaries, but the results may be insightful when comparing for example the species composition nearer the coast or on land with that at sea. The first quarter was recently updated with a full survey, adding to two earlier, partial surveys. The data collected for the second quarter are now seriously ageing. Mid-summer surveys (June-July) would also be valuable to complete the picture, in particular to get a better idea of the presence and abundance of Antarctic seabirds in that part of the year (see for example Wynn & Krastel 2012).

Results (1) - Seabirds at sea data, species information

In Mauritania, there is a list of at least 70 species of seabirds known to occur at least occasionally (Appendix 1, Isenmann *et al.* 2010, Camphuysen 2022). At least 11 listed species are vagrants: Northern Fulmar *Fulmarus glacialis,* Swinhoe's Storm Petrel *Oceanodroma monorhis,* Red-footed Booby *Sula sula,* Brown Booby *Sula leucogaster,* Red-necked Phalarope *Phalaropus lobatus,* Laughing Gull *Leucophaeus atricilla,* Franklin's Gull *Leucophaeus pipixcan,* Common Gull *Larus canus,* Herring Gull *Larus argentatus,* Common Guillemot *Uria aalge*, and Razorbill *Alca torda*. Among those are two auks that are highly vulnerable to oil pollution within their more traditional wintering range (NW Europe).

Of all seabirds listed, 16 species breed in Mauritania: Little Grebe *Tachybaptus ruficollis,* White-breasted Cormorant *Phalacrocorax lucidus,* Long-tailed Cormorant *Phalacrocorax africanus,* African Darter *Anhinga melanogaster,* Great White Pelican *Pelecanus onocrotalus,* Pink-backed Pelican *Pelecanus rufescens,* Grey-headed Gull *Chroicocephalus cirrocephalus,* Slender-billed Gull *Chroicocephalus genei,* Cape Kelp Gull *Larus dominicanus vetula,* Gull-billed Tern *Gelochelidon nilotica,* Caspian Tern *Hydroprogne caspia,* Royal Tern *Thalasseus maximus albidorsalis,* Common Tern *Sterna hirundo,* Bridled Tern *Onychoprion anaethetus,* Little Tern *Sternula albifrons,* and African Skimmer *Rynchops flavirostris* (Isenmann *et al.* 2010).

In total 48 seabird species have been encountered during systematic boat-based surveys used for this atlas while ‘on effort’. Nine vagrants have not been encountered (as could be expected) during any of these surveys (Red-footed Booby, Brown Booby, Red-necked Phalarope, Laughing Gull, Franklin's Gull, Common Gull, Herring Gull, Common Guillemot, and Razorbill). The other species ‘missed’ were species that typically occur in (inland) wetlands, in the Banc d’Arguin National Park, or at best occasionally in coastal estuaries (Little Grebe, Black-necked Grebe *Podiceps nigricollis,* Long-tailed Cormorant*,* African Darter*,* Pink-backed Pelican, White-winged Black Tern *Chlidonias leucopterus*, and African Skimmer).

This leaves us with six coastal species (Moroccan Cormorant *Phalacrocorax carbo maroccanus,* Common Scoter *Melanitta nigra,* Grey-headed Gull*,* Black-headed Gull *Chroicocephalus ridibundus,* Cape Kelp Gull*, and* Great Black-backed Gull *Larus marinus),* and a pelagic species (Sooty Tern *Onychoprion fuscatus*) that have never been encountered during any of our cruises while on effort. Grey-headed Gull*,* Black-headed Gull*,* and Cape Kelp Gull have been seen, sometimes in numbers, during counts at onshore beach roosts, Moroccan Cormorants have been seen roosting in fishing harbours. There are no reasons to believe that any of these species are ever numerous at sea, or it must be in nearshore waters (cormorant, scoter, *Chroicocephalus*-gulls).

Results (2) - Species specific OVI assessments

An OVI has been assessed for all Mauritanian species, irrespective of their status or apparent abundance at sea off Mauritania, such that their index could be included with ease in any atlas update using more comprehensive, new data. Results are presented in **Appendix 2**.

Very high scores were found for the auks (very rare in these waters) and for the at least seasonally abundant Cape Verde Shearwaters and Northern Gannets (**Table 1**). On the other end of the spectrum are two terns that only rarely occur in an ocean environment (Urban *et al.* 1986, Isenmann *at al.* 2010). Auks, tube-noses (shearwaters, petrels, and storm-petrels), gannets and boobies, and phalaropes tended to be on the higher end of the vulnerability spectrum, pelicans, terns, grebes, and skimmers scored much lower.

Table 1. Ranking of Mauritanian seabirds following their OVI scores, grouping vulnerability to oil pollution relative to each other, as very low, low, rather low, moderate, rather high, high or very high (Appendix 2 for individual scores).

Euring	Species	OVI		Euring	Species	OVI	
10710	Razorbill	80	Very high	2400	Long-tailed Cormorant	50	Moderate
10950	Common Guillemot	80		9040	Parasitic Jaeger	50	
900	Cape Verde Shearwater	76		9320	Yellow-legged Gull	50	
2280	Northern Gannet	74		9670	Great Black-backed Gull	50	
880	Scopoli's Shearwater	70	High	9900	unidentified large gull	50	
1370	Faea's Petrel	70		10310	Bridled Tern	50	
1480	Barolo Shearwater	70		10350	Lesser Crested Tern	50	
1570	Sooty Shearwater	70		9030	South Polar Skua	48	
1690	Balearic Shearwater	70		9070	skua	48	
1930	Band-rumped Storm Petrel	70		9160	Herring Gull	48	
885	Scopoli's/Corys shearwater	68		9410	Grey-headed Gull	48	
890	Cory's Shearwater	68		10420	Sooty Tern	48	
2040	Swinhoe's Storm Petrel	68		2230	Great White Pelican	47	
9980	Black-legged Kittiwake	67		10270	Common / Arctic tern	47	
1560	Great Shearwater	66		9530	Slender-billed Gull	46	
1880	European Storm Petrel	66		10120	Black Tern	46	
1900	unidentified storm-petrel	66		10560	unidentified tern	46	
860	Bulwer's Petrel	64		10380	Caspian Tern	44	
2150	Red-billed Tropicbird	64		10390	Roseate Tern	44	
2520	Moroccan Cormorant	64		10500	Arctic Tern	44	
8880	Red Phalarope	64		10520	Sandwich Tern	44	
8890	Red-necked Phalarope	64		400	Black-necked Grebe	42	
9250	Audouin's Gull	64		9710	Little Gull	42	
1680	Manx Shearwater	62		10440	Common Tern	42	
2070	White-faced Storm-petrel	62		2250	Pink-backed Pelican	41	
9830	Sabine's Gull	62		2390	African Darter	40	Low
2340	Brown Booby	60	Rather high	9240	Laughing Gull	40	
2360	Red-footed Booby	60		9680	Mediterranean Gull	38	
2550	White-breasted Cormorant	60		9790	Franklin's Gull	38	
940	Northern Fulmar	58		10660	African Skimmer	38	
1920	Wilson's Storm-petrel	58		530	Little Grebe	36	
1970	Leach's Storm Petrel	58		9820	Black-headed Gull	36	
6200	Common Scoter	54		10290	Little Tern	34	
9060	Great Skua	54		10130	Gull-billed Tern	31	
9490	Lesser Black-backed Gull	54		10100	Whiskered Tern	30	Very low
9020	Long-tailed Jaeger	52		10110	White-winged Black Tern	26	
9050	Pomarine Skua	52					
9360	Common Gull	52					
9470	Cape Kelp Gull	52					
10480	Royal Tern	52					

Results (3) - Area sensitivity scores

Whether or not particular species of seabirds had an effect on the area-sensitivity as a whole depended not only on their OVI score, but also on their numerical abundance at sea during our surveys. Following the calculations outlined earlier, categories are based on the frequency distri-

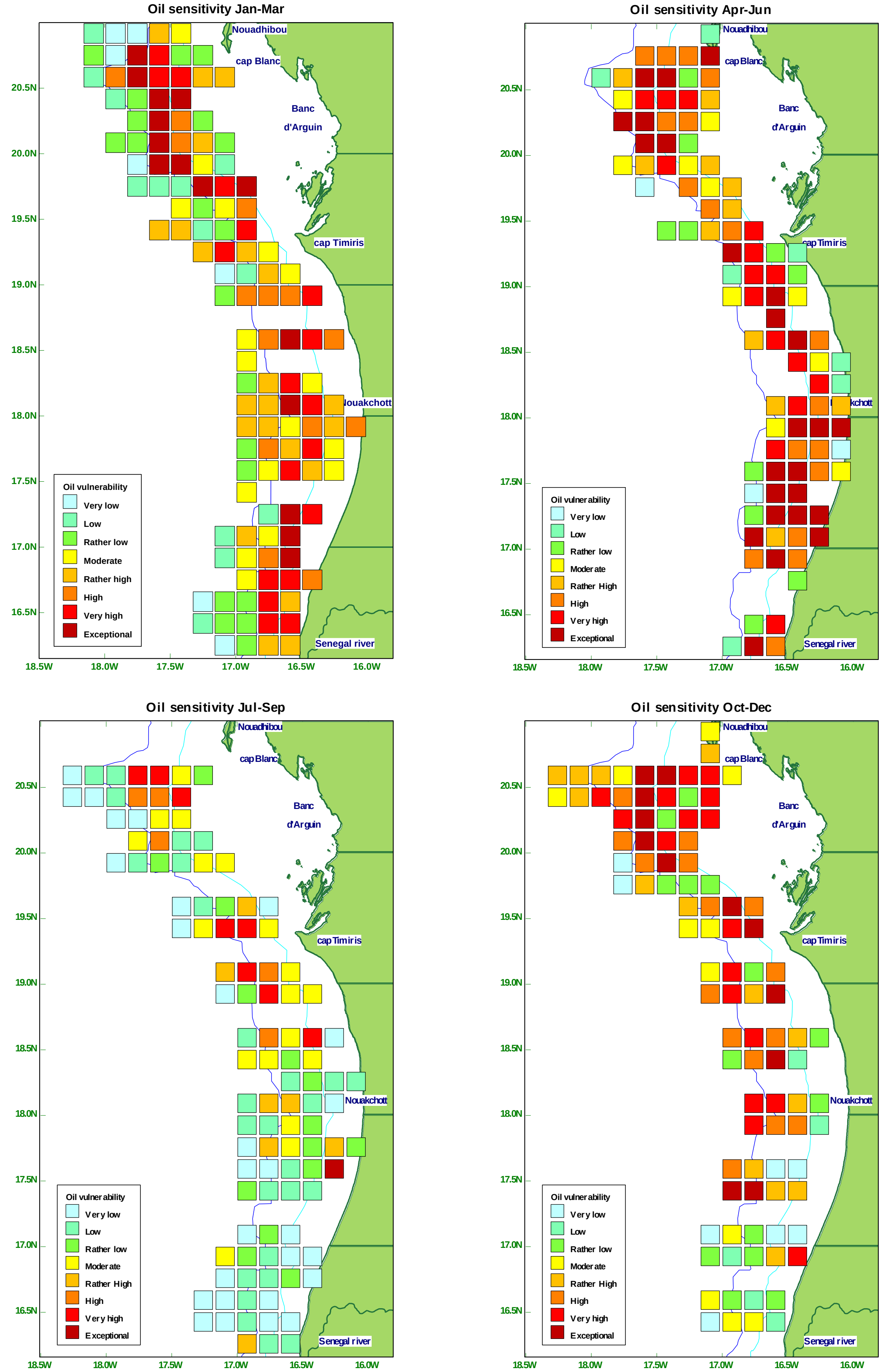

Figure 3. Area sensitivity (categories) in Mauritanian waters per quarter, expressed per 10' Lat. x 10' Long. rectangle, based on *ln* transformed seabird densities multiplied with species specific OVIs (see Methods). Source: NW African Seabirds at Sea Database.

bution of sensitivity values in all rectangles over the entire year, cut into eight equal portions, ranked from very low to exceptionally high, so that values can be compared within and between seasons (**Fig. 3**). Underlying overall bird densities were lowest and least variable in late summer/early autumn (Jul-Sep; see Table). The patterns found are fairly striking in the second half of the year (Jul-Dec), but not so clear in late spring and early summer (Apr-Jun). Overall, the sensitivity to oil pollution was considerably higher in Apr-Jun, and the sensitivity was 'all over' the area, without clear areas of lesser importance. Part of the explanation is that seabird densities were higher and seabirds were more widespread in that period (Table in **Fig. 3**).

The area categorized as 'Deep ocean' (>1000m depth) has a lower sensitivity to oil pollution than the Shelfbreak (1000-200m) or the Neritic zone (<200m depth) in all seasons. In both the late spring-early summer period (Apr-Jun) and in late summer-early autumn (Jul-Sep), it was the Neritic zone that was of most concern, whereas the Shelfbreak was slightly less vulnerable. In winter (Oct-Mar), it was clearly the Shelfbreak that mattered most. In winter, also the zone of upwelling off Capo Blanc stood out as a particularly sensitive area, while the southern sectors of Mauritanian offshore waters, *i.e.* closest to the planned operations by BP, gained importance in late winter and early spring (Jan-Mar) and remained important in late spring and early summer (Apr-Jun). In the second half of the year (Jul-Dec), that southernmost part of the study area had a relatively low sensitivity to oil pollution.

