Premier Oil Exploration & Production Limited

Falkland Islands Business Unit

2015 Falkland Islands Exploration Campaign Environmental Impact Statement

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Abbreviations

Abbreviation	Definition	Abbreviation	Definition
ACAP	Agreement for the Conservation of Albatrosses and Petrels	IUCN	International Union for Conservation of Nature
ACC	Antarctic Circumpolar Current	JNCC	Joint Nature Conservation Committee
AIS	Automatic Identification System	KCl	Potassium Chloride
AIW	Antarctic Intermediate Water	km	Kilometre
Al	Aluminium	LC	Least Concern
AVS	Area Vulnerability Score	LTOBM	Low Toxicity Oil Based Mud
BAS	British Antarctic Survey	m	metre
bbls	Barrel of Oil	MPA	Marine Protected Area
BOD	Basis of Design	MPC	Mount Pleasant Complex
BOP	Blow Out Preventer	NEF	North Eastern Front
cm	Centimetre	NFB	North Falkland Basin
CMS	Conservation of Migratory Species	Ni	Nickel
CTD	Conductivity, Temperature, Depth	NNR	National Nature Reserve
Cu	Copper	NPD	Naphthalene, Phenanthrene and Dibenzothiophene
DMR	Department of Mineral Resources	NPOA-S	National Plan of Action - Seabirds
DP	Dynamic Positioning	NPOA-Tr	National Plan of Action - Trawling
DS	Deepwater Slope	NS	Northern Slope
DST	Drill Stem Test	NT	Near Threatened
EEZ	Exclusive Economic Zone	NWOS	North-western Outer Shelf
EIA	Environmental Impact Assessment	ODS	Ozone Depleting Substances
EIS	Environmental Impact Statement	OVI	Oil Vulnerability Index
EMP	Environmental Management Plan	PAH	Polycyclic Aromatic Hydrocarbons
EN	Endangered	Pb	Lead
EPB	East Plateau Basin	pH	Measure of Acidity
EPD	Environmental Planning Department	PHCB	Patagonia High Chlorophyll Band
ERA	Environmental Risk Assessment	PL	Production Licence number
ERRV	Emergency Response and Rescue Vessel	PLONOR	Pose Little Or NO Risk
ESIA	Environmental and Social Impact Assessment	PON	Petroleum Offshore Notification
FCO	Foreign Commonwealth Office	ppg	Pounds per gallon
FIBU	Falkland Islands Business Unit	ppge	Pounds per gallon equivalent
FICZ	Falklands Interim Conservation Zone	ppt	Parts per thousand
FIG	Falkland Islands Government	ROV	Remotely Operated Vehicle
FIGFD	Falkland Islands Government Fisheries Department	SAERI	South Atlantic Environmental Research Institute
FMCF	Falkland/Malvinas Current Front	SAST	Seabirds at Sea Team
FOCZ	Falklands Outer Conservation Zone	SASW	Sub-Antarctic surface waters
FOSA	Falklands Offshore Sharing Agreement	SD	Standard Deviation
FPV	Fisheries Patrol Vessel	SEOS	South-eastern Outer Shelf
FWL	Free Water Level	SF	Southern Front
GDP	Gross Domestic Product	SFB	South Falkland Basin
GOC	Gas-Oil Contact	SLMC	Sea Lion Main Complex
H_2S	Hydrogen Sulphide	SMSG	Shallow Marine Surveys Group
HOCNS	Harmonised Offshore Chemical Notification Scheme	SS	Southern Slope
HSES	Health, Safety, Environment and Security	TD	Total Depth
IBA	Important Bird Area	TDF	Temporary Dock Facility
IMO	International Maritime Organisation	TDS	Tourism Development Strategy
IPA	Important Plant Area	TOC	Total Organic Carbon
IS	Inner Shelf	VSP	Vertical Seismic Profile

Abbreviation	Definition	Abbreviation	Definition
TOM	Total Organic Matter	VU	Vulnerable
TVDSS	True Vertical Depth Sub-Sea	WBM	Water Based Mud
TZ	Transition Zone	WIF	Western Inshore Front
UKOOA	UK Offshore Operators Association	WOF	Western Offshore Front
μm	Micrometre	Zn	Zinc
VMS	Vessel Monitoring System		

Glossary

Abbreviation	Definition
bbls	One barrel of oil, equal to 159 litres of oil.
Benthic fauna	Organisms that live on, associated with, or in the seabed sediments.
Bentho-pelagic	Species that feed both within the water column and near the seabed
Biogenic	Produced by a living organism.
Block	Division of the FICZ/FOCZ into units. Block is a sub-division of a Quadrant. There are 30 Blocks within one Quadrant. Block 14/05 is the 5th Block in Quadrant 14.
Brood-guard	During brooding period whilst adults are feeding young chicks, and one parent stays with chick on the nest during the daytime.
Depo-centre	An area or site of thickest deposition in a sedimentary basin.
Ecotone	Transitional area between two habitats and communities.
Endemic	Native to or confirmed to a particular region
Environmental Impact Assessment	Process to identify and assess the impacts associated with a particular activity or plan.
GIIP	Gas initially in place, the volume of gas in a reservoir before production
Graben	Depressed block of land bordered by parallel faults
MMbbls	One million barrels of oil
P50 Reserves	Probable reserves for recovery
Petrogenic	Unburned petroleum products
Photic Zone	The upper water column, which received enough light for photosynthesis to occur.
Physico-chemical	Parameters such as temperature, nutrients or chemicals.
Post-guard	During brooding period whilst adults feeding older chicks. Adult does not remain on nest during the daytime.
Pyrogenic	Produced under conditions involving intense heat
STOIIP	Stock-tank oil initially in place, the volume of oil in a reservoir prior to production.
Syncline	Downward fold of stratified rock in which the strata slope towards a vertical axis
Trophic	Relates to feeding.

1.0 Non-technical Summary

1.1 Introduction

This Environmental Impact Statement (EIS) presents the findings of the Environmental Impact Assessment (EIA) conducted by Premier Oil Exploration and Production Limited (Premier Oil) for the 2015 exploration drilling campaign in the North Falkland Basin (NFB).

1.2 Project description

Premier Oil is planning to drill four exploration wells within Licence Blocks PL032, PL004a, b & c, see Figure 1. The purpose of the drilling campaign is to evaluate exploration targets in the NFB that were identified during seismic processing. The four well locations named Zebedee, Isobel Deep, Jayne East and Chatham will be drilled during a 2015 Exploration Drilling Campaign (currently anticipated to be between March and November).

The exploration wells will be drilled from the *Eirik Raude* drilling rig, which will be transported from West Africa to Falkland Islands waters to conduct a joint 240 day drilling campaign shared by Premier Oil and Noble Energy.

The *Eirik Raude* is a semi-submersible rig, which will be supported by two rig supply vessels operating from a shore base in Stanley. The recently constructed Temporary Dock Facility (TDF) will be used for all cargo transfers but refuelling will be undertaken at Falklands Interim Port and Storage System (FIPASS). A 500 m exclusion zone will be established around the rig whilst on location at each well site, which will be continually monitored by a Emergency Response and Rescue Vessel (ERRV).

Each well will be drilled in three sections to a specified total depth using water based muds, with drill cuttings and muds from the top two well sections being discharged to the seabed and the third section discharged at the sea surface. If any hydrocarbons are encountered they may be tested, therefore it is possible that flaring may occur. A Vertical Seismic Profile (VSP) of each well will validate the geology at each site. On completion, each well will be plugged and abandoned.

