

**KIFFA 3D  
MARINE SEISMIC SURVEY,  
PSC AREA A,  
MAURITANIA**

**ENVIRONMENT PLAN**



**August 2004**



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# KIFFA 3D MARINE SEISMIC SURVEY, PSC AREA A , MAURITANIA. ENVIRONMENT PLAN

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## 1. INTRODUCTION

Woodside Mauritania Pty. Ltd. (Woodside) proposes to carry out a 3D marine seismic survey offshore from the Islamic Republic of Mauritania, in north-west Africa. The objective of the survey, labelled as the Kiffa 3D Marine Seismic Survey (MSS), is to acquire approximately 2,926 km<sup>2</sup> of 3D seismic data within the PSC (Production Sharing Contract) Area A, in water depths ranging from 50 to 1,600 metres (Figure 2-1). Woodside has prepared this Environment Plan as part of the preparation for the proposed Kiffa 3D MSS, which will be conducted during the period late August to late November 2004.

The overall purpose of this Environment Plan is not only to comply with statutory requirements but also to ensure that the seismic activities are planned and conducted in line with Woodside corporate environmental policies and Health, Safety and Environment (HSE) Management System.

This Environment Plan includes:

- A description of the proposed 3D seismic survey activities (Section 2);
- A description of the existing environment in the area of proposed operations (Section 3);
- The identification and assessment of all environmental risks in advance of the seismic programme (Section 4);
- The definition of appropriate environmental performance objectives, standards and criteria against which Woodside intends to measure performance with regard to protection of the environment (Section 5) ; and
- A description of measures, including specific systems and practises and procedures to be implemented to ensure that the environmental effects and risks of the activity are reduced to as low as reasonably practicable (Section 6).

### 1.1. Corporate Environmental Policy

Woodside is committed to protecting the environment and consequently manages health, safety and environment (HSE) matters as a critical business activity. Woodside has a written corporate environmental policy (see Appendix A) that provides a public statement of the corporate commitment to protecting the environment during offshore exploration operations such as seismic surveys. In addition, Woodside employs a structured approach to the management of HSE issues via a formal and documented HSE Management System (HSE-MS). The HSE-MS ensures that impacts from Woodside's operations are either avoided or kept to as low as reasonably practicable (ALARP).

### 1.2. Environment Legislation and Approvals

#### 1.2.1. *International Agreements and Conventions*

A number of international agreements and conventions may have impacts on petroleum activities in offshore waters under Mauritanian jurisdiction. The principal ones are:

- *United Nations Convention on the Law of the Sea 1982 (UNCLOS)*;
- *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1989*;
- *International Convention for the Prevention of Pollution from Ships 1973 (commonly known as MARPOL 73/78)*;
- *Protocol to International Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter 1972 (commonly known as the London Dumping Convention)*;
- *International Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC)*;
- *International Convention on Civil Liability for Oil Pollution Damage 1969 & 1992 (CLC 69 & 92)*;

- *International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971 & 1992 (Fund 71 & 92); and*
- *Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the West and Central African Region 1981 (Abidjan Convention).*

To date, Mauritania has not ratified the London Dumping Convention. As at September 1, 2001 CLC 69 and Fund 71 were in force in Mauritanian waters, rather than CLC 92 and Fund 92.

### **1.2.2. National Instruments**

The rights and obligations of companies undertaking petroleum exploration and production activities in Mauritania are defined in Production Sharing Contracts (PSCs), signed between the State, represented by the Minister of Mines and Industry, and the companies. The Ministry of Mines and Industry (MMI) administers the activities of the offshore petroleum industry via the PSCs. The Ministry of Fishing and Maritime Economy (MFME) is responsible for the fishing sector and for prevention of pollution of the marine environment.

#### **Production Sharing Contract**

The PSC for Area A, Block 3 in place between Woodside and its Joint Venture Partners (JVPs) and the Government of Mauritania requires the Contractor to:

"...take any necessary actions for the protection of the environment..."

The Contractor shall, *inter alia*, take any reasonable steps in order to:

"ensure that all the facilities and equipment used for the requirements of the petroleum operations are in good order and correctly maintained in good repair during the term of this contract; avoid losses and discharges of petroleum produced as well as losses and discharges of mud or any other product used in the petroleum operations;" [Clause 6.4]

"The Contractor shall take all necessary precautions to prevent pollution of the marine area of the Exploration Perimeter and observe, *inter alia*, all the provisions of the International Convention on the prevention of petroleum pollution of sea waters signed in London on May 12 1954 and the amendments and texts enacted for the implementation thereof. In order to prevent pollution, the Government may also decide in agreement with the Contractor on any additional action it deems necessary to ensure the preservation of the marine environment." [Clause 6.6].

#### **Mining Code**

The Mining Code (*Law No. 99-013 Relating to the Mining Code*) defines a number of general environmental management requirements for mining activities. Exploration and production of offshore petroleum deposits are covered under the definition of mining described in the Mining Code. Articles 33 and 54 require those seeking an exploitation licence to meet the environmental requirements of the national and international laws in force in Mauritania. Article 33 also refers to compliance with specific provisions of a decree relating to environmental management of mining activities, including environmental impact assessment and measures taken for protection of the environment during, and at the end of, the exploitation. Article 53 requires operators to carry out exploitation of mineral resources according to the principles of sustainable development.

#### **Central Environment Code**

A central regulatory environmental framework (*Law No. 2000-45 Relating to a Framework Law on the Environment*) has the objective of establishing the general principles that will be the basis for a national environmental policy (Article 1). The precautionary principle (Article 6) as well as the polluter-pays principle (Article 7) are listed under the heading "fundamental principles" of the Central Environment Code. The requirement for EIA is also introduced (Articles 14-20) and a list of actions and areas that necessitate an EIA are to be listed in the form of a decree (Article 16). Among these, procedures and modes of implementation of environmental impact studies are a priority.

**Marine Environment Code**

The underlying intent of the draft *Marine Environment Code* is to implement the requirements of MARPOL 73/78 (*Convention for the Prevention of Pollution from Ships 1973*) in marine waters under Mauritanian jurisdiction.

The draft *Marine Environment Code* incorporates regulatory requirements for fixed and mobile petroleum exploration and production installations. *Title VIII* of the draft *Code* (Articles 97 to 113) covers activities of fixed installations (platforms, including drilling ships), seismic vessels, FPSOs (Floating Production Storage and Offtake facilities) and MODUs (Mobile Offshore Drilling Units), either under tow or anchored.

**POLMAR Plan**

The draft *Contingency Plan for the Spill of Hydrocarbon and Hazardous Chemical Substances* (POLMAR Plan) defines the organisation and resources for the prevention of and response to pollution caused by accidental spills of hydrocarbon and hazardous chemicals. The main authority responsible is the MFME (Director of Merchant Marine).

The draft POLMAR Plan defines measures for monitoring marine navigation and responsible organisations, measures to be taken in case of emergency, including risk assessment and intervention measures. It also defines contingency planning measures, although these remain theoretical as Mauritania does not yet have the necessary resources for specific pollution response action. The POLMAR Plan establishes the general organisation of response action, and details specific measures to be undertaken in case of accidental oil spill.

## 2. PROPOSED SEISMIC PROGRAMME

### 2.1. Survey Timing and Location

The proposed Kiffa 3D MSS in PSC Area A is scheduled to be carried out over approximately three months during the period from late August to late November 2004. The survey will cover a total area of approximately 2,926 km<sup>2</sup> (full-fold), with an average line length of 65 km. The details for the survey area are shown in **Table 2-1**.

**Table 2-1: Kiffa 3D MSS Survey Details**

PSC Area	Survey Area (km <sup>2</sup> )	Water Depth (m)	Distance Offshore (km)
A (Block 3)	2,926	50 - 1,600	20

The relative location of the survey area is shown in **Figure 2.1**. The most northerly part of the survey area is located approximately 200 km south from the southern boundary of the Banc d'Arguin National Park (PNBA).

### 2.2. Description of the Survey

Data collection will be conducted from the PGS seismic vessel *M/V Ramform Explorer* towing two compressed air sound energy sources and eight streamer (hydrophone) cables. Details of the seismic array for the Kiffa 3D MSS are provided in **Table 2-2**.

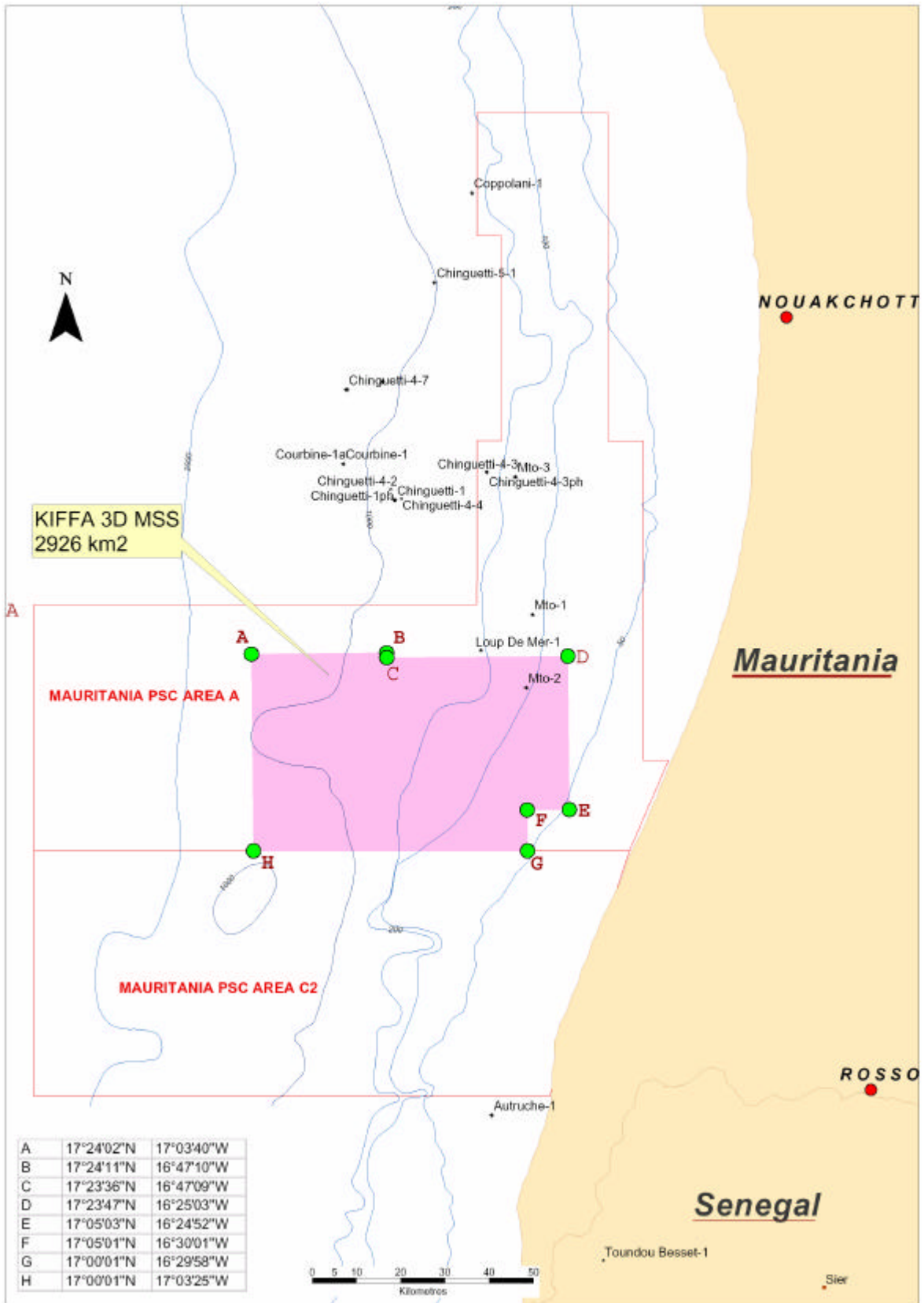
**Table 2-2: Kiffa 3D MSS Seismic Array Data**

Parameter	Data
Total 3D Survey Area	2,926 km <sup>2</sup>
No of streamers	8
Streamer length	4,500 m
Source capacity	3,090 cui
Operating pressure	2,000 psi
Streamer depth	8 m
Source depth	6 m
Shotpoint interval	18.75 m
Peak source sound pulse	220-240 dB re 1µPa rms
Frequency range	10-110 Hz

The seismic vessel will be accompanied by a support vessel (the *M/V Sanco Sea*) which will provide victualling and refuelling support services, as well as by a chase vessel (the *M/V Furore*), which will manage interactions with fishing vessels and other maritime traffic. Due to the duration of the survey (approximately three months) it is anticipated that the seismic vessel will need to be refuelled at sea several times during the acquisition programme. In consideration of the fishing activity expected in the survey area, the chase vessel will also be utilised to interact with the fishermen and to scout for fishing gear which may become entangled with the towed seismic array and associated equipment.



Figure 2-1: Location Map, Kiffa 3D MSS, PSC Area A, Block 3



### 3. DESCRIPTION OF THE EXISTING ENVIRONMENT

A detailed assessment of the physical, biological and socio-economic environment in the area of seismic acquisition is presented in Appendix B.

#### 3.1. Physical Environment

The Mauritanian offshore region is characterised by significant up-welling of deep, cold, nutrient-rich waters with significantly enhanced primary productivity in surface waters. Winds are characterised by the 'Harmattan', which is a dry and dust-laden north easterly trade wind blowing from the Sahara Desert. As a result of the fairly strong and steady trade winds, up-welling occurs throughout the year but is most intense in spring, June/July and autumn when the winds are strongest. The up-welling is predominantly confined to the continental shelf, but can take place as far as 200-300km offshore. The marine sediments situated on the offshore continental shelf of the Mauritanian coast are composed primarily of two general sediment types—principally, soil-based and organic-based sediments. The upper continental slope offshore Mauritania, at water depths of approximately 500m, is characterised by numerous emergent seabed features, believed to be carbonate sediment deposits or mud mounds.

#### 3.2. Biological Environment

The biological environment of the offshore waters of Mauritania is extremely diverse. The coastal environment and interface into which the marine and coastal environments are merged represents an important habitat for both marine and terrestrial species. The presence of fish, marine mammals and birds, is dependent upon oceanographic-atmospheric interactions and in particular the constant variations in currents, swell, tides and bathymetric profiles. For example, cycles of warm and cold currents determine the arrival of fish species including hake, and red mullet, and tropical species such as dolphin fish and flying fish. Even more dependant on these interactions is the Mediterranean monk seal colony found below the cliffs of Cap Blanc. Twenty-two species of cetaceans (whales, dolphins and porpoises) have been recorded for Mauritanian coastal waters. There is very little information available on cetacean populations in the deeper, offshore waters. Similarly, there is no information relating to calving, nursing, breeding or resting areas for any cetacean species in Mauritanian waters.

The seabed sediments at the proposed well locations are likely to support a low diversity, low abundance burrowing infauna, mainly crustaceans and polychaete worms, which have a high recovery potential following physical disturbance. The carbonate mud mounds may support significant benthic communities of deepwater hard corals and associated fauna. The coastal zone is home to the northern-most area of mangroves and has an extremely diverse wetland community. The Banc d'Arguin provides habitat for over two million wintering birds, making it one of the most important wintering sites in the world.

#### 3.3. Socio-Economic Environment

The offshore waters support very productive industrial and artisanal fisheries. Limited information is available on historic shipwreck sites in Mauritanian waters. Undoubtedly the best known historic shipwreck in these waters is that of the French frigate *La Meduse*, which was wrecked on the Banc d'Arguin in July 1816. There are three significant protected areas in the marine and coastal environment of Mauritania. These are the Banc d'Arguin National Park, in the north of the country (Figure B-1), and the Chat T'boul Reserve and the Diawling National Park in the south, adjacent to the border with Senegal. The Banc d'Arguin National Park is Africa's largest coastal and marine national park, an UNESCO World Heritage site and a Ramsar listed Wetland of International Importance.

## 4 DESCRIPTION AND ASSESSMENT OF ENVIRONMENTAL RISKS AND EFFECTS

### 4.1 Potential Environmental Effects

The environmental hazards that may arise during routine and non-routine activities associated with the proposed Kiffa 3D MSS were identified through an environmental hazard identification process. This process included reference to previous incident reports and industry wide knowledge network. The potential significance of the identified hazards were assessed using *Woodside's 'Guidelines for HSE Decision-Making'* (Woodside Procedure HSE 18), which is broadly similar to the *AS/NZS 4360:1999 Risk Management* Standard.

The components of the Kiffa 3D MSS that have the potential to result in significant environmental effects were assessed as being:

- Operation of the seismic vessel and towing of the airgun and streamer (hydrophone) arrays through the survey areas;
- Discharge or 'firing' of the airgun arrays;
- Routine waste discharges from the survey and support vessels;
- At sea refuelling of the survey vessel from the support vessel;
- Accidental fuel and oil spills from the survey and support vessels; and
- Accidental loss of streamers and associated equipment.

The key potential environmental aspects associated with these components of the proposed 3D seismic survey are discussed in the following Sections 4.2 to 4.7.

### 4.2 Disturbance to Marine Fauna

#### 4.2.1 Sonic Disturbance

Environmental issues relating to seismic surveys have largely focused on the potential effects of sonic disturbance to fish stocks and marine mammals from the sound waves associated with the seismic energy source. Concerns have included:

- Pathological effects (lethal and sub-lethal injuries)—immediate and delayed mortality and physiological effects to nearby marine organisms;
- Behavioural change to populations of marine organisms;
- Disruptions to feeding, mating, breeding or nursery activities of marine organisms in such a way as to affect the vitality or abundance of populations;
- Disruptions to the abundance and behaviour of prey species for marine mammals, seabirds and fish; and
- Changed behaviour or breeding patterns of commercially targeted marine species, either directly, or indirectly, in such a way that industrial or artisanal fishing activities are compromised.

Immediate pathological effects are likely to be restricted to very short ranges and high sound intensities. Consequently pathological effects will largely be unlikely to occur for the majority of species, as most free-swimming animals will practice avoidance manoeuvres well before they get within the ranges at which such effects may occur. Animals which do not move away from the path of a seismic vessel because of behavioural or physical constraints, or which are caught unaware within a few hundred metres of an array when it suddenly starts up, will be most at risk from pathological damage. The sound intensities required to produce pathological effects in nearly all marine animals are poorly known, but probably occur at ranges from an airgun array of less than 100 m for marine mammals and 200 m for fish (McCauley, 1994).

#### 4.2.2 Disruption to Cetaceans

Cetaceans employ an extremely acute acoustic sense to monitor their environment and are correspondingly sensitive to sounds below and, to a lesser extent, above the water surface. Sound waves created from seismic operations may interfere with the acoustic perception and communication of any cetaceans in the vicinity, and may have the potential to induce stress. In the short to medium term, repetitious acoustic disturbance could cause abandonment of important habitats such as calving and nursery sites. Disturbances associated with the proposed seismic programme are likely to be temporary, infrequent and very localised—therefore, effects on marine mammals are expected to be minimal.

A study carried out by McCauley *et al.* (1998) has recently monitored the effects of seismic survey noise on humpback whales in the Exmouth Gulf region of Western Australia. The following conclusions were drawn from this research:

- Only localised avoidance was seen by migrating whales during the seismic operation, indicating that the 'risk factor' associated with the seismic survey was confined to a comparatively short period and small range displacement;
- Coupled with the fact that humpbacks were seen to be actively utilising the 'sound shadow' near the surface, then it is unlikely that animals will be at any physiological risk unless at very short range from a large airgun array, perhaps of the order of a few hundred metres;
- Given these two factors, that displacements to migratory animals are comparatively short in time and involve small ranges and the low chance of physiological effects, then there appears to be a low risk for migratory animals;
- The same could not be said for humpback whales which are not migrating, but which remain in an area for socialising, resting, calving, mating, feeding or some other purpose. In these areas the continual displacement by any operating seismic survey vessel may have much more profound and serious effects on individual animals and populations. For example, calves 4-8 weeks old are small and comparatively weak and possibly vulnerable to predation and exhaustion. The continual dislocation of these animals in a confined area would disrupt their resting and feeding with potentially more serious consequences for populations of humpback whales. Similarly, any repetitive displacement or disruption of animals on their calving grounds during the time they are present may have serious consequences at the population level.
- Upper levels of noise at 1.5 km from the seismic survey array were in the order of 182 dB re  $1\mu\text{Pa}^2$ , which is still well below the source levels of the highest components of humpback whale song (192 dB re  $1\mu\text{Pa}^2$ ). Thus at 1.5 km the received airgun signal is still well within the range which humpback whales would be expected to cope with physiologically, since it would be difficult to argue that humpback whale song can cause physiological problems to the animals (McCauley, 1994).

No published information is available about the reactions of any smaller toothed cetaceans (dolphins and porpoises) to seismic noise (McCauley, 1994). Smaller toothed cetaceans have poor hearing in the low frequency range of airgun array noise (10-300 Hz), so may be able to approach operating seismic vessels closely without adverse behavioural or pathological effects. The hearing capability of larger toothed whales (such as the sperm whale) is unknown, but it is possible that they can hear better in the lower frequencies than the smaller toothed cetaceans. If this is the case, in lieu of any other information, their reactions to seismic survey vessels may be akin to those of the baleen whales (McCauley, 1994).

Evidence suggests that whales will only change migratory paths if surveys operate for long periods of time across constricted paths. This is an unlikely event given the open water nature of the survey area.