Results (4) - The distribution of marine mammals

Spatial patterns in the presence and relative abundance of marine mammals (cetaceans. Pinnipeds, and sirenians) are no part of the equation used to assess the vulnerability to oil pollution of particular sea areas (**Fig. 3**). Yet, this part of the megafauna community would deserve better, even though the effect of oil pollution on these animals is not well understood (Geraci & Smith 1977, NRC 1985), perhaps because for insulation and buoyancy cetaceans and most seals rely on a layer of subcutaneous fat (blubber) unaffected by contact with oil (Kingston 1999). Where oiled seabirds usually suffer immediate, high levels of mortality during spills, cetaceans such as dolphins, even in heavily polluted sea areas, experience 'disease conditions, consistent with petroleum hydrocarbon exposure and toxicity' (Schwacke *et al.* 2013). Following the major spill of the Exxon Valdez in 1986 in Alaska, only Sea Otters *Enhydra lutris* and Harbour Seals *Phoca vitulina* showed population declines associated with the spill (Loughlin *et al.* 1996). Arguably, while oil spills can have direct effects on organisms (e.g. mortality or morbidity), negative impacts could also result from indirect effects, such as through the alteration of lower trophic levels (Ridoux *et al.* 2004). Even though the immediate effects of oil pollution on cetaceans tend to be difficult to discern, marine mammals can be seen as ecosystem sentinels, due to their documented sensitivities and responses to environmental changes, and given that they amplify trophic information across multiple spatiotemporal scales (Moore 2008, Hazen *et al.* 2019).

Regarding **pinnipeds**, the significance of Cap Blanc monk seal population, up to 200 individuals inhabiting the border area between Mauritania and Morocco, is beyond any dispute (González *et al.* 2012). The Mediterranean monk seal *Monachus monachus* is currently the most endangered seal species in the world. Once abundant (González 2015), it is now estimated that fewer than 700 individuals survive in three or four isolated subpopulations in the eastern and western Mediterranean, the archipelago of Madeira and with a very substantial part in the Cap Blanc area in the NE Atlantic (Karamanlidis *et al.* 2015). Very little is known about the offshore distribution of Monk Seals, even though within the Mediterranean individuals may travel long distances. During our Mauritanian surveys, Mediterranean Monk Seals have been encountered only twice: once off Cansado (near Nouadhibou), and once 10km to the south of Cap Blanc, *i.e.* always near the known rookery of the species at Cap Blanc (**Fig. 4**).

Mediterranean Monk Seal *Monachus monachus*, Cap Blanc, 31 Oct 2016, R. van Bemmelen

Sirenians, in this case West African Manatees *Trichechus senegalensis*, occur in coastal marine waters, rivers, and estuaries from southern Mauritania to northern Angola (Jefferson *et al.* 1993), and inland as far as Mali, Niger and Chad (CMS 2021). It is the least studied of all sirenians, and its status across much of its currently expected range is only poorly known. It lives in the middle and lower reaches of rivers in NW Africa, but also in adjacent seasonal floodplains, flooded forests, lakes and shallow coastal waters and around some offshore archipelagos and islands. It does not occur in deep marine waters, but it is thought to move regularly between countries, along both rivers and coastlines. Occurrence in Mauritania within the Senegal River and associated wetlands, such as the Diawling National Park, with regular movements between Mauritania and Senegal within the transboundary Senegal River. There were no sightings during offshore surveys, but the operations of the Grand Tortue Ahmeyim (GTA) gas development project do pose a potential risk for any population of manatees currently resident in the Senegal River and its associated wetlands.

Cetaceans occur in large numbers and are widespread in Mauritanian waters and the number of species known to occur is so large that even during the initial seismic operations to study the environment and search of oil and gas reserves marina mammal observers were employed to help reduce the impact of that work by for example Tullow in 2012, and Kosmos in

2013 (Paixao *et al.* 2011, Vines *et al.* 2012, Mars *et al.* 2013, Vines *et al.* 2013, Crawford & Gater 2014, Gater & Tuffy 2014). Our surveys and the MMO reports are in general agreement with respect to the biodiversity in the area. The exact whereabouts of particular hotspots are hard to derive from scattered reports of area-specific MMO work linked to seismic surveys, by the very nature and planning of that work, and because some form of avoidance behaviour of cetaceans cannot be excluded when the seismic source was firing (Mars *et al.* 2013). An analysis of existing data collected during all or most of the MMO observations is therefore warmly recommended.

All cetacean sightings during our surveys have been used in order to find spatial patterns of significance and possible hotspot areas in Mauritanian waters (**Figs. 4-5**). First, all sightings were plotted on charts superimposing representations of the observer effort (km steamed using 180° scan; see methods). Secondly, the distribution of sightings was simplified by calculating the frequency of sightings per unit effort (n km^{-1}) for each of the 10x10' rectangles. The exact plots show sightings of baleen whales (X̶) and sperm whales (X) irrespective of the number seen on that location, red circles are used for sightings of smaller cetaceans with an indication of the pod size for each record (see legend **Fig. 4**).

Sightings were relatively few and far apart in late spring (Apr-Jun), without a clear pattern (**Fig. 4-5**). The second half of the year, however, cetacean sightings were frequent and the biodiversity was high: dolphin groups were most common in the south in early autumn, but distinctly further to the north around the end of the year. The much larger baleen and Sperm Whales were usually most abundant in the northern part of the study area, usually over the shelf break, but often venturing into remarkably shallow waters. Encounter rates were such that the southern half of the study area was of particular concern in early autumn (Jul-Sep), whereas the northern half was far more important in late autumn and early winter (Oct-Dec; **Fig. 5**).

Throughout, most sightings of cetaceans, certainly Odontocetes, were in relatively deep waters, that is either in the deeper ocean areas (Oceanic), or on the deeper parts of the Shelfbreak, rather than over shallower parts of the Continental Shelf (**Fig. 6-7**). Only Harbour Porpoises *Phocoena phocoena* were exclusively (and rarely) recorded within the Neritic zone. The baleen whales were most widespread, with a remarkable frequency of sightings in shallower parts of the study area, and that included numerous sightings of the majestic Blue Whale *Balaenoptera musculus*, especially in late winter/early spring 2022.

Surfacing **Blue Whale** *Balaenoptera musculus*, Mauritania, 25 Feb 2022 (Kees Camphuysen)

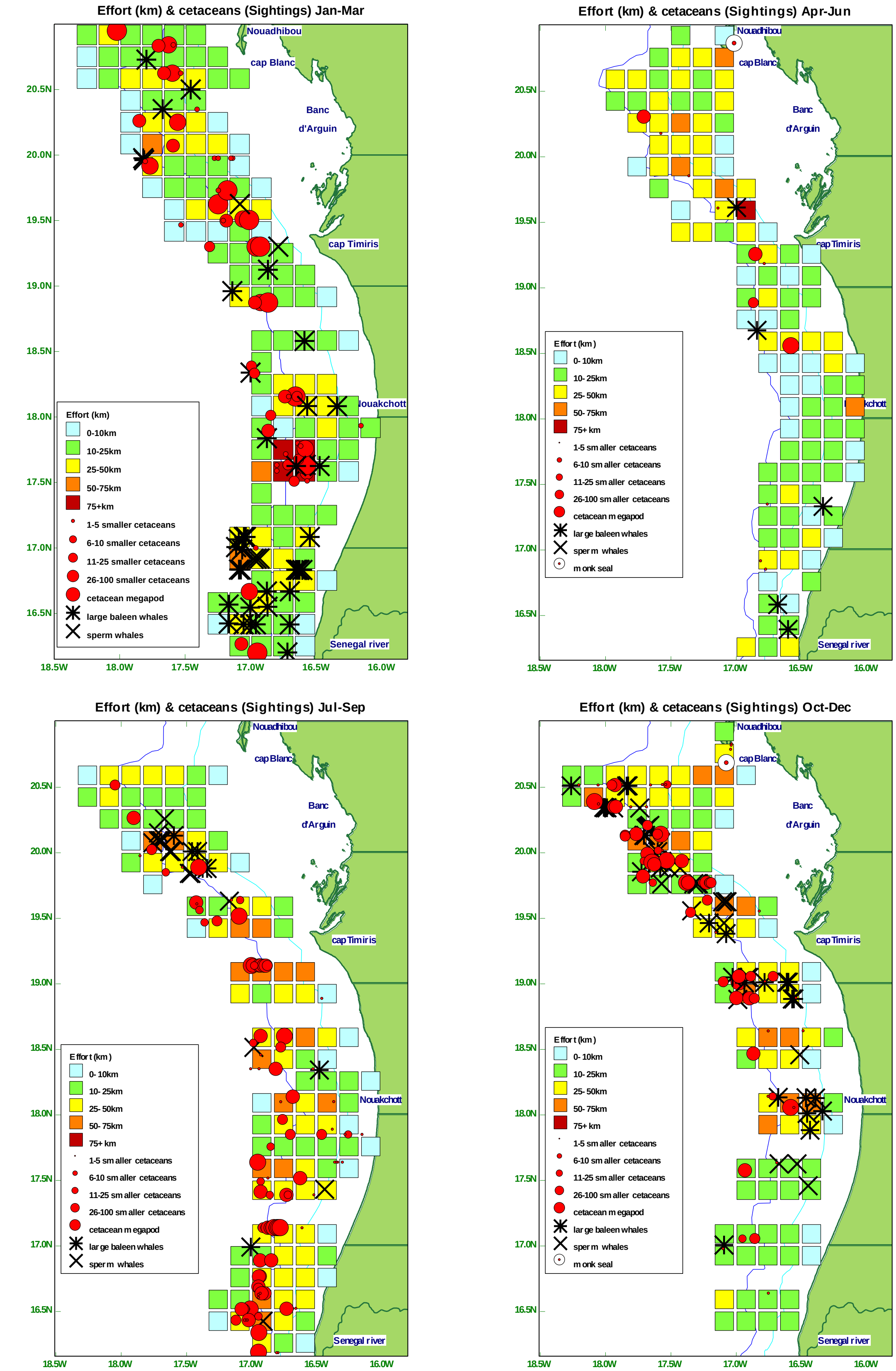

Figure 4. Observer effort (km steamed) in Mauritanian waters per quarter, expressed per 10' Lat. x 10' Long. rectangle, based on systematic ship-based surveys, 1988-2022, at more or less constant speed (8.1 ± 0.7 knots), using a 180° forward horizon scan for cetaceans. **Source:** NW African Seabirds at Sea Database.

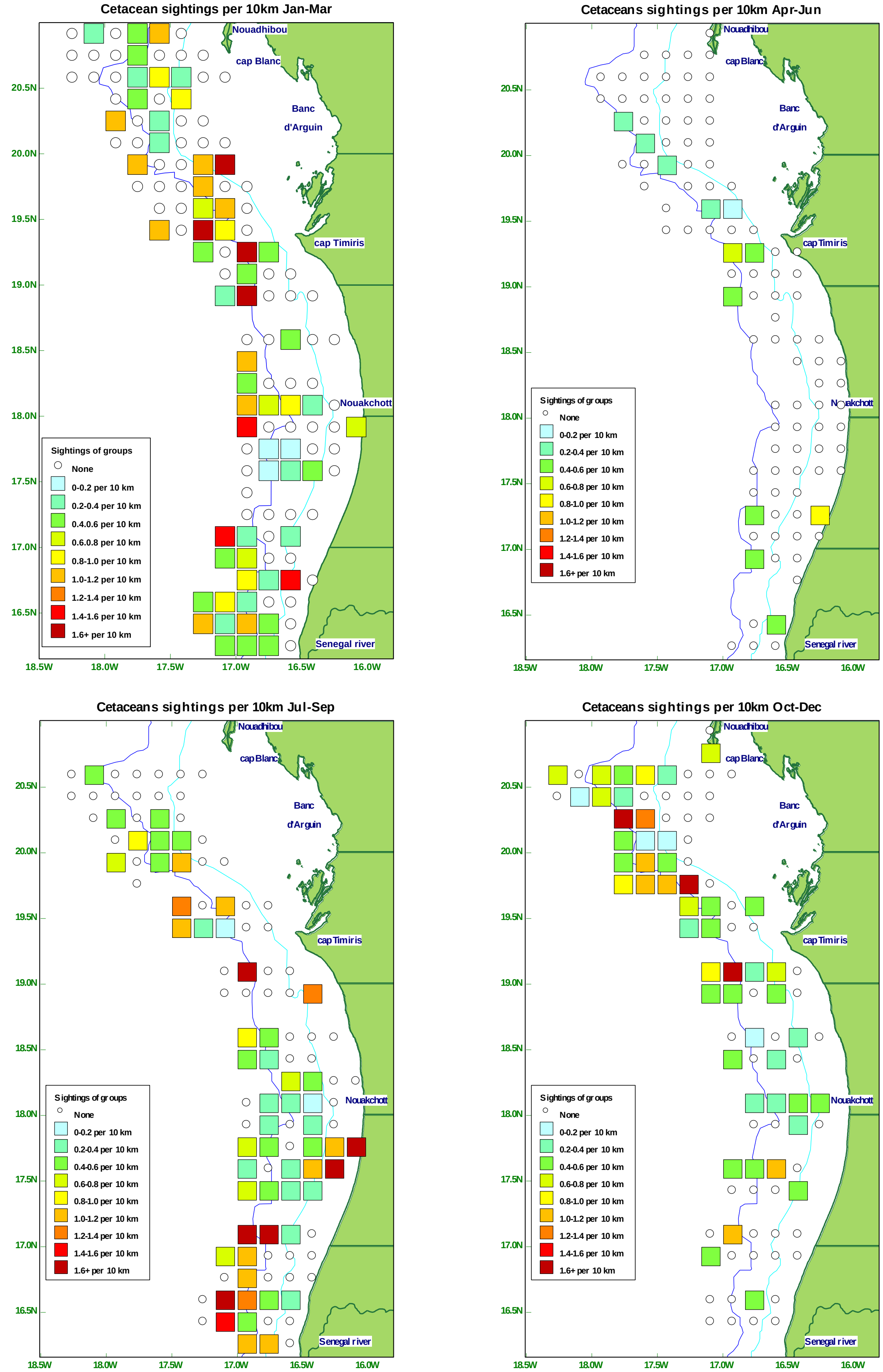

Figure 5. Sightings of cetaceans per 10 km steamed in Mauritanian waters per quarter, expressed per 10' Lat. x 10' Long. rectangle, based on systematic ship-based surveys, 1988-2022, at more or less constant speed (8.1 ± 0.7 knots), using a 180° forward horizon scan for cetaceans. **Source:** NW African Seabirds at Sea Database.