1.3 Environmental Management

Premier Oil will conduct the exploration drilling campaign in a manner that is consistent with their Corporate Health Safety and Environment Policy. The policy acknowledges Premiers Oil's HSE responsibilities in relation to its business activities and includes commitments to continual improvement of performance, to assess and manage risks, meet or surpass regulatory requirements, plan and prepare for any emergencies, provide appropriate resources and to encourage open and honest communication.

Premier Oil's Falkland Islands Business Unit implements the corporate HSE policy through a specific business unit Health, Safety, Environment and Security (HSES) Management System (MS). The business unit management system interfaces with the Premier Oil's corporate management system, and with relevant contractor management systems via development of contractor bridging documents.

The monitoring and mitigation measures identified during this EIA process will be incorporated with any licence conditions issued by FIG post-consent and, in conjunction with the drilling rig contractor and other key contractors, into a project specific Environmental Management Plan (EMP).

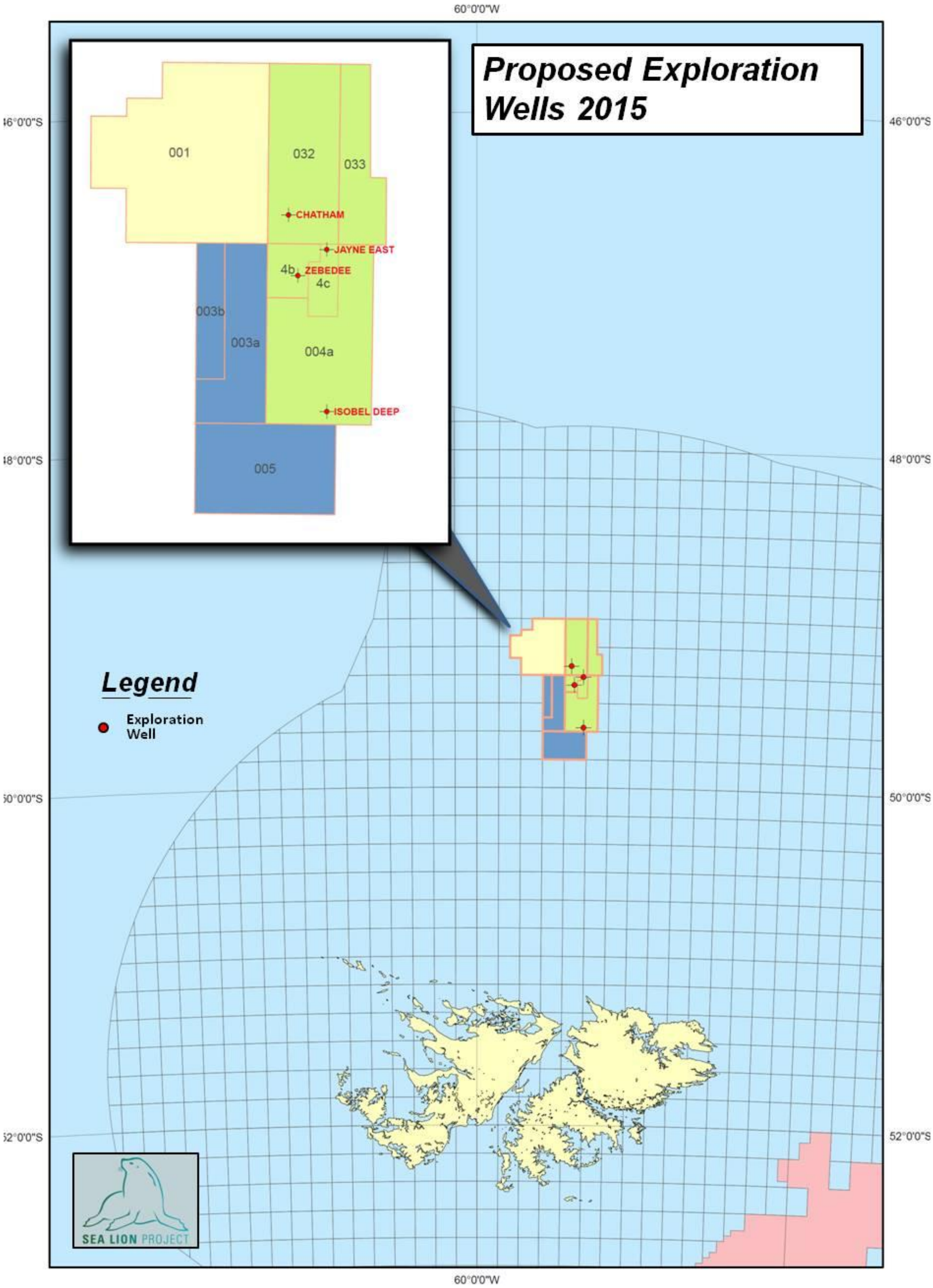

Figure 1: Licence Block Location and Four Exploration Well Locations

1.4 Environmental Baseline Description

1.4.1 Physical Environment

The Drilling Campaign Area is located in the NFB, approximately 220 km north of the Falkland Islands, 770 km northeast of Cape Horn and 480 km from the nearest point on the South American mainland (Figure 2). The well sites are located in waters ranging between 350 and 450 m in depth.