#### **4.2.3 Disruption to Turtles**

Electro-physical studies have indicated that the best hearing range for marine turtles is in the range 100-700 Hz, which overlaps with the frequency range of maximum energy in the horizontally propagating component of a seismic array 'shot' (McCauley, 1994). No absolute thresholds are known for the sensitivity to underwater sounds or the levels required to cause pathological damage. Based on the limited data available, it would appear that significant impacts on marine turtle populations resulting from seismic survey noise are likely to be restricted to:

- Short ranges and high sound intensities (perhaps <30 m range from source);
- Surveys that take place over protracted periods close to areas important for feeding, breeding and nesting; and
- Surveys that take place over protracted periods close to areas that constitute narrow, restricted migratory paths.

Marine turtles may possibly be exposed to noise levels sufficient to cause pathological damage if airgun arrays start suddenly with turtles nearby (<30 m). In circumstances where arrays are already operating (as a vessel moves along an acquisition line), individuals would be expected to implement avoidance measures before entering ranges at which pathological damage might take place.

#### **4.2.4 Disruption to Fish**

Studies (APPEA, 1998) have shown that fish can be exposed directly to the sound of seismic survey without lethal effects. There is a wide range of susceptibility among fish, however, those with a swimbladder will be more susceptible than those without this organ (McCauley, 1994). Many adult fishes, including the elasmobranchs (sharks and rays) do not possess a swimbladder and so are not susceptible to swimbladder-induced trauma. Most pelagic fish are expected to swim away when seismic noise reaches levels at which it might cause pathological effects, however the presence of many open sea fish near operating vessels suggest that some of these species are hardly affected by the sounds at all.

For some fish, strong 'startle' responses have been observed at sound levels of 200-205 dB re 1 $\mu$ Pa, indicating that sounds at or above this level may cause fish to flee. Sound levels of this level are likely to occur approximately 100-300 m from an airgun array. Based on this an approximate range of 200 m is given as the minimum distance at which fish may flee from an operating array and below which pathological effects may occur (McCauley, 1994). Based on existing information, significant impacts on fish populations resulting from seismic survey noise are likely to be restricted to:

- Short ranges and high sound intensities (ie <200 m range from source);
- Populations that cannot move away from operating arrays (eg site-attached benthic species);
- Surveys that take place over protracted periods close to areas important for the purposes of feeding, spawning or breeding; and
- Surveys that take place over protracted periods close to areas that constitute narrow, restricted migratory paths.

#### **4.2.5 Disruption to Benthic Invertebrates**

Most marine benthic invertebrates have poorly developed mechano-sensory systems and would therefore be little affected by seismic survey noise. The water depth range over which the survey is to occur (50–1,600 m) mitigates against any potential impact on the benthic fauna.

#### **4.2.6 Disruption to Planktonic Organisms**

Except for larvae, fish eggs and other minute planktonic organisms within a few meters of an airgun, no planktonic organisms are likely to be significantly affected by airgun array discharges (McCauley, 1994). For a large seismic array, a pathological effect out to 10 m from source is considered a generous value, with known effects demonstrated only to five metres (McCauley,

1994). Studies show that effects on fish eggs and planktonic larvae is insignificant compared with the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms.

#### **4.3 Disturbance to Benthic Habitats**

Disturbance to benthic habitats from the proposed Kiffa 3D MSS is highly unlikely given the depth of water in the survey areas (50-1,600 m) and the fact that the vessels will not be anchoring during the surveys (except in case of emergency). The only possible activity that could have impacts on benthic habitats would be the accidental loss of equipment that could sink to the seabed as debris.

#### **4.4 Interference with Industrial and Artisanal Fishing**

As identified in Appendix B, the area of continental shelf waters covered by the proposed Kiffa 3D MSS is utilised by a variety of industrial and artisanal fishing vessels. Disruption to these fisheries could result from:

- Direct effects of noise disturbance on target fish populations;
- Indirect effects of noise disturbance on fish prey species;
- Restriction of access to fishing grounds;
- Loss or damage to fishing gear.

#### **4.5 Interference with Shipping**

As identified in Appendix B, the proposed Kiffa 3D MSS survey area are well to the east of the main shipping lane for large ocean-going vessels travelling along the north-west African coast. The survey and support vessels and towed array represent a potential navigational hazard to the activities of smaller merchant vessels moving through coastal waters inshore of the main shipping lane.

#### **4.6 Waste Disposal**

Routine discharges from seismic survey and support vessels are restricted to sewage and putrescible wastes (food scraps). Disposal of sewage and putrescible wastes overboard may cause a localised temporary increase of the nutrient content in the water column. No significant environmental impacts are expected because of the biodegradability of the waste, short period of seismic activities and large dilution factor. Total nutrient (nitrogen and phosphorus) input levels will be insignificant compared with natural levels in most bodies of seawater.

The survey and support vessels also produce a variety of other solid and liquid wastes, including packaging and domestic wastes, such as aluminium cans, bottles, paper and cardboard and hazardous materials such as acids, solvents and toxic wastes. A variety of chemicals, such as lubricating oils and cleaning chemicals, are also stored and used on the survey vessel. All of these materials could potentially impact the marine environment if accidentally released in significant quantities.

#### **4.7 Fuel and Oil Spills**

During the proposed Kiffa 3D MSS, as with most marine operations, there is a low risk of fuel and oil spillage. Spillage may occur as a result of leaking hydraulic hoses, leaking oil drums, spillage for diesel fuel during at sea refuelling operations, or some other unforeseen accident. The size of spills is typically less than 50 litres, the maximum size possible would be in the order of several hundred tonnes, however this could only occur in the event of a failure of the vessel fuel tanks (e.g. complete rupture).

Due to the duration of the survey (approximately three months) it is anticipated that the seismic vessel will need to be refuelled at sea several times during the acquisition programme.

In the unlikely event of a major spillage during at sea refuelling operations the maximum spill volume that could result would be in the order of 400 tonnes of diesel fuel (approximately 500 cubic metres or 400,000 litres). Diesel is a light petroleum distillate that, given the high energy environment that prevails in the proposed area of operations, is expected to undergo rapid dispersion and evaporation. Consequently, any slicks are likely to break up and disperse in a short space of time.

The potential effects of a hydrocarbon spill on the marine environment varies greatly depending on factors such as the weather and sea state at the time of release and the sensitivities of the habitats affected. In the warm open ocean habitat where the proposed surveys will occur any spilled fuel or oil would be subject to rapid dispersal, weathering, evaporative losses and dissipation throughout the water column. Potentially affected biota include seabirds, marine mammals and turtles that may come into contact with an area of spill.

#### **4.7.1 Streamer Damage or Loss**

Streamers may be damaged by a number of events ranging from shark bites penetrating the streamer skin to snagging on unseen obstacles. In the event of damage to or loss of a streamer, potential environmental effects will be limited to:

- Undetectable acute effects resulting from toxicity of the streamer fluid (ISOPAR M, a mixture of light, hydrotreated petroleum distillates, predominantly C<sub>12</sub>-C<sub>15</sub> isoparaffinic hydrocarbons, very similar to kerosene);
- Physical impacts on benthic communities arising from the cable and associated equipment sinking to the seafloor; and
- Potential chemical/biological impacts on benthic, demersal and pelagic communities arising from slow leakage of ISOPAR M, as individual sections of the cable are punctured.

Because of the nature of the streamer fluid, expected weather and sea-state conditions, and the relatively small volumes likely to be released, spillages of ISOPAR M are likely to disperse and weather very quickly. As a result of this, there will be limited opportunity for any adverse effects on biota in the area. Physical impacts on soft sediment communities from a lost streamer and associated equipment (such as the 'birds') will be limited, as the gear is not likely to penetrate the substrate to any great extent.

#### **4.8 Overall Environmental Risk Assessment**

Table 4-1 presents a summary of the environmental risk assessment. The level of risk has been determined from a generic environmental event potential matrix (Table 4-2) consistent with Woodside's procedure for risk assessment (HSE 18) and the AS/NZS 4360:1999 *Risk Management* Standard.

The risk assessment process indicates that a tolerable level of environmental risk is presented from acoustic disturbance, interference with industrial and artisanal fishing and shipping, damage to or loss of streamer and potential fuel and oil spills. Risk reduction and management actions (control and mitigation measures) for these tolerable level risks are identified in the Implementation Strategy in Section 6.

**Table 4-1: Summary of Environmental Risk Assessment for the Kiffa 3D MSS**

Aspect	Potential Environmental Effects	Likelihood	Consequence	Risk Level
Acoustic disturbance to marine fauna	Disruption to populations of cetaceans, turtles, seabirds, fish, benthic invertebrates, and plankton from discharge of the airgun arrays	Virtually certain	Minor Effect. Some disturbance expected to fish, cetaceans and turtles within close proximity to source, but both have capability to actively avoid vessel. Limited effects on migrating yellow mullet due to water depth range of survey (50-1,600 m).	Tolerable
Physical disturbance to benthic habitats	Damage and/or destruction of seafloor habitats from anchoring and loss of seismic equipment	Unlikely	Negligible Effect. Potential for localised physical impacts on seafloor habitats and benthic communities .  Anchoring extremely unlikely to occur given water depth range for survey area (50-1,600 m). All reasonable measures will be taken to recover any seismic equipment lost.	Negligible
Interference with industrial and artisanal fishing	Disruption to fishing vessels. Loss of catch and loss of gear through entanglement with seismic array	Likely	Minor Effect. Some potential for localised and short-term disruption of industrial and artisanal fishing vessels.	Tolerable
Interference with shipping	Disruption to small merchant vessels travelling inshore of main shipping route	Likely	Minor Effect. Some potential for localised and short term disruption of shipping	Tolerable
Waste disposal	Damage to sensitive resources from discharge of sewage and putrescible wastes	Virtually certain	Negligible Effect. Some possible incidental effects from routine discharge of sewage and putrescible waste, all other wastes not discharged	Negligible
Damage to or loss of streamer	Impacts on seafloor habitats and benthic communities from cable and associated equipment sinking to the seafloor.  Possible interference to industrial and artisanal fishing, and shipping  Ecotoxicity effects to benthic, demersal and pelagic communities from slow leakage of ISOPAR M from punctured section(s) of streamer cable	Likely	Minor effect. Only localised disturbance to benthic communities expected due to loss of equipment.  Due to relatively small spill volume, rapid dispersal and biodegradability of ISOPAR M, any ecotoxicity effects are anticipated to be of low significance	Tolerable
Fuel and oil spills	Spills from survey and support vessels, leaks from streamers or other equipment, or spills during at sea refuelling.	Unlikely	Major Effect. Some potential for effects on fish, cetaceans, turtles and seabirds feasible. Diesel fuel and streamer fluid likely to evaporate and disperse readily	Tolerable



**Table 4-2: Generic Environmental Event Potential Matrix**

			EVENT LIKELIHOOD				
			1	2	3	4	5
			Virtually Impossible (Only once in more than 1,000,000 years)	Rare (Once in 10,000 to 1,000,000 years)	Unlikely (Once in 100 to 10,000 years)	Likely (Once in one to 100 years)	Virtually Certain (More than once per year)
ENVIRONMENTAL CONSEQUENCE	E	Negligible Effect	Negligible	Negligible	Negligible	Negligible	Negligible
	D	Minor Effect	Negligible	Negligible	TOLERABLE	TOLERABLE	TOLERABLE
	C	Major Effect	TOLERABLE	TOLERABLE	TOLERABLE	TOLERABLE	TOLERABLE
	B	Severe Effect	TOLERABLE	TOLERABLE	TOLERABLE	Intolerable	Intolerable
	A	Disastrous Effect	Intolerable	Intolerable	Intolerable	Intolerable	Intolerable

**KEY:**

- Negligible:** Generally no risk reduction actions required
- Tolerable:** Demonstrate risk reduction options, where possible to ALARP
- Intolerable:** Risk unacceptable, undertake actions to reduce to tolerable levels
- Negligible** Possible incidental impacts to flora and fauna in a locally affected environmental setting. No ecological consequences.
- Minor:** Reduction of the abundance/biomass of flora and fauna in the affected environmental setting. No changes to biodiversity or ecological system.
- Major:** Reduction of abundance/biomass in the affected environmental setting. Limited impact to local biodiversity without loss of pre-incident conditions.
- Severe:** Substantial reduction of abundance/biomass in the affected environmental setting. Significant impact to biodiversity and ecological functioning. Eventual recovery of ecological systems possible, but not necessarily to the same pre-incident conditions.
- Disastrous:** Irreversible and irrecoverable changes to abundance/biomass in the affected environmental setting. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions.

## 5 PERFORMANCE OBJECTIVES, STANDARDS AND CRITERIA

The performance objectives, standards and criteria for the Kiffa 3D MSS are described in **Table 5-1**.

**Table 5-1: Performance Objectives, Standards and Criteria for the Kiffa 3D MSS**

<b>Objectives</b>	<b>Standards</b>	<b>Criteria</b>
Minimise disruption to cetaceans	<ul style="list-style-type: none"> <li>• Woodside <i>Environmental Policy</i> (Appendix A) and <i>HSE Management System</i></li> <li>• Environment Australia <i>Seismic and Whale Interaction Guidelines</i> (Appendix C)</li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> </ul>	<ul style="list-style-type: none"> <li>• Whale interaction procedures in place and adhered to</li> <li>• Soft start procedures</li> <li>• Whale watch and stop work procedures</li> <li>• Use of dedicated cetacean observer</li> <li>• Sighting reports (Appendix D) completed and returned to Woodside</li> </ul>
Minimise disruption to turtles and fish	<ul style="list-style-type: none"> <li>• Woodside <i>Environmental Policy</i> and <i>HSE Management System</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> </ul>	<ul style="list-style-type: none"> <li>• Soft start procedures</li> <li>• Use of dedicated cetacean observer</li> </ul>
Minimise disturbance to benthic habitats	<ul style="list-style-type: none"> <li>• Woodside <i>Environmental Policy</i> and <i>HSE Management System</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> </ul>	<ul style="list-style-type: none"> <li>• No anchoring of vessels will take place during the surveys (only in case of emergency)</li> <li>• Recording and reporting of all items lost overboard</li> <li>• All reasonable measures taken to recover any lost equipment.</li> <li>• Use of support and chase vessels</li> </ul>
Minimise interference with industrial and artisanal fishing	<ul style="list-style-type: none"> <li>• Woodside <i>HSE Management System</i> and <i>Corporate Affairs Issues Management Process</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> </ul>	<ul style="list-style-type: none"> <li>• Use of support and chase vessels</li> <li>• Recording of sightings of fishing vessels</li> <li>• Mauritanian fisheries representative onboard chase vessel</li> <li>• Consultation with fishermen onshore and at sea</li> <li>• Consultation with Ministry of Fisheries and Maritime Economy and other key stakeholders</li> <li>• Operations carried out in a manner that does not interfere with fishing to a greater extent than is necessary.</li> <li>• In order to avoid impacts on yellow mullet populations, airguns will be shut down during line turns on the eastern side of the survey area, to minimise noise impacts in water depths shallower than 30 m (refer Figure B-8 for yellow mullet distribution).</li> </ul>
Minimise interference with shipping traffic	<ul style="list-style-type: none"> <li>• Woodside <i>HSE Management System</i> and <i>Corporate Affairs Issues Management Process</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> </ul>	<ul style="list-style-type: none"> <li>• Use of support and chase vessels</li> <li>• Display of appropriate navigational beacons and lights</li> <li>• Radar watch</li> <li>• Radio warnings to shipping</li> <li>• Operations carried out in a manner that does not interfere with navigation to a greater extent than is necessary</li> </ul>

Objectives	Standards	Criteria
Minimise effects of sewage discharge	<ul style="list-style-type: none"> <li>• Woodside <i>Environmental Policy and HSE Management System</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> <li>• PGS <i>Waste Management Procedure 942VES00</i></li> <li>• MARPOL 73/78 Annex IV</li> </ul>	<ul style="list-style-type: none"> <li>• Procedures for treatment and disposal of sewage are in place</li> <li>• Approved sewage treatment plant in place and operational</li> <li>• Relevant discharge requirements are adhered to</li> <li>• Vessel <i>Waste Log Form</i> completed, indicating quantities of comminuted sewage discharged overboard</li> </ul>
Minimise potential impacts of solid and hazardous wastes	<ul style="list-style-type: none"> <li>• Woodside <i>Environmental Policy and HSE Management System</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> <li>• PGS <i>Waste Management Procedure 942VES00</i></li> <li>• MARPOL 73/78 Annex V</li> </ul>	<ul style="list-style-type: none"> <li>• Correct segregation of solid and hazardous wastes</li> <li>• A vessel <i>Waste Log Form</i> is kept detailing quantities of wastes transported ashore</li> <li>• Procedures comply with MARPOL requirements</li> </ul>
Minimise occurrence of fuel and oil spills	<ul style="list-style-type: none"> <li>• Woodside <i>Environmental Policy and HSE Management System</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> <li>• PGS <i>Refuelling At Sea Towing Procedure 979VES02</i></li> <li>• PGS <i>Refuelling At Sea Side To Side Procedure 979VES01</i></li> <li>• PGS <i>Vessel To Vessel Fuel Transfer Operations Procedure 979VES00</i></li> <li>• MARPOL 73/78 Annex I</li> </ul>	<ul style="list-style-type: none"> <li>• Refuelling at sea carried out in accordance with following procedures:                             <ul style="list-style-type: none"> <li>➢ At sea refuelling supervised by Vessel Master or nominated Officer</li> <li>➢ Refuelling does not commence without Woodside approval</li> <li>➢ All valves and the flexible transfer hose checked for integrity prior to use</li> <li>➢ Use of dry-break couplings</li> </ul> </li> <li>• Adherence to PGS operational procedures</li> <li>• Procedures comply with MARPOL 73/78 requirements</li> <li>• MARPOL <i>Oil Record Book</i> kept up to date</li> <li>• Any spills &gt;80 litres are reported to the Ministry of Mines and the Ministry of Fisheries and Maritime Economy</li> </ul>
Minimise effects of fuel and oil spills	<ul style="list-style-type: none"> <li>• Woodside <i>Environmental Policy and HSE Management System</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> <li>• PGS Vessel Safety Case</li> <li>• PGS <i>Accidental Oil Spillage Procedure 910VES00</i></li> <li>• Vessel SOPEP (<i>Shipboard Oil Pollution Emergency Plan</i>)</li> </ul>	<ul style="list-style-type: none"> <li>• Fuel spill contingency procedures are in place and operational</li> <li>• Sufficient spill response equipment on board</li> <li>• Appropriate actions are taken to minimise pollution</li> <li>• At sea refuelling only takes place in approved locations.</li> <li>• Personnel responsibilities are clearly identified</li> <li>• <i>Pollution Report</i> is completed for any incidents</li> </ul>
Key stakeholders satisfied that seismic survey activities are managed in a manner which is not detrimental to their interests	<ul style="list-style-type: none"> <li>• Woodside <i>HSE Management System</i> and Corporate Affairs <i>Issues Management Process</i></li> <li>• Woodside <i>Environmental Standards &amp; Aspirations</i></li> </ul>	<ul style="list-style-type: none"> <li>• Key stakeholder consultation has been carried out prior to survey commencing</li> <li>• Consultation continues to include period during and after survey</li> </ul>

## 6 IMPLEMENTATION STRATEGY

To either eliminate potential environmental risks and effects of the proposed Kiffa 3D MSS, or to reduce them to as low as reasonably practicable, a number of key control and mitigation measures will be implemented. The key control and mitigation measures are described below.

### 6.1 Control of Environmental Impacts

#### 6.1.1 Disturbance to Marine Fauna

**Table 6-1:** summarises the control and mitigation measures that eliminate or reduce any significant environmental impacts on marine life to as low as reasonably practicable.

**Table 6-1: Control and Mitigation Measures to Minimise Marine Fauna Impacts**

Sensitive Marine Fauna	Control and Mitigation Measures
Whales	Whale interaction procedures (daylight hours) (Appendix C). Soft start procedures. Use of dedicated cetacean observer.
Other Cetaceans	Soft start procedures will minimise impacts on dolphins and porpoises not observed during pre start-up visual observations (daylight hours), or encountered at night. Use of dedicated cetacean observer.
Turtles	The surveys will be conducted at least 200 km from any shallow water habitat areas known to be important for turtle feeding and breeding. Soft start procedures. Use of dedicated cetacean observer.
Fish	The surveys will not be operating over any identified fish spawning or nursery areas. Soft start procedures. No firing of airguns during line turns on the eastern side of the survey area, to minimise any potential of noise impacts on migrating yellow mullet in water depths shallower than 30 m.

#### **Whale Interaction Procedures**

The main control measure to minimise the potential impacts of the Kiffa 3D MSS on whales and other cetaceans during daylight hours is the implementation of the whale interaction procedures detailed in Appendix C. These procedures have been adapted from the Environment Australia *Management Guidelines for Seismic Vessels Operating in Australian Waters so as to Avoid or Minimise Interference with Whales and Certain Other Larger Cetaceans* (Environment Australia, 2001).

These procedures have the following key elements:

- A visual check for the presence of whales will be made before the commencement of each acquisition line (during daylight hours);
- Airgun discharge will not begin unless whales are a minimum distance of two kilometres from the survey vessel;
- A sequential build-up of warning pulses (over a period of 10-20 minutes) will be made at the start of each acquisition line ('soft start') to warn and deter whales from approaching the survey vessel;

- A continuous watch for whales will be maintained during 'soft start' sequences (during daylight hours) to determine the presence or absence of whales within two kilometres of the vessel;
- Airgun array discharge will cease when an individual whale, or pod of whales, approaches within two kilometres of the vessel. Operations will not recommence until the animals have been seen to moved outside the 2 km range, or have not been seen for 30 minutes.
- Visual observations of at least 10 minute duration per hour will be carried out during seismic operations (during daylight hours)

The start-up delay, soft start and stop work procedures detailed in Appendix C only apply if whales are detected within 2 km of the vessel. They do not apply to sightings of dolphins and porpoises within 2 km of the vessel. For night-time operations, only the soft start procedures apply.