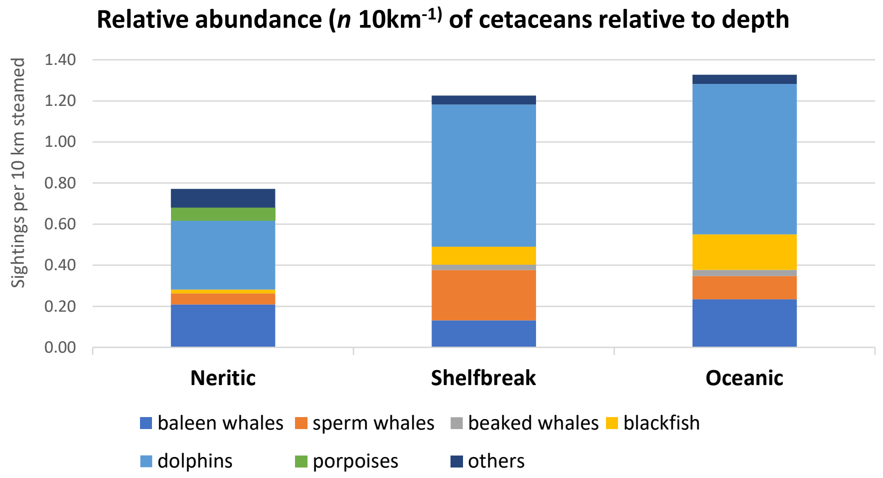

Figure 6. Frequency of sightings of cetaceans per 10 km steamed in Mauritania relative to water depth, based on systematic ship-based surveys, 1988-2022, at more or less constant speed (8.1 ± 0.7 knots), using a 180° forward horizon scan for cetaceans.

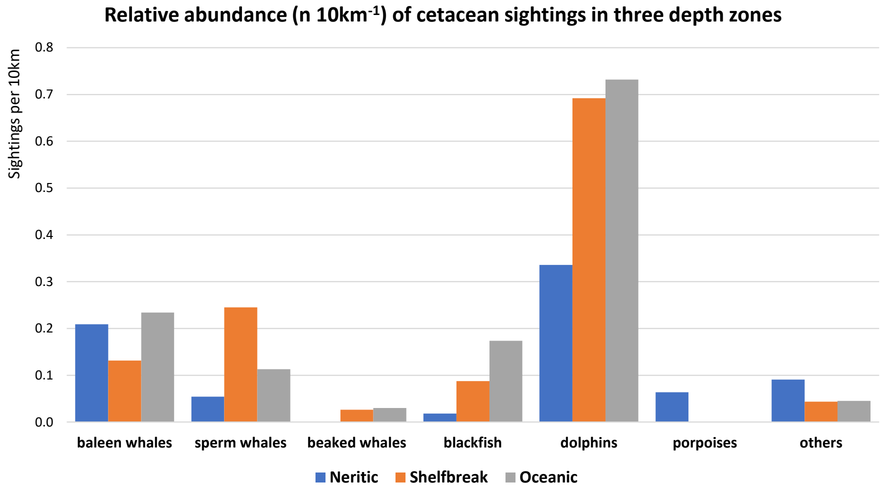

Figure 7. Relative abundance (n 10km^{-1}) of sightings of various cetaceans per km steamed in Mauritania in three depth zones, based on systematic ship-based surveys, 1988-2022, at more or less constant speed (8.1 ± 0.7 knots), using a 180° forward horizon scan for cetaceans.

Recent observations in Mauritanian waters, this being a combination of the data collected in the NW African database and six MMO reports, resulted in positive identifications of at least 26 species of cetaceans, including 5 baleen whales (Mysticeti) and 21 toothed whales (Odontoceta; **Table 2**). Beaked whales *Mesoplodon* spp. Were grouped, because of the immense identification challenges, but at least two and probably more species occur in these waters. A recent discovery, the Omura's whale *Balaenoptera omurai*, found stranded near Chott Boul, Mauritania, and a first for the North Atlantic Ocean (Jung *et al.* 2015), would likely go undetected at sea, where a considerable fraction of the baleen whales encountered remains 'unidentified' onto species level. By far the commonest species, or the most frequent encounters, are with Short-beaked Common Dolphin *Delphinus delphis*, Bottlenose Dolphin *Tursiops truncatus*, Short-finned Pilot Whale *Globicephala macrorhynchus*, Sperm Whale *Physeter macrocephalus*, Risso's Dolphin *Grampus griseus*, and Atlantic Spotted Dolphin *Stenella frontalis*. Remarkably frequent were sightings with Clymene Dolphin *Stenella clymene,* Bryde's Whale *Balaenoptera edeni*, and Blue Whale *Balaenoptera musculus*, suggesting that Mauritanian waters are of considerable significance for these species (see also Perrin *et al.* 1981, Sears *et al.* 2005, Weir 2006, Baines & Reichelt 2014, Weir *et al.* 2014). Comparing the species spectrum from systematic surveys with that from MMOs in recent seismic surveys, the absence of beaked whales during seismic surveys is striking (**Table 2**). Beaked whales are probably amongst the most auditory sensitive of all cetaceans (Jepson *et al.* 2003, Rossiter 2003, Barlow & Gisiner 2006), and it would be quite possible that avoidance behaviour of the whales during firing of the acoustic sources made sightings unlikely.

Table 2. Positively identified species of cetaceans reported during systematic surveys of Mauritanian waters (this atlas, NWA Database) in comparison with species observed during several MMO observations (references).

	NWA Database	Gater & Tuffy 2014	NWA Database	Vines *et al.* 2012	Paixao *et al.* 2011	NWA Database	Vines *et al.* 2013	Mars *et al.* 2013	NWA Database	Crawford & Gater 2014
	Jan-Mar	**Mar-Apr**	**Apr-Jun**	**May-Jun**	**Jun-Jul**	**Jul-Sep**	**Sep-Oct**	**Jun-Nov**	**Oct-Dec**	**Dec-Jan**
Balaenoptera borealis	X									X
Balaenoptera edeni					X		X	X	X	X
Balaenoptera musculus	X			X		X	X	X	X	X
Balaenoptera physalus	X		X					X	X	
Delphinus capensis						X				
Delphinus delphis	X	X	X	X	X	X	X		X	X
Feresa attenuata								X		
Globiceph. macrorhynchus	X		X	X	X	X	X	X	X	X
Grampus griseus	X			X		X	X	X	X	X
Kogia simus						X				
Lagenodelphis hosei	X							X		
Megaptera novaeangliae	X		X	X		X	X	X	X	
Mesoplodon spp.[2)]	X		X			X			X	
Orcinus orca	X		X			X	X		X	X
Phocoena phocoena	X								X	
Physeter macrocephalus	X			X		X		X	X	X
Pseudorca crassidens						X				
Souza teuszii	X									
Stenella attenuata						X	X	X		
Stenella clymene	X				X	X	X	X	X	X
Stenella coeruleoalba	X									X
Stenella frontalis	X			X	X	X	X	X	X	
Stenella longirostris	X				X		X	X		
Steno bredanensis				X		X				
Tursiops truncatus	X		X	X	X	X	X	X	X	X
Ziphius cavirostris	X					X				
Species reported (n= 26)	19	1	7	9	7	17	12	14	14	11
%	79	4	27	35	27	65	46	54	54	42

Additional information on ecological importance

Modern tracking studies have revealed a wealth of information on the at-sea distribution patterns of seabirds (Brooke 2008, Camphuysen 2022). Some of these tracking study yield data of an exceptionally high resolution (modern GPS trackers), others produce more vague whereabouts, but are small and light and can be deployed on much smaller animals or at much lower cost (geolocators). Numerous tracking studies of Northern Gannets, various species of shearwaters, skuas, and gulls have demonstrated the significance of the Canary Current large marine ecosystem as a major stop-over site, foraging area, or a non-breeding staging area for seabirds from both Hemispheres (Kopp *et al.* 2011, Magnusdottir *et al.* 2012, Gremillet *et al.* 2015, Paiva *et al.* 2015, Garthe *et al.* 2016, Shamoun-Baranes *et al.* 2016, Van Bemmelen *et al.* 2019, Brown *et al.* 2021). Most studies report on single species, sometimes on rather few individuals with between individuals strikingly different flight patterns and staging areas, but over the years, with accumulating data sets, rather clear-cut distribution patterns emerge. Very important positive aspects of such data are the independence of human observers, such that poorly researched but clearly very important areas become known to science. Also, loggers produce data around the clock, sometimes revealing highly significant diurnal patterns in behaviour and distribution that would otherwise have been difficult to appreciate. Combining the existing data on a seabird community level, for example as for our study area, is unfortunately still a bridge too far.

The online BirdLife Marine Important Bird Area e-atlas (https://maps.birdlife.org/marineibas/; Accessed May 2021; **Fig. 8**) shows confirmed and proposed IBA polygons for a number of seabird species. Some of the data may be derived from tracking studies, but the species selection is far from clear. One proposed offshore site, Canary Current shelf-break north (50 m-1000 m deep) of the highly productive waters of the Canary current, but is listed for Morocco (#3 in **Fig. 8**, BirdLife International 2021). This proposal connects to a confirmed IBA further south, the Canary Current Shelfbreak South (#4), and together they are assumed to house important numbers of Band-rumped Storm-petrels (referring to the species complex breeding on Macaronesian islands; Flood & Fisher 2011), Cory's Shearwaters, Northern Gannets, Audubon's Shearwaters *Puffinus lherminieri* (not known to occur this side of the Atlantic), Grey Phalaropes, and Pomarine Skuas.

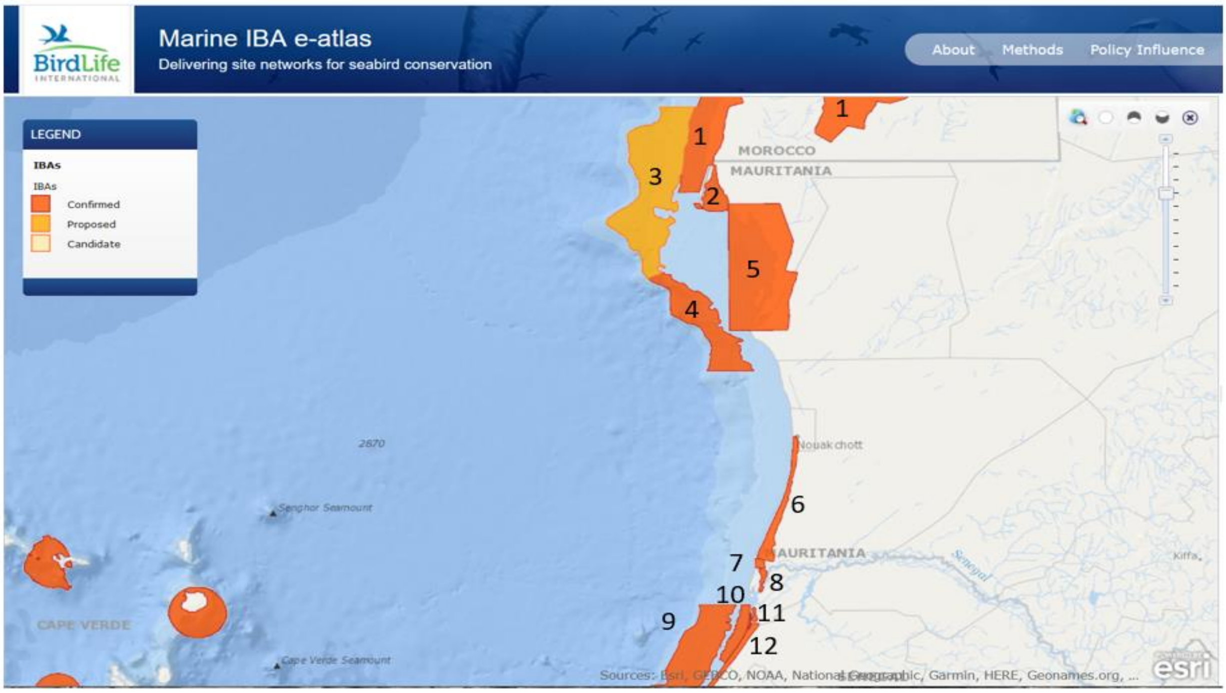

Figure 8. Proposed (yellow) and confirmed (orange) Important Bird and Biodiversity areas from the BirdLife Marine IBA e-atlas (Accessed May 2021). Legend (including highlighted key biodiversity):

1.	**Dakhla area** (Morocco)	Lesser Bl.b Gull, Sandw Tern
2.	**Cap Blanc** (Mauritania)	Slender-b Gull, Lesser Bl.b Gull, Caspian T, Sandwich T
3.	**Canary Current Shelfbreak North** (Morocco)	Band-r Storm-p, Cory's Shw, N Gannet, Grey Phal, Pom Skua
4.	**Canary Current Shelfbreak South** (Mauritania)	Band-r Storm-p, Cory's Shw, N Gannet, Audubon Shw, Grey Phal
5.	**Banc d'Arguin National Park** (Mauritania)	GW Pelican, Great Cormorant, Slender-b Gull
6.	**Aftout es Sâheli** (Mauritania)	GW Pelican, Great Cormorant, Slender-b Gull, Grey-h Gull
7.	**Chott Boul** (Mauritania)	Slender-b Gull, Caspian Tern
8.	**Diawling National Park** (Mauritania)	GW Pelican, Slender-b Gull, Caspian Tern
9.	**Northern Senegal Shelfbreak** (Senegal)	Cape Verde Shearwater
10.	**Parc National de la Langue de Barbarie** (Senegal)	Slender-b Gull, Grey-h Gull, Little Tern, Caspian Tern, Royal Tern
11.	**Guembeul Avifaunal Reserve** (Senegal)	Slender-b Gull, Grey-h Gull
12.	**Niayes** (St Louis to Dakar; Senegal)	Slender-b Gull

The Dakhla area (#1 in **Fig. 8**), including the tip of peninsula Cap Blanc, and the area around Nouadhibou (IBA Cap Blanc, #2) are listed for Lesser Black-backed Gulls, Slender-billed Gulls, Sandwich Terns, and Caspian Terns (but not for Audouin's Gulls that roost here sometimes in flocks of more than 1000 individuals, or ~1.5% of the world population). IBA Banc d'Arguin (#5) has been selected as an important area for Great White Pelicans, Great Cormorants (*Palacrocorax carbo*, considered very rare here (Isenmann *et al.* 2010), but probably outdated taxonomy has been used, White-breasted Cormorant may be referred to here), Gull-billed, Common, Sandwich, Caspian, and Royal Terns, plus the gulls mentioned before.