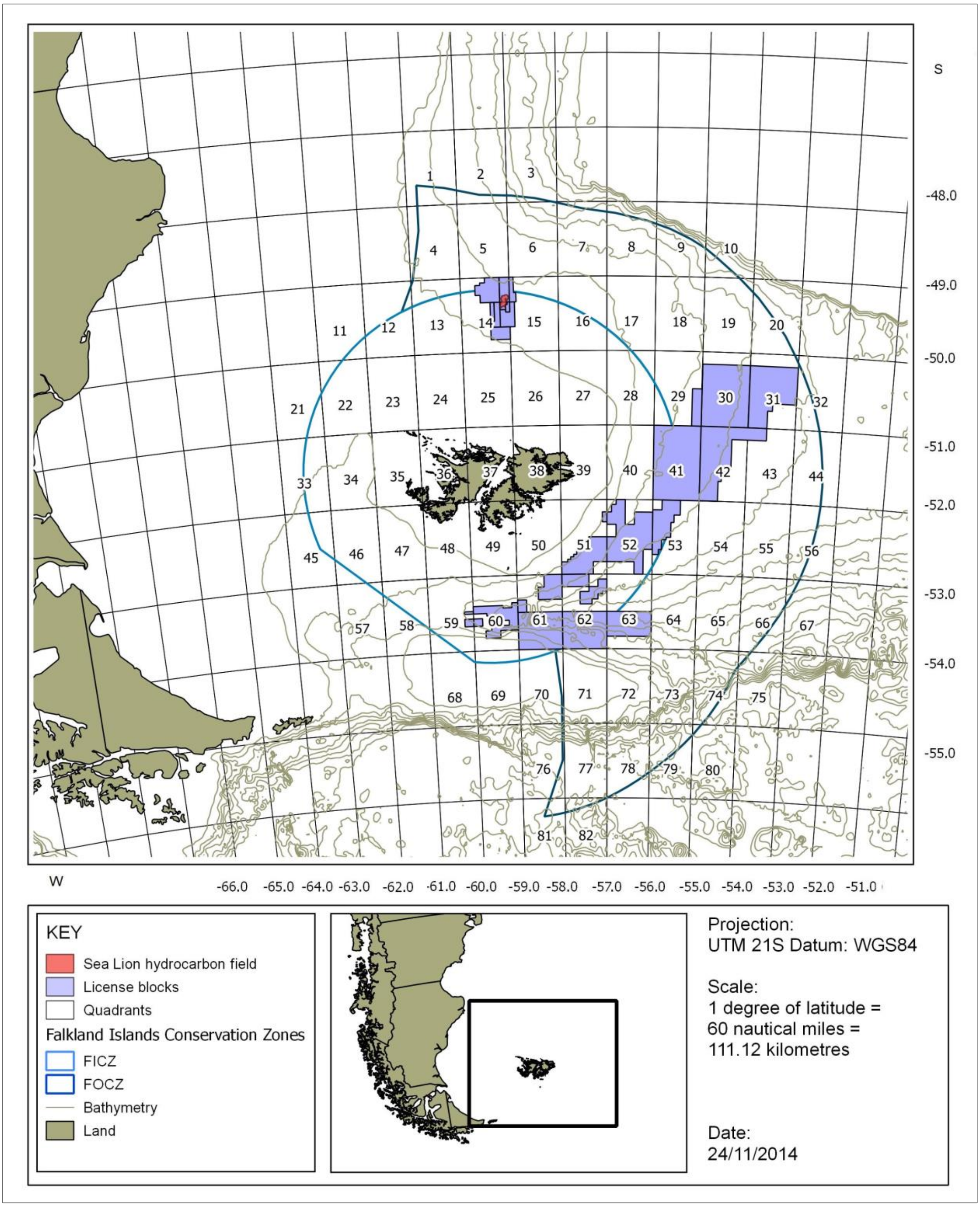

Figure 2: The location of the Licence Blocks in relation to the Falkland Islands, fisheries conservation zones and the South American mainland

Oceanography

The oceanography of the region is dominated by the influence of the Falkland Current, a northward flowing offshoot of the Antarctic Circumpolar Current. The Falkland Current splits into two branches, one passes to the east and the other to the west of the Islands. A number of oceanographic fronts exist on the Falkland Islands continental shelf, primarily in areas to the south and east of the Falkland Islands. Few have been identified on the northern shelf in the vicinity of the Campaign Area.

Previous survey data

In 2012, Premier Oil and their partner, Rockhopper Exploration, conducted an area wide environmental baseline survey of the Sea Lion Field component of the Drilling Campaign Area in the NFB to determine the physical, chemical and biological character of the environment in support of future development of the area. The survey consisted of 54 stations spaced at approximately two km intervals. In addition to the area wide survey, specific well site surveys comprising 6-8 stations each were conducted for five historic well sites drilled in Quadrant 14 of the Sea Lion Field component of the area.

Several other environmental surveys have been conducted in the vicinity of the Drilling Campaign Area and further afield on the Falklands continental shelf, which provide background and contextual data for comparison with the Sea Lion area.

1.4.2 Biological Environment

Plankton

The strong Falkland Current brings nutrient rich waters to the southern Patagonian Shelf, which creates an area of very high zooplankton productivity immediately to the north of the Islands on the shelf break (30 – 40 km South of the Sea Lion Field) and as such supports complex communities of zooplankton, which in turn support complex pelagic and demersal ecosystems.

The waters to the north of the Falkland Islands are characterized by seasonally high diatom abundance and zooplankton that is dominated by the amphipod *Themisto gaudichaudii* and gelatinous salps and comb jellies.

Benthic ecology

Drilling activity has a direct effect on the benthic ecology through physical and chemical disturbance of cuttings discharge. A number of pre- and post-drilling surveys have been undertaken in association with this and previous campaigns. Overall, the general taxonomic assemblage found across all these surveys is very similar, with polychaetes and crustaceans being the two most abundant groups present, followed by molluscs.

The community throughout the survey area, both pre- and post- drilling, is that of a typical silt/mud benthic environment, and also appears to be undisturbed and unpolluted. To date, drilling activities appear to have had no effect on the benthic community within the historic drilling areas.

The southernmost well site (Isobel Deep) is slightly different in character due to the influence of ancient iceberg groundings, from the Pleistocene or older. Some hard corals were present in the soft sediment and isolated octocorals were found in association with glacial erratic rocks on the seabed.

Fish and squid

The productive waters surrounding the Falklands are important feeding grounds for a number of species of fish and squid, some of which are commercially exploited. The area of exploratory drilling lies between the productive finfish trawl fishery on the edge of the Falklands Continental Shelf and the Patagonian toothfish (*Dissostichus eleginoides*) longline fishing grounds in deeper water of the Continental Slope. The largest fishery in Falkland Islands waters targets Argentine shortfin squid (*Illex argentinus*), which are seasonally present within Falklands waters between

February and June. This species seasonally passes near and through the Sea Lion Field, depending on environmental conditions.

Marine mammals

Marine mammals comprise cetaceans (whales and dolphins) and pinnipeds (seals and sea lions). Confirmed sightings and stranding records indicate that 25 species of cetacean occur within Falkland Islands waters. Many of these species are rare and inconspicuous, some are only known from stranded animals. Of the 25 species listed as occurring in the southwest Atlantic, two species are listed as Endangered on the IUCN Red List, fin (*Balaenoptera physalus*) and sei whales (*B. borealis*), and one species, the sperm whale (*Physeter macrocephalus*), is listed as Vulnerable.

Three species of pinniped breed on the Islands and a number of other species have been recorded as visitors or vagrants.

A number of visual and acoustic surveys have been conducted in Falkland waters in recent years, which provide a brief glimpse into the lives of these animals. However, like elsewhere in the world, the distribution of marine mammals within Falklands' waters is poorly understood.

Seabirds

Internationally important populations of seabirds breed on the Falkland Islands and feed in the productive waters that surround the Islands. Over 70% of the global population of black-browed albatross (*Thalassarche melanophris*) breed on the Islands with a significant proportion of the global populations of gentoo (*Pygoscelis papua*) and rockhopper penguins (*Eudyptes chrysocome*) also breeding on the Islands, 33 and 36% respectively. Of the species of seabird recorded in the Campaign Area the Atlantic petrel (*Pterodroma incerta*), grey-headed albatross (*Thalassarche chrysostoma*) and northern royal albatross (*Diomedea sanfordi*) are listed as Endangered on the IUCN Red List, and the white-chinned petrel (*Procellaria aequinoctialis)*, southern royal albatross (*Diomedea epomophora)* and the wandering albatross (*D. exulans)* are listed as Vulnerable.

Numerous studies have been conducted over the past 20 years, which give an indication of the seasonal distribution patterns of seabirds around the Falklands. However, much is still to be learnt and studies into seabird ecology are ongoing.

Protected areas

The Falklands Conservations Zones are managed sustainably, which provides a level of protection to seabirds, marine mammals and other marine species. This is achieved through measures such as; closed areas, catch limits and seabird bycatch mitigation measures. However, there are no designated marine protected areas in Falkland Islands waters. Several candidate marine Important Bird Areas (IBA) have been proposed but not accepted at present. On land, a number of IBAs have been designated on account of the breeding seabird populations that they support. Additionally, a network of National Nature Reserves (NNR) and Important Plant Areas protect many of the most important seabird breeding sites and areas supporting native flora.

Socio-economic environment

The Falkland Islands is one of 14 British Overseas Territories. Supreme authority is vested in HM The Queen and exercised by the Falkland Islands Governor on her behalf, with advice and assistance of the Executive Council and Legislative Assembly.