Soft starts over a 10-20 minute period at the start of each new line will also serve to warn and scatter any other free-swimming fauna (i.e. dolphins, porpoises, turtles, pelagic and demersal fish) in the area, thereby minimising the likelihood of animals being within pathological effects range. Soft starts are comprised of a process where, at the commencement of operations or when the array has been shut down completely, the air-gun array is ramped-up to full operating levels starting with the smallest air-gun and output is then increased at a rate of approximately 6 dB per minute.

Throughout the entire survey a dedicated cetacean observer (or Marine Mammal Observer – MMO) will be aboard the survey vessel. The MMO's role will be to provide advice on the application of the Environment Australia Guidelines; to monitor adherence to the Guidelines during airgun operations; to keep a watch for cetaceans and turtles during daylight hours; and to record and report all sightings of cetaceans and turtles. Sighting effort, record of operations and any cetacean and turtle sightings during the pre start-up, soft start and 10 mins per hour visual observations should be recorded on the appropriate forms detailed in Appendix D.

#### **6.1.2 Disturbance of Benthic Habitats**

The 3D survey is unlikely to have any significant effects on benthic communities due to the water depths of the survey area (50-1,600 m). The seismic and support vessels will not be anchoring during the survey, although the vessels may have to anchor in an emergency situation. The only activity that may have impacts on benthic habitats would be the accidental loss of equipment that could sink to the seabed as debris. In the event of loss of a streamer or associated equipment (e.g. paravanes, tail buoys) there is the potential for some limited disturbance of benthic habitats to occur. Wherever possible, streamers and associated equipment are recovered when lost during survey activities.

#### **6.1.3 Interference with Industrial and Artisanal Fishing**

The control and mitigation measures to eliminate or minimise potential impacts from the proposed surveys on industrial and artisanal fisheries in the survey areas are:

- Use of a support vessel (the *M/V Sanco Sea*) and a chase vessel (the *M/V Furore*) to warn fishing vessels of approach of the survey vessel, and to remove fishing equipment from acquisition lines;
- Monitoring for presence of fishing vessels;
- Mauritanian fisheries representative aboard chase vessel;
- Direct consultation with fishermen at sea and onshore;
- Consultation with Ministry of Fisheries and Maritime Economy, and other key stakeholders (Secretary General of the Federation National de Pêches (FNP), President of Artisanal Fisheries section of FNP, Délégation à la Surveillance des Pêches et au Contrôle en Mer (DSPCM), Head of the Mauritanian Navy, Director Parc National du Diawling, and Marine Nationale Senegal);

- Standard maritime safety procedures (radio contact, display of appropriate navigational beacons and lights); and
- Airguns will be shut down during line turns on the eastern side of the survey area to avoid any noise impacts in water depths shallower than 30 m, and therefore minimise potential effects on the migrating yellow mullet population (refer Figure B-9); and
- Recording of all sightings of fishing vessels.

#### **6.1.4 Interference with Shipping**

The control and mitigation measures to minimise adverse impacts on shipping transiting the Kiffa 3D MSS survey areas are:

- Use of a support vessel (the *M/V Sanco Sea*) and a chase vessel (the *M/V Furore*) to warn merchant vessels of navigational hazard presented by survey vessel and towed array; and
- Standard maritime safety procedures (radio contact with approaching vessels, display of appropriate navigational beacons and lights).

#### **6.1.5 Waste Disposal**

Risks to marine environmental resources in the Kiffa 3D MSS survey areas and adjacent waters from disposal of wastes are considered to be negligible given that all garbage will be retained on board both the seismic and support vessels for disposal onshore other than food waste, sewage and putrescible material.

All waste disposal must conform with the requirements of PGS's *Waste Management Procedure 942VES00*. Sewage and putrescible waste (foodscraps) disposal must conform to the requirements of MARPOL 73/78 Annex IV. Foodscraps are to be macerated to a diameter of less than 25 mm prior to discharge into the sea. Under MARPOL 73/78 Annex IV, discharge of sewage is prohibited except when:

- the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than four nautical miles from the nearest land, or sewage which is not comminuted or disinfected at a distance of more than 12 nautical miles from the nearest land (only when sewage that has been stored in holding tanks is not discharged instantaneously but at a moderate rate when the ship is en route and proceeding at not less than 4 knots); and
- the effluent shall not produce visible floating solids in, nor cause discolouration of, the surrounding water.

Records must be kept of the quantities of sewage discharged, in the vessel *Waste Log Form*.

In accordance with MARPOL 73/78 regulations, no plastics or plastic products of any kind are to be disposed of overboard. No domestic waste, i.e. cans, glass, paper or other waste from living areas is to be discharged overboard. No maintenance wastes, i.e. paint sweepings, rags, deck sweepings, oil soaks, machinery deposits etc., are to be disposed of overboard. All combustible items must be separated for incineration aboard the vessel. All other items must be compacted (if possible) and stored in designated areas for proper disposal onshore.

A *Waste Log Form* must be maintained, detailing the quantities of waste and sludge incinerated aboard the vessel and non-combustible wastes produced and returned to shore for disposal.

All chemical and hazardous wastes, such as cleaning products, acids, solvents, toxic waste and medical waste, must be segregated into clearly marked containers prior to onshore disposal. All storage facilities and handling equipment must be segregated, in good order and designed in such a way as to prevent and contain any spillages as far as practicable.

The survey vessel has an oil / water separator and any ballast water discharged must be handled according to the MARPOL 73/78 regulations and all events related to ballast water management must be recorded on a *Ballast Water Handling Log*.

#### **6.1.6 At Sea Refuelling**

There are a number of specific control and mitigation measures that must be implemented to eliminate or minimise the risk of spills and potential environmental impacts from at sea refuelling. These are:

- Refuelling of the survey vessel at sea must be undertaken from a supply vessel positioned directly alongside or in front of the survey vessel;
- The operation must be managed through detailed vessel specific procedures for bunkering at sea (PGS *Refuelling At Sea Towing Procedure 979VES02*; *Refuelling At Sea Side To Side Procedure 979VES01*; *Vessel To Vessel Fuel Transfer Operations Procedure 979VES00*) which are designed to minimise the risk of a spillage of fuel during bunkering from other vessels;
- The refuelling must take place in a location that minimises risks to sensitive environmental resources (e.g. away from the coastline). Prior to commencement of the surveys, primary and secondary refuelling locations must be identified by PGS, and this information must be submitted to Woodside for approval. Refuelling must only take place in these approved locations.
- If possible, Woodside Project Geophysicist should be advised of any refuelling operations including time and location, 24 hours prior to commencement of refuelling.
- Additional procedures are to be in place to further minimise the risks of fuel spillage. These measures must include:
  - dry-break couplings for the flexible transfer hoses;
  - documented inspection and maintenance schedule for the transfer hoses;
  - threshold sea-state and wind conditions above which the operation will not be conducted;
  - a stipulation that the operation can only be conducted during daylight hours; and
  - the exclusion of concurrent refueling and streamer maintenance operations.
- In the event that vessel refuelling becomes critical and the sea-state conditions are unsuitable, approval must be obtained from Woodside to return to port to complete this task.

#### **6.1.7 Fuel and Oil Spills**

The vessel has specific fuel spill contingency procedures in the unlikely event of a fuel spill (Vessel *Shipboard Oil Pollution Emergency Plan – SOPEP*; and PGS *Accidental Oil Spillage Procedure 910VES00*). For any major diesel spills during at sea refuelling operations, Woodside has the capability to initiate real-time oil spill fate and trajectory modelling using the OILMAP model.

Any fuel or oil spills must be reported using PGS's *Incident Report Form* and Woodside's reporting procedure. Stocks of absorbent materials aboard the survey vessel must be checked for their adequacy and replenished as necessary prior to the commencement of activities within the survey areas.

Any incidents involving the loss of fuel or oil of greater than 80L must be reported to the Mauritanian Ministry of Mines and Ministry of Fisheries and Maritime Economy by Woodside as soon as possible after the event.

### **6.2 Roles and Responsibilities**

The key roles and responsibilities for conduct of this Environment Plan are listed in **Table 6-2**. All crew and personnel associated with the Kiffa 3D MSS will be provided with an induction prior to the commencement of the surveys to ensure that they are aware of their roles and responsibilities and have the necessary skills and training with regard to environmental protection.

**Table 6-2: Key Environmental Roles and Responsibilities**

<b>Personnel</b>	<b>Responsibilities</b>
Vessel Master	Responsible for the safe execution of all operations of the survey vessel.
	Overall responsibility for HSE management aboard the vessel, and for ensuring that appropriate control and mitigation measures are implemented to minimise potential environmental effects resulting from vessel operations (e.g. waste management/disposal, refuelling, fuel/oil spill response).
	Responsible for immediately notifying the Client Site Representatives of any incidents/activities arising from vessel operations that are likely to have a negative impact on the performance objectives detailed in this Environment Plan.
	Responsible for notifying relevant authorities, as per requirements of Woodside reporting procedures and any other reporting requirements of Mauritanian Government bodies.
	Responsible for determining appropriate locations for refuelling activities.
Party Chief	Responsible for safe execution of all operations carried out by the seismic crew aboard the survey vessel.
	Responsible for ensuring that appropriate control and mitigation measures are implemented to minimise potential environmental impacts resulting from seismic acquisition (e.g. 'soft start' procedures, whale watch and stop work procedures, cetacean recording).
	Responsible for ensuring compliance with all aspects of HSE reporting and for investigations of all incidents and near misses.
	Responsible for immediately notifying the Client Site Representatives of any incidents/activities arising from seismic operations that are likely to have a negative impact on the performance objectives detailed in this Environment Plan.
Client Site Representatives	Responsible for ensuring that, during the Kiffa 3D MSS, the Contract company (and all sub-contractors), performs operations in a manner consistent with the performance objectives and environmental management procedures detailed in this Environment Plan.
	Responsible for ensuring that the Vessel Master and Party Chief are adhering to the requirements of this Environment Plan.
	Responsible for keeping fully apprised of ongoing operations, particularly for environmentally critical activities.
	Responsible for immediately alerting the Woodside Project Geophysicist of any issues or any changes in operations which could have a negative impact on environmental performance.
	Responsible for reporting any reportable incidents to the Woodside Project Geophysicist.
Woodside Project Geophysicist	Responsible for ensuring that the relevant Mauritanian Government bodies are notified of all reportable incidents in a timely fashion.
	Responsible for ensuring full briefing of all project personnel of the environmental sensitivities of the survey areas and environmental management procedures and commitments detailed in this Environment Plan.
	Responsible for pro-actively communicating details of the Kiffa 3D MSS to relevant Government agencies and NGOs (Non-Governmental Organisations) in advance of operations commencing.
Environmental Coordinator International	Responsible for ensuring that survey personnel are aware of their roles and responsibilities, with respect to environmental protection, and of the requirements of this Environment Plan.
Marine Mammal Observer	Responsible for providing advice on the application of the Environment Australia Guidelines; monitoring adherence to the Guidelines during airgun operations; keeping a watch for cetaceans and turtles during daylight hours; and recording and reporting all sightings of cetaceans and turtles.
All	All Woodside personnel and contractors in all areas of the Company's activities are responsible for applying the Corporate Environmental Policy.



### 6.3 Monitoring, Audit and Review

The monitoring, audit and review programme for the Kiffa 3D MSS will consist of the following actions:

- The project start-up meeting will include a presentation to review the environmental sensitivities of the survey locations, key environmental performance objectives and commitments, as detailed in this Environment Plan.
- The survey vessel used during the surveys will be subject to a number of internal HSE inspections and audits,
- An environmental audit will be carried out aboard the survey vessel prior to or during the survey. This audit will include a vessel inspection and an assessment of the environmental components of the contractor's HSE Management System. This review will particularly focus on aspects of applied environmental management aboard the vessel, including waste management, effluent and emission control, transport and materials supply, project management, contingency planning and preparedness and operations effects and control.
- Recording of all cetacean sightings on UK JNCC *Marine Mammal Recording Form Report* sheets. Copies of these sheets will be provided to Woodside's Environmental Coordinator International.
- Recording of all interactions with industrial and artisanal fishing vessels/equipment.
- Total number of environmental incidents (minor spills, streamer loss etc.) and reportable environmental incidents (spills >80 litres) will be recorded according to Woodside HSE Management System requirements.
- A *Waste Log Form* will be maintained, detailing the quantities of waste and sludge incinerated aboard the vessel and non-combustible wastes produced and returned to shore for disposal.
- All fishing vessel sightings will be logged and the sheets forwarded to Woodside's Environmental Coordinator International.

### 6.4 Reporting

All incidents that have the potential to cause significant effects on the environment must be reported and investigated according to legislative requirements and the procedures laid down in the Woodside HSE Management System.

- Woodside must be informed within 24 hrs of any incidents involving fuel/oil spill, the loss of streamers/individual streamer sections and spillage of ISOPAR M.
- Any spills greater than 10 tonnes must be reported to Woodside within one hour, via the Woodside International Emergency Response Number (+61-8-9158 8333).

Woodside will notify the Mauritanian Ministry of Mines and Ministry of Fisheries and Maritime Economy of all spills >80 litres.

### 6.5 Consultation

Consultation during planning and preparation for seismic survey activities offshore Mauritania will be managed according to an external affairs strategy developed under Woodside's Corporate Affairs Team management process. This will involve pre-survey notification and discussions with key stakeholders. Woodside maintains a list of identified stakeholders relevant to the Mauritanian exploration and development campaign.

Identified stakeholders will be notified in advance in writing about the proposed survey activities. This will include the commencement date, anticipated duration of activities, general nature of these activities and the names of appropriate personnel to contact in Woodside.

The consultation process will ensure that relevant individuals and stakeholder groups are made aware that survey and support vessels will be operating in their area for several months. This will also allow logistical details of the survey to be managed in relation to local and regional offshore activities occurring during the survey period.

Initial stakeholder consultation on the Kiffa 3D survey has already taken place with the Ministry of Fisheries and Maritime Economy (Director of Merchant Marine), the Ministry of Mines & Industry (Director of Hydrocarbons), the Secretary General of the Federation Nationale de Pêches (FNP), the President of the Artisanal Fisheries section of FNP, the Délégation à la Surveillance des Pêches et au Contrôle en Mer (DSPCM), the Head of the Mauritanian Navy, the Director Parc National du Diawling, and representatives from the Marine Nationale Department, Senegal. Further consultation is planned prior to the start of the survey, with FNP and DSPCM in Nouadhibou, and at fishing villages and camps north and south of Nouakchott.

During planning for the proposed Kiffa 3D MSS there have been consultations with IUCN and IMROP to get a better understanding of the timing and location of the yellow mullet migration, and where key sensitive areas are located. Collaboration and cooperation between Woodside, IMROP and IUCN will ensure that potential effects from this survey on migrating yellow mullet are either eliminated or minimised as far as is practicable.

## 7 REFERENCES

- APPEA (1998). Seismic surveys and the petroleum industry. Independent Scientific Review Committee Internet Database, Fact Sheet 1. Australian Petroleum Production and Exploration Association.
- Environment Australia (2001). *Management Guidelines for Seismic Vessels Operating in Australian Waters so as to Avoid or Minimise Interference with Whales and Certain Other Larger Cetaceans*. <http://www.ea.gov.au/epbc/assessapprov/guidelines/seismic/attachment6.html>
- McCauley, R.D. (1994). The environmental implications of offshore oil and gas development in Australia – seismic surveys. In: *Environmental Implications of Offshore Oil and Gas Development in Australia - The Findings of an Independent Scientific Review*, J.M. Swan, J.M. Neff and P.C. Young, (eds.), pp. 123-207. Australian Petroleum Exploration Association, Sydney.
- McCauley, R.D., Jenner, C., Jenner, M-N., McCabe, K.A. and Murdoch, J. (1998). The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey noise: Preliminary results of observations about a working seismic vessel and experimental exposures. *APPEA Journal* 1998, **38(Pt 1)**: 692-707.

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## **APPENDIX A:**

### **Corporate Environment Policy**

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## The Woodside Group of Companies Environmental Policy

### General Policy Objectives

Woodside is an oil and gas exploration and production company. Our vision is to provide for society's energy needs in ways that make us proud. While recognising that the world's hydrocarbon reserves are finite, we share the desire of the community to develop these resources in ways that meet the needs of the present, without compromising the environment for future generations.

At all stages of our business, we plan and perform activities so that adverse effects on the environment are avoided or kept as low as reasonably practicable.

### Strategies

To implement this Policy we will:

- Delay or stop activities where effective environmental controls are not in place.
- Comply with all applicable laws and regulations while aspiring to higher standards.
- Apply responsible standards where laws and regulations do not exist.
- Apply and demonstrate a systematic approach to environmental management to ensure compliance and achieve continuous performance improvement.
- Set and regularly review environmental objectives and targets.
- Strive to prevent pollution, and seek improvement with respect to emissions, discharges, wastes, energy use, resource consumption and ecological footprint.
- Monitor the effects of our activities on the environment and take action to address effects where necessary.
- Openly communicate our environmental performance with our workforce, Government and the wider community.
- Foster a culture that empowers and rewards everyone to act in accordance with this Policy.

### Application

The Managing Director of Woodside Energy Ltd. is accountable to the Board of Directors for ensuring this Policy is implemented. This Policy will be reviewed every three years.

This Policy applies to all personnel, contractors and joint venturers engaged in activities under Woodside's operational control. Responsible Woodside managers will use their influence to promote this Policy in non-operated ventures.



J H Akehurst  
Managing Director  
June 2003

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## **APPENDIX B:**

### **Description of the Existing Environment**

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## DESCRIPTION OF THE EXISTING ENVIRONMENT

### Physical Environment

#### *Climate*

Mauritania is characterised as a hot and extremely arid environment, particularly in the desert areas.

The country is divided into two general climatic zones:

- Sahelian Zone; and
- Saharan Zone.

The Sahelian Zone itself, is the key climatic zone dominating the coastal environment of Mauritania. It is limited in its extension north by the presence of drier conditions where average annual rainfall is below 150 mm. The Sahelian Zone is subdivided into two further climatic zones; the coastal and continental zones. The transitional area at the interface of these two climatic zones is characterised by a constant humidity and relatively low temperatures with a small daily and annual range. The coastal climate zone is characterised by mild weather, a small temperature range and rain in summer, linked to the monsoon season. The rainy season in the south of Mauritania is from July to October, extending north to the central districts, but only for a few weeks of the year.

For those regions that do receive rainfall, the distribution, intensity and magnitude of rainfall events, differs according to the geographical location. Two thirds of Mauritania is classified as "Saharan", where rainfall is either non-existent or negligible in most years and always under 100 mm (IUCN, 1993). In addition, rainfall has been declining over successive years as Saharan conditions encroach further south.

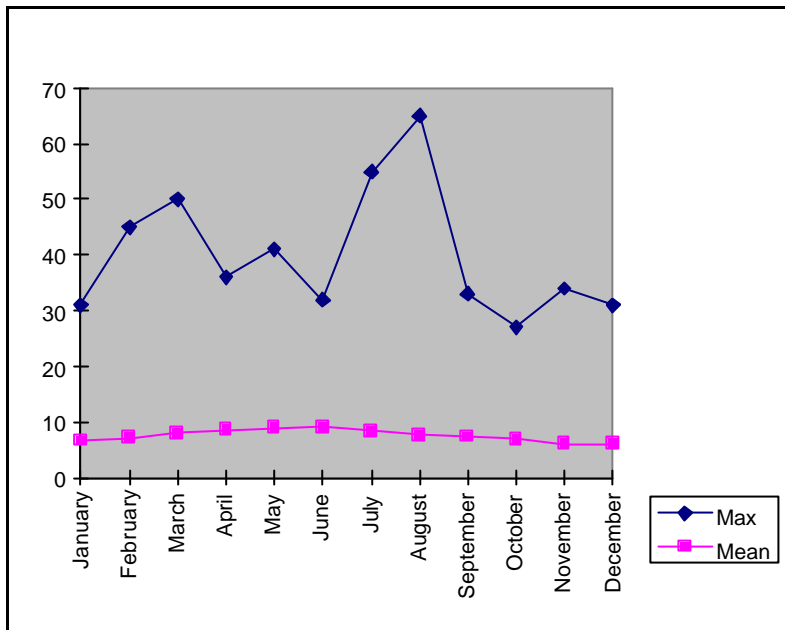
Mean annual temperatures are again variable, with temperatures at Nouakchott averaging 21°C in the winter months and 30°C in the warmer summer months, compared to 20°C and 35°C for Atar.

Winds are characterised by the 'Harmattan', which is a dry and dust-laden north-easterly trade wind blowing from the Sahara Desert. The north-easterly trade winds are strongly associated with the Canary Current up-welling and the movement of water south-westerly along the coast of north-west Africa.

From meteorological observations at Nouâdhibou Airport, over the period 1953-1990, it has been estimated that northerly trade winds account for 85% of the winds in this area (Dedah, 1993). The frequency distribution of wind speeds is shown in Figure B-1. Typically, the coastal winds from December through to May blow directly from the north down the coast of Mauritania. From June to September the winds are more westerly as a result of the high pressure air mass to the north-east of Mauritania, moving further east. At the beginning of October this air mass moves further west, bringing about a change in the wind direction, back to northerly winds (Toupet, 1977).

Relative humidity in the coastal zone is highest from July through to September where it reaches 80%. In contrast, humidity is lowest from December through to March, when it maintains a level of less than 20% (Toupet, 1977).