Further to the south, marine IBA Aftout er Sâheli (# 6 in **Fig. 8**), has seaward extensions around breeding colonies Great Cormorants and Gull-billed Terns, 22km away from the closest coastline (0-52m depth, not charted; BirdLife International 2021). The IBA should be of significance also for Slender-billed and Grey-headed Gulls.

Close to the Senegal river, but still in Mauritania, are two further marine IBAs, Chott Boul (#7), and Diawling National Park (#8), both with apparent significance for Slender-billed Gulls and Caspian Terns, but the former also for Great White Pelicans. Three inshore marine IBAs in Senegal (#10, 11, 12 in **Fig. 8**) are of importance for Slender-billed and Grey-headed Gulls, and for Little, Caspian, and Royal Terns.

Cape Verde Shearwater *Calonectris edwardsii*, off Cap Blanc, Mauritania, 1 Nov 2016, R. van Bemmelen

Finally, and rather surprisingly, the large offshore marine IBA bordering Mauritania with an abrupt boundary (#9, or Northern Senegal Shelfbreak) is considered of significance for Cape Verde Shearwaters *Calonectris edwardsii*, in the life-history stage 'incubation', which is otherwise not explained. Cape Verde Shearwaters incubate May-July, with chicks fledging from late September to November. From the offshore surveys used for this atlas, it was clear that Cape Verde Shearwaters occur widespread and in large numbers in Mauritanian waters in autumn and almost throughout the entire Mauritanian shelf area. During the earliest of our surveys (<2004), all in late spring, when Cape Verde Shearwaters were still formally considered a subspecies of Cory's Shearwaters (Hillcoat *et al.* 1997), and when the characteristics used for identification were largely unknown (Porter *et al.* 1997), the birds were recorded as “Cory’s Shearwaters” (at the time *Calonectris diomedea*). For the vulnerability analysis shown in **Fig. 3**, this has little or no effect.

None of the IBA’s accounts for the occurrence of Antarctic species in these waters and the gap between Canary Current Shelfbreak South and Northern Senegal Shelfbreak is both unexplained and inconsistent with our observations in recent years. More important, the marine IBA e-atlas does not provide information on seasonal patterns or any other megafauna within the area. As a single source of information to assess the vulnerability of an area for oil pollution the selected sites in the marine IBA e-atlas, even though some partially overlap with areas of significance highlighted from recent boat-based surveys, are at best misleading.

Gremillet et al. (2015), using miniaturised GPS, satellite transmitters and geolocators tracked the migratory movements of 64 adult and juvenile Northern Gannets and Scopoli’s shearwaters *Calonectris diomedea* after their breeding season in the temperate eastern Atlantic and the Mediterranean Sea, respectively. During winter (Oct-Mar) birds made extensive use of marine areas within the exclusive economic zones of Morocco, Western Sahara, Mauritania and Senegal, which is fully consistent with our own data. The tracking study by Garthe *et al.* (2016) confirmed the significance of NW African waters as a major wintering ground for Norther Gannets breeding in Iceland. Paiva *et al.* (2015) studied the foraging ecology of the Cape Verde Shearwater and their results confirmed that marine ecosystems such as the Canary Current system off West Africa attracts marine predators, Cape Verde Shearwaters included. There was an apparent inter-annual consistency on the spatial, foraging and trophic ecology of the Cape Verde shearwater, but a strong alteration on the foraging strategies of adult breeders among various phases of breeding. During incubation, birds mostly targeted discrete regions off West Africa, also highly exploited by international industrial fishery fleets, but when hen chick-rearing, adults exploited the comparatively less productive tropical environment within the islands of Cape Verde, at relatively close distance from their breeding colony. The latter result contradicts our survey data, but it could shed light on the age composition and breeding success of the birds utilizing the Mauritanian shelf in autumn and early winter. Magnusdottir *et al.* (2012) compared the wintering distribution of Great Skuas *Stercorarius skua* breeding in Scotland, Iceland and Norway, and found that all populations used the NW Africa shelf area, but with most birds wintering off Morocco and rather small numbers off Mauritania. Kopp *et al.* (2011) highlight the use of NW African waters as a stop-over site for a small number of South Polar Skuas *Catharacta maccormicki* based on only 27 tracked individuals, confirming a status as passage migrant not yet appreciated by Isenmann *et al.* 2010.

Shamoun-Baranes *et al.* (2016), Brown *et al.* (2021) studied used GPS tracking to quantify the movements of Lesser Black-backed Gulls throughout their annual cycle and compared various migration strategies. A small portion of the birds could be characterized as long-distance migrants wintering in West Africa, over 4000 km from their breeding colony. The results are consistent with results from colour-ring readings (Hallgrimsson *et al.* 2012), in which a striking difference was discovered in proportions of resightings in France, Iberia and northwest Africa of birds breeding in the Netherlands or in Iceland, suggesting that Icelandic birds leapfrog both the Dutch and UK populations and are relatively numerous in NW Africa. An important aspect was, that GPS tracking data showed that nocturnal behaviour and presence at sea by gulls as much more widespread and consistent than foreseen from visual (daytime) observations and night roost counts. These data indicate an extra risk for species that were thought to roost on land rather than to forage at sea during the dark hours of the day (Camphuysen 2022).

Various tracking studies, insofar published, confirmed the significance of the study area for a large number of seabirds, but also that important regions (largely unsurveyed using recent observation protocols extend in a northerly direction (Western Sahara and West Morocco, up to at least 35°N) and in a southerly direction (Senegal towards Gulf of Guinea), for some species even beyond and into Ghanese waters (Camphuysen 2022). Tracking studies using geolocators are not exact enough to pin-point ecological relevant areas with any precision, and GPS tracking studies are still ‘novel ‘, ongoing and thereby often unpublished, or have been analyses such that exact information on whereabouts at sea are difficult to summarize in ecological terms. In most studies, attempts to discriminate between (major) foraging areas, based on concrete foraging behaviour, are clearly in their infancy, various proxies that require interpretation are used and are potentially misleading, and most studies lack ground truthing in offshore wintering or stop-over areas. Nevertheless, the future potential for tracking studies is enormous, and that no on-site observers are required is one of the most important aspects on the plus side of that approach. One of the negative aspects is that tracking studies are essentially single-species studies, with a strong bias to individual behaviour and differentiation. Again, in the (near) future, high-quality tracking studies will become so widely used that major datasets can be combined to pinpoint offshore areas of particular importance, just as recently was conducted for an unknown major seabird hotspot in the North Atlantic (Davies *et al.* 2021).

Apart of tracking studies, other observations confirmed the importance of NW Africa as a staging or non-breeding area for seabirds. Opportunistic boat-based surveys to the Mauritania upwelling zone in July 2005 discovered major concentrations of Wilson's Storm-petrels *Oceanites oceanicus,* an Antarctic species, with flocks of up to 600 birds concentrated along the boundary between warm surface waters and cooler upwelled waters (Wynn & Krastel 2012). In an earlier study, a research cruise visiting the upwelling zone off Mauritania from mid-April to mid-May 2003, Wynn & Knefelkamp (2004) thousands of Sabine's Gulls *Larus sabini*, skuas and terns were seen on northward migration. Fish, zooplankton and phytoplankton in the study area occurred concentrated along the shelf edge and upper slope, where relatively cool, nutrient-rich, upwelled waters was brought to the surface and the highest concentrations of seabirds were found in this area.

Oiled **Lesser Black-backed Gull** *Larus fuscus*, off Cap Blanc, Mauritania, 1 Mar 2022, Kees Camphuysen

Discussion

The ecological importance of the Mauritanian coastal zone, shelf area, and shelf-break waters and its rich biodiversity is beyond doubt and in fact has been acknowledged for much longer, but this knowledge is based on a variety of difficult to merge datasets: incidental (boat-based) visits of the area ('anecdotes'), MMO observations during seismic surveys[2], coastal observations (seawatching), and more recently tracking data derived from birds carrying geolocators (GLS), satellite transmitters (PTT), and GSM or GPS loggers (see summary in Camphuysen 2022). Despite rapid technological advances in recent years, the more detailed tracking data are still mostly available from larger animals, capable to carry at least ~15g devices attached with harnesses. More or less systematic observations of marine mammals are often conducted on separate cruises or as an obligation during seismic operations of the industry itself, often forming separate, difficult to consult sets of data. Just as with seabirds, there are many different observation techniques, often focused on hotspots or rare species rather than on general area surveillances and ecological interactions, and, hence, with limited use for an overall assessment of differences in area vulnerability regarding environmental disasters. In a poorly researched area such as the Mauritanian Continental Shelf area, however, all these datasets have value to detect areas or time periods of significance that were thus far overlooked during the systematic surveys.

A combination of research techniques is key to appreciate the significance of the area best, and especially techniques that do not depend on human effort (such as bird-borne devices) may add information of presence and relevant activities of animals in adverse weather or during the night. For the (near-) future, an attempt to combine the various datasets would be an important development.

Using the most readily accessible data, all collected using standardised survey techniques for boat-based observations, the vulnerability for oil pollution for three quarters of the year can be drafted as in **Fig. 9 A-D**, this being a combination of area vulnerability based on observed seabird densities and their species-specific OVIs (shown in **Appendix 2**) and sightings of marine mammals. These maps can be seen as the key outcome of this project. Summarising the results in short:

In late winter and early spring (Jan-Mar, **Fig. 9-a**), more sensitive areas (shades of dark orange and red) were found all along the upper shelf break, bordering the Neritic zone. Pods of dolphins tended to occur mostly within that same realm, while the important occurrences of large baleen whales (among them numerous Blue Whales) were slightly more widespread, but with important numbers in the southernmost part of the study area. Of seabirds, the very high densities of Northern Gannets, European Storm Petrels, Pomarine Skuas, Lesser Black-backed Gulls, and Red Phalaropes have contributed most to the overall area sensitivity to oiling.

[2] MMOs, or Marine Mammal Observers, are typically focussed on presence/absence information of marine mammals and use at best 'inappropriate' survey techniques for seabirds on vessels of opportunity, if they observe seabirds at all. Few MMOs have sufficient training for systematic seabird observations or indeed even identification. These data are very difficult to interpret in terms of spatial or temporal patterns of relative abundance.

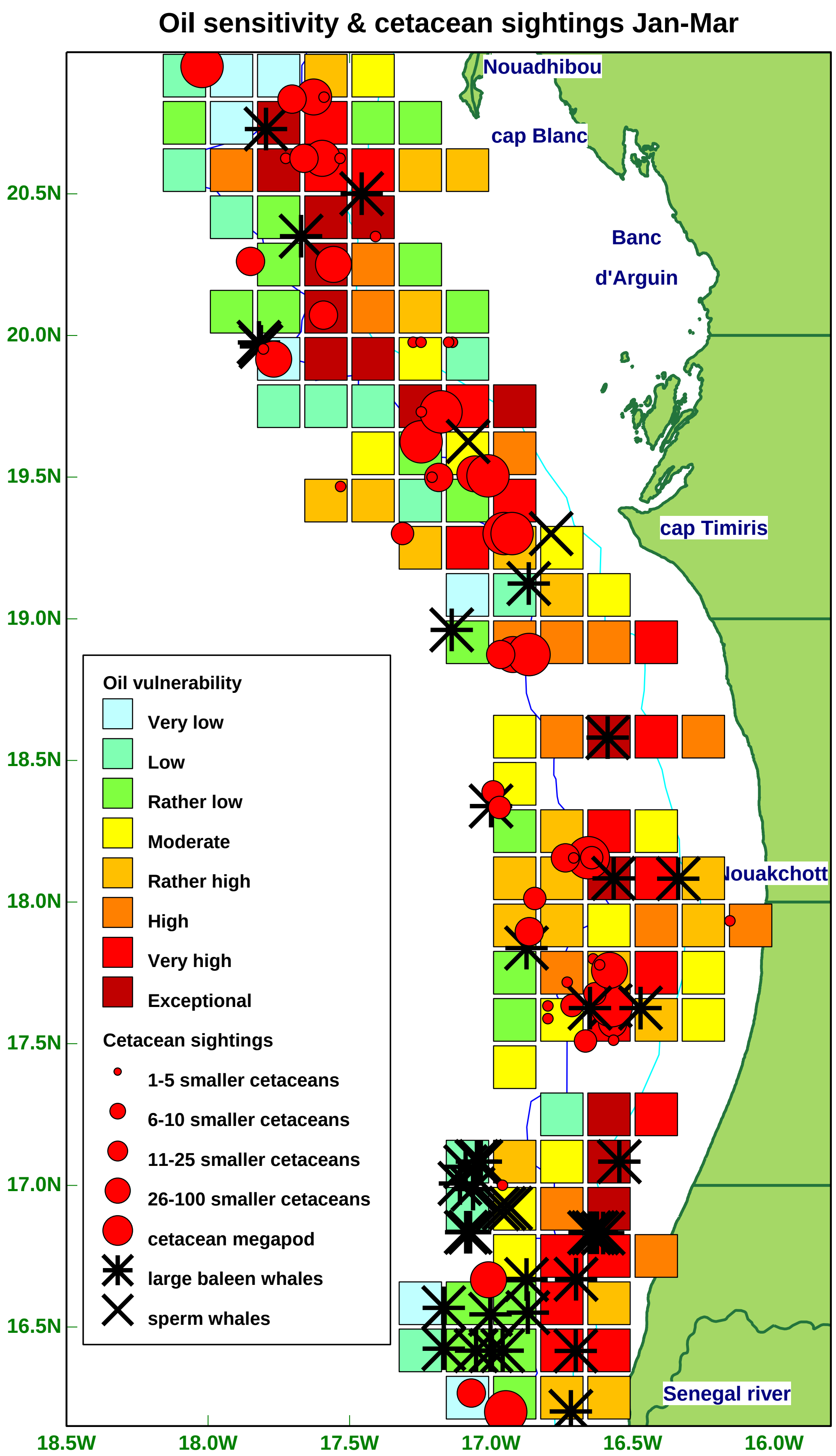

Figure 9-A. Area sensitivity (categories) Jan-Mar in Mauritanian waters, expressed per 10' Lat. x 10' Long. rectangle, based on *ln* transformed seabird densities multiplied with species specific OVIs (as in Figure 3) and Individual sightings of cetaceans and pinnipeds plotted on the exact sighting location (as in Figure 4) against that background of area sensitivity.