The Falkland Islands were first inhabited in 1764, and the current permanent population of the Islands stands at 2,931. The majority of the Falkland Islands population (74.7%) live in the capital Stanley, which is the only town on the Islands and is based on East Falkland. Outside Stanley, in what is referred to as Camp, there are a number of smaller settlements. According to the 2012 Falkland Census, the total population of Camp represents about 12% of the total resident population of the Falkland Islands. The remainder are civilians working at the military base at Mount Pleasant Complex (MPC).

Prior to the mid-1980s, the Falkland Islands' economy was almost completely based on agriculture, mainly sheep farming and the export of wool for income. Following the establishment of the Falklands Interim Conservation Zone in 1986 for fishery purposes, and creation of a 200 nautical mile Exclusive Economic Zone (EEZ) in 1990, the bulk economic activity shifted to the sale of fishing licences to foreign fleets operating within Falklands' waters. The income from these licence fees fluctuates, but currently makes between 50-60% of the Government's revenue.

Falkland Islands fisheries

The two most important fisheries within the Falklands EEZ are the jig fishery for Argentine shortfin squid and the trawl fishery for Patagonian long-finned squid (*Doryteuthis gahi*), which accounted for 54% and 15% of the 2013 catch by weight respectively. There is also a fleet of trawlers that operate over the Falklands continental shelf that target a range of finfish species. Currently, the only other fishery in the Falklands EEZ is the longline fishery for Patagonian toothfish, which operates in the deeper waters.

Marine archaeology

The UK Hydrographic Office Wrecksite database indicates that there are 177 wrecks recorded within Falkland Islands waters, with records dating from the 1800's to present day. There are six recorded wrecks within 100 nautical miles of the proposed drilling sites; the closest of these wrecks is located approximately 50 nautical miles from the nearest well site.

1.5 Scoping Consultation Summary

Premier Oil conducted an EIA scoping exercise in July 2014 to raise awareness of the 2015 exploration drilling campaign and to invite comment on the proposed programme and associated activities. Initial consultation meetings were held with the Department of Mineral Resources (DMR), statutory consultees and other interested parties.

This phase of consultation provided stakeholders with an opportunity to enter into a discussion about the proposed project so that any issues and concerns could be identified at an early stage and be considered within the scope of the EIA.

Areas of concern raised during the consultation meetings can be broadly summarised in the following categories:

- Generation of artificial light to attract seabirds resulting in potential collision risk or mortality if in relation to flaring;
- Appropriate assessment required for drilling mud and drill cuttings discharges;
- Supply vessels associated with the campaign could cause over crowding in Stanley Harbour;
- Noise generated from helicopter transits between Stanley and the rig could disturb sensitive seabird colonies underneath the flight path;
- Potential for vessels from outside the Falkland Islands to carry marine invasive species;
- The drilling campaign will increase demand for local accommodation and could lead to shortages in availability for visitors;
- Waste management is required as there is limited capacity for waste disposal in the Falkland Islands;
- Potential opportunities for the charter flight to benefit Falkland Islanders through additional passenger and cargo spaces.

1.6 Impact Assessment Methodology

The EIA process provides a framework for assessing the environmental consequences of a project during the planning stages, such that favourable alternatives may be considered, and mitigation measures may be proposed to adjust impacts to acceptable levels prior to the decision for project sanction.

Premier Oil conducted this environmental impact assessment in accordance with Falkland Islands Government's DMR *Field Developments Environmental Impact Statements Guidance Notes (2012)* and Premier Oil's Health, Safety and Environmental Policy.

The EIA follows a structured methodology outlined in Figure 3 to systematically identify and assess the nature and significance of environmental impacts arising from project activities and risks arising from unplanned or accidental events. Where impacts and risks were assessed to be of a moderate or high significance, mitigation measures have been developed to reduce the severity or likelihood of the impact or risk. Where confidence in the assessment is compromised by data gaps and uncertainties, monitoring measures have been identified, where feasible, to provide an early indication of whether impacts have exceeded acceptable levels.

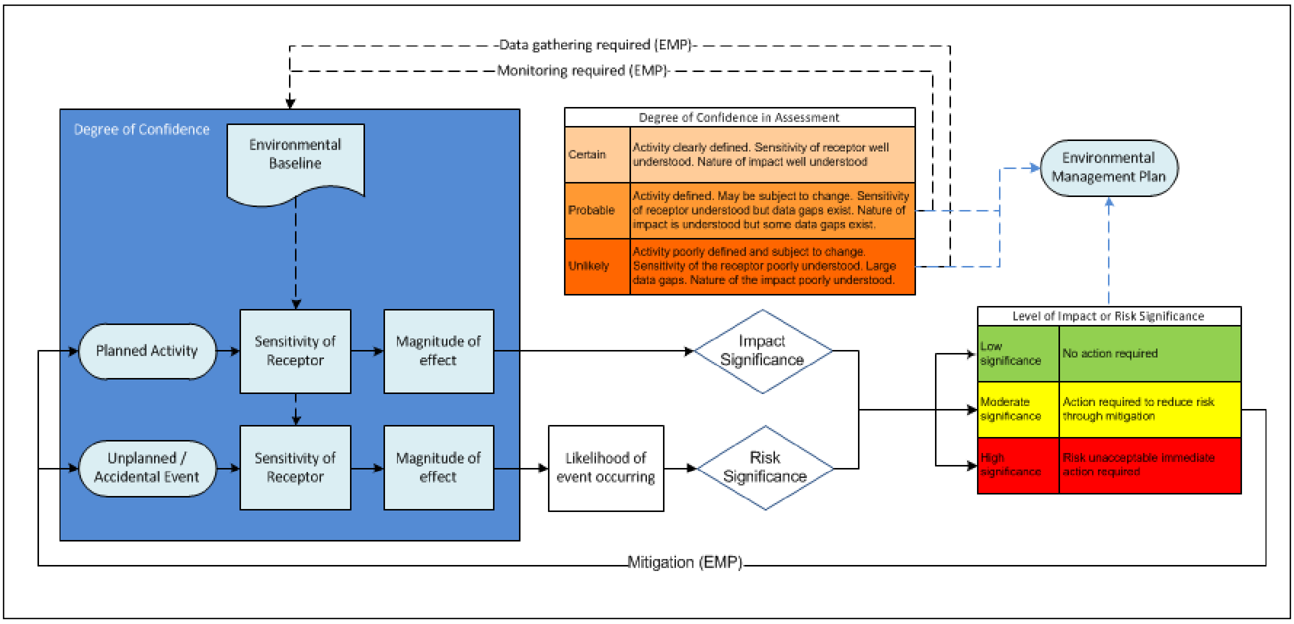

Figure 3: Overview of the Environmental Impact Assessment Process

The project activities that were identified through the environmental impact and risk assessment process as requiring further consideration in the EIA are listed below:

- Generation of underwater noise;
- Generation of atmospheric emissions;
- Generation of light offshore, attracting seabirds and marine life;
- Onshore and inshore impacts;
- Waste management;
- Discharge of drilling mud and cuttings; and
- Accidental events;
    - Significant loss of containment from an uncontrolled release or from rig failure to maintain location on DP;
    - Loss of rig or vessel resulting from collision.

1.7 Underwater Noise Assessment

The properties of sound in water are used by many marine animals to communicate, find food and navigate. Anthropogenic sounds have the potential to interfere with these processes and, in extreme cases, have the potential to cause temporary or permanent hearing loss and physical injury.