Figure B-1: Maximum and Mean Wind Speeds (m/sec) at Nouâdhibou Airport (1953-1988)



(Dedah, 1993)

### Regional Currents

On a regional scale, there are essentially three wind-driven currents operating off the west coast of Africa which affect the coastal waters of Mauritania:

- Canary Current;
- North Equatorial Current; and
- Equatorial Counter Current.

The Canary Current flows south-west along the coast of West Africa. It transports cool, nutrient-rich water and is strongest near the continental coast, becoming progressively weaker offshore. It accelerates locally, as it passes between the Canary Islands. The coast and continental shelf topography are a major influence on up-welling. Major up-welling occurs between 25° and 23° N off western Africa, due to a transverse shift in the current at 50 m depth; and is most active in the south, where the Canary Current contacts inter-tropical water off the continental shelf.

From Cap Blanc off Mauritania, the current is deflected westward, past the Cape Verde Islands where it turns towards the west and merges into the North Equatorial Current (African Pilot, 1992). The current has a year-round presence off Cap Blanc and moves at varying speeds during different periods of the year. In the summer months the current has a speed of 1-1.5 knots, decreasing to 0.5-1 knots in the winter months (Sevrin-Reyssac, 1993).

The North Equatorial Current, with which the Canary Current is strongly associated, appears west of 25° W, flowing at a speed of approximately 0.5 knots towards the Caribbean (African Pilot, 1992).

The Equatorial Counter Current, separating the North and South Equatorial currents respectively, is most extensive in summer and can be detected to 35° to 40° W. During the summer months this current bifurcates as it approaches the coast, with a small proportion of it turning north-east into the coastal regions of Sierra Leone and Liberia, to the south of Mauritania. From here the water branches and subdivides again with a small mass of water turning north-west along the coast as far as 15° to 18° N. This has the effect of causing a reversal of the normal south-easterly flow. However, the north-westerly flow is relatively slow moving (in the region of 0.5 knots), and begins to diminish as the Equatorial Counter Current weakens in the winter months.

The effect of tidal currents on the general circulation system is thought to be relatively minimal. Over the entire north-west African up-welling area the mean amplitude of semi-diurnal tidal currents, recorded at several sites, was only 6 cm/s  $\pm$  3 cm/s. Therefore, mixing by tidal currents is hardly noticeable even in shallow waters (Fugro, 1999).

### Coastal Up-Welling

The cold coastal waters found off Mauritania are a result of up-welling which is strongest offshore of Cap Blanc. The up-welling is wind-driven and occurs in a relatively narrow band of water, 20-30 km along the coast (Fugro, 1999). Table B-1 illustrates the characteristics of up-welling events along the north-west coast of Africa.

**Table B-1: Principal Environmental Characteristics of the Up-Welling Season**

Location	Up-welling Season	Temperature (°C)			Water Speed (m/sec <sup>-1</sup> )		
		min	max	average	min	max	average
34°N-36°N	Apr-Aug	16.21	22.37	19.03	5.18	6.44	5.77
32°N-34°N	Apr-Aug	16.80	22.25	19.36	4.96	6.31	5.75
30°N-32°N	Mar-Aug	17.14	21.30	19.12	5.18	7.91	6.73
28°N-30°N	Mar-Aug	17.63	21.65	19.47	5.29	7.92	6.47
26°N-28°N	Permanent	18.48	22.40	20.27	5.47	8.59	6.79
24°N-26°N	Permanent	18.57	22.03	20.15	5.50	7.87	6.68
22°N-24°N	Permanent	18.28	21.38	19.66	5.58	8.16	7.00
20°N-22°N	Permanent	18.22	22.62	19.88	5.73	8.52	7.10
18°N-20°N	Oct-Jun	18.92	26.38	21.89	4.54	7.41	6.21
16°N-18°N	Oct-Jun	19.54	27.76	23.22	4.15	6.66	5.51
14°N-16°N	Dec-May	19.68	28.09	24.05	3.62	5.71	4.86
12°N-14°N	Dec-May	20.25	28.37	24.83	2.83	5.06	4.16
10°N-12°N	Jan-Apr	22.18	28.25	25.91	2.12	5.41	3.40

(Cury and Roy, 1999)

The waters off the coast of Cap Blanc are the convergence point between two deep water masses, the North Atlantic Central Water (NACW) and the South Atlantic Central Water (SACW). These two deepwater masses both follow the continental shelf until they meet, at which point they become separated by a thermocline. The NACW and SACW begin to move towards the surface, as the Canary Current in the surface waters above, is forced offshore. The cold, nutrient-rich bottom waters are advected to the surface, replacing the surface Canary Current waters.

As a result of the fairly strong and steady trade winds, up-welling occurs throughout the year but is most intense in spring, June/July and autumn when the winds are strongest. However, from July to October, the warm counter current is dominant south of Cap Blanc, and this influences up-welling, which becomes progressively weaker (Mittelstaedt, 1991). The up-welling is predominantly confined to the continental shelf, but can take place as far as 200-300 km offshore.

Studies have shown that the coastal up-welling system off Mauritania is extremely productive, containing nutrient-rich waters. This is especially the case off Cap Blanc, where giant filaments of relatively high pigment concentration persist throughout the year (Lange *et al.*, 1997). Here, substantial seasonal and inter-annual variations occur, enhanced by the westward flowing North Equatorial Current. Filament analysis using infra red images from NOAA satellites has helped to track the intensity of these up-welling events. Results indicate that between 15°N and 20°N up-

welling occurs in winter and spring, after which it gradually moves northwards and becomes more intense between 20°N and 33°N in the spring and summer months (see Figure B-2). In autumn, the strength of the trade winds declines and the intensity of the up-welling correspondingly decreases (Fugro, 1999).

### **Localised Currents**

The coastal waters of Mauritania are characterised by seasonal changes in the directional movement, strength and presence of two localised currents known as the 'Mauritanian Current' and the 'Sahara Current'. During the summer months, the northerly-moving Mauritanian Current is dominant and is fed by a branch of the North Equatorial Current (Chavance *et al.*, 1991). The Mauritanian Current extends as far north as Cap Blanc, where it splits and circulates around the Banc d'Arguin in one direction and moves offshore rejoining the Equatorial Counter Current in the other (). In shallow coastal waters between 17° and 19° N the current dissipates and two anti-cyclonic eddies are formed (Chavance *et al.*, 1991).

In the winter months, a body of water fed by the Canary Current branches off and moves south, along the Mauritanian coast. This current is known as the Sahara Current. The existence of the Sahara Current in the winter months consequently forces the Mauritania Current slightly further off shore from its position in the summer months (see Figure B-2 and B-3).

### **Sea Surface Temperatures**

Sea Surface Temperatures (SST) fluctuate throughout the year (Chavance *et al.*, 1991). Between January and May the coastal SSTs are in the region of 18°C - 19°C for the entire coast. As the year progresses, SSTs remain at around 19°C in the north around Cap Blanc, increasing further south to around 25°C off the Senegal River delta. This dramatic change in sea surface temperature is likely to be due to the cold up-welling which is more pronounced further north. Between August and October as the up-welling in the north becomes less intense, SSTs increase to around 22°C, increasing further south to 27°C. This followed by a change back to slightly cooler water in the north (18°C) and 21°C in the south, between November and December.

### **Bathymetry and Sediments**

The marine sediments situated on the offshore continental shelf of the Mauritanian coast are composed primarily of two general sediment types—principally, soil-based and organic-based sediments.

Soil-based sediments are derived from eroded terrestrial rocks, fed by wind-driven dust from the predominantly north-westerly winds. Soil-based sediments occur mainly south of Cap Timiris at a water depth of between 50-70 metres, and are predominantly quartzite. These sediments are associated with the main areas of coastal up-welling between Cap Blanc and Cap Timiris.

Organic-based sediments, rich in continental shelf detritus and dominated by the remains of sea urchins, occur mainly off the northern coast of Mauritania, on the upper part of the continental shelf. This sediment zone also occurs south of Nouakchott, discontinuously along the upper part of the continental shelf above 50 metres water depth. There appears to be a clear distinction between the sedimentary coverage to the north and south of Cap Timiris. North of the Cap the sediments are dominated by coarse sand, with a high carbonate content. In contrast, to the south, the sediments are dominated by very fine sediments, with a low carbonate content.

Figure B-2: Localised Currents off Mauritania during Summer

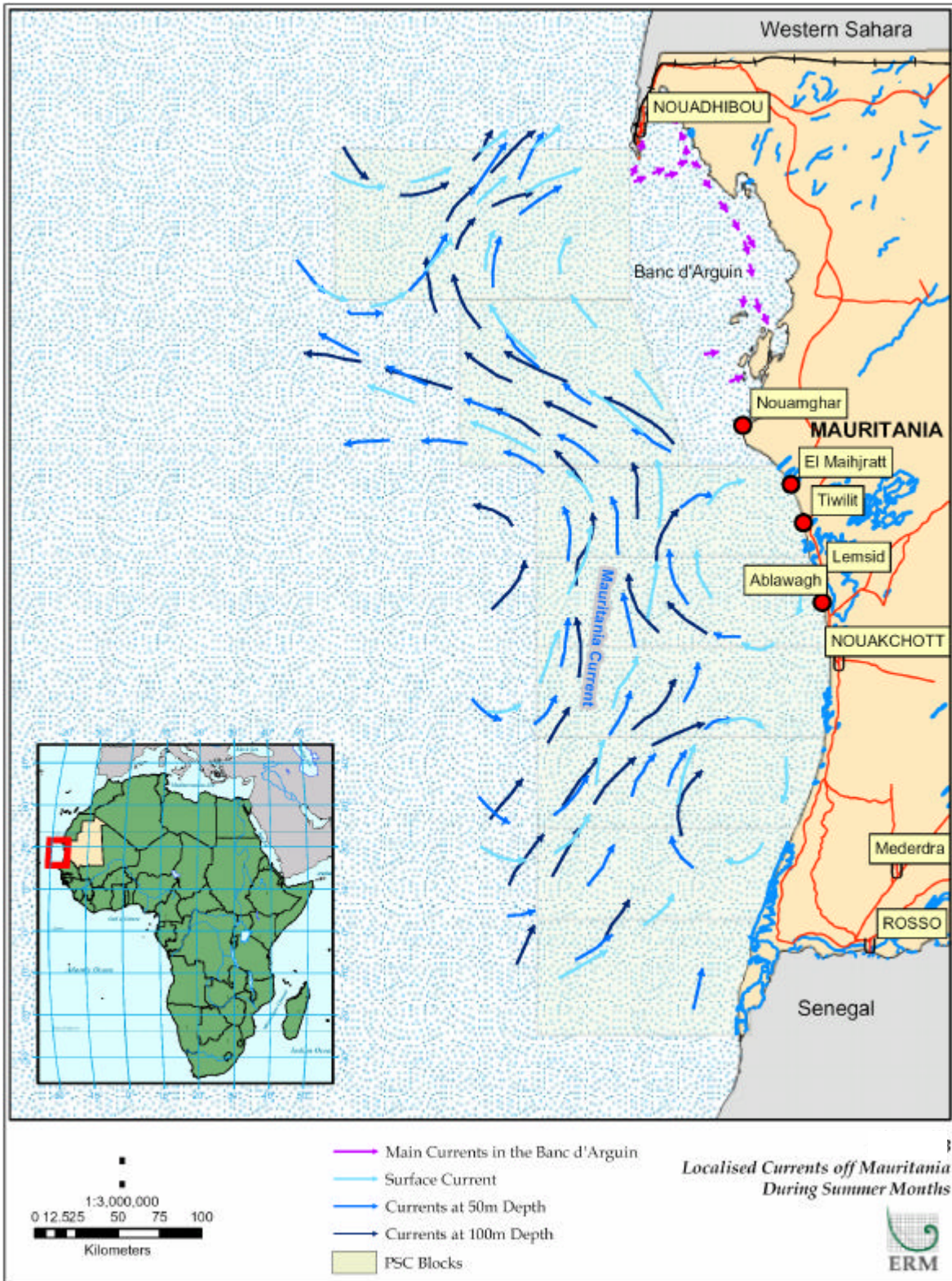
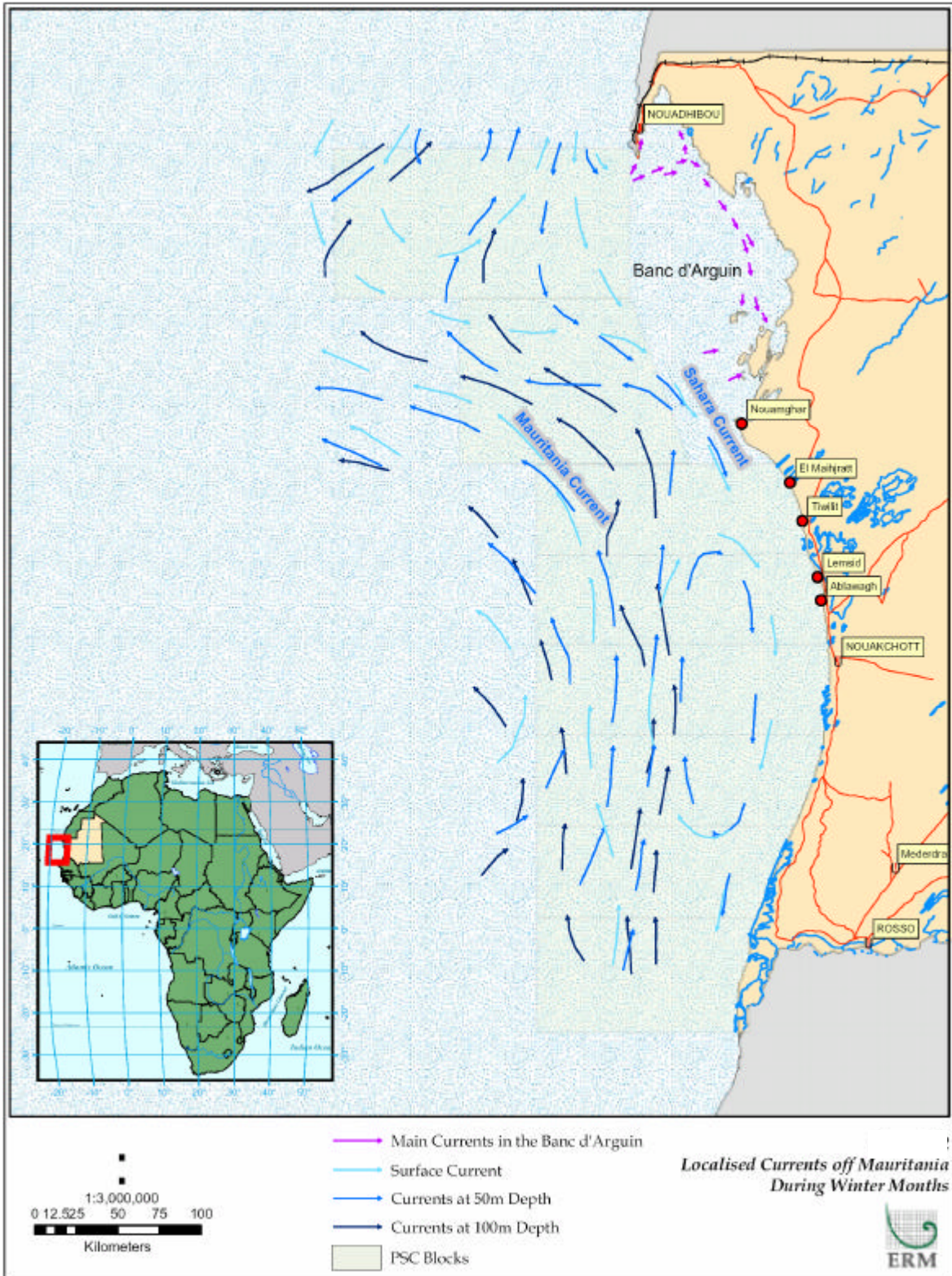


Figure B-3: Localised Currents off Mauritania during Winter





### **Carbonate Mud Mounds**

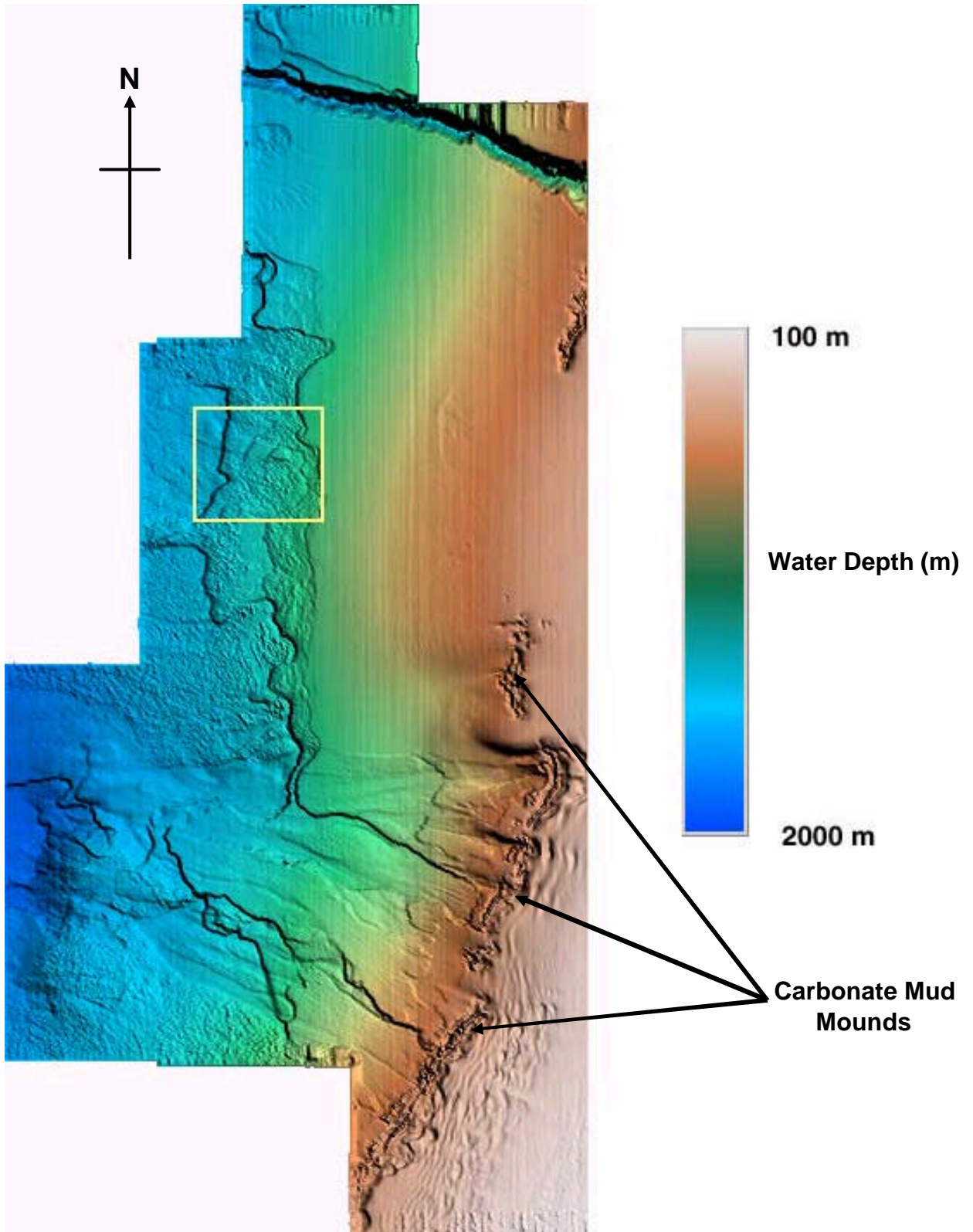
Carbonate mounds have been closely associated with the occurrence of deepwater coral communities throughout the north-east Atlantic (Rogers, 1999). Therefore, the recent discovery of carbonate mud mounds offshore Mauritania is likely to lead to the identification of significant coral communities associated with these seabed features. A 3D seismic survey, undertaken by Woodside in PSC Areas A and B in early 2000, revealed a series of carbonate mounds at approximately 500 metres water depth. These mounds are positioned parallel to the coast and cover a linear extent of at least 85 km (Figure B-4). More recently, interpretation of 3D seismic data, undertaken by Dana Petroleum in Block 7, confirmed that similar mound structures occur at a depth of 460 m in the area to the west of the Banc d'Arguin.

Carbonate mounds are found in coastal waters of the north-east Atlantic in water depths ranging from 100-2,000 m (B. Bett, Southampton Oceanography Centre, *pers. comm.*, 2001). Historically, the formation of the carbonate mounds has been associated with the seepage of methane or other hydrocarbons (Peckmann *et al.*, 1998). A number of studies have investigated this relationship, the first of which centred around a reef off the coast of Norway. This reef is located on a ridge with over twice the background levels of methane compared to surrounding waters (Rogers, 1999). However, many of these studies have not taken account of the fact that the dominant cold water, reef-forming coral occurring on carbonate mounds, *Lophelia pertusa*, grows on hard substrate, which suggests that other physical factors play a role in determining the location of these mounds and not simply whether hydrocarbon seepages are present. Geotechnical and geochemical surveys undertaken by Woodside off Mauritania indicated that sediments on the carbonate mounds have a very low hydrocarbon content and a high content of dead coral material (Woodside, 2001).

The Mauritanian carbonate mounds, which are approximately 100 m in height and 500 m in diameter at the base (see Figure B-5), are arranged in a series of rows that are likely to have been formed by seabed currents. The 3D seafloor image shows the mounds extending as linear features with remarkable lateral continuity at around 500 m water depth and a localised curved or arcuate form (see Figure B-5). Currents near the seafloor are thought to play an important role in determining the shape of the carbonate mounds.