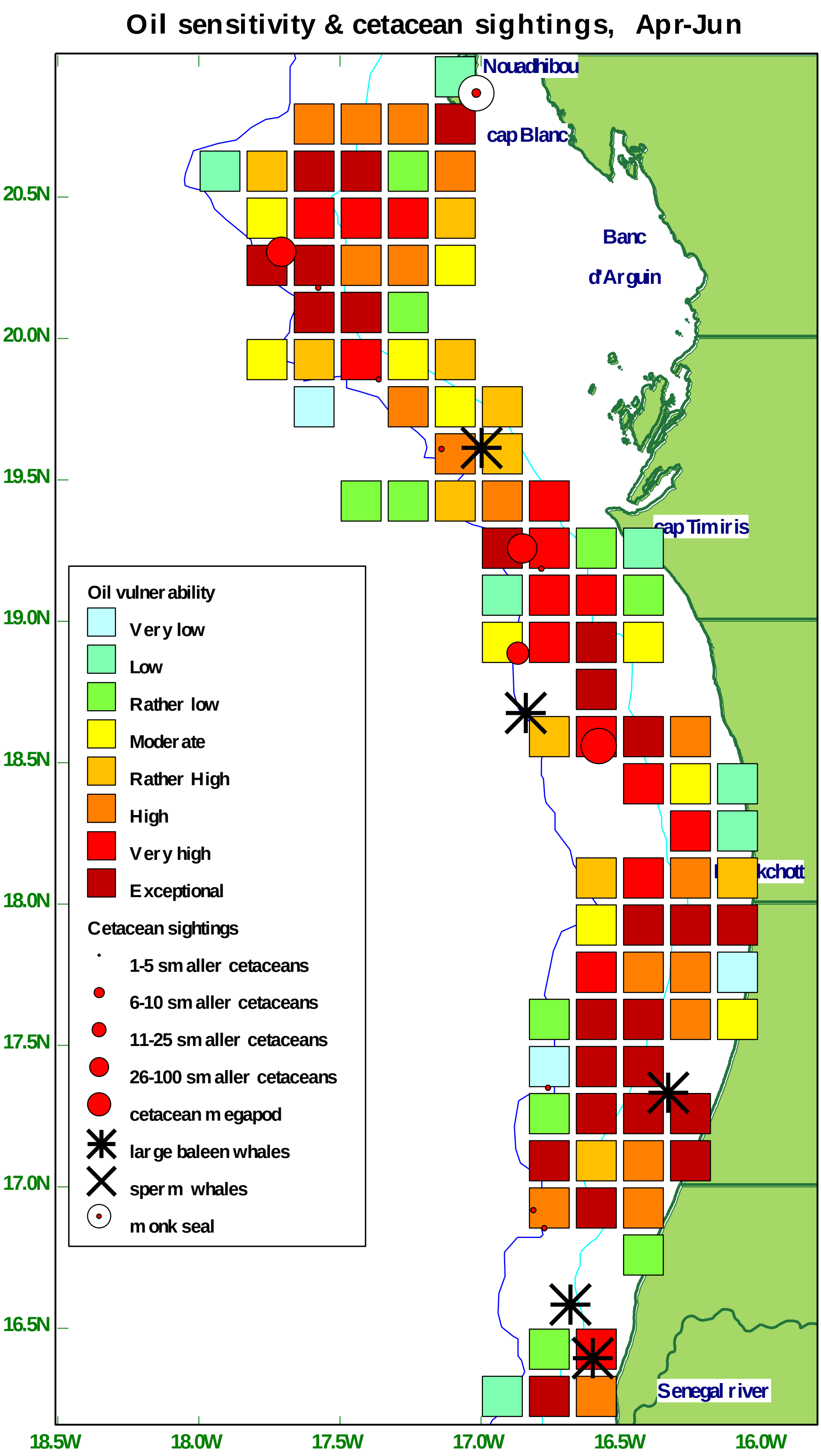

Figure 9-B. Area sensitivity (categories) Apr-Jun in Mauritanian waters, expressed per 10' Lat. x 10' Long. rectangle, based on *ln* transformed seabird densities multiplied with species specific OVIs (as in Figure 3) and Individual sightings of cetaceans and pinnipeds plotted on the exact sighting location (as in Figure 4) against that background of area sensitivity.

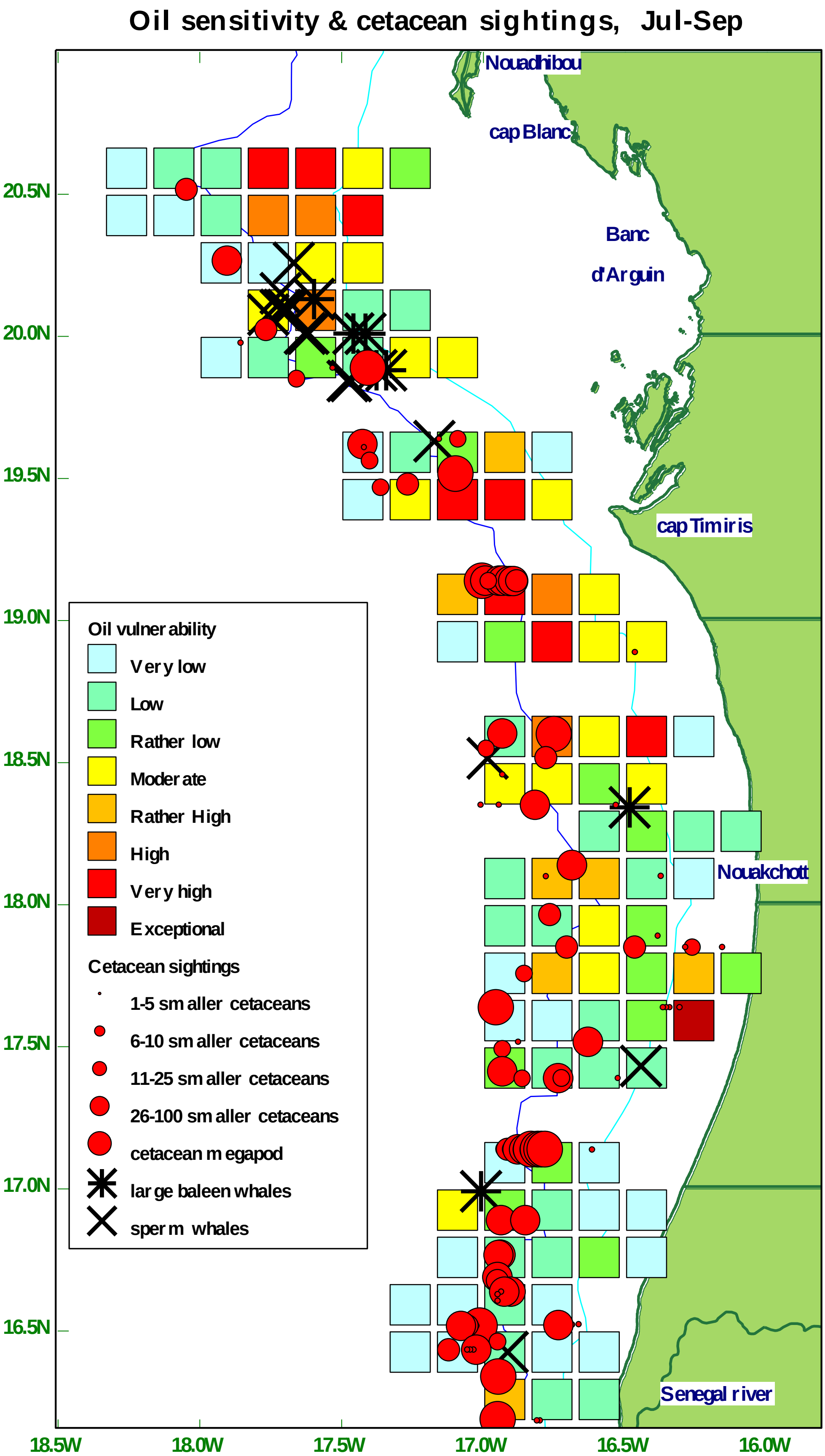

Figure 9-c. Area sensitivity (categories) Jul-Sep in Mauritanian waters, expressed per 10' Lat. x 10' Long. rectangle, based on *ln* transformed seabird densities multiplied with species specific OVIs (as in Figure 3) and Individual sightings of cetaceans and pinnipeds plotted on the exact sighting location (as in Figure 4) against that background of area sensitivity.

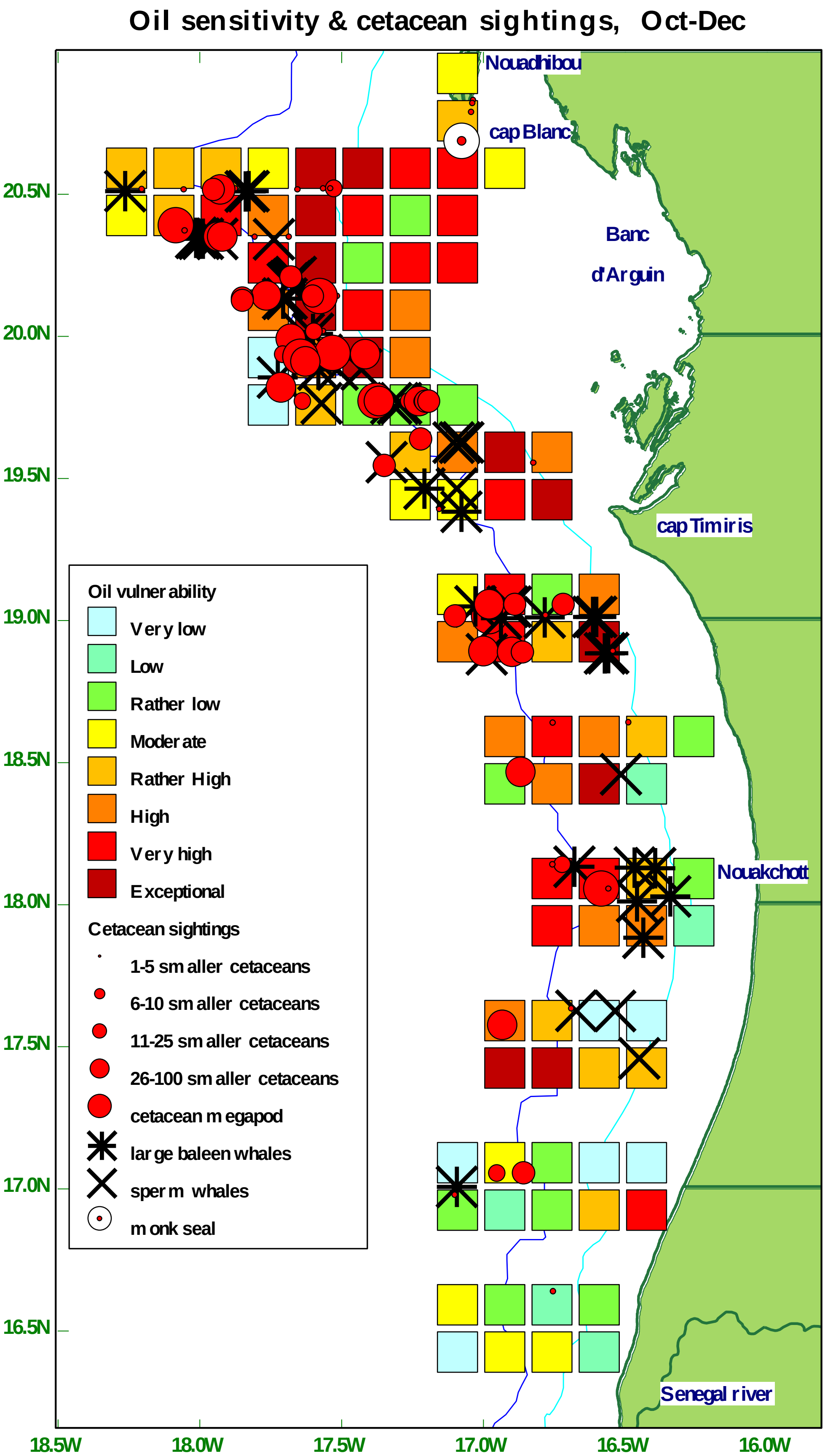

Figure 9-D. Area sensitivity (categories) Oct-Dec in Mauritanian waters, expressed per 10' Lat. x 10' Long. rectangle, based on *ln* transformed seabird densities multiplied with species specific OVIs (as in Figure 3) and Individual sightings of cetaceans and pinnipeds plotted on the exact sighting location (as in Figure 4) against that background of area sensitivity.

In late spring and early summer (Apr-Jun, **Fig. 9-b**), the more sensitive areas were again found along the upper shelf break, with frequent 'spillover' into the Neritic zone, but with marine mammals much less frequently encountered throughout the entire study area. High concentrations of seabirds in this season were long-distance migrants, generally arriving, peaking and subsequently disappearing within a matter of days. perhaps weeks. Of seabirds, the very high densities of Wilson's Storm-petrels, European Storm Petrels, Common / Arctic terns, Sabine's Gulls, Black Terns, and Pomarine Skuas have contributed most to the overall area sensitivity to oiling.

In late summer and early autumn (Jul-Sep, **Fig. 9-c**), the more sensitive areas were all in the northern two-thirds of the study area, with a fairly patchy, more inconsistent nature. Of seabirds, the very high densities of Wilson's Storm-petrels and Black Terns have contributed most to the overall area sensitivity to oiling.