Activity during the drilling campaign involving vessels and rig movements will generate underwater sound. The intensity of the sound produced varies between vessels according to engine/thruster size and activity. The loudest continuous sounds will be produced by the Dynamic Positioning (DP) thrusters used to maintain the position of the rig and supply vessels.

Other sources of sound include drilling operations and Vertical Seismic Profiling (VSP). A VSP uses an airgun to create a sound impulse that is used to verify the geology of the well and is the most intense sound source associated with the drilling campaign. A VSP will be conducted on each well and will last for 12-15 hours.

Some species of fish, squid and planktonic organisms are sensitive to intense sound, however, the impact on these species is regarded as insignificant and the assessment focused on the impact on marine mammals, which are generally considered to be of greatest conservation concern in relation to underwater noise.

There is still much to learn regarding the seasonal distribution of marine mammals within Falklands waters and ‘new’ species to the area are still being discovered (for example false killer whale was recorded for the first time in 2013). Visual and acoustic surveys indicate that a number of species of marine mammal; including baleen whales such as the Endangered sei and fin whales, are present in the NFB throughout the year. However, the number of animals present is generally highest during the summer months. The hearing range of baleen whales is believed to be most sensitive to low frequencies (<1 kHz, reflecting their vocal range), which overlaps with the sound generated by vessels and airguns. Therefore, due to their conservation status and hearing range baleen whales were assessed to be the most sensitive environmental receptor to anthropogenic sound. Other species of cetacean are most sensitive to higher frequencies (20-40 kHz). Although there will be some anthropogenic sounds produced in this frequency range the intensity of the sound is lower and therefore the potential impact is also lower. Baleen whales represent the worst-case scenario and are therefore the focus of this assessment.

Sound levels for the various anthropogenic sound sources were obtained from the literature and the sound attenuation was calculated to indicate sound levels at increasing distances from the source. These values were compared with the hearing sensitivity of marine mammals to assess whether impacts; such as disturbance, avoidance or potential trauma; would be experienced by the animal exposed to sound at this level.

Due to a lack of data for baleen whales, the hearing sensitivity used was generic and represented a worst-case scenario (based on the minimum hearing sensitivities of a range of marine species). The only sound source with the potential to cause trauma (temporary or permanent hearing loss) was the VSP airgun. It is assessed that animals within 100 m of the airgun could suffer trauma. All other vessel sources of sound were assessed to elicit a range of responses, from strong avoidance at close range to disturbance at moderate range (within 1,000 m for large vessels).

The conservation status of the receptors makes the sensitivity of the worst-case scenario cetaceans ‘**High**’ and the severity of noise from VSP airguns ‘**Moderate**’, which equates to ‘**Moderate**’ significance. Marine mammals are known to react to approaching vessels, which causes avoidance behaviour and disturbance, therefore the severity of the impact from vessels was assessed as ‘**Minor**’. Overall, the significance of vessel traffic for the most sensitive receptors was assessed as ‘**Moderate**’. With the available data, the level of confidence in the impact predictions (in terms of the nature of the impact and its level of significance) is considered to be ‘**Probable**’ and the data gaps are not considered to have the potential to significantly change the outcome of the assessment.

The major difference between these sources of sound is the duration of the output. Engine noise is constant and will increase, or decrease, gradually, which enables marine mammals to move away from excessively loud sounds. However, VSP airguns are pulsed sounds and therefore a marine mammal could be exposed to a sudden intense sound that has the potential to result in hearing loss.

In an attempt to reduce the potential impact on marine mammals, a dedicated marine mammal observer will be deployed during VSP operations. Observations will be conducted for 60 minutes prior to the start of airgun discharges to ensure the area within a 500 m radius of the rig is clear of marine mammals. Soft-start procedures (a slow increase in sound intensity) will commence once the area is confirmed clear of marine mammals.

1.8 Atmospheric Emissions

Activities associated with the exploration drilling campaign will generate atmospheric emissions as a result of power generation, transportation of crew and cargo and potentially flaring during well testing.

The main sources of emissions are summarised below:

- Drilling rig transit to the Falkland Islands and between well locations, and maintaining position during drilling operations, and transit back to West Africa;
- Drilling operations;
- Supply vessel transporting materials and equipment to and from the field;
- ERRV providing support to the drilling rig in the field throughout the campaign;
- Coaster vessels delivering cargo to and from the UK;
- Potential flaring of hydrocarbons during the well test operations;
- Transportation associated with crew change, including fortnightly charter flights to and from the UK, minibus transfer from MPC to Stanley, helicopter flights between Stanley and the rig; and
- Operation of the onshore supply base.

All of these emissions result from the burning of hydrocarbon fuels. The products of combustion of each fuel type are known and therefore it is possible to calculate the total campaign emissions. The quantities of fuel used in each phase of the drilling campaign were estimated from projected activity and known fuel consumption rates. Conversion factors were used to calculate the quantities of each gas produced.

Atmospheric emissions contribute to several global issues that give rise to global warming, ozone depletion and ocean acidification. The impact on regional air quality is also considered.

Global warming

Gases that cause global warming are referred to as greenhouse gases because they absorb and effectively trap heat within the Earth's atmosphere. The six main greenhouse gases are Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Sulphur Hexafluoride (SF_6), Hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs). To account for the varying efficiency of different greenhouse gases in warming the Earth, the Global Warming Potential (GWP) is also applied to the atmospheric emissions to calculate the CO_2 equivalent.

In order to put the emissions from the drilling campaign into context, the emissions were compared with those of the UK. Although overall emission figures are available for the Falklands, the lack of major industries in the Islands makes the comparison inappropriate. In this context, the total emissions generated from the 2015 drilling campaign would represent 0.03% of total UK emissions. The quantity of greenhouse gases resulting from the campaign is relatively low in comparison to similar exploration and oil and gas activity in the rest of the world; the campaign is of a moderate to short duration (<1 year) and the emissions in isolation would have a barely detectable effect.

Ozone depletion

Another global issue related to atmospheric emissions is ozone depletion. Ozone in the upper atmosphere (stratosphere – 15-25 miles above the Earth's surface) intercepts much of the harmful ultraviolet (UV) light produced by the sun. Ozone depleting substances (ODS) contribute to the breakdown of ozone into oxygen in the upper atmosphere, and consequently allow these harmful rays to pass through the Earth's atmosphere. It is suspected that a variety of biological consequences such as increases in skin cancer, cataracts, damage to plants, and reduction of plankton populations in the oceans' photic zone may result from the increased UV exposure due to ozone depletion.

Common examples of ODS potentially used in oil and gas exploration and production activities include refrigerants, solvents, foam blowing agents and fire fighting fluids, such as the fluorinated gases chlorofluorocarbons, hydrochlorofluorocarbons and Halon. Premier Oil will audit the *Eirik Raude* prior to accepting the rig on hire to ensure that all of the appropriate certificates are in place and that international standards are being met.

No ozone depleting substances will be used except hermetically sealed domestic-type appliances (e.g. refrigerators) with an inventory <3 kg.

Ocean acidification

Along with the impact of CO_2 as a greenhouse gas, it is also responsible for ocean acidification. As CO_2 is absorbed from the atmosphere by direct air-sea exchange it dissolves in the oceans to form carbonic acid (H_2CO_3), which leads to ocean acidification. One well-known effect of ocean acidification is the lowering of calcium carbonate saturation states, which impacts shell-forming marine organisms from plankton to benthic molluscs, echinoderms, and corals (Doney et al, 2009).