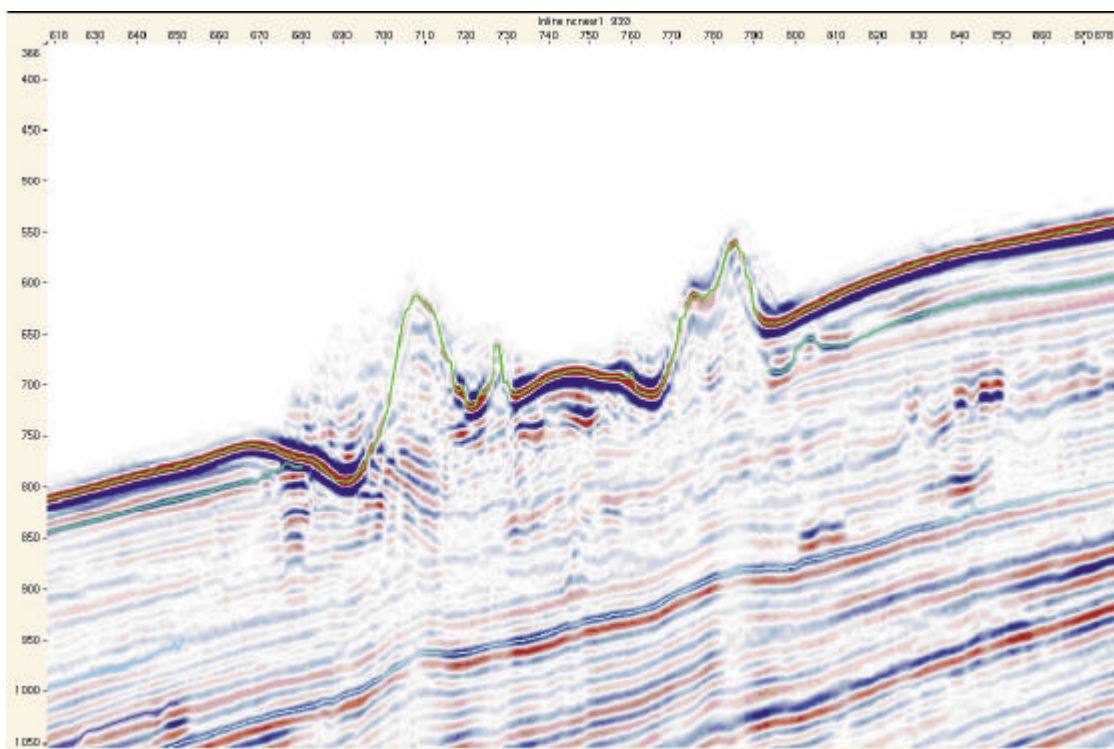
Water column salinity and temperature profile data from Blocks 3, 4 and 6 indicated a well developed halocline at approximately 450 m water depth, with saline (Canary Current) water overlying the fresher Antarctic Intermediate Water. It is possible that this interface has promoted the development of the deepwater corals. The internal waves developed on the interface could reduce sedimentation (or erode material) and produce the moats associated with the edge of the mounds. The increased clay content over the mounds possibly results from entrapment of very fine material by the coral stems/debris.

Figure B-4: 3D Seafloor Image showing Carbonate Mud Mounds

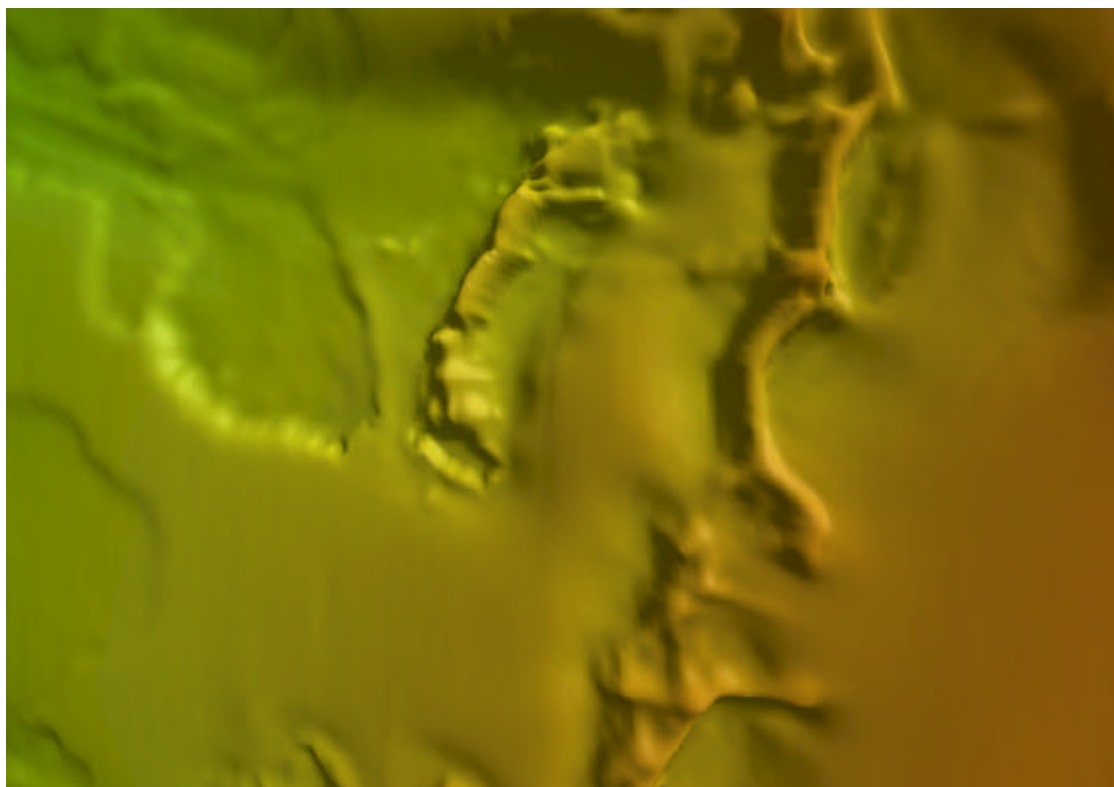


(For location of survey area, see Figure 2-1)

**Figure B-5: 3D Seismic Section through Mauritanian Carbonate Mud Mounds**



**Figure B-6: 3D Seafloor Representation of Mauritanian Carbonate Mud Mounds**



## Biological Environment

### General

The biological environment of the offshore waters of Mauritania is extremely diverse. The coastal environment and interface into which the marine and coastal environments are merged represents an important habitat for both marine and terrestrial species. The presence of fish, marine mammals and birds, is dependent upon oceanographic-atmospheric interactions and in particular the constant variations in currents, swell, tides and bathymetric profiles. For example, cycles of warm and cold currents determine the arrival of fish species including hake, and red and yellow mullet, and tropical species such as dolphin fish and flying fish. Even more dependant on these interactions is the Mediterranean monk seal colony found below the cliffs of Cap Blanc.

Similarly, the coastal zone is home to the northern-most area of mangroves and has an extremely diverse wetland community. The Banc d'Arguin provides habitat for over two million wintering birds, making it one of the most important wintering sites in the world. This location is classified as a National Park (Banc d'Arguin National Park) and also has international significance as a World Heritage site.

The proposed Kiffa 3D MSS is located approximately 20 km from the coast and 200 km south of the southern boundary of the Banc d'Arguin National Park. Consequently, it is highly unlikely that there will be any impacts on these areas from the proposed seismic acquisition. This description of the biological environment, therefore, will focus on the information available for offshore waters, in water depths from approximately 100 to 2,000 m.

### Deepwater Coral Communities

Drop core samples taken from carbonate mud mounds (see Section 3.3.2) in PSC Blocks 3, 4 and 6 indicate the presence of the reef-forming corals including *Lophelia pertusa*, *Madrepora* sp. and *Dendrophyllia cornigera* (A. Rogers, Southampton Oceanography Centre, pers. comm., 2001). *Lophelia*, which has a hard, branched external skeleton of calcium carbonate giving it a variable appearance from white through to pink (WWF/IUCN, 2001), is the most studied stony cold-water coral. It is found predominantly in the North Atlantic, which is where the majority of more recent records are attributed. In west African waters, *Lophelia* has been recorded off the coast of Morocco to the north and Senegal to the south (Rogers, 1999).

The wide geographical distribution and concentration in the north-east Atlantic (Wilson, 1979) is believed to be due to a number of interacting factors, including, but not limited to:

- biogeographic history of the region;
- high productivity associated with surface waters;
- availability of suitable types of seabed; and
- favourable hydrographic and chemical conditions.

*Lophelia* is a member of the family Caryophylliidae and the functional group of azooxanthellatae corals (Rogers, 1999). Coral colonies can take several different growth forms ranging from a compact bushy form to one where the polyps are elongated. These differing growth forms can occur as colonies, thickets or reefs. Thickets consist of either single colonies or groups of colonies separated by areas of seabed (WWF/IUCN, 2001). Reef-complexes may develop in areas where individual reefs are found close together, forming bioherms. *Lophelia* reefs are typically characterised by zones of living and dead coral. Living coral is generally restricted to the top of the reef whereas, dead coral is found below the top and down to the foot of the reef.

### Benthos

There are limited data available on the benthos, as most research has been confined to the waters surrounding the Banc d'Arguin (Duineveld and de Wilde, 1993). These studies have focused primarily on the epifaunal species and have not considered infaunal communities.

Unpublished information and data may be held by CNROP (National Centre for Oceanographic Research and Fisheries).

### **Turtles**

A number of beaches along the Mauritanian coast provide important nesting sites for a range of species including:

- green turtles (*Chelonia mydas*);
- olive Ridley (*Lepidochelys olivacea*);
- loggerhead (*Caretta caretta*);
- hawksbill (*Eretmochelys imbricata*) and;
- leatherback (*Dermochelys coriacea*).

Green and loggerhead turtles are internationally listed endangered species. The leatherback turtle is listed as critically endangered on the IUCN 2000 Red List of Threatened Animals. Records and research into the distribution of sea turtles is based primarily on casual observations such as the sighting of a head at the surface or the bumping of the bow of a boat on the shell of a sleeping turtle (Campredon, 2000).

Loggerhead and green turtles are commonly found in the Banc d'Arguin and Baie du Lévrier areas. No information is available on the distribution and abundance of turtles in Mauritania's offshore waters. It is possible that turtles could be encountered periodically in these offshore waters as they migrate to and from nesting beaches on the Mauritanian coast.

### **Cetaceans**

Information on cetaceans in Mauritania is drawn mainly from a review of historical records and systematic surveys conducted in 1994-95 as part of the European programme "Biodiversity of the Littoral in Mauritania (Robineau and Vely, 1998). That information is supplemented by observations of cetaceans during several recent offshore surveys, notably during seismic acquisition off Mauritania by Woodside in 1999-2000, and other vessel-based surveys of cetaceans and seabirds conducted in January 2000, and in March 2003 (Burton and Camphuysen, 2003 and Burton, 2003). The latter was aimed specifically at reducing information gaps existing about cetaceans and seabirds likely to be present in the vicinity of the Chinguetti field.

Information about cetaceans off the coast of Senegal is drawn mainly from accounts from the above review (Robineau and Vely, 1998) and also from the documented findings of a UNEP/CMS-sponsored survey (Project WAF CET I), conducted in 1997-98 (Van Waerebeek *et al.*, 2000). Cetacean populations along the Mauritanian coast are poorly understood, with few publications and little information available on calving, nursing, breeding or migration and resting areas for most species.

The only systematic survey, in 1994-95, focused on the Baie du Lévrier, the Banc d'Arguin region and coastal waters along the "Grande Beach" (central and southern coastline of Mauritania south of Cap Timiris to the Senegal River delta). Twenty-one cetacean species were recorded (Robineau and Vely, 1998). Little information is available on cetacean diversity, distribution and abundance in deeper offshore waters off Mauritania.

The most commonly recorded species in Mauritanian waters are:

- bottlenose dolphin (*Tursiops truncatus*);
- common dolphin (*Delphinus delphis*);
- Atlantic spotted dolphins (*Stenella frontalis*);
- Atlantic humpbacked dolphin (*Souza teuzii*);
- common porpoise (*Phocoena phocena*); and
- killer whale (*Orcinus orca*);

Some, such as bottlenose dolphin and Atlantic spotted dolphins are permanent residents within the Banc d'Arguin region.

Fewer species are recorded in Mauritania compared with records for the north-east tropical Atlantic. The species missing from Mauritanian records are almost all pelagic species, including those rare to

the region (Robineau and Vely,1998). Available information suggests that the waters in the vicinity of the Chinguetti field could potentially be visited by passing pods of the different pelagic species of whales and dolphins that occur in these waters. From the available information, the Chinguetti field location does not coincide with any recognised locally-specific migration route or feeding area.

Twenty four species of cetaceans are confirmed as occurring in the EEZ waters of Senegal, Gambia and Guinea-Bissau (Van Waerebeek *et al.*, 2000). Many of these are common with those documented for Mauritania. Historical records for the different cetacean species from Mauritania and Senegal are summarised in Table B-2. Observations from the cetacean and seabird surveys conducted off Mauritania are discussed further below.

### **Offshore surveys**

*Offshore survey (seismic acquisition: November 1999 - March 2000, Western Geophysical, 2000)*  
Sightings comprised 26 dolphins, 10 pilot whales, three humpback whales and one killer whale, during seismic acquisition in the PSC Areas A and B.

### **Offshore fauna survey: January 2000 (Camphuysen, 2003)**

At least six species of cetaceans were observed in deeper offshore waters, as opposed to only two on the shelf edge and two over the shelf. Cetaceans peaked in numbers near Mauritanian transects C (offshore Nouamghar) and D (offshore Nourakchott) (Camphuysen, 2003). Cetaceans were slightly more numerous over the shelf edge (1.69 per kilometre) than on either side of the shelf break (0.91-1.15 per kilometre).

Dolphin species (and numbers) encountered over the five day survey off Mauritania included: *Delphinus delphis delphis* (401), *Delphinus delphis* (145), *Tursiops truncatus* (6), unidentified (58). Whale species included *Globicephala macrorhynchus* (50), *Globicephal melas* (22), *Hyperodon ampullatus* (5) *Ziphius cavirostris* (4) *Physeter macrocephalus* (17) and large *Balaenoptera* species (5). Greatest numbers and diversity of dolphins were sighted along Transect C (offshore Nouamghar). Sightings of the large *Balaenoptera* species (identities not confirmed) and *Physeter* (Sperm whale) were made along Transect E, offshore from the southern part of the Mauritania coast (south-west of Nouakchott).

### **Offshore survey (seismic acquisition): February 2002 - July 2002 (Burton, 2003)**

Substantial sightings, of ~5,000 individual cetaceans, were made over ~70 observer days during acquisition of seismic data in PSC Blocks A, B and C, off the mid-west coast of Mauritania. Eleven cetacean species were sighted. Dolphins accounted for ~90% of the observations, with large baleen whales making up <1%. Dolphins included *Stenella frontalis*, *Tursiops truncatus* and *Delphinus delphis*. Baleen sightings were all in May (five species: *Megaptera novaeangiae*, *Balaenoptera borealis*, *B. musculus*, *B. physalus*, and *B. acutorostrata*). The rest of the sightings were of larger, toothed whales, mainly *Globicephala macrorhynchus* and *G. melas*. One *Orcinus orca* was sighted. Cetacean sightings peaked across the continental slope, mainly between 500m and 1,300m depth, and generally increased late in the survey, towards June-July.

### **Offshore fauna survey: March 2003 (Burton and Camphuysen, 2003)**

The survey route was restricted to the general vicinity of the Chinguetti field and departure route from the Chinguetti field to port (Nouakchott). Over the eight-day survey, several pods of dolphins were sighted. Species and total numbers (in parentheses) sighted included *Delphinus delphis* (526), *Stenella clymene* (40), *S. longirostris* (40), *S. coeruleoalba* (15), *Grampus griseus* (17) and *Souza teuszii* (2). The sighting of 40 Clymene dolphins with calves was notable (a new record), as well as ~550 or more of the dolphins, *D. delphis*, *S. coeruleoalba* and *S. longirostris*, swimming together. One feeding *Balaenoptera borealis* was sighted.

### **Oceanographic influences**

The only detailed systematic survey of cetaceans in Mauritania (Robineau and Vely,1998) was conducted mainly in autumn and winter and this acknowledged the restricted scope and duration of observations. Warm water currents from equatorial regions are likely to be important in defining the range of cetaceans present in the region. With the similar oceanographic conditions that exist between Cap Timiris and Cap Vert, apparent differences in the cetacean records of Mauritania and Senegal may gradually disappear as new information becomes available (Robineau and Vely,1998).

***Cetacean mortality incidents***

Mass mortalities of marine fauna have occurred in the past in coastal waters off Mauritania. For example, many (125) Atlantic spotted dolphins were found dead on beaches in 1995. The local purse seine fishery, operating up to 50km offshore, was believed to be responsible as a number of the corpses had netting marks (Nieri *et al.*, 1999). Purse seine fishing was subsequently banned throughout Mauritanian waters.

Beached carcasses of cetaceans, marine turtles and various fish were reported in the international and Mauritanian press during June and July 2003. While causes have yet to be identified, photographic evidence of carcasses, and reports at the time, pointed to several possible causes, including entanglement in fishing gear, fishing by-catch, dumping of spoiled catch and effects of pollution.

**Table B-2: Records and Observations of Cetaceans in Mauritania and Senegal**

Species / Common Name	Presence*	Standing & sighting historical records	Offshore surveys, Mauritania, 2000-2003
<i>Balaenoptera acutorostrata</i> Minke whale	M, S	Stranding record of individual young, male north of Nouakchott, 1994. Senegal: stranding, Langue de Barbarie, female, September 1977; species confirmed from coastal areas of north and central Senegal; several records from Senegal suggest it is not uncommon.	Five large <i>Balaenoptera</i> sighted (species unconfirmed) during January 2000 survey. Five species sighted during 2002 survey (all in May): <i>Megaptera novaeangiae</i> , <i>Balaenopteris borealis</i> , <i>B. musculus</i> , <i>B. physalus</i> , and <i>B. acutorostrata</i> .
<i>Balaenoptera borealis</i> Sei whale	M, S	Individual stranded on west coast of Baie du Lévrier, February 1981. Senegal: parts recovered from shark landed at Joal, 1949; dead ship strike casualty landed at Dakar, 1998. Strike location unconfirmed. Two other dead balaenopterids found off coast, March 1998-possibly sei whales.	See above. One feeding individual sighted during March 2003 survey.
<i>Balaenoptera edeni</i> Bryde's whale	S	Senegal: a juvenile stranded alive Dakar, March 1955; several unidentified <i>Balaenoptera</i> strandings off Senegal.	No sightings.
<i>Balaenoptera musculus</i> Blue whale	M?	Reports of several at-sea sightings of <i>Balaenoptera</i> during winter (1981).	No confirmed sightings: five large <i>Balaenoptera</i> sighted (species unconfirmed) during January 2000 survey
<i>Balaenoptera physalus</i> Fin whale	M, S?	Female captured in Baie de l'Archimede 1971; stranding in Nouâdhibou, 1975. Unconfirmed occurrence in Senegal. Floating carcass of balaenopterid near Dakar, May 1981.	See above.
<i>Delphinus delphis</i> Common dolphin <i>Delphinus capensis</i> Long-snouted common dolphin	M, S	Second-most common recorded species in Mauritania. Observed through year off Senegal; captured in coastal areas, mainly off Dakar and Gorée. Several new records of delphinid species, 1995-1999, mainly from Cap Vert and Petite Côte; Species is common in coastal waters. Abundance is difficult to determine on basis of current data.	Over 400 sighted during January 2000 survey. Sighted (with <i>Stenella frontalis</i> and <i>Tursiops truncatus</i> ) during February-July 2002 survey. Over 520 sighted during March 2003 survey.
<i>Eubalaena galacialis</i> Northern right whale	S	Documented to occur Madeira to Senegal; may occur in Mauritania.	No sightings.
<i>Feresa attenuata</i> Pygmy killer whale	S	Captured off Senegal, April 1958. Only record.	No sightings.
<i>Globicephala macrorhynchus</i> Short-finned pilot whale	M, S	First record in Senegal: 151 in mass stranding, May 1943; common stranding on beaches of Senegal; one stranding only in Mauritania, in Baie du Lévrier.	10 pilot whales sighted during seismic surveys of PSC Areas A and B; 50 sightings in January 2000 survey; sighted also during February-July 2002 survey.
<i>Globicephala melas</i> Long-finned pilot whale	M	Five strandings on Great Mauritanian Beach; one sighting at sea; the strandings are the only confirmed record for Mauritania. Not found south of Mauritania (cold-water species).	See comment for pilot whales above; 22 sightings in January 2000 survey; also observed during February-July 2002 survey.