In late autumn and early winter (Oct-Dec, **Fig. 9-d**), the more sensitive areas were all in the northern two-thirds of the study area, were over the lower shelfbreak, bordering Oceanic conditions, and in the upwelling area to the south of Cap Blanc. Of seabirds, the very high densities of Northern Gannets, European Storm Petrels, Red Phalaropes, Cory's Shearwaters, and Pomarine Skuas, nearly all Northern Hemisphere winter visitors in the area have contributed most to the overall area sensitivity to oiling.

Results on seabird distribution and area vulnerability resulting from our analysis (Figs. 3 & 9) never contradicted earlier observations or modern tracking studies, but are more comprehensive (multi-species), precise and hopefully more consistent in their nature. As such the results are different and more informative than simple lists of species thought to be important in marine IBAs proposed or confirmed by BirdLife International.

Baines & Reichelt (2014) identified critical habitats for baleen whales in the Mauritanian upwelling zone, using data collected from a 60-day geophysical survey, ~100km southwest of Cap Blanc in winter 2012/13. The study area included parts of the Cap Timiris Canyon system and large whales accounted for 70% of the 238 cetacean sightings. Densities were highest around 500-2250m depth near the canyon system (6.18 whales/100km^{-2}, 95% CI 6.03-6.51). It was proposed that steep seabed topography created by canyons running off the shelf edge, together with the upwelling system, created optimal foraging habitats for the whales. While the numbers (and flock size) of baleen whales during these surveys were higher than reported during any other known study in Mauritanian waters, the area highlighted by them as being particularly important overlaps precisely with the area shown in Fig. 9C-D (high density area at the shelf break to the NW of Cap Timiris, SW of Cap Blanc). However, surveys in late winter, including Feb-Mar 2022 (Fig. 9A), when even extra effort was dedicated to the area highlighted by Baines & Reichelt (2014), did not support these earlier findings. High numbers of (often foraging) baleen whales were found in the southernmost part of the study area (Fig. 9A, see also Camphuysen *et al.* 2022).

For smaller cetaceans, the picture is quite different, and considerable differences were found between areas of high biodiversity in each of the studied seasons (quarters). A general guideline would be that most pods of smaller marine mammals (notably oceanic dolphins) were seen over deeper waters (Deep Ocean and Shelfbreak) than most marine birds, the disclaimer being that data for our visual observations were gathered during daylight, while nocturnal foraging behaviour (common in many cetaceans) could lead to excursions into shallower waters at night (Goold 2000, Pierpoint *et al.* 2000, Baird *et al.* 2001, 2002, Herzing & Elliser 2013).

Although the amount of available survey data is still relatively small, spatial and temporal patterns in area sensitivity are prominent and it would be possible to make use of these patterns and trends during oil spills or accidents such that the importance of some areas over others can be appreciated leading to appropriate actions to minimise any (further) damage. The results also show that the situation regarding area sensitivity may change over time, to the worse or to the better, during prolonged periods of damage such as during blow-outs or other difficulty to control incidents.

The seabird community at risk in Mauritanian waters, is numerically (*i.e.* in numbers, not biomass, of individual birds) dominated by taxa originating from the Arctic, Subarctic, and northern Temperate zones from September through April, and by species from an Antarctic origin from May through August (see also Camphuysen 2022). Again, in terms of numerical abundance, 'local species' (of a Macaronesian or Mediterranean breeding origin) are relatively poorly represented (<5-10% of the overall densities of seabirds at sea in the Northern Hemisphere summer, <20% in winter). The decision to subdivide the year in four quarters is an arbitrary choice, for the avian community chances continuously and throughout the year. Frankly speaking, only a higher resolution data set, with at least monthly coverage, would do justice to the marked changes in biodiversity (and related area sensitivity) throughout the year. Current data sets are simply not comprehensive enough to complete the annual cycle on more than a quarterly basis. However, with such a dominance of animals breeding far away (to the north or south of the area itself), the Mauritanian shelf as a foraging ground has a global importance and significance, but especially for Antarctic and Subantarctic bird species 'wintering' over the shelf in the Northern summer (arriving in March/April and leaving in Oct/Nov), and for Arctic, Subarctic, and Northern Temperate zone birds in the Northern winter (arriving in September, leaving in May). The late Northern winter period (February) requires more survey data to complete an analysis, most certainly also for 'wintering' (Northern) cetaceans (**Fig. 2**). Next on the list would be the mid-summer period (June-July), when 'wintering' birds originating from the Southern Hemisphere are at their peak (**Fig. 2**).

The earliest surveys were not conducted with the current BP project in mind. Hence, the Grand Tortue Ahmeyim (GTA) location specifically, on the boundary of Mauritania and Senegal, did not get sufficient attention, especially in the Northern early winter months, nor did Senegalese waters to the south of the scheduled operations get any attention. The data used were simply the best available dataset collected for other purposes, or other oil- and gas developments. In terms of the level of preparedness, the lack of data in the impacted area itself is an issue of concern. Fortunately, the observed spatial patterns and trends are such that the area sensitivity at the GTA location can somehow be inferred from existing data, most certainly in the summer period (Apr-Sep). Nevertheless, it would be wise to conduct additional surveys in potentially impacted areas given drift models that could project trajectories of potential spills given the prevailing (trade) winds and currents in the area. Aerial surveys could solve the problem to some extent, but it should be realised that the species at risk are often very small (storm-petrels, phalaropes), and could be very hard to detect. Alternatively, an in-depth analysis of 'local' oceanographical conditions (in search for the *likelihood* of ecological hotspot areas), coupled with knowledge on offshore habitat requirements of marine species in the area at large (based on tracking data and existing survey data such as those used for this atlas), could help guide and direct small-scale ship-based surveys to close the gap, with emphasis on the 'apparently' most promising regions of the GTA area.

The high abundance of large baleen whales found in late winter, just to the north of the the Grand Tortue Ahmeyim (GTA) location, is concerning. Blue Whales were seen foraging and while doing so, these animals are notoriously slow in their movements and thereby at risk for ship-strikes. Further (behavioural) studies of these balaenopterid foraging areas are now most urgently required, with emphasis on the winter period, in order to design a mitigation plan that could minimise the risk of ship-strikes, given an expected major increase in shipping within the area as part of the drilling operations.

Off the coast of NW Africa, coastal upwelling is observed during the whole year (Hagen 2001). Upwelling is particularly strong near 20°N throughout the year because the prevailing surface winds blow from the north and northeast, parallel to the coast. Because the winds vary with time in both speed and direction, upwelling is also time-variable. If the winds are strong and more or less steady in the equatorward direction for several days, then strong surface currents flowing offshore over the middle of the continental shelf and intense upward motion nearshore are likely to develop. This intensification of coastal upwelling is called a coastal upwelling event. (Jones & Haplern 1981). So there is no correlation between the quarterly analysis of seabird and cetacean data and the extent of upwelling in the area. The relationship between the coastal winds, SST and the biological response (e.g. changes in chlorophyll) off Mauritania seems to be strong and almost immediate (Fischer *et al.* 2016), but is also highly variable, and so (likely) is the effect on higher trophic levels such as on seabirds and cetaceans. Earlier studies have shown convincingly, that the main drivers of seabird distribution patterns are fisheries and upwelling events, or combinations thereof (Wynn & Knefelkamp 2004, Camphuysen & Van der Meer 2005). Another driver is the bathymetry of the system, with consistently higher densities and more substantial (natural) foraging aggregations near and over the shelf-break than anywhere else in the system for most seabirds, canyons along the shelf-break and seamounts and other underwater features for deep diving cetaceans (Baines & Reichelt 2014, Camphuysen 2022). The relative importance of each of these features, and the importance of vertical migration of prey types and nocturnal foraging behavior are key aspects for future studies to help understand the ecological relationships between apex predators and their prey in Mauritanian waters.

Notes on the risk for oil spills, levels of preparedness and contingency plans

Mineral hydrocarbon spills at sea have significant effects on marine life and human health. In case of an oil spill at sea, spill managers have to decide on the most effective spill response to minimize the damage to the environment. In order to manage risks for accidents to As Low As Possible

(ALAP), decision makers require an authoritative and frequently updated array of information and planning documents for effective emergency response. They need to assess the potential impacts of an accident, improve preparedness and gain an *a priori* understanding of the value of one of the most biodiverse and sensitive pelagic sea areas of the Atlantic Ocean. With the emerging risks for accidents or leakages of hydrocarbons within the Grand Tortue Ahmeyim (GTA) gas development project, a first step in preparedness is the recognition of that need coupled with an immediate analysis of existing data *before* there is any problem at hand, so *before* there is a spill. Hence this atlas.

International maritime traffic off North-West Africa may be the biggest oil spill risk factor, with common illegal spills (e.g. of polluted bilge water) being a constant concern. Every year, tons of crude oil are shipped through the area and the risk of ship collisions or storm damage are to be taken seriously. The new activities planned within the Grand Tortue Ahmeyim (GTA) gas development project will lead to larger numbers of vessels working these waters (with the associated risks), plus risky or 'challenging' operations with the production and transport of gas (production wells, a floating production platform (FPSO), an LNG hub to liquefy the gas for export, and connecting pipelines). While maritime transport associated with the GTA project will increase risks of the already existing threat for accidental spills by international maritime transport, condensate spills due to a rupture of the wet gas pipeline by dense demersal fishing activity of the world's largest fleets, or (nowadays) even also sabotage in an international war situation where the commerce of gas plays central role, should be considered carefully.

There is still limited information on the environmental consequences of gas condensate spilled at sea (Bogatyreva & Vorsina 2021), but a blow-out or a major spill may cause considerable damage in sensitive areas for surface, pelagic, and benthic fauna alike, especially if the response is inadequate or with the wrong techniques. Experimental evidence showed that exposure to even thin condensate oil films results in significant increases in feather mass and clumping in seabirds (Matcott *et al.* 2019).

Considerable effort by the industry itself goes in preventing spills from happening, for example through operational and technical barriers. Nevertheless, in the unlikely event that a spill does occur, and depending on the kind of accident or leakage, spills require not only a technical response, but also a wildlife response to minimise further environmental damage. This vulnerability atlas is meant to assist in planning such as response, and in particularly sensitive areas responses are more urgent, likely even different, than in other area. Note, however, that this atlas shows the sensitivity of megafauna at the sea surface, it does not provide information on vulnerable benthic communities, or indeed the risk for forage fish stocks or fisheries. A proper contingency plan should weigh the risks for different parts of the environment, and given the characteristics of a spill make an informed decision on the type of action required, the prioritisation of particular response actions, and the choice of materials.

For heavy crude oil spills, response decisions will differ from required actions during leakages of light fuel oils or gas condensates. Globally, the use of dispersants is often advocated as the preferred strategy to deal with oil spills further at sea (e.g. Chapman *et al.* 2007, Lewis & Prince 2018), even though there are conflicting scientific views concerning the potential risks for human health and the environment generated by the use of dispersants during maritime oil spills (Grote *et al.* 2016). In many instances (controlled) *natural* dispersion of the spilled hydrocarbons may be a better solution than an active response with dispersants. In the relatively windy and warm Mauritanian waters perhaps even particularly so, but decisions should be on a case by case basis, considering all options and their likely effects, including a careful consideration of the oil vulnerability of the affected sea area.

Gas condensate is planned to be stored mid-water in a Floating Production, Storage and Offloading facility (FPSO), to be regularly exported to international countries. Condensate can be highly toxic, has a low density and higher flammability comparing to other types of oil. Acute effects of oil and oil-dispersant mixtures are similar, but depend on the constituents of the oil spilled (Grote *et al.* 2016). In Mauritanian waters, cold-water coral communities living more than 400 meters below the surface at the seabed could become affected. In the Gulf of Mexico, during the Deepwater Horizon spill, dispersants increased the formation of (now oiled) marine snow, descending into the abyss, thereby smothering benthic communities including cold water corals (White *et al.* 2012, Fisher *et al.* 2014, Daly *et al.* 2016, Brakstad *et al.* 2018).

Preparedness includes working on different scenarios and with the most appropriate (state of the art) data at hand. National oil spill contingency plans, worldwide, all too often lack the adequate information on marine areas, and focus on the protection of wetlands, estuaries, and the coast as a whole. In virtually all oil spills around the world, however, most wildlife damage has been done at sea (Camphuysen *et al.* 1999, 2005), even though the effects may have become visible mostly on beaches, and it is sensitive *sea areas* that require attention first, not coastal wetlands, estuaries or colonies. This atlas provides that info for the surface waters of the Mauritanian shelf sea and its bewildering biodiversity.

Oiled **Lesser Black-backed Gulls** *Larus fuscus*, Nouadhibou and Nouakchott, Mauritania, February 2014
Numerous oiled birds were seen in Réserve du Sel Iode (Nouakchott), and on various locations along the coast and in harbours, signalling what must have been a considerable offshore oil spill.