The principal combustion product of the proposed 2015 drilling campaign activities is CO_2, which is directly related to the rate of ocean acidification. The amount of CO_2 generated as a result of the proposed drilling campaign is finite and very low in relation to overall UK emissions and would therefore have a negligible effect on the oceans' pH.

Regional air quality

At the local, regional and transboundary levels, gaseous emissions may impact air quality. Key issues include the formation of acid rain from oxides of sulphur (SO_X) and nitrogen (NO_X), direct impacts on human health from particulate matter (formed by chemical reactions involving pre-cursor gases NO_X, SO_X, and volatile organic compounds (VOCs)) (EEA, 2012).

The primary contributors to atmospheric emissions come from rig and vessel movement and operation, and return charter flights to the UK. These activities will either take place in the offshore environment over 200 km from the nearest land, or along the flight path from the UK to the Falkland Islands. Any impacts to the local air quality from offshore operations are considered to be minimal, and would only have a very low level and short-term effect on local air and marine life with no expected effects on the population of the Falkland Islands.

The quantity of emissions generated during the 2015 exploration campaign is expected to have a '**Slight**' effect to the environmental receptors, which in the context of global emissions have a **'low'** sensitivity. Consequently the overall significance has been assessed as '**Low**'. These activities will contribute a very small incremental effect to global atmospheric emissions. The activity has been well defined, the sensitivity of the receptor and nature of the impacts are well understood and hence the impact predictions are considered to be of '**Certain**' degree of confidence.

1.9 Generation of Artificial Light Offshore

Artificial light can affect the natural behaviour of animals leading to attraction and disorientation of animals when exposed to man-made light sources. This behaviour can be exploited to catch squid, as seen in the large fleet of jiggers that operate in Falklands waters. Seabirds have evolved in what is essentially a dark night-time environment. However, they do use naturally occurring sources of light, such as the moon and stars and bioluminescence to navigate and find food. It has long been known that seabirds are attracted to artificial lights at-sea, which can lead to birds colliding with vessels. When large numbers of birds are involved, this is known as a bird strike. Birds can suffer injury or die directly from a collision. If they survive, a bird's feathers frequently come into contact with oil or grease on the deck, which results in a loss of waterproofing and a risk of hypothermia.

Offshore operations associated with the campaign will introduce several sources of artificial light into the offshore waters of the NFB, including supply vessels, the ERRV and the drilling rig. Drilling, and other rig activities, will operate for 24 hours a day and to do this safely, all working areas will have to be well illuminated. Sources of light on the vessels will include navigational lights, illuminated living spaces within the ships and rig, floodlighting to provide a safe working environment on the decks of ships and rig and any gas or oil brought to the surface will be flared (burnt) off.

Recorded bird strike events indicate that the most vulnerable species are small nocturnally active petrels and shearwaters. The abundance of these birds within the NFB varies seasonally, with highest numbers encountered during the summer months. Plankton, fish and squid may also be attracted to artificial light but there is no apparent negative impact on these animals.

Bird strikes occur sporadically and are linked to; light use, seabird abundance and weather conditions on any given night. Although birds can become disorientated at any time, large bird strikes tend to be associated with the use of bright lights in areas containing high densities of birds on nights when visibility is poor (due to fog or snow).

It is not possible to quantify the number of birds at risk from bird strikes, caused by artificial lighting, during the 2015 campaign. However, from experience gained on vessels that operate in Falkland Islands waters and on oil and gas platforms elsewhere, it is considered likely that some birds will collide with vessels at-sea or the rig. Although the species concerned have large population sizes, a collision with a vessel, the rig or flare is likely to result in injury and/or death of the individual. However, it is considered that the impact would be barely detectable on the size of any species' population, as the impact is localised and short-term. The proportion of the local populations that are at risk is considered to be small, as most of the vulnerable species migrate away from Falklands waters in the winter. Overall, the significance of the impact of artificial light on seabirds has been assessed as '**Low**'. The duration of the campaign and light sources have been confirmed, though flaring activities have, as yet, not been confirmed. The nature of the impact on the environmental receptor is understood, however, the scale of the potential impact is difficult to predict due to its episodic nature. As such, the level of confidence in the impact predictions is considered to be '**Probable**'.

Despite the apparently Low impact, some simple measures can be taken to reduce the horizontal spread of light, which will further reduce the risk to seabirds. Heli-deck landing lights will be switched off when not in use (if not required to be left on for safety reasons) to reduce potential impacts of these skyward facing lights on any bird species that may be present. In addition, the ERRV and supply vessel deck lighting will be switched off when not in use (if not required to be left on for safety reasons). Floodlights can be directed downwards and inboard whenever possible and practical, and accommodation should be blacked-out. If flaring occurs, a seabird observer will be deployed to attempt to quantify the scale of the impact.

1.10 Inshore and Onshore Impacts

1.10.1 Introduction

Stanley will be the hub through which all cargo and personnel will pass before onward transport to the drilling rig. Inshore and onshore impacts cover a range of activities associated with the operation of vessels, on the TDF and at the laydown yard. These include:

- Interference to other sea users due to increased vessel traffic in Stanley Harbour;
- Collisions between support or supply vessels and marine mammals;
- Introduction of marine invasive species by support or supply vessels;
- Disturbance to wildlife and the human population onshore from helicopter noise;
- Introduction of terrestrial invasive species with cargo;
- Disturbance to Stanley residents and wildlife from inshore and onshore light and noise sources; and
- Demands for accommodation in Stanley.

Impacts associated with each of these aspects and activities are described below:

1.10.2 Interference to other sea users due to increased vessel traffic in Stanley Harbour

Stanley is a working harbour used by fishing vessels, cruise ships and cargo vessels. Space for vessel manoeuvres in Stanley Harbour and through the passage into Port William (The Narrows) can be tight and there is a history of vessel collisions and groundings within these areas. The 2015 drilling campaign will increase the amount of shipping traffic in the Harbour, which has the potential to interfere with other sea users.

A number of different vessels associated with the 2015 drilling campaign will be using Stanley Harbour. These include;

- Coaster cargo vessels will travel between Aberdeen (Scotland) and Stanley to deliver all the equipment required for the drilling campaign. On average, a coaster will arrive in Stanley Harbour every 10 to 14 days over a period of 5-6 months. On arrival, coasters will moor alongside the TDF to facilitate the transfer of cargo.
- The two rig supply vessels will travel between the drilling rig and Stanley on a five to seven day rotation throughout the drilling campaign. On arrival in Stanley Harbour, these vessels will moor alongside the TDF to facilitate the transfer of cargo.
- The rig ERRV vessel will spend the majority of the time offshore, close to the position of the rig, however, it will return to Stanley occasionally (on a four-six week basis) to refuel and change crew.

Any disruption to third-party vessels has the potential to impact fishing and cargo operations, which could result in a loss of business revenue, due to the additional time and fuel needed to complete their activities. The key area restricting shipping activity in Stanley Harbour is the lack of berth space at the Falklands Interim Port and Storage System (FIPASS). At times, demand outstrips available space and vessels may have to leave FIPASS and anchor to create space for other vessels, or wait for a berth to become available. Due to the necessity to transfer cargo to and from lay-down yards onshore, the oil and gas industry have been heavy users of FIPASS in previous campaigns.

The number of visits to FIPASS by regular users (fishing and cargo vessels etc.) was reasonably consistent between 2008 and 2013, however, supply vessel visits varied considerably, reflecting oil and gas exploration activity. Exploration drilling campaigns were on-going throughout most of 2010, 2011 and into 2012. The necessity to move cargo through FIPASS resulted in a considerable increase in demand for this facility. For instance; during 2011, supply vessels accounted for over 39% of all vessel visits to FIPASS.