Species / Common Name	Presence*	Standing & sighting historical records	Offshore surveys, Mauritania, 2000-2003
<i>Grampus griseus</i> Risso's dolphin	M	Five strandings: Cap Blanc (1); north of Nouakchott (2); in Nouakchott (1) and south and close to Senegal border (1); no record in Senegal but sighted at sea around Cape Verde Islands.	17 sightings during March 2003 survey.
<i>Kogia breviceps</i> Pygmy sperm whale	M, S	Individual stranding north of Nouakchott, 1992 and calvarium from PNBA, 1995. Senegal: two specimens stranded in Dakar, July 1957; another pair stranded Rufisque, May 1965.	No sightings.
<i>Kogia sima</i> Dwarf sperm whale	S	Senegal records: Two strandings, males, 1977 and 1981.	No sightings.
<i>Lagenodelphis hosei</i> Fraser's dolphin	S	Records from carcass at Sangomar Island and from Delta du Saloum, 1997 (=only mainland record for W Africa)	No sightings.
<i>Megaptera novaeangliae</i> Humpback whale	M, S?	Individual stranding, Baie du Lévrier, 1954; apparently never recorded off Senegal-no confirmed occurrence.	Three sighted during 1999-2000 seismic survey. Sighted in May during 2002 survey.
<i>Mesoplodon densirostris</i> Blainville's beaked whale	M	Record from one skull of an animal stranded on the beach north of Nouakchott, 1992.	No sightings.
<i>Mesoplodon europaeus</i> Gervais' beaked whale	M	Never recorded on Mauritania coast; carcass of female found on beach south of Nouakchott, 1992; unknown in Senegal.	No sightings.
<i>Orcinus orca</i> Killer whale	M, S	In Mauritania, two sightings and two strandings - three individuals in Baie du Lévrier and two strandings along Great Beach, north and south of Nouakchott; numerous observations in Baie du Lévrier and off Banc d'Arguin; recorded several times along Senegal coast, at Hann and off Dakar.	One sighting during November 1999 - March 2000 survey; one sighting February-July 2000 survey.
<i>Peponocephala electra</i> Melon-headed whale	M, S	Single skull only Mauritanian record; stranding Delta du Saloum, 1966. No regional abundance information.	No sightings.
<i>Phocoena phocoena</i> Harbour (common) porpoise	M, S	Many stranding records; Cap Blanc, Baie du Lévrier, Great Beach, south of Nouakchott; rare in waters of Banc d'Arguin; recorded several times along Senegal coast-taken in nets Cap Vert, 1949; reported as far south as Fadiouth.	No sightings.
<i>Physeter macrocephalus</i> Sperm whale	M	Recorded as <i>P. catadon</i> in the record from a stranding at Iwick, PNBA. Three individuals observed near Cap Timiris 1962, in depths 100-200m; stranding in 1980 on beach 20km south of Nouakchott. Senegal: first record a stranding on la Petit Côte, January 1954. Sighted in numbers off St Louis, May 1979; live stranding, Delta du Saloum, 1997.	17 sightings during January 2000 survey.
<i>Souza teuszii</i> Atlantic humpbacked dolphin	M, S	Mauritania: 15 strandings; 15 sightings of 69-93 individuals; almost all from within PNBA. No data for Baie du Lévrier; 5 sightings south of Nouâmgâr; one stranding south of Nouakchott. Senegal: records from M'Bour and Sangomar Island, Petite Côte; known distribution centres at Langue de Barbarie and Delta du Saloum.	Two sightings during March 2003 survey.
<i>Stenella clymene</i> Clymene dolphin	M, S	Calvarium found 113 km north of Nouakchott as only Mauritanian	40 Clymene dolphins with calves sighted

Species / Common Name	Presence*	Standing & sighting historical records	Offshore surveys, Mauritania, 2000-2003
		record; only known from Senegal by one observation and three strandings.	during March 2003 offshore survey.
<i>Stenella coeruleoalba</i> Striped dolphin	M, S	Recorded from a calvarium on the Great Beach; four strandings only along NW coast of Africa. Senegal record from unspecified site, 1882 and photograph from Cap Vert, 1942.	During March 2003 survey, 15 sightings and also ~550 or more of <i>Delphinus delphis</i> , <i>S. coeruleoalba</i> and <i>S. longirostris</i> , swimming together.
<i>Stenella frontalis</i> Atlantic spotted dolphin	M, S	Senegal records from Cap Vert. Observed off Casamance River mouth, September 1995. See comments for <i>S. longirostris</i> .	Sighted during February-July 2002 survey. See also comments for <i>Delphinus delphis</i> .
<i>Stenella longirostris</i> Spinner dolphin	M, S	Very few stranding records in region for <i>Stenella</i> species-five species recorded along NW African coast. Four specimens of <i>S. longirostris</i> caught off Dakar, September 1958.	During March 2003 survey, 15 sightings; ~550 or more <i>Delphinus delphis</i> , <i>S. coeruleoalba</i> and <i>S. longirostris</i> , swimming together.
<i>Steno bredanensis</i> Rough-toothed dolphin	M, S	Four observations in Baie du Lévrier and a stranding at Cap Timiris. Senegal records: mass strandings of mostly males at Cap Vert, 1948.	No confirmed sightings.
<i>Tursiops truncatus</i> Bottlenose dolphin	M, S	Most common species in coastal Mauritania; 94 strandings and 67 sightings; common in PNBA; rare in Baie du Lévrier . Reported as most common species in Senegal (1949); recorded Petite Côte; inhabits Delta du Saloum (July-September); occurs Camance River.	Observed offshore during 2000 and 2002 surveys.
<i>Ziphius cavirostris</i> Cuvier's beaked whale	M, S	First record for Mauritania-calvarium found on beach north of Nouakchott, 1990. Few records for Senegal-calvarium of a male. Senegal is now a recognised range state for species.	Four sightings during January 2000 survey.

\*M: Mauritania; S: Senegal

#### Reference sources

Standing & sighting historical records from Robineau and Vely, 1998 and Van Waerebeek *et al.*, 2000

Offshore surveys data from Camphuysen, 2003, Burton and Camphuysen, 2003, Burton, 2003 and Western Geophysical, 2000.

### **Seabirds**

Information pertaining to the distribution of seabirds and their general migration patterns is relatively sparse in western Africa, albeit for a collection of observations from passing freighters and research vessels. The only area for which there is some information is the offshore waters adjacent to the Banc d'Arguin.

Seabird distribution was investigated over the shelf waters west of the Banc d'Arguin in 1988, at the end of the up-welling season (Leopold, 1993). The survey revealed that the Mauritanian shelf slope area supports several categories of seabirds, including local breeders and migratory birds moving to breeding colonies at higher latitudes (e.g. skua, black tern and Sabine's gull). The area also supports immature (sub-adult) northern hemisphere species (e.g. gannet, several gull and tern species, British storm-petrel and some skua and shearwater species) and breeding birds of the Antarctic, which use the area to moult and to spend the southern winter—e.g. Wilson's storm-petrel.

The survey encompassed oceanic waters from the 20 to 500 m depth contour, between Cap Blanc and Cap Timiris. The most numerous seabird group observed in this area were storm-petrels (Oceanitidae), with an average density of 14.5/km<sup>2</sup>. The most numerous species was Wilson's storm-petrel (*Oceanites oceanicus*). Storm-petrels were most abundant over water patches rich in zooplankton. Four species of shearwater, the northern gannet, several species of skua, several gull species, including Sabine's and Audouin's gull and the lesser black-backed gull, and seven species of tern, including the locally-breeding royal tern (*Sterna maxima*) were also recorded. It was not possible to relate patterns of seabird density with other environmental features during the survey due to the trawlers operating in the waters, whose wastes provided a highly attractive food source around which the birds would congregate.

In addition, four species of shearwaters are found in this region, the Cory's shearwater (*Calonectris diomedea*) being the most numerous. The main seabird breeding areas of the wider region are in Mauritania, Senegal and Gambia. The oceanic islands, including the Cape Verde archipelago, also have important seabird nesting sites, although in many places these are declining (Wells and Bleakley, 1995; and references cited therein).

### **Demersal Fauna**

There is a range of demersal fish, crustacean and cephalopod species found off the coast of Mauritania. Table B-3 identifies the geographical distribution of the key demersal species and their habitat type. Figure B-7 provides information on the species likely to be found within these habitat groups. The following discussion concentrates on the geographical distribution of the main species.

Croakers and ray-finned fish are predominantly found throughout the Banc d'Arguin, between 19° and 21° N and off the coast from Nouakchott (Figure B-7). These species favour a sandy habitat and the inshore waters in the Banc area reflect this preference. Octopus (*Octopus vulgaris*), which are an important commercial species, are distributed along the entire coast of Mauritania, but are particularly abundant south of Cap Blanc and off the coast from Nouakchott. This is also where their nursery grounds are located (CNROP, 1991). Species including grouper are only found over rocky ground, on inshore waters between Cap Timiris in the north and Nouakchott in the south (Figure B-7). They are also found further south, down as far as the Senegal River delta.

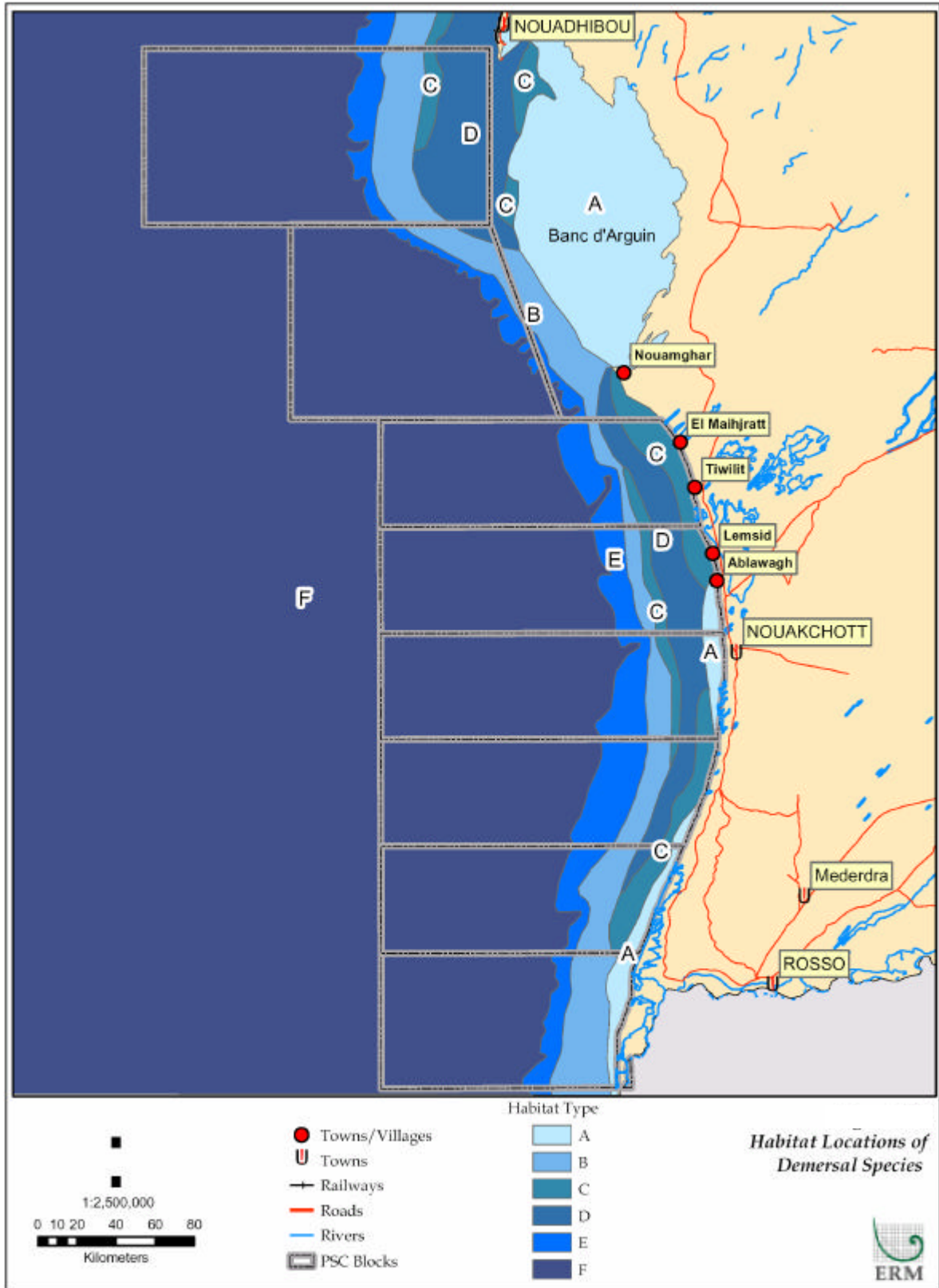
Further offshore, in deeper waters on the continental slope, species including hake (*Merluccius* spp.) and gulper shark (*Centrophorus* spp.), and crustaceans such as the southern spiny lobster (*Palinurus mauritanicus*) and shrimp (*Plesioenaeus* spp.), occur.

**Table B-3: Key Demersal Species Associated with Habitat Type**

Habitat (see Fig. B-7)	Community	Scientific name	Non-scientific name	
<b>A</b>	Banc Sand Community	<i>Pseudotolithus senegalensis</i>	Croaker	
		<i>Pseudotolithus typus</i>	Flathead captain fish	
		<i>Argyrosomus regius</i>	Shape fish	
		<i>Cynoglossus canariensis</i>	Canary tongue sole	
<b>B</b>	Shelf Sand Community	<i>Zeus faber mauritanicus</i>	John Dory	
<b>C</b>	Rocky Seabed Community	<i>Epinephelus guaza</i>	Dusky grouper	
		<i>Epinephelus alexandrinus</i>	Golden grouper	
		<i>Mycteroperca rubra</i>	Comb grouper	
		<i>Plectorhynchus mediterraneus</i>	Rubberlip grunt	
		<i>Lithognathus mormyrus</i>	Striped sea bream	
		<i>Dentex canariensis</i>	Canary dentex	
		<i>Parapristipoma octolineatum</i>	African striped grunt	
		<i>Pomadasyus incisus</i>	Bastard grunt	
		Mixed Substrate Community	<i>Pagellus bellottii</i>	Red pandora
			<i>Mustelus sp.</i>	Smooth hound
	<b>D</b>	White Hard Ground Community	<i>Epinephelus aenus</i>	White grouper
<i>Diplodus bellottii</i>			Sea bream	
<i>Pagrus caeruleostictus</i>			Blue-spotted sea bream	
<i>Solea spp.</i>			Sole	
<i>Synaptura spp.</i>			Sole	
<i>Octopus vulgaris</i>			Octopus	
<i>Sepia spp.</i>			Cuttlefish	
<b>E</b>	Shelf Community	<i>Brotula barbata</i>	Bearded brotula	
		<i>Dentex angolensis</i>	Angola dentex	
		<i>Dentex macrophthalmus</i>	Large eye dentex	
		<i>Heliclenus dactylopterus</i>	Bluemouth	
		<i>Umbrina canariensis</i>	Canary drum	
		<i>Scorpaena spp.</i>	Red rock cod	
<b>F</b>	Slope Community	<i>Merluccius spp.</i>	Hake	
		<i>Centrophorus spp.</i>	Gulper shark	
		<i>Geryon spp.</i>	Crab	
		<i>Palinuris mauritanicus</i>	Southern spiny lobster	
		<i>Plesioenaeus spp.</i>	Shrimp	
		<i>Aristeus spp.</i>	Red shrimp	
		<i>Parapenaeus spp.</i>	Pink shrimp	

(CNROP, 1991)

Figure B-7: Habitat Locations of Demersal Species



Crustaceans are also present in the coastal waters. For example, lobsters are distributed along the northern coastline between Nouakchott and Cap Blanc. The southern spiny lobster (*Palinurus mauritanicus*) tends only to be found on the continental slope between 200-500 m water depth (CNROP, 1991).

### **Pelagic Fish Species**

There are a large number of pelagic fish species recorded off the Mauritanian coast. Below is a summary of the migration seasons and routes of the main commercial species found within these waters.

#### ***Sardinella aurita* (Round sardinella)**

Round sardinella or Spanish sardine is found along the west African coast between Cape Spatel and southern Angola. This species is known to prefer non-turbid, rather cool waters. It is an active filter feeder, feeding on phytoplankton and zooplankton which is particularly abundant in the upwelling areas off Cap Blanc (Marchal, 1991). The main nursery grounds in Mauritanian waters for this species are within the Banc d'Arguin stretching further south to Nouakchott.

The movement and surface distribution of adult *Sardinella aurita* is related to climatic factors. Their migratory cycle can be summarized as follows:

- October-January—dispersal from Mauritania to Western Sahara;
- January-February—rapid southerly migration;
- March-April—concentration of stocks in the southern part of their habitat (Guinea Bissau and Senegal) prior to spawning; and
- May-September—northerly migration to 24-25° N and spawning (Barry-Gerard, 1993).

#### ***Sardinella maderensis* (Madeiran sardinella)**

The distribution of *Sardinella maderensis* is more or less the same as *S. aurita*, but this species is more coastal and are never found in deep water. Two nurseries have been identified in the Senegalese-Mauritanian region (Barry-Gerard, 1993). The nursery ground off the coast of Mauritania encompasses the Banc d'Arguin waters and beyond, extending northwards into Western Sahara and south to Nouakchott. Adult biology and surface distribution is not well known.

It seems there is only one school, and their connection with the two nursery areas is also poorly understood. Juveniles make small seasonal movements within the inshore areas of these nurseries.

#### ***Trachurus trachurus* (Atlantic horse mackerel)**

Horse mackerel off the Mauritanian coast represent the main stock in its geographical distribution from Senegal to Norway. Individuals of the adult stock migrate from north of Cap Blanc (summer) to north of Dakar in Senegal (winter) before returning to Mauritanian waters in November (Marchal, 1991). During the hot season, the fish are found concentrated at depth in the open sea on the continental shelf, whereas in the cold season, they are found along the coast. Strong parallel migration along the coast is also common. The main nursery grounds stretch parallel to the coast extending from Nouakchott, north into Western Sahara.

#### ***Trachurus trecae* (Cunene horse mackerel)**

The general biological features of this species are very similar to that of *T. trachurus*. Migrations of *T. trecae* are predominantly undertaken by adults and are linked with the massing of cold waters. Migrations are also synchronized with those of *T. trachurus*, but its distribution stretches further to the south, and they are found as far as the Casamance (between Senegal and Guinea Bissau) in February-March, and as far as 26° N in September (Barry-Gerard, 1993). Juveniles tend to stay in the vicinity of the nurseries which are located inshore, along the coast of Mauritania from Cap Blanc down as far as Gambia in the south.

#### ***Caranx rhonchus* (Yellow horse mackerel)**

The population of yellow horse mackerel or false scad is found further south than those species previously discussed. The species migrates south in November and December before turning north in March, reaching Mauritanian waters in June. The north-south migration patterns of *Caranx rhonchus* are also linked to hydrological conditions. Longitudinal east-west migrations also take place (Marchal, 1991).

#### ***Mugil cephalus* (Yellow mullet)**

Yellow mullet stay in the Parc National du Banc d'Arguin area during the warm season (May to September). In October and November the adults migrate south in shallow waters (generally less than 30m depth, refer Figure B-8). The bulk of the migration takes place in October to November, with smaller numbers in the following months. The adults stay in shallow waters south of Nouakchott to the mouth of the Senegal River to spawn during December to February. At the end of the cold season (March to April) the adults migrate north back to the PNBA in slightly deeper water than the southward migration (30 to 80 m depth, refer Figure B-8). Some portion of the population may migrate north slightly later in May to June (IMROP, 2004).

#### ***Pomatomus saltatrix* (Bluefish)**

This species spawns off the coast of Nouakchott between June and July. The main adult population can be found slightly further north off the Banc d'Arguin in the highly productive waters. The species migrates in December and occupies waters off Senegal from January to May. It then returns in June and July and breeds.

#### ***Epinephelus aeneus* (White grouper)**

The white grouper is found in large numbers off the coast of Mauritania between 17° and 19° N. Between July and September it breeds in this area before migrating further south to Senegalese waters in February. From here, the species migrates back to Mauritanian waters beginning in May and ending in July.

#### ***Pagrus caeruleostictus* (Blue-spotted sea bream)**

This species has a similar migration pattern to that of the bluefish. However, this species undertakes reproduction in two different areas. The first is off the Banc d'Arguin in June and the second is further south off the Senegal River delta in May and June.

### **Socio-Economic Environment**

Due to coastal up-welling, Mauritanian waters are particularly rich in fish resources. The fishery sector represents over 50% of the export revenues of the country. The sector also contributes significantly to employment with about 26,000 jobs, comprised of 11,000 direct jobs in the artisanal sector, 8,000 indirect jobs linked to artisanal fisheries and 7,000 jobs in the industrial fishery sector. The sector also represents a very important source of foreign currency. It is one of the main sources of income in a country where more than 50% of the population live below the poverty line.