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Acknowledgments

The most recent research (2012-18) presented in this atlas on pelagic biodiversity of the shelf break was carried out by the Royal Netherlands Institute for Sea Research (NIOZ) and Institut Mauritanien de Recherche Océanographique et des Pêches **(**IMROP) in the framework of the Programme « Biodiversity Oil and Gas », an initiative of the Mauritanian Ministry of Environment and Sustainable Development, in partnership with the Ministry of Energy, Oil and Mines and the Ministry of Fisheries and Maritime Economy. This research was sponsored by the German Agency for International Cooperation (GIZ), Kosmos Energy, Dallas and Texas (USA Earlier surveys were conducted in 1988 by Mardik Leopold and Rob Witbaard (NIOZ, Dutch 1988 Mauritania expedition, financed by the Netherlands Marine Science Foundation), in 2000 by Kees Camphuysen and Jaap van der Meer (NIOZ) for the Responses 2000 project under the NIOZ/NWO Around Africa Programme 2000-2001, in 2003 by Kees Camphuysen (CSR Consultancy) and Chris Burton (Western Whale Research), for Bowman Bishaw Gorham (Chinguetti Development Marine Fauna Survey, March 2003) on behalf of Woodside Engery Pty Ltd (Australia), and in 2004 by Mardik Leopold, Ingrid Tulp, and Erwin Winter (Pilot survey programme by Netherlands Institute for Fisheries Research & Alterra Wageningen UR in co-operation with IMROP). Special thanks to Sandra Kloff (programme co-ordination, logistics), Frederic Marret and Florence Dovillez (GIZ, logistics), Abdellahi Ould Samba, Khairdine Ould Mohamed Abdallahi and Moulaye Wagne, Ahmedou Ould Mohamed El Moustapha and Mohamed Ahmed Jiyid ould Taleb (all IMROP), Tom van Spanje (cruise leader and co-observer, 2012-18), Rob van Bemmelen, Matxalen Pauly Salinas, Threes Schreurs, and Hans Verdaat (co-observers and photographers). Thanks also to all further observers and co-observers, students, organizers and (co-) funding agencies in any of the earlier programmes. British Petroleum BP provided the funds to consolidate and analyse the data collected at sea in the preliminary edition of this vulnerability atlas. We particularly thank Gaelle Baldelli for her involvement in this project. Jack Gootjes (NIOZ) deserves a special acknowledgement for his administrative patience and skills. Particular thanks also to Mardik Leopold and Sandra Kloff for critical remarks (both), the OVI peer review (MFL), and for long-lasting efforts to get studies such as the field studies underlying this analysis actually done (SK).

Appendix 1. Species of seabirds and coastal waterbirds of Mauritania, including Scientific, French and English names, Status and Habitat according to Isenmann *et al.* 2010* (plus suggested amendments for species not listed by Isenmann, provided in [ ]), and offshore habitats where the species was encountered during the boat-based surveys used for the present atlas. Blank under 'Survey habitat' means: not encountered during any of these systematic surveys.

Scientific name	Nom français	English name	Status*	Isenmann habitat**	Survey habitat
Tachybaptus ruficollis	Grèbe castagneux	Little Grebe	RB WV	Suitable wetlands	
Podiceps nigricollis	Grèbe à cou noir	Black-necked Grebe	WV	Suitable wetlands	
Fulmarus glacialis	Fulmar boréal	Northern Fulmar	[AV]	(No known records)	Neritic
Pterodroma feae	Pétrel gongon	Fea's Petrel	IV	Offshore	Neritic
Bulweria bulwerii	Pétrel de Bulwer	Bulwer's Petrel	NT	Offshore	Oceanic
Calonectris diomedea	Puffin cendré	Scopoli's Shearwater	PM WV	Offshore	Neritic, Shelfbreak
Calonectris borealis	Puffin boréal	Cory's Shearwater	PM WV	Offshore	Neritic, Shelfbr, Oceanic
Calonectris edwardsii	Puffin du Cap-Vert	Cape Verde Shearwater	[WV]	(No known records)	Neritic, Shelfbr, Oceanic
Ardenna gravis	Puffin majeur	Great Shearwater	PM	Offshore	Neritic, Shelfbr, Oceanic
Ardenna grisea	Puffin fuligineux	Sooty Shearwater	PM	Offshore	Neritic, Shelfbr, Oceanic
Puffinus puffinus	Puffin des Anglais	Manx Shearwater	PM	Offshore	Neritic, Shelfbr, Oceanic
Puffinus mauretanicus	Puffin des Baléares	Balearic Shearwater	PM	Offshore	Neritic, Shelfbreak
Puffinus baroli	Puffin de Macaronésie	Macaron. Shearwater	NT	Offshore	Oceanic
Oceanites oceanicus	Océanite de Wilson	Wilson's Storm-petrel	WV	Offshore	Neritic, Shelfbreak
Pelagodroma marina	Océanite frégate	White-f. Storm-petrel	IV	Offshore	Oceanic
Hydrobates pelagicus	Océanite tempete	European Storm Petrel	PM	Offshore (Neritic)	Neritic, Shelfbreak
Oceanodroma leucorhoa	Océanite culblanc	Leach's Storm Petrel	PM	Offshore	Shelbr, Oceanic
Oceanodroma monorhis	Océanite de swinhoe	Swinhoe's Storm Petrel	[IV]	(No known records)	Shelbr, Oceanic
*Oceanodroma castro****	Océanite de Castro	Band-rumped St Petrel	PM	Offshore	Neritic, Shelbr, Oceanic
Phaethon aethereus	Phaéton à bec rouge	Red-billed Tropicbird	IV	Offshore	Oceanic
*Sula sula*****	Fou à pieds rouges	Red-footed Booby	[AV]	(No known records)	Oceanic
Sula leucogaster	Fou brun	Brown Booby	IV	Stragglers, coastal	
Morus bassanus	Fou de Bassan	Northern Gannet	WV	Offshore (Neritic)	Neritic, Shelfbreak
Phalacrocorax maroccanus	Grand cormoran marocain	Moroccan Cormorant	NT	Coastal	
Phalacrocorax lucidus	Cormoran à poitrine blanche	White-breasted Cormorant	RB	Estuarine	Neritic
Phalacrocorax africanus	Cormoran africain	Long-tailed Cormorant	RB	Estuarine	
Anhinga melanogaster	Anhinga d'Afrique	African Darter	RB	Estuarine	
Pelecanus onocrotalus	Pélican blanc	Great White Pelican	MB	Estuarine	Neritic
Pelecanus rufescens	Pélican gris	Pink-backed Pelican	CB WV	Estuarine	
Melanitta nigra	Macreuse noire	Common Scoter	WV	Coastal	
Phalaropus lobatus	Phalarope à bec étroit	Red-necked Phalarope	AV	Stragglers, coastal	
Phalaropus fulicarius	Phalarope à bec large	Red Phalarope	WV	Offshore	Neritic, Shelbr, Oceanic
Stercorarius pomarinus	Labbe pomarin	Pomarine Skua	PM WV	Offshore	Neritic, Shelfbreak
Stercorarius parasiticus	Labbe parasite	Parasitic Jaeger	PM WV	Offshore, coastal	Neritic, Shelfbreak
Stercorarius longicaudus	Labbe à longue queue	Long-tailed Jaeger	PM	Offshore	Neritic, Shelbr, Oceanic
Stercorarius skua	Grande Labbe	Great Skua	WV	Offshore, coastal	Neritic, Shelfbreak
Stercorarius maccormicki	Labbe Antarctique	South Polar Skua	[PM]	(No known records)	Neritic, Shelfbreak
Ichthyaetus melanocephalus	Mouette mélanocéphale	Mediterranean Gull	WV	Estuarine	Neritic
Leucophaeus atricilla	Mouette atricille	Laughing Gull	AV	Coastal vagrant	
Leucophaeus pipixcan	Mouette de Franklin	Franklin's Gull	AV	Coastal vagrant	
Hydrocoloeus minutus	Mouette pygmée	Little Gull	WV	Coastal	Neritic
Xema sabini	Mouette de Sabine	Sabine's Gull	PM	Offshore	Neritic, Shelfbreak
Chroicocephalus ridibundus	Mouette rieuse	Black-headed Gull	PM WV	Coastal, estuarine	
Chroicocephalus cirrocephalus	Mouette à tête gris	Grey-headed Gull	RB	Estuarine	
Chroicocephalus genei	Goéland railleur	Slender-billed Gull	RB WV	Coastal, estuarine	Neritic
Ichthyaetus audouinii	Goéland d'Audouin	Audouin's Gull	PM	Coastal	Neritic
Larus canus	Goéland cendré	Common Gull	AV	Coastal vagrant	
Larus fuscus	Goéland brun	Lesser Black-backed Gull	PM WV	Coastal, offshore	Neritic, Shelfbreak
Larus argentatus	Goéland argenté	Herring Gull	AV	Coastal vagrant	
Larus michahellis	Goéland leucophée	Yellow-legged Gull	WV	Coastal, offshore	Neritic, Shelfbreak
Larus dominicanus vetula	Goéland dominicain	Cape Kelp Gull	[CB]	Estuarine	
Larus marinus	Goéland marin	Great Black-backed Gull	IV	Estuarine	
Rissa tridactyla	Mouette tridactyle	Black-legged Kittiwake	WV	Offshore	Neritic, Shelbr, Oceanic
Gelochelidon nilotica	Sterne hansel	Gull-billed Tern	MB WV	Freshwater, estuarine	Neritic
Hydroprogne caspia	Sterne caspienne	Caspian Tern	RB	Estuarine, coastal	Neritic
Thal. maximus albidorsalis	Sterne royale	Royal Tern	MB	Coastal, neritic	Neritic, Shelfbreak

Scientific name	Nom français	English name	Status*	Isenmann habitat**	Survey habitat
Thalasseus bengalensis	Sterne voyageuse	Lesser Crested Tern	PM	Coastal	Neritic
Thalasseus sandvicensis	Sterne caugek	Sandwich Tern	PM WV	Coastal	Neritic, Shelfbreak
Sterna dougallii	Sterne de Dougall	Roseate Tern	PM	Coastal, offshore	Neritic, Shelbr, Oceanic
Sterna hirundo	Sterne pierregarin	Common Tern	RB WV	Coastal, offshore	Neritic, Shelbr, Oceanic
Sterna paradisaea	Sterne arctique	Arctic Tern	PM	Coastal, offshore	Neritic, Shelfbreak
Onychoprion anaethetus	Sterne bridée	Bridled Tern	MB	Coastal	Neritic, Shelbr, Oceanic
Onychoprion fuscatus	Sterne fuligineuse	Sooty Tern	IV	Pelagic	
Sternula albifrons	Sterne naine	Little Tern	RB WV	Coastal	Neritic
Chlidonias hybrida	Guifette moustac	Whiskered Tern	PM WV	Freshwater wetlands	Shelfbreak
Chlidonias niger	Guifette noire	Black Tern	PM WV	Coastal, offshore	Neritic, Shelbr, Oceanic
Chlidonias leucopterus	Guifette leucoptère	White-winged Black Tern	PM WV	Freshwater wetlands	
Rynchops flavirostris	Bec-en-ciseaux d'Afrique	African Skimmer	CB IV	Inland wetlands	
Uria aalge	Guillemot marmette	Common Guillemot	AV	Coastal vagrant	
Alca torda	Petit pengouin	Razorbill	AV	Coastal vagrant	

*) Status abbreviations: RB *Resident breeder*, MB *Migrant breeder*, CB *Casual breeder*, PM *Passage migrant*, WV *Winter visitor*, AV *Accidental visitor*, IV *Irregular visitor*, NT *No definite status* (Isenmann *et al.* 2010).

**) Isenmann P., M. Benmergui, P. Browne, A. Diam Ba., C.H. Diagana, Y. Diawara & S. El Abidine ould Sidaty 2010. Oiuseaux de Mauritanie. SEOF, Paris.

***) Taxonomic status highly complicated due to recent revisions suggesting that the 'band-rumped complex' comprises at least four cryptic taxa that are extremely difficult (if at all) to identify in the field, including Grant's Storm-petrel (not formally described; cool-season breeder Macaronesian Islands (except Cape Verde) and Berlengas), Madeiran Storm-petrel *Oceanodroma castro* (hot-season breeder Canaries, Selvagens and Desertas), Monteiro's Storm-petrel *O. monteiroi* (breeds in the Azores), and Cape Verde Storm-petrel *O. jabejabe* (breeds Cape Verde). All species could occur in Mauritanian waters (Robb *et al.* 2008, Flood & Fisher 2011).

****) Species not recorded during surveys used for this report and not known as a Mauritanian species by Isenmann *et al.* 2010, but confidently recorded at least twice during MMO observations off Mauritania in 2012 (Ryan Irvine *in litt.*).

Appendix 2. Oil Vulnerability Indices for Mauritanian seabirds (see 'Oil vulnerability scores for each seabird species')