Although the construction of the TDF will take much of the pressure from the oil and gas industry away from FIPASS, the TDF has no capacity to refuel vessels. Therefore, there will be a degree of interference while refuelling takes place.

The TDF is situated in an area that is not usually used as an anchorage so the disruption to other users of Stanley Harbour, who wish to anchor, will be minimal. On the basis of the localised and short-term nature of the impact, the severity of disruption to other user of Stanley Harbour is assessed as '**Minor**'. With the TDF in place, there is moderate capacity to absorb the added pressure from the oil and gas industry without significant alterations to present working practices. There will however be some disruption to other users of Stanley Harbour, which may have economic implications. Therefore the sensitivity of the receptors involved has been assessed as '**Moderate**'. The overall significance is assessed as '**Moderate**' and measures are proposed to reduce the impact on other users of Stanley Harbour, including;

- The appointment of a Marine Superintendent who will liaise with the Harbour Master, FIPASS management, Stanley Services and other users, and who will help to keep everyone well informed and promote good working relationships;

- Notes to Mariners will be issued to inform all masters of vessels of the presence of a new shoreline facility;
- A navigational risk assessment will be completed to inform the preparation of a Stanley Harbour Management Plan. This Plan will be prepared in close collaboration with the Harbour Master and cover the following as a minimum: pre-notification protocols associated with the entry of vessels in Stanley Harbour; pre-defined passage routes within Stanley Harbour; procedures associated with vessel collision and emergency response;
- Marine night-time lighting will be required and procedures will be put in place for periods of poor weather.

1.10.3 Collisions between support or supply vessels and marine mammals

Elsewhere in the world, collisions between cetaceans and vessels are having a negative impact on the populations of Endangered species.

As discussed, the 2015 drilling campaign will increase the amount of shipping traffic over inshore waters close to Stanley. At certain times of the year, large numbers of sei whales can be encountered within these waters of the Falkland Islands. As a hub for vessel traffic and sei whale activity there is a risk of collisions between vessels and these animals in inshore waters close to Stanley.

The sei whale is by far the most numerous species of large whale in the coastal waters near Stanley but they are also found throughout the inshore waters of the entire archipelago. Anecdotally, there is evidence that the number of sei whales within Falklands waters, has been increasing over the past 15 years. However, sufficient survey data to determine a population estimate is currently unavailable.

Sei whales appear to respond to approaching vessels and are relatively fast swimmers, and they tend to swim just below the surface leaving a clear trail of ‘fluke prints’ in their wake. There are many records from around the world of collisions between sei whales and vessels, collated by the International Whaling Commission.

The probability of a collision between a cetacean and a vessel is related to the density of shipping traffic and cetacean density in the same area. The outcome of the collision is related to the size and speed of the vessel. The supply vessels used in previous campaigns have been approximately 80 m in length and travel at about 12 knots. The available data suggests that a cetacean would have in the region of a 50% chance of surviving a collision with such a vessel.

As shipping traffic increases and whale populations begin to recover from the impact of commercial whaling, the likelihood of collisions between cetaceans and shipping increases. Currently, this is a very much understudied area and research efforts have been focused on protecting Endangered species.

The conservation status and life history of large cetaceans mean that any collision that could result in mortality would have a moderate short-term impact on the species. For these reasons the severity of collisions between ships and cetaceans has been assessed as ‘**Moderate**’.

Although the drilling campaign will increase shipping by about 25%, the total number of vessel visits to Berkeley Sound and Port William is relatively low (about 1,500 per year). Collisions between cetaceans and shipping are often unreported or unobserved. However, the lack of recorded incidents and relatively low density of shipping suggest that this is not currently a major issue in the waters around the Falklands. The likelihood of a collision has been assessed as ‘**Remote**’.

The overall significance of collisions between vessels and cetaceans has been assessed as ‘**Moderate**’ and measures will be put in place to reduce the risk. Data gaps exist regarding the inter-annual variation in density of marine mammals in the Falklands, and it is clear that not all incidents of collisions between marine mammals and vessels are reported or even evident to the crew of the vessel. For these reasons, confidence in the assessment is ‘**Probable**’.

A number of common sense precautions should be taken to reduce the likeliness of collisions with cetaceans;

- Mariners should be made aware of the issue and how it relates to the Falkland Islands (see IFAW (2013) leaflet); and
- Along with the usual duties of a watch keeper, additional vigilance is required to detect cetaceans in inshore waters.

1.10.4 Introduction of marine invasive species by support or supply vessels

The International Union for the Conservation of Nature (IUCN) has identified the introduction of non-native species as one of the major threats to native biological diversity. Island ecosystems are particularly vulnerable to the introduction of non-native species, as animals and plants may have evolved in the absence of competitors, predators or disease. If non-native species are introduced, and go on to survive, reproduce and thrive, they often have a major impact on native biodiversity but can also have a socio-economic impact. At this stage, the introduced species becomes invasive.

The nature of the impact of an invasive species depends on the species concerned and how it interacts with the local environment and species.

The nature of the marine environment makes it difficult to detect the introduction of non-native species before they have become established. Once established, marine invasive species are virtually impossible to remove. There are many examples from around the world where invasive species are having a dramatic impact. Recent dive surveys in Stanley Harbour have identified several invasive species but their impact appears to be minor at present.

The past history of a vessel and the similarity between the home and destination ports, in terms of water temperature and salinity, influence the likelihood of introducing non-native species. For instance, vessels that are tied up in port will accumulate more biofouling organisms than a vessel that is active offshore. The identity of the vessels involved in the drilling campaign is currently unknown but they are likely to come from either Aberdeen, Scotland or West Africa.

In the marine environment, there are two main routes for non-native species introduction;

- Ballast water – ballast, in the form of seawater, is used to trim a vessel to improve stability. Ballast water will contain planktonic organisms; including larval stages and eggs. When ballast water is discharged, these organisms can be introduced to a ‘new’ environment.
- Biofouling – is the growth of marine organisms on the subsea surface of a vessel. In particular, semi-enclosed areas (such as sea chests) can harbour a diverse assemblage of encrusting organisms.

In recognition of this threat, there are International conventions and International Maritime Organisation (IMO) guidelines to prevent the spread of marine invasive species.

If invasive species were introduced during the drilling campaign the impact on the benthic ecology of the Islands may not be evident for a number of years. However, the long-term implications for the Islands ecology could be severe and irreversible. The severity of the impact will be species specific but following the precautionary principle (worst-case scenario) the severity has been assessed as ‘**Major**’.

There are International conventions regarding ballast water and biofouling management. Although the Falklands are currently not signatories, the vessels used during the drilling campaign will follow the IMO’s best practice guidelines. The IMO’s guidelines on exchanging ballast water and managing biofouling organisms, will greatly reduce the likelihood of introducing non-native species. Introduction of invasive species has happened in the Falklands, and by the industry elsewhere, and therefore the likelihood of invasive species becoming established as a result of the Drilling campaign has been assessed as ‘**Remote**’.

The overall significance of the introduction of invasive species has been assessed as **'Moderate'** and measures will be put in place to reduce the significance, including;

- The rig, *Eirik Raude*, will be carrying some ballast water while on passage to the Falklands, however, they will be following the IMO guidelines on ballast water exchange;
- The *Eirik Raude* has recently been cleaned and surveyed by divers. Prior to departing for the Falklands a second survey will be completed;
- All vessels entering Falklands waters will conduct ballast water exchange in line with IMO guidelines; and
- Checks will be made to ensure that the Biofouling Management Plans of all vessels involved in the campaign are up to date.