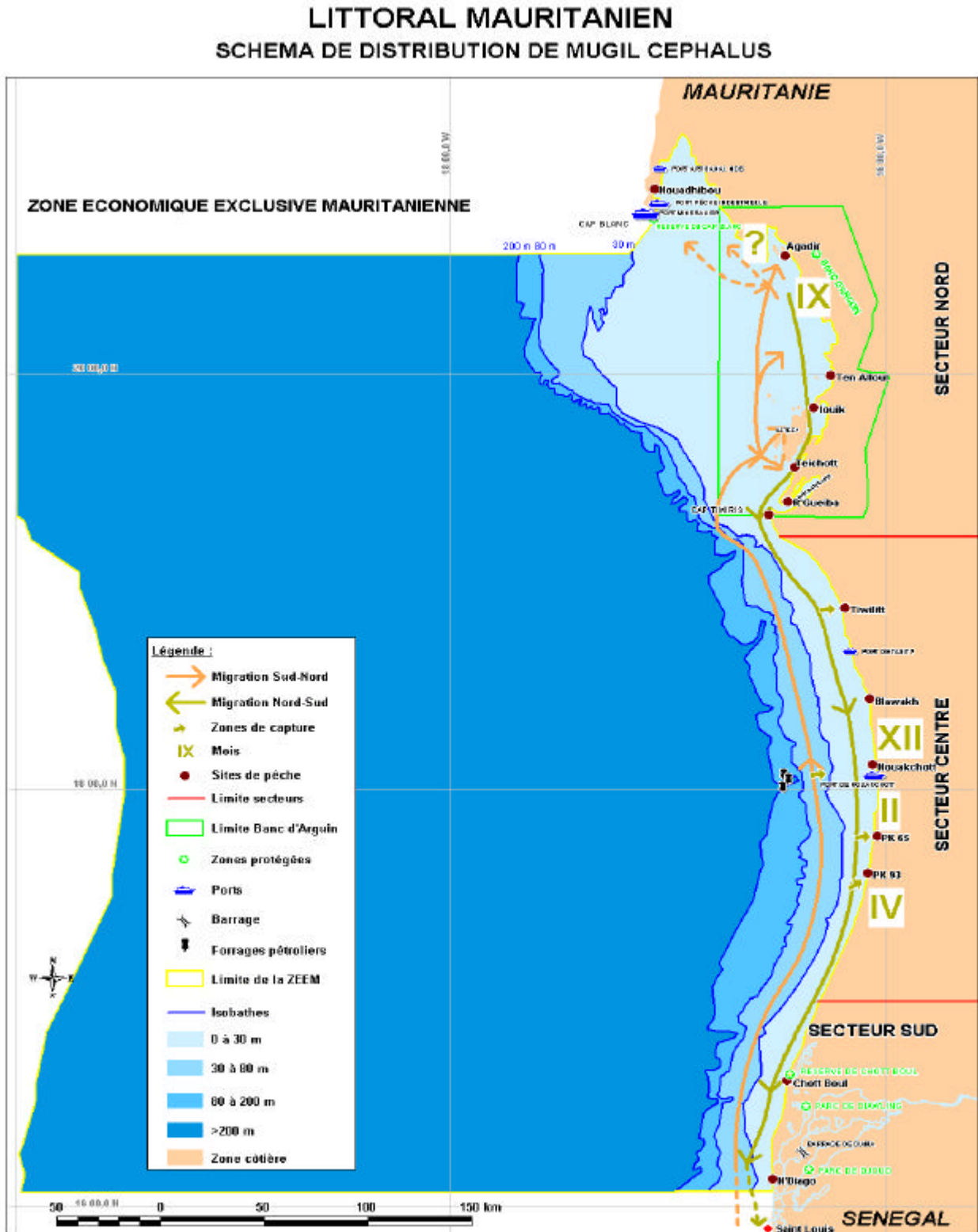
#### **Industrial Fisheries**

Industrial fisheries represent approximately 95% of the total production. In recent years, total catches in the industrial fisheries sector amounted to:

- 60,000 tonnes of demersal fish (including 23,000 tonnes of octopus) and 446,000 tonnes of small pelagic fishes in 1999; and
- 72,000 tonnes of demersal fish (including 28,000 tonnes of octopus) and 569,000 tonnes of small pelagic fishes in 2000.

The total fishing resources potential is estimated to be at least 650,000 tonnes, although IMROP considers these estimates as conservative, with a more realistic potential of 850,000 tonnes.

Figure B-8: Distribution of Yellow Mullet (*Mugil cephalus*)



Source: IMROP (2004)

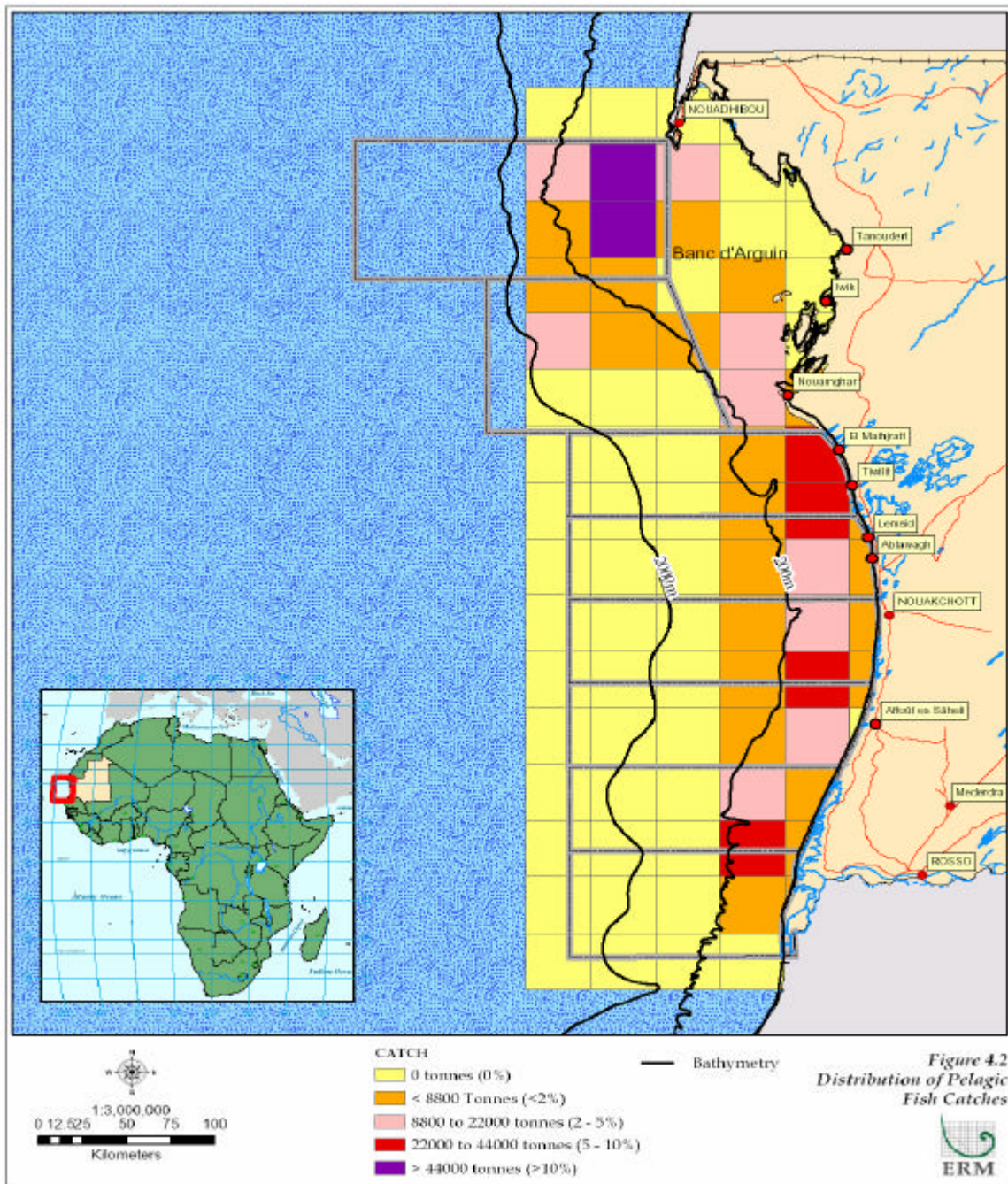


The main trends with regard to fish catches are:

- over-exploitation of the cephalopods;
- moderate exploitation of demersal species, crustaceans and shellfish; and
- significant exploitation potential for pelagic species (tuna, pilchard, sardines, sardinella, mackerels).

Figure B-9 provides an incomplete but indicative picture of the location of the main fishing grounds for pelagic species.

**Figure B-9: Distribution of Pelagic Fish Catch**



The industrial fleet comprises three components:

***The National Fleet***

The national fleet includes about 70 vessels (1997 figures). Its fishing capacity is relatively small due to low equipment levels. The fleet is mainly owned by private companies with, on average, 1 to 5 vessels each. It exploits principally cephalopods and some demersal species.

***The Fleet under Licence***

The licensed fleet includes boats of different nationalities that are operating under agreements signed with Mauritania. These include:

- European fleet with more than 200 vessels which fish mainly pelagic species and cephalopods;
- approximately 15 Japanese vessels which exploit mainly tuna;
- Ukrainian, Russian and certain Eastern European vessels; and
- African vessels under recently signed agreements.

There are no data available to confirm the catches from this fleet.

***The 'Chartered' Fleet***

The foreign fleet operating in the Mauritanian EEZ includes vessel groups from the former Soviet Union (Russia, Ukraine, Lithuania, Latvia and Estonia) and to the European Community (the Netherlands, France, UK, Sweden, Germany) and other non-EU countries (Malta, Cyprus, Poland, Panama, Ghana, Marshall Islands, Saint Vincent and Grenadine). Foreign fleets are often operated by joint venture companies. There are no data available on their catch but it is anticipated to be a minor component of the industry.

**Table B-4: Main Features of Industrial Fisheries in the Mauritanian EEZ**

<b>Fishery</b>	<b>Typical Gear</b>	<b>Vessel statistics</b>	<b>Principal Catch</b>	<b>Exclusions Zones &amp; Other Regulations</b>	<b>Comment</b>
Deep water, large pelagic species eg <i>Thunnus</i> (Tuna)	Seines, rods, long lines; Industrial seines can go to 200m depth, but rarely exceed 120m due to currents.		<i>Thunnus albacares</i> ; <i>T. obesus</i> ; <i>Euthynnus pelamis</i> .	EU-IRM 2001 Fishing Agreement - 30nm from the coast to ensure vessels not present in depths <200m.	Tuna vessels do not operate in the vicinity of the Chinguetti field (source: IMROP).
Pelagic trawlers	Mainly trawling nets; seine nets progressively abandoned; operate at 50-60m; Some large vessels may operate to 1500m.	2000-2001: ~100 licensed vessels mostly from eastern European block flying national flags and flags of convenience; 2001 pelagic fleet ~63 vessels, mainly from Ukraine, CIS, Holland St Vincent and Latvia; The average gross registered tonnage of international pelagic trawlers operating in 2001 was ~5,200, range ~1,900-9,300 (latter a large Dutch trawler); towed gear can be very large, to 2.5 km and with otter boards of several tons.	Western European vessels (UK and The Netherlands) target fish close to surface, mainly <i>Sardina</i> and <i>Sardinella</i> ; Others target mainly <i>Trachurus</i> sp and other species found at depths to 400m and also close to the seabed.	Present zoning (under decree 89-100): to 12nm from low tide mark, 19°21'N-16°04'N; EU-IRM Fishing Agreement limits are similar to Mauritanian 91095 decree Jun 30 1991: to 13nm from low tide mark, 19°21'N-17°50'N and to 12nm from low tide mark, from 17°50'N to southern border; Future exclusion zones: as for EU-IRM above; Limits on seine net and trawl prevent fishing in waters <50m depth; apparently this does not deter some vessels from fishing; On board limits on size of kept secondary catch of 3%.	Excludes estimates for catches by unlicensed vessels operating in the region.
Demersal cephalopod trawl fishery	Two riggings used- Korean trawl nets and Spanish nets, the latter mainly used on EU vessels.	Two fleets of vessels operate- smaller, refrigerated trawlers (coolers) and larger, more powerful refrigerated vessels (freezers); Coolers are exclusively Mauritanian. The freezer vessels are either Mauritanian or from EU countries. Vessels are typically conventional deep-sea stern trawlers with a back gantry, with average gross registered tonnage in 2001 of ~200-400, with a wide range ~11-560; the maximum trawling speed is ~4 knots.	Main target is Octopus on the continental shelf, 10-200m water depth. Fishing is at depths of 30-50m for the national fleet and 30-200m for the foreign fleet (mostly Spanish); Deepest zones are not the most desirable in commercial terms since this is where oldest individuals (of lesser commercial value) are mainly concentrated.	Present zoning: to 6nm from low tide mark, south of 19°21'N; EU-IRM Agreement: to 9nm from low tide mark, 19°15.6'N-17°50'N and to 6 nm from low tide mark, 17°50'N to southern border; Future exclusion zones: as for EU-IRM above; Future regulations also will establish a ban on tickler chains on trawl gear. Biological recovery period operates September-October each year.	Cephalopod catch by local fleet decreased over last few years; 51% of catch by domestic vessels (including artisanal fisheries) and 49% for European vessels in 2000.

Fishery	Typical Gear	Vessel statistics	Principal Catch	Exclusions Zones & Other Regulations	Comment
Demersal shrimp and crab fishery	Shrimp by trawl, net (~1.5 tons) with Floridian (outrigger) rigging which drag two nets; usually four otter boards each of ~300-350 kg used; trawl speed ~2,5-3.5 knots; Fish silty-sandy zones; chain in front of net lifts shrimp from bottom; Crab by fish trap.	Shrimp fleet mainly European vessels (Spain, Portugal, Greece, Italy) with some local vessels; ~60 vessels in fleet (1999-2001); Freezer trawlers average gross registered tonnage of ~170 and with range ~45-400; Same vessels can target coastal or deep-sea species, with appropriate gear; UE-IRM 2001 agreement allows gross registered tonnage of 6000 for shrimp fishing vessels.	Coastal shrimps <i>Penaeus notialis</i> and <i>Kerathurus</i> (langostinos); caught at night on shelf, 15-80m; Deep-sea shrimps <i>Parpenaeus longirostris</i> (gambas) caught during day, 120-400m, with maximum activity at 150-300m all along coast; <i>Aristeus varidens</i> (Alistados) and deep-sea crab, <i>Geryon</i> sp. as a secondary catch, caught during day, 400-800m all along coast; trawl to depths of ~800m occasionally; Alistados and Gambas more plentiful between 20°30N and 17°00N, and close to Senegal River.	Present zoning: to 6nm from low tide mark, south of 19°21'N; EU-IRM Agreement: to 6nm from low tide mark, 19°21'N to southern border; Biological recovery period operates September-October each year; Future exclusion zones: Langostinos : to 9nm from low tide mark, 19°15.6'N-17°50'N and to 6 nm from low tide mark, 17°50'N to southern border; Gambas: to 18nm from low tide mark, 19°15.6'N-17°50'N and to 12nm from low tide mark, 17°50'N to southern border; Future exclusion regulations will become effective at the end of the EU-IRM Agreement 2001, on 31 July 2006.	
Demersal hake fishery	Stern trawlers usually dragging a single net; Otter boards; trawling speed ~3.5 knots.	Fleet mainly Spanish and Mauritanian, with 15-23 vessels (1999-2001 figures); Vessel average gross registered tonnage ~240, with range ~125-500 (2001 figures).	<i>Merluccius</i> species (hake, black hake), living close to seafloor on continental shelf at depths of 100-600m; Fishing occurs mainly at depths 200-500m; also constitutes an important secondary catch for pelagic trawlers (see above); Vessels only operate south of 19°N and 17°N during cold season; hake migrate north from May; Fleet is concentrated north of 20°N from July-September.	Present zoning: to 6nm from low tide mark south of 19°21'N; EU-IRM Agreement: to 18 nm from low tide mark, 19°15.6'N to 17°50'N and to 12nm from low tide mark, 17°50'N to southern border; The 2001 EU-IRM agreement allows a total catch of 8,500 TJB; Future exclusion zones: as for EU-IRM Agreement, above. Biological recovery period operates September-October each year.	
Other demersal with bottom trawling net	Freezer trawlers and also vessels targeting with other gear (long line, fixed net, traps, seines.	Two fleets, mostly Spanish and Greek; seven vessels in 2000; 11 vessels in 2001, of which eight were deep sea licences; Average gross registered tonnage ~185, range ~95-255; deep-sea licences vessel tonnage	Demersal species of the continental shelf (excluding hake).	Present zoning : to 6 nm from low tide mark south of 19°21'N; EU-IRM Agreement: to 18 nm from low tide mark, 19°15.6'N-17°50'N and to 12nm from low tide mark, 17°50'N to southern border; Future exclusion zones: as for EU-IRM	

Fishery	Typical Gear	Vessel statistics	Principal Catch	Exclusions Zones & Other Regulations	Comment
		~270, range ~240-270; Freezer trawlers permitted to maximum gross registered tonnage of 4,000; vessels with other gears to maximum 3,300 allowed.		Agreement, above. Biological recovery period operates September-October each year.	

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### Artisanal Fisheries

The artisanal fishery has significantly developed since the 1970s, as the Government began to promote the small-scale fishing sector. The fleet has increased from 580 vessels in 1986 to 3,500 in 1997, half of it fishing exclusively for cephalopods. It is mainly located at Nouâdhibou and Nouackchott, in the Imraguen villages and settlements inside and bordering the Banc d'Arguin National Park, and in a seasonal camp located south of Cap Timiris.

An artisanal vessel is defined under the Mauritanian Government Decree 89/00 of 26 July 1989, as a vessel which employs a technique other than the trawl, which is not equipped with freezing equipment and has an engine capacity of under 200 horsepower.

Species important for artisanal fishery include:

- Octopus;
- Bluefish (*Pomatomus saltatrix*);
- Mullet (*Mugil* sp.);
- Burro;
- Grunt;
- Dentex;
- Smoothhound;
- Spiny lobster;
- Spanish mackerel;
- Bonito; and
- Little tuna.

provides the main characteristics of artisanal fisheries in Mauritania.

**Table B-5: Characteristics of Artisanal Fisheries in Mauritania**

Fishing Centres	Targeted species	Gear	Depth (m)	Fishing season	Men/ pirogue	Fishing hours per day	Outings per month
Migrant camps: Tarfaya, Tainitt, PK28, PK42, PK65, PK93, PK140	<i>Octopus vulgaris</i>	Pot	10-25	Jun-Jul & Nov-Dec	3-4	24	20
	<i>Pagrus caeruleostictus</i>	Line	10-25	May-July	3-4	12	20
	<i>Epinephelus aeneus</i>	Net	5-10	April-June	3-4	12	20
	<i>Palinurus regius</i>	Net	5-10	April-June	3-4	24	20
	<i>Solea senegalensis</i>	Net	5-10	April-June	3-4	24	20
	<i>Argyrosomus regius</i>	Net	5-10	April-June	3-4	24	20
Nouakchott	<i>Sepia officinalis</i>	Net	5-10	April-June	3-4	24	20
	<i>Octopus vulgaris</i>	Pot	10-25	July-Aug & Nov-Jan	3-4	24	20
	<i>Mugil cephalus</i>	Net	10-25	Oct-Jan	10-12	6	20
	<i>Palinurus regius</i>	Net	5-10	Nov-Dec	3-4	24	20
	<i>Pagrus caeruleostictus</i>	Line	10-25	March-Nov	3-4	12	20
	<i>Sardinella aurita</i>	Net	10-25	Jan-Oct	10-12	6	20
	<i>Solea senegalensis</i>	Net	5-10	Nov-Dec	3-4	24	20
	<i>Argyrosomus regius</i>	Net	5-10	Jan-May	3-4	24	20

Source: Ocean Development (2002)

Traditional fishing is performed mainly by the Imraguen (literally translated as 'the ones that came from the sea') who are the only fishermen legally allowed to fish in the shallow water of the Banc d'Arguin. There are eight Imraguen villages along the coast. Their economy is entirely based on subsistence fishing using traditional methods. In the Banc d'Arguin National Park, they are required to use old lateen-sail vessels only, or fish on foot with nets, mainly catching yellow mullet (see below). Artisanal fishing also occurs in the salt or brackish waters at the mouth of the Senegal River.

In the other Imraguen areas outside the Banc d'Arguin National Park, the main vessels used are pirogues with engine. Catches are landed in Nouâdhibou or Nouakchott. Artisanal fishermen from Senegal, Mali and Ghana also fish in Mauritanian waters, principally near Nouâdhibou and Nouakchott.

About 3,500 people are dependent on fishing from 12 camps located along the coast between Nouakchott and Nouâdhibou. The Imraguen fish for mullet, in two seasons, from February to May and from October to December. The traditional fishing technique involves dolphins, which drive the fish toward the Imraguen nets. Outside the mullet season, the Imraguen fish for other species along the coast.

In recent years, the Imraguen have abandoned subsistence fishing and have turned instead to hunting sharks and rays because of high prices for fins in South-East Asia. They have also started to use motorised vessels, rather than the traditional sailing vessels historically used in the area. It is believed that growing competition from industrial fisheries operating outside the Banc d'Arguin National Park, plus illegal 'pirate' fishing within the park boundaries, has driven the Imraguen to switch from their traditional subsistence fishing of mullet, to fishing shark and ray for the Asian market. This has led not only to a drastic decline in the mullet population, but also a sharp decrease in shark and ray catches.

In 1997, the total catch from artisanal fisheries was estimated at about 10,000 tonnes, half of which was exported. Octopus is also a precious resource for the artisanal fisheries. Between 1985 and 1992, octopus catches by the artisanal fleet increased from 60 tonnes to 8,000 tonnes. Octopus is fished with strings of plastic pots. Artisanal fishermen also catch sharks and rays. Although not targeted for fishing, turtles are often caught in shark nets.

Artisanal fishing is usually performed by young men. It has been reported that their vessels often get run over by large trawlers and several people are killed each month. The large trawlers also destroy the nets.

### ***Fisheries Infrastructure***

The industrial fishery is essentially located in Nouâdhibou, as the city has the relevant infrastructure adapted to this type of fishery.

The main two ports where all of the industrial fishery and part of the artisanal fishery fleets is concentrated are Nouâdhibou and Nouakchott. These have operated since 1919 and 1986 respectively, with Nouâdhibou handling 26% of the landings and Nouakchott handling 56%. Approximately 23% of the catch is landed at sites for artisanal vessels along the coast.

Nouakchott and Nouâdhibou contain 24 and 20 fish processing plants respectively, with capacity ranging from industrial factories to micro-enterprises.

### ***Shipping***

Information on shipping lanes and levels of activity for Mauritanian waters is limited. It is expected that the main shipping lane used by large ocean-going vessels travelling north and south along the West African coast lies to the west of the survey areas for the proposed Kiffa 3D MSS. Only occasional traffic of merchant vessels was encountered during the previous 3D survey acquired between October 1998 and January 1999 (Schlumberger Geco-Prakla, 1999).