			Range				Popul.		Habits						Mortality				Marine expos.				
Nom Français	**English name**	**Scientific name**	**Breed**	**Migr**	**Winter**	**MarOrient**	**Pop size**	**Reprod pot**	**Roost**	**Forage**	**Escape**	**Flock**	**Nest**	**Special**	**Hunting**	**Wrecks**	**Bycatch**	**Oiling**	**Jan-Mar**	**Apr-Jun**	**Jul-Sep**	**Oct-Dec**	**OVI**
Grèbe à cou noir	Black-necked Grebe	*Podiceps nigricollis*	1	3	3	1	1	1	1	5	5	3	3	3	3	1	1	3	1	1	1	1	**42**
Grèbe castagneux	Little Grebe	*Tachybaptus r. ruficollis*	1	5	1	1	1	1	1	5	5	3	3	1	1	1	1	1	1	1	1	1	**36**
Pétrel de Bulwer	Bulwer's Petrel	*Bulweria bulwerii*	5	3	3	5	1	5	5	1	1	3	1	5	3	1	1	1	5	5	5	5	**64**
Puffin cendré	Scopoli's Shearwater	*Calonectris diomedea*	5	3	3	5	3	5	5	3	1	5	3	3	1	1	3	1	5	5	5	5	**70**
Puffin cendré/boréal	Scop./Corys shearwater	*Calonectris spp.*	5	3	3	5	1	5	5	3	1	5	3	3	1	1	3	1	5	5	5	5	**68**
Puffin boréal	Cory's Shearwater	*Calonectris borealis*	5	3	3	5	1	5	5	3	1	5	3	3	1	1	3	1	5	5	5	5	**68**
Puffin du Cap-Vert	Cape Verde Shearwater	*Calonectris edwardsii*	5	5	5	5	5	5	5	3	1	5	3	3	3	1	1	1	5	5	5	5	**76**
Fulmar boréal	Northern Fulmar	*Fulmarus glacialis*	1	3	3	5	1	5	5	3	1	1	1	3	1	3	1	1	5	5	5	5	**58**
Pétrel gongon	Faea's Petrel	*Pterodroma feae*	5	5	5	5	5	5	5	1	1	1	1	5	3	1	1	1	5	5	5	5	**70**
Puffin de Macaronésie	Barolo Shearwater	*Puffinus baroli*	5	5	5	5	5	5	5	3	1	1	1	3	3	1	1	1	5	5	5	5	**70**
Puffin majeur	Great Shearwater	*Ardenna gravis*	3	1	3	5	1	5	5	3	1	3	3	3	1	3	5	1	5	5	5	5	**66**
Puffin fuligineux	Sooty Shearwater	*Ardenna grisea*	3	1	3	5	1	5	5	3	1	3	3	3	5	3	5	1	5	5	5	5	**70**
Puffin des Anglais	Manx Shearwater	*Puffinus puffinus*	3	1	3	5	3	5	5	3	1	1	3	3	1	3	1	1	5	5	5	5	**62**
Puffin des Baléares	Balearic Shearwater	*Puffinus mauretanicus*	5	3	5	5	5	5	5	3	1	1	3	3	1	1	3	1	5	5	5	5	**70**
Océanite tempete	European Storm Petrel	*Hydrobates pelagicus*	3	3	3	5	3	5	5	1	1	5	3	5	1	1	1	1	5	5	5	5	**66**
Hydrobatidés	uniden storm-petrel	*Ocean./Hydrob./Oceanit*	3	3	3	5	3	5	5	1	1	5	3	5	1	1	1	1	5	5	5	5	**66**
Océanite de Wilson	Wilson's Storm-petrel	*Oceanites oceanicus*	1	1	1	5	1	5	5	1	1	5	3	5	1	1	1	1	5	5	5	5	**58**
Océanite de Castro	Band-rump Storm Petrel	*Oceanodroma castro*	5	5	5	5	5	5	5	1	1	3	1	5	1	1	1	1	5	5	5	5	**70**
Océanite culblanc	Leach's Storm Petrel	*Oceanodr. leucorhoa*	3	1	1	5	1	5	5	1	1	3	3	5	1	1	1	1	5	5	5	5	**58**
Océanite de swinhoe	Swinhoe's Storm Petrel	*Oceanodroma monorhis*	5	5	5	5	5	5	5	1	1	1	1	5	1	1	1	1	5	5	5	5	**68**
Océanite frégate	White-fac Storm-petrel	*Pelagodroma marina*	5	3	3	5	1	5	5	1	1	1	3	5	1	1	1	1	5	5	5	5	**62**
Phaéton à bec rouge	Red-billed Tropicbird	*Phaethon aethereus*	5	3	3	5	5	5	5	3	1	1	1	3	1	1	1	1	5	5	5	5	**64**
Pélican blanc	Great White Pelican	*Pelecanus onocrotalus*	3	3	3	1	3	3	0	5	3	5	5	3	1	1	1	3	1	1	1	1	**47**
Pélican gris	Pink-backed Pelican	*Pelecanus rufescens*	3	5	3	3	5	3	0	5	3	3	3	1	1	1	1	1	0	0	0	0	**41**
Fou de Bassan	Northern Gannet	*Morus bassanus*	3	3	3	5	3	5	5	3	1	5	5	3	1	1	5	3	5	5	5	5	**74**
Fou brun	Brown Booby	*Sula leucogaster*	1	3	1	5	3	5	1	3	1	3	3	1	1	3	3	3	5	5	5	5	**60**
Fou à pieds rouges	Red-footed Booby	*Sula sula*	1	3	1	5	3	5	1	3	1	3	3	1	1	3	3	3	5	5	5	5	**60**
Anhinga d'Afrique	African Darter	*Anhinga rufa*	3	3	3	1	5	1	1	5	5	1	3	1	1	1	1	1	1	1	1	1	**40**
Cormoran africain	Long-tailed Cormorant	*Microcarbo africanus*	3	3	3	3	5	1	1	5	5	1	3	1	1	1	1	1	3	3	3	3	**50**
Cormoran marocain	Moroccan Cormorant	*Phalacr. C. maroccanus*	5	5	5	1	5	1	1	5	5	5	5	3	1	1	3	1	3	3	3	3	**64**
Corm à poitrine blanche	White-br. Cormorant	*Phalacrocorax lucidus*	1	5	5	1	5	1	1	5	5	5	5	3	1	1	3	1	3	3	3	3	**60**
Macreuse noire	Common Scoter	*Melanitta nigra*	1	1	1	5	1	1	5	5	5	5	1	3	3	1	1	5	5	0	0	5	**54**
Phalarope à bec large	Red Phalarope	*Phalaropus fulicarius*	1	1	5	5	3	1	5	5	3	5	1	5	1	5	1	5	5	1	1	5	**64**
Phalarope à bec étroit	Red-necked Phalarope	*Phalaropus lobatus*	1	1	5	5	3	1	5	5	3	5	1	5	1	5	1	5	5	1	1	5	**64**
Labbe à longue queue	Long-tailed Jaeger	*Stercorarius longicaudus*	1	1	3	5	3	3	5	5	1	3	1	3	1	1	1	3	5	1	1	5	**52**

Labbe Antarctique	South Polar Skua	*Stercorarius maccormicki*	1	1	3	5	5	3	5	3	1	1	1	1	1	1	1	3	1	5	5	1	**48**
Labbe parasite	Parasitic Jaeger	*Stercorarius parasiticus*	3	1	3	5	3	3	5	3	1	1	1	3	1	1	1	3	5	1	1	5	**50**
Labbe pomarin	Pomarine Skua	*Stercorarius pomarinus*	1	1	3	5	5	3	5	3	1	3	1	1	1	3	1	3	5	1	1	5	**52**
Grande Labbe	Great Skua	*Stercorarius skua*	3	3	5	5	5	3	5	3	1	1	1	1	1	1	1	3	5	1	1	5	**54**
Labbe	skua	*Stercorarius spec.*	3	1	3	5	3	3	5	3	1	1	1	1	1	1	1	3	5	1	1	5	**48**
Goéland argenté	Herring Gull	*Larus argentatus*	1	3	1	3	3	3	1	3	1	3	5	1	1	1	3	3	3	3	3	3	**48**
Mouette atricille	Laughing Gull	*Leucophaeus atricilla*	3	3	1	1	3	3	1	1	1	1	5	1	1	1	1	1	3	3	3	3	**40**
Goéland d'Audouin	Audouin's Gull	*Ichthyaetus audouinii*	5	3	5	5	5	3	3	3	1	3	5	5	1	1	1	3	3	3	3	3	**64**
Goéland leucophée	Yellow-legged Gull	*Larus michahellis*	1	3	3	1	3	3	3	3	1	3	5	1	1	1	3	3	3	3	3	3	**50**
Goéland cendré	Common Gull	*Larus canus*	3	3	3	3	3	3	3	3	1	3	5	1	1	1	1	3	3	3	3	3	**52**
Goéland railleur	Slender-billed Gull	*Chroicocephalus genei*	3	3	3	1	3	3	1	1	1	1	5	3	1	1	1	3	3	3	3	3	**46**
Mouette rieuse	Black-headed Gull	*Chroic. ridibundus*	1	1	1	1	1	3	1	1	1	1	5	1	1	1	1	3	3	3	3	3	**36**
Mouette à tête gris	Grey-headed Gull	*Chroic. c. poiocephalus*	3	3	3	1	3	3	3	3	1	3	5	1	1	1	1	1	3	3	3	3	**48**
Goéland dominicain	Cape Kelp Gull	*Larus dominicanus vetula*	5	3	5	1	5	3	3	3	1	3	3	1	1	1	1	1	3	3	3	3	**52**
Goéland brun	Lesser Bl-backed Gull	*Larus fuscus*	1	3	3	3	3	3	3	3	1	3	5	1	1	1	1	3	5	3	3	5	**54**
Goéland marin	Great Bl-backed Gull	*Larus marinus*	3	3	3	5	3	3	3	3	1	1	3	1	1	1	1	3	3	3	3	3	**50**
Mouette mélanocéphale	Mediterranean Gull	*Ichth. melanocephalus*	3	3	3	1	3	3	1	1	1	1	5	3	1	1	1	3	1	1	1	1	**38**
Mouette pygmée	Little Gull	*Hydrocoloeus minutus*	3	3	3	1	5	3	1	1	1	1	3	3	1	1	1	3	3	1	1	3	**42**
Mouette de Franklin	Franklin's Gull	*Leucophaeus pipixcan*	3	3	1	1	1	3	1	1	1	1	5	1	1	1	1	1	3	3	3	3	**38**
Mouette de Sabine	Sabine's Gull	*Xema sabini*	3	3	1	5	5	3	5	3	3	3	3	3	1	1	1	3	5	3	3	5	**62**
grande Mouette	unidentified large gull	*Larus spec.*	1	3	3	3	3	3	3	3	1	3	3	3	1	1	1	3	3	3	3	3	**50**
Mouette tridactyle	Black-legged Kittiwake	*Rissa tridactyla*	3	3	3	4	1	3	5	3	1	3	5	3	1	3	1	5	5	5	5	5	**67**
Guifette moustac	Whiskered Tern	*Chlidonias hybrida*	1	1	1	1	3	3	1	1	1	3	1	5	1	1	1	1	1	1	1	1	**30**
Guifette leucoptère	White-wing Black Tern	*Chlidonias leucopterus*	1	1	1	1	1	3	1	1	1	3	1	3	1	1	1	1	1	1	1	1	**26**
Guifette noire	Black Tern	*Chlidonias niger*	1	1	1	3	3	3	3	3	1	5	1	5	1	1	1	1	5	1	1	5	**46**
Sterne hansel	Gull-billed Tern	*Gelochelidon nilotica*	3	1	3	1	5	3	0	1	1	1	1	3	1	1	1	1	1	1	1	1	**31**
Sterne naine	Little Tern	*Sternula albifrons*	1	1	1	1	5	3	1	3	1	1	1	3	1	1	1	1	3	1	1	3	**34**
Sterne fuligineuse	Sooty Tern	*Onychoprion fuscatus*	1	1	1	5	1	3	5	5	1	1	5	3	1	1	1	1	3	3	3	3	**48**
Sterne bridée	Bridled Tern	*Onychoprion anaethetus*	3	3	3	3	5	5	1	3	1	1	3	3	1	1	1	1	3	3	3	3	**50**
Sterne caugek	Sandwich Tern	*Thalasseus sandvicensis*	3	1	1	3	3	3	1	3	1	3	5	1	1	1	1	1	3	3	3	3	**44**
Sterne voyageuse	Lesser Crested Tern	*Thalasseus bengalensis*	3	5	3	3	5	3	1	3	1	1	3	3	1	1	1	1	3	3	3	3	**50**
Sterne royale	Royal Tern	*Thal. max. albidorsalis*	5	3	5	3	3	3	1	3	1	3	5	1	1	1	1	1	3	3	3	3	**52**
Sterne caspienne	Caspian Tern	*Hydroprogne caspia*	3	3	3	1	5	3	1	3	1	1	3	1	1	1	1	1	3	3	3	3	**44**
Sterne de Dougall	Roseate Tern	*Sterna dougallii*	3	1	3	3	5	3	1	3	1	1	1	3	1	1	1	1	3	3	3	3	**44**
Sterne pierregarin	Common Tern	*Sterna hirundo*	1	1	1	3	3	3	1	3	1	5	3	1	1	1	1	1	3	3	3	3	**42**
Sterne arctique	Arctic Tern	*Sterna paradisaea*	1	1	1	3	3	3	1	3	1	3	3	1	1	1	1	1	5	3	3	5	**44**
Sterne pierr/arctique	Common / Arctic tern	*S. hirundo/paradisaea*	3	2	3	4	2	3	1	3	1	3	3	3	1	1	1	1	3	3	3	3	**47**
Sterne	unidentified tern	*Sterna spec.*	3	1	3	3	3	3	1	3	1	3	3	3	1	1	1	1	3	3	3	3	**46**
Bec-en-cis. d'Afrique	African Skimmer	*Rynchops flavirostris*	3	3	3	1	5	3	1	1	1	1	3	5	1	1	1	1	1	1	1	1	**38**
Petit pengouin	Razorbill	*Alca torda*	3	3	3	5	1	5	5	5	5	3	5	3	3	5	1	5	5	5	5	5	**80**
Guillemot marmette	Common Guillemot	*Uria aalge*	3	3	3	5	1	5	5	5	5	3	5	3	3	5	1	5	5	5	5	5	**80**

About the author

Dr Kees (C.J.) Camphuysen (1959) is currently employed as a senior research scientist at the Royal Netherlands Institute for Sea Research (NIOZ) at Texel, The Netherlands. He studies marine ecology, seabird demography, marine mammals, marine (oil) pollution and the effects of fisheries on marine ecosystems since the mid-1970s. Completed his PhD on the historical ecology and demography of closely related gull species in 2013 at the University of Groningen*. As a co-founder of systematic seabirds-at-sea studies in Europe (European Seabirds at Sea database, currently maintained at ICES Copenhagen), he was involved in many hundreds of boat-based surveys in the Atlantic, ranging from the Antarctic Peninsula, South Georgia, and South Africa and Namibia to the high arctic, including Greenland, Jan Mayen, and Svalbard, covering ~125,000km on effort. Research emphasis was and is on the North Sea basin, however (1978-present), with more irregular attention to the Canary Current area (2000 to present). His work on marine oil pollution includes the monitoring of stranded (oiled) seabirds in The Netherlands since 1974 commissioned by the Dutch government and to report to OSPAR, and the involvement as a biological advisor and impact assessor during major spills around Europe. Currently developing courses to boost the level of impact assessments and damage control during oil spills or other wildlife incidents under the EU Eurowa 2 programme**.

Over 300 publications, virtually all directly available at
https://www.researchgate.net/profile/Cornelis-Camphuysen

*) Camphuysen C.J. 2013. **A historical ecology of two closely related gull species (Laridae): multiple adaptations to a man-made environment.** Ph.D.-thesis, Univ. Groningen, Groningen, ISBN/EAN 978-90-9027538-3 http://dissertations.ub.rug.nl/faculties/science/2013/c.j.camphuijsen/.

**) https://www.oiledwildlife.eu/eurowa/news/new-phase-eurowa-%E2%80%93-eurowa-2-project-begins

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