### **Shipwrecks**

Similarly, limited information is available on historic shipwreck sites in Mauritanian waters. Undoubtedly the best known historic shipwreck in these waters is that of the French frigate *La Meduse*, which was wrecked on the Banc d'Arguin (at position 19° 52'45" N; 16° 57'44" W) in July 1816.

### **Conservation Areas**

There are two significant protected areas in the marine and coastal environment of Mauritania. These are the Banc d'Arguin National Park, in the north of the country, and the Diawling National Park in the south, adjacent to the border with Senegal.

#### **Banc D'Arguin National Park**

The Banc d'Arguin National Park covers some 1,200,000 hectares, of which some 50% is made up of intertidal and subtidal marine habitats. The Park is situated midway between Nouakchott in the south and Nouâdhibou in the north, and includes more than 180 km of coastline.

The Park was established in 1976 by the Government of Mauritania, with technical and financial support from the Worldwide Fund for Nature (WWF). The wetland area (comprising 1,173,000 hectares) was designated as a Ramsar Wetland of International Importance in 1982, and in 1989 the Park became a World Heritage Site.

#### **Diawling National Park**

Diawling National Park, with an area of approximately 13,000 hectares, is located in the Senegal River delta, adjacent to Djoudj National Park in Senegal. It includes significant estuarine and intertidal areas, saline flats, dunes and some five hectares of mangroves. The Park provides important breeding grounds for fish and crustaceans and habitat for over-wintering migratory birds.

Additional coastal areas of environmental significance within mainland Mauritania include the Aftoût es Sâheli, a 120,000 hectare coastal lagoon that extends from Nouakchott to St. Louis in Senegal. This wetland area is important for fish and waterfowl and has been recommended as a Ramsar site and as a marine protected area (GBRMPA / WB / IUCN, 1995).

### **REFERENCES**

- African Pilot Vol 1, (1992). Admiralty charts and publications, thirteenth edition, 1992.
- Barry-Gerard (1993). l'Evaluation Des Ressources Exploitablees Par La Peche Artisanale Senegalise, Symposium, Dakar, du 8 au 13 Fevrier 1993,ORSTOM.
- Burton, C. (2003). Compilation and analysis of marine mammal sightings from the El Mourabitin 3D Seismic Survey in Mauritanian waters, by Woodside Energy, February to July 2002. Unpublished report to Woodside Energy Ltd, May 2003.
- Burton, C and Camphuysen, C.J. (2003). Seabird and Cetacean Surveys in the Vicinity of the Chinguetti Oil Field, Offshore Mauritania. March 2003. Unpublished report to Woodside Energy Ltd, May 2003.
- Camphuysen, C.J. (2003). Seabirds and marine mammals off West Africa. Responses 2000 cruise report, Netherlands Institute for Sea Research, Texel, The Netherlands, January 2003
- Campredon, P. (2000) Between the Sahara and the Atlantic, Banc d'Arguin National Park, FIBA, la tour du valat, Arles, France.
- Chavance, P., Loktionov Y., & Mahfoud, M. (1991). Importance des saisons de transition hydrologique et impact des anomalies climatiques sur l'active d'une flottille industrielle pelagique en ZEE mauritanienne. CNROP.



- CNROP (1991). L'Environnement, Les Ressources Et Les Pecheries De La ZEE Mauritanienne, Bullentin Du Centre National De recherches Oceanographiques Et Des Peches, Ministere des Peches et de L'Economie Maritime.
- Cury, P. & Roy, P. (1991). Pecheries Ouest Africanines, Variabilite, Instabilite Et Changement, ORSTOM.
- Dedah, S. (1993). Wind, surface water temperature, surface salinity and pollution in the area of the Banc D'Arguin *Hydrobiologia*, **258**: 9-19.
- Duineveld, G.C.A. & de Wilde, P.A.W.J. (1993). The benthic infauna and benthic respiration off the Banc d'Arguin, *Hydrobiologia*, **258**: 107-119.
- Fugro (1999). Current Regime Offshore Mauritania (Marine Environment Desk Study). Prepared by Fugro GEOS for Woodside Energy Ltd, Report No. C50075, September 1999.
- GBRMPA / WB / IUCN (1995). Global Representative System of Marine Protected Areas. Volume II. Wider Caribbean, West Africa and South Atlantic. Great Barrier Reef Marine Park Authority, The World Bank, The World Conservation Union (IUCN), Gland, Switzerland.
- Hammond, P.S. and Lockyer, C. (1988). Distribution of Killer Whales in the eastern North Atlantic. Rit Fisikideildar, *Journal of the Marine Research Institute of Reykjavik*, **11**: 24-41.
- IMROP (2004). Note technique sur la migration du *Mugil cephalus* dans la ZEEM.
- IUCN (1993). Environmental Synopsis, Mauritania. Mauritania Information Package.
- Lange, C.B., Romero, O.E. and Wefer, G. (1997). Offshore influence of coastal upwelling off Mauritania, NW Africa, as recorded by diatoms in sediment traps at 2195m water depth. *Deep Sea Research*, **45**: 985-1013.
- Leopold, M.F. (1993). Seabirds in the shelf edge waters bordering the Banc d'Arguin, Mauritania, in May, *Hydrobiologia*, **258**: 197-210.
- Marchal, E. (1991). Attempts to Characterise the Coastal Pelagic Fish Populations: the case of the West African Coast *Sardinella aurita*, in *West African Fisheries: Variability, Instability and Change*, ORSTROM Editions, 1991, pp 192-200.
- Mittelstaedt, E. (1991). The ocean boundary along the Northwest African coast: circulation and oceanographic properties at the sea surface. *Progress in Oceanography*, **26(4)**: 307-355.
- Nieri, M., Grau, E., Lamarche, B. and Aguilar, A. (1999). Mass mortality of Atlantic spotted dolphins (*Stenella frontalis*) caused by a fishing interaction in Mauritania. *Marine Mammal Science*, **15(3)**: 847-854.
- Ocean Development (2002). Fisheries Assessment Study Mauritania. Final Report by Oceanic Development in association with Promoconsult with the support of IMROP for Woodside Australian Energy, October 2002.
- Peckmann J., Reitner J. and Neuweiler F. (1998). Seepage related or not? Comparative analyses of Phanerozoic deep-water carbonates. TTR7 Postcruise meeting - Conference, Abstracts book, 26-27.
- Perry, S.L., Demaster, D.P. and Silber, G.K. (1999). The Humpback Whale. *Marine Fisheries Review*, **61(1)**: 24-37.
- Robineau, D. & Vely, M. (1998). Cetaceans of the coast of Mauritania (North-west Africa). Specific aspects, spatial and seasonal variations in their distribution: role of oceanographic factors. *Rev. Ecol. (Terre Vie)*, **53**: 123-152.

- Rogers, A. (1999). The biology of *Lophelia pertusa* and other deep-water reef-forming corals and impacts from human activities, *International Review of Hydrobiology*, **84**: 315-406.
- Schlumberger Geco-Prakla (1999). Final field report, marine seismic reflection survey, Mauritania. R/V Akademik Shatskiy, Geco-Prakla Job No. 8948. 23 October 1998 to 14 January 1999, unpublished.
- Sevrin-Reyssac, J. (1993), Hydrology and underwater climate of the Banc D'Arguin, Mauritania - a review. *Hydrobiologia*, **258**: 1-8.
- Smith, T.D., Allen, J., Clapham, P.J., Hammond, P.S., Katona, S., Larsen, F., Lien, J., Mattila, D., Palsbøll, Sigurjónsson, J., Stevick, P.T., and Øien, N. (1999). An ocean-wide mark-recapture study of the North Atlantic humpback whale, *Megaptera novaeangliae*. *Marine Mammal Science*, **15**:1-32.
- Toupet, C. (1977). *Atlas de la Republique Islamique de Mauritanie*, Editions Jeune Afrique.
- Van Waerebeek, K., Ndiaye, E., Djiba, A., Diallo, M., Murphy, P., Jallow, A., Camara, A., Ndiaye, P. and Tous, P. (2000). A Survey of the Conservation Status of Cetaceans in Senegal, The Gambia and Guinea-Bissau. Final Report. WAF CET 1 Project. Convention on the Conservation of Migratory Species, September 2000.
- Wells, S. and Bleakley, C. (eds.) (1995). Marine Region 8. West Africa. In: *Global Representative System of Marine Protected Areas. Volume II. Wider Caribbean, West Africa and South Atlantic*. Great Barrier Reef Marine Park Authority, The World Bank, The World Conservation Union (IUCN), Switzerland.
- Western Geophysical (2000). Final operations report for the Mauritania 3D marine seismic survey offshore Mauritania, R/V Western Legend, Party 142. 10 November 1999 to 24 March 2000, unpublished.
- Wilson, J.B. (1979). The Distribution of the coral *Lophelia pertusa* in the North-east Atlantic. *Journal of the Marine Biological Association of the UK*, **59**: 149-164.
- Woodside (2001). Offshore Exploration Wells, PSC Area B, Mauritania. Environment Plan, Woodside Energy Ltd, unpublished.
- WWF/IUCN (2001). The status of natural resources on the high-seas. WWF/IUCN, Gland, Switzerland.

## **APPENDIX C:**

### **Whale Interaction Procedures**

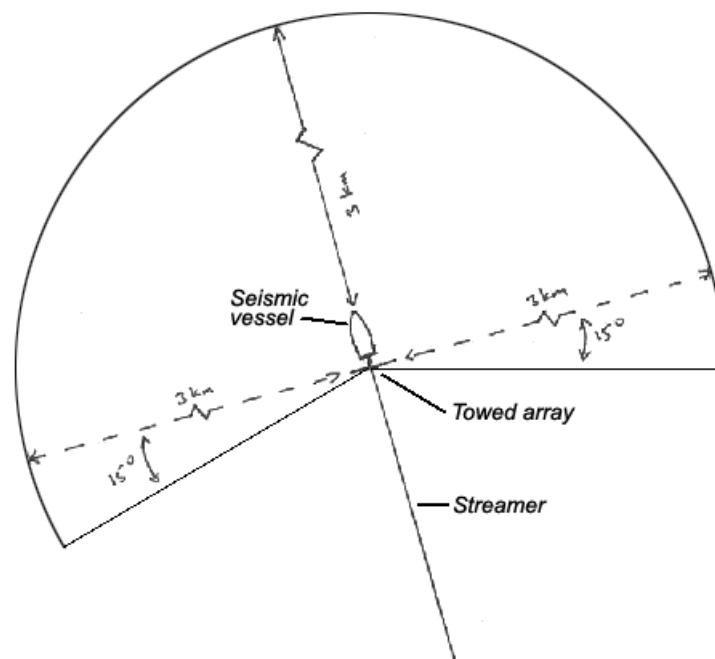
(Adapted from: Environment Australia (2001). *Management Guidelines for Seismic Vessels Operating in Australian Waters so as to Avoid or Minimise Interference with Whales and Certain Other Larger Cetaceans*)

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### PRE START-UP VISUAL OBSERVATION PROCEDURES

- During daylight hours, visual checks (using binoculars from a suitable, high observation platform on the survey vessel) for the presence of whales will be undertaken before the commencement of operations.
- Observations will begin at least 60 minutes prior to use of any high-energy acoustic sources, with particular focus on a 2 km radius around the survey vessel (see diagram below).

For information, indicators of whale activity may be in the form of blows and surface activity resulting in large splashes.



### START-UP DELAY PROCEDURES

- Discharge of the acoustic sources will not commence unless there are no whales within a minimum distance of 2 km from the survey vessel.
- If whales are detected within this zone the start up of acoustic sources will be delayed until they have been observed to move away, allowing adequate time after the last sighting (at least 30 minutes) for the animals to move well out of range.

### SOFT START PROCEDURES

- A sequential build-up of warning pulses (over 10-20 mins) will be carried out at the commencement of all lines. The whole array will not be fired without a full soft start. Soft starts will be used even if no whales have been seen.
- Visual observation will be maintained continuously during soft starts to establish the presence or absence of whales within 2 km of the vessel (during daylight hours).
- If whales are sighted during this soft start procedure within the 2km zone, the seismic source will be shut down. Re-commencement of soft start procedures will take place after 30 minutes has lapsed since the last whale sighting within the 2km zone.
- In the event that the array is completely shut down between the lines of a survey, the full start-up delay and soft start procedures will be undertaken prior to the whole array being fired.

## **VISUAL OBSERVATION PROCEDURES DURING SURVEY LINE**

- Visual observations of 10 minute duration per hour will be carried out during seismic operations in daylight hours.
- All cetacean observations during daylight hours, whether within 2 km or not, should be documented and reported (see below).

## **STOP WORK PROCEDURES**

- Where a seismic vessel with an operating acoustic source approaches within 2 km of an individual whale or pod of whales, the acoustic source will be shut down.
- Where an individual whale or pod of whales approaches within 2 km of a seismic vessel, the acoustic source will be shut down unless the animal or animals are seen to be skirting the edge of the 2km limit.
- Seismic source operations will not recommence until the animal or pod has been seen to move outside of a 2 km range, or has not been seen for 30 minutes.

## **RECORDING AND REPORTING PROCEDURES**

- Any cetacean and turtle sightings will be recorded on the UK JNCC *Marine Mammal Recording Form* (Appendix D). Copies of all report forms are to be submitted to:

Jeremy Colman, Woodside Energy Ltd, Box D188, GPO, Perth,  
Western Australia 6840, Australia  
fax. 61-8-9214 2754; e-mail jeremy.colman@ woodside.com.au

## **DOLPHINS AND PORPOISES**

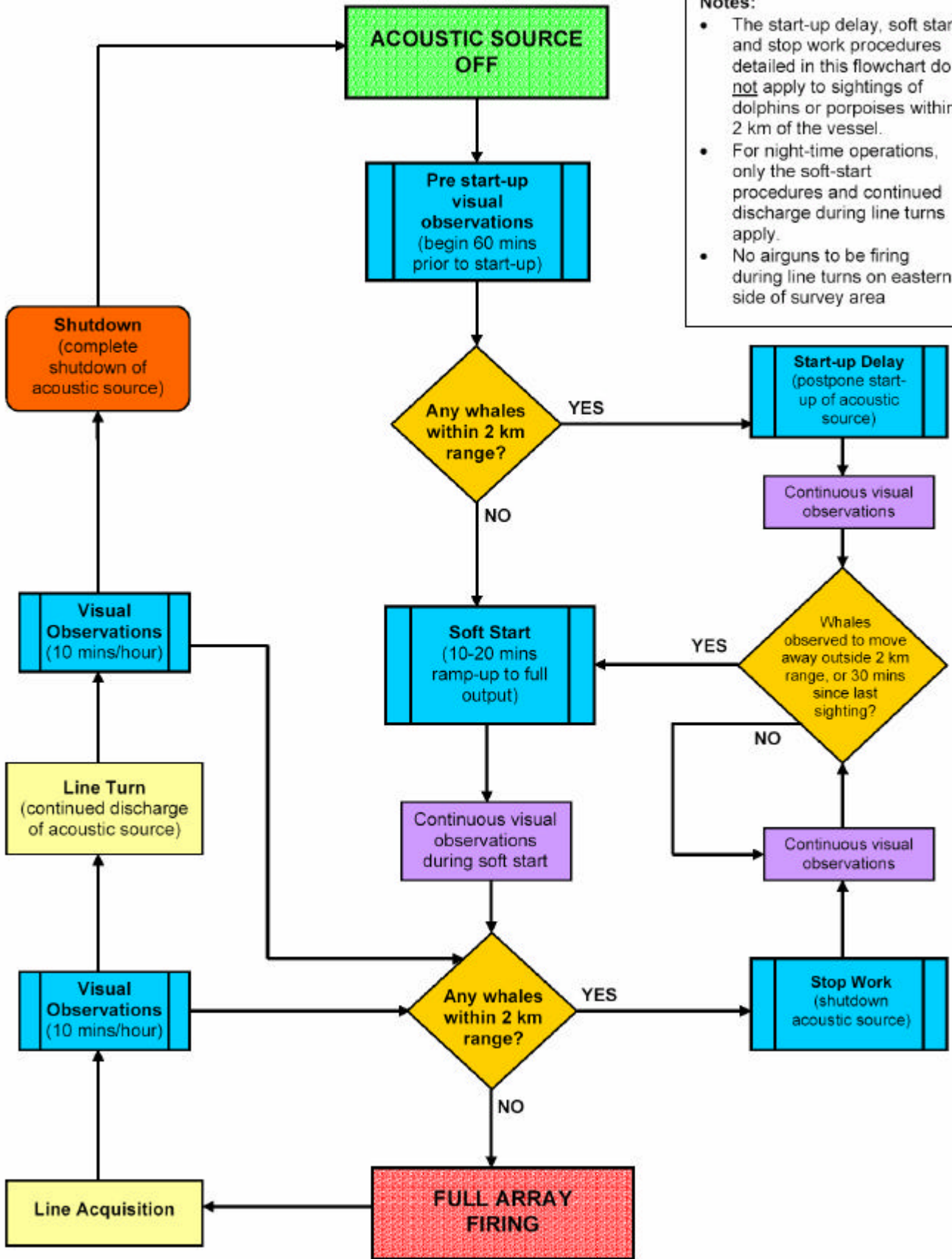
The start-up delay, soft start and stop work procedures detailed above only apply if whales are detected within 2 km of the vessel. **They do not apply to sightings of dolphins and porpoises within 2 km of the vessel.**

## **NIGHT-TIME OPERATIONS**

**For night-time operations, only the soft start procedures apply.**

**Attachment 1: Flowchart of Whale Interaction Procedures for Daylight Hours, Kiffa 3D MSS, M/V Ramform Explorer**

- Notes:**
- The start-up delay, soft start and stop work procedures detailed in this flowchart do not apply to sightings of dolphins or porpoises within 2 km of the vessel.
  - For night-time operations, only the soft-start procedures and continued discharge during line turns apply.
  - No airguns to be firing during line turns on eastern side of survey area



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## **APPENDIX D:**

### **Marine Mammal Recording Forms**

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**MARINE MAMMAL RECORDING FORM - RECORD OF SIGHTING**

*Options in italics should be circled or underlined as appropriate*

<b>Date</b>		<b>Time (GMT)</b>	
<b>How did this sighting occur?</b> <i>(please tick on mark or write)</i> While you were keeping a continuous watch for marine mammals <input type="checkbox"/> Spotted incidentally by you or someone else <input type="checkbox"/> Other (please specify) ..			
<b>Ship Name</b>		<b>Observer Name</b>	
<b>Ship's position</b> (latitude and longitude)		<b>Water depth</b> (metres)	
<b>Species</b>  <i>Large      Medium      Small</i>		<b>Certainty of identification</b>  <i>Definite / probable / possible</i>	
<b>Total number of animals</b>		<b>Number of adults</b> <b>Number of juveniles</b>	
<b>Description</b> (include features such as overall size; shape of head; colour and pattern; size, shape and position of dorsal fin; height, direction and shape of blow) sketch if possible		<b>Photograph or video taken</b>  <i>Yes / No</i> <b>Film No.</b> <b>Frame Nos.</b>	
		<b>Direction of travel of animals in relation to ship</b> (draw arrow)  	
<b>Behaviour</b>		<b>Direction of travel of ship</b> (compass heading)	
<b>Activity of ship</b> (on a line; turning; in transit etc)	<b>Airguns firing</b>  <i>Yes / No</i>	<b>Closest distance of animals from airguns</b> (metres) (Record even if not firing) binocs: by eye:	

Please continue overleaf or on a separate sheet if necessary

Return to:      Jeremy Colman, Woodside Energy Ltd, Box D188, GPO, Perth,  
 Western Australia 6840, Australia  
 fax. 61-8-9348 5539; e-mail [jeremy.colman@woodside.com.au](mailto:jeremy.colman@woodside.com.au)

**MARINE MAMMAL RECORDING FORM - LOCATION AND EFFORT DATA**

Ship ..... Ship type (seismic/guard etc.) ..... Survey type (site, 2D, 3D, 4C etc.) ..... JNCC SS ref. no. ....

Please record the following information every day (as many lines per day as you wish), even if no marine mammals are seen.

Date	Observer	Time you started looking for marine mammals (GMT)	Time you stopped looking for marine mammals (GMT)	Duration of watch for marine mammals (hrs & mins)	Length of time airguns were shooting while you were looking for marine mammals (hrs & mins)	Blocks transited while looking for marine mammals (or start and end position if blocks not known)	Wind force and direction (use Beaufort scale)	Sea state Choose from: G = glassy (like mirror) S = slight (no or few white horses) C = choppy (many white horses) R = rough (large waves, foam crests, spray)	Swell Choose from: O = low (< 2 m) M = medium (2-4 m) L = large (> 4 m)	Visibility Choose from: P = poor (< 1 km) M = moderate (1-5 km) G = good (> 5 km)

**MARINE MAMMAL RECORDING FORM - RECORD OF OPERATIONS**

Ship ..... Client ..... Seismic Contractor ..... JNCC SS ref. no. ....

**Complete this form every time the airguns are used, including overnight, whether for shooting a line or for testing or for any other purpose.**  
 Times should be in GMT.

Date	Airgun activity			Pre-shooting search					Action necessary		
	Time when soft start began	Time when airguns reached full power	Time when airguns stopped	Who carried out a search for marine mammals? (Job title)	Time when pre-shooting search for marine mammals began	Time when search for marine mammals ended	Was there any reason why marine mammals may not have been seen? (e.g. dark, fog, swell, etc.)	Were hydro-phones used?	Were marine mammals present in the 30 minutes before the airguns began firing?	If yes, give time when marine mammals were last seen	If marine mammals were present, what action was taken? (e.g. delay shooting)

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