1.10.5 Disturbance to wildlife, livestock and the human population onshore from helicopter noise

Helicopters will be used throughout the drilling campaign to transport personnel between Stanley (and Mount Pleasant Airport) and the drilling rig. There is concern that overflying helicopters could cause disturbance to wildlife, the local community and livestock.

Three Sikorsky S92 helicopters will be used throughout the campaign. Flights will occur on a daily basis but multiple flights (five) will occur every two weeks to facilitate crew changes. If the same flight path is used, this has the potential to cause disturbance to wildlife, livestock and the human population of the Falklands.

Penguins appear to be particularly vulnerable to this type of disturbance, particularly when breeding or moulting. Disturbance of breeding birds could result in the loss of eggs or chicks to predators or being crushed by panicked adults. When moulting, penguins are unable to enter the water to feed for about a month, this is energetically extremely demanding and any disturbance would place an additional burden on the animal's reserves. The most vulnerable species are king penguins, which breed year-round at Volunteer Point. Other species of penguin will be moulting in the early weeks of the campaign.

The helicopters will be based at Stanley Airport, which is approximately 3.5 km from the nearest residents of Stanley. There are numerous Camp settlements that are potentially on the flight path between Stanley and the rig.

The positions of all vulnerable seabird colonies, NNRs, IBAs and Camp settlements are known and flight plans can be routed to avoid overflying these areas. When it is not possible to avoid an area completely minimum flight heights will be specified.

Due to the potential for chronic effects in small areas over the course of the campaign (scheduled March-November), the severity of helicopter over-flights on wildlife has been assessed as '**Moderate**'.

There are areas that are designated as NNRs close to the direct flight paths between the rig and Stanley or MPC; Kidney and Cochon Islands, Volunteer Point and Cow Bay, Cape Dolphin and Moss Side. Additionally, the north coast of East Falkland, known as Seal Bay, and Bertha's Beach, near MPC, are designated IBAs for their colonies of penguins. The national importance of these areas means that the sensitivity of the receptors is assessed as '**High**'. The overall significance of the potential disturbance caused by helicopters to local wildlife is '**Moderate**'. To mitigate this, specific flight paths will be planned to avoid sensitive areas. Where this is not possible a minimum flight height of 3,000 ft (900 m) will be required.

The impact of helicopter noise will be localised and short-term resulting in a barely detectable impact on the local population. The severity of the impact on Falklands' residents is '**Minor**'.

The use of aircraft to transport passengers is an everyday occurrence in the Falklands so there is a degree of tolerance. Direct flight lines between the heliports and the drilling rig locations do not pass directly over settlements. The sensitivity of the local population to helicopter disturbance is assessed as '**Low**'. The overall significance of helicopter noise on the human population is '**Low**'.

However, flight paths will be planned and reviewed to ensure minimal disturbance to the human population, along with wildlife and livestock.

The project activities are clearly defined and avoiding sensitive areas should be easily achievable. As such, confidence in the assessment is '**Certain**'.

1.10.6 Introduction of terrestrial invasive species with cargo imports

In the past, there have been numerous introductions of non-native terrestrial species into the Falkland Islands. In recent years, there has been a concerted effort by the Falkland Islands Government (FIG) to reduce the risk of visitors to the Islands unintentionally introducing more non-native species and biosecurity procedures have been improved. There are numerous examples in the Islands where invasive species have had socio-economic impacts and almost certainly impact on the biodiversity of the Islands. For example, the invasion by the European earwig (*Forficula auricularia*) of Stanley is a timely reminder of the risks posed by non-native species.

Any cargo arriving from outside the Islands during the 2015 exploratory campaign poses a risk of unintentionally introducing non-native species. In this regard, the highest risks are invertebrates, seeds and soil (containing micro-organisms) that can adhere to the outside of containers or be hidden within cargo. During the previous round of exploratory drilling in 2011, fresh fruit and vegetables were imported into the Falkland Islands on the campaign charter flight. Whilst this was welcomed by local residents, it also represents one of the greatest risks of introducing non-native species; within the produce, in adhering soil or packaging.

It is clear that many species have been introduced in the past; however, quantifying the risk is not straight forward. It is likely that many cargos arriving in the Falklands are harbouring some non-native species, whether these are able to survive, and breed to become invasive depends on the species concerned and whether they find a niche to exploit in the Falklands. Therefore, the impact of any introduction should be assessed on a case-by-case basis.

The long-term implications for the Islands could be severe and difficult to reverse. In the terrestrial environment the possibility of detecting potential invasive species and eradication, thereby reversing the effect, is easier than in the marine environment, on this basis the severity has been assessed as '**Moderate**'.

The transportation of invasive species to the Falklands has happened in recent years. Additionally, the introduction of invasive species has happened in the industry elsewhere in the world and therefore the likelihood of invasive species becoming established as a result of the drilling campaign has been assessed as '**Possible**'. The overall significance of the impact is assessed as '**Moderate**' and measures will be taken to reduce the potential impact. Confidence in the assessment is assessed as '**Probable**'.

The best means of reducing the likelihood of introducing non-native species is to ensure that all materials are clean when packed or loaded in the port of origin, particularly items of fresh fruit and vegetables.

- All PMO personnel should be briefed on the significance of non-native species and instructed to capture/kill any invertebrates that are found while unloading/unpacking cargo.
- Cargo should be clean when packed and sealed in invertebrate proof packaging, where appropriate.
- Falkland Islands Biosecurity Guidelines will be adhered to for any freight imported via the charter flight.

On arrival in the Falkland Islands, cargo will be inspected for biosecurity breaches. Any breaches should be reported to the FIG Biosecurity Officer.

1.10.7 Disturbance to Stanley Residents and Wildlife from Inshore and Onshore Light and Noise Sources

Prior to the start of construction, an EIA was completed to cover the construction, operation and decommissioning of the TDF (Noble Energy/RPS, 2013). The findings of that assessment are discussed and updated in line with activities specific to the 2015 exploratory campaign.

The main environmental impacts are associated with production of artificial light and noise. It is anticipated that at times the TDF, and laydown yards will be floodlit to enable safe working of cargo. Activity on the TDF could occur 24 hours a day, seven days a week, therefore, there could be a visual impact during night time hours. The most significant noise generating sources and activities during operations are considered to be:

- Vessel arrival / departure during drilling programme Supply Vessels, typically 5,000 to 10,000 brake horsepower; and
- Vessel loading / unloading using a 250-tonne crane, a 30-tonne crane; and a 15-tonne forklift.

The potential receptors to light and noise disturbance are;

- The residents of Stanley;
- FIG Air Service (FIGAS) pilots; and
- Local wildlife.

Light and Stanley Residents

Light spillage towards Stanley will be minimised, given the orientation of the lights and attenuation with distance. In addition, the lighting is unlikely to add significantly to the light emitted by FIPASS and will be of a similar nature to that already employed there. The impact will be localised and short-term and therefore the severity is assessed as '**Minor**'. The sensitivity of Stanley residents is assessed as '**Low**' as they are already subjected to artificial light from FIPASS and from within the town. Overall the significance of the laydown yard lighting on the residents of Stanley is assessed as '**Low**' and no mitigation measures are proposed.

Light and FIGAS Pilots

The main deck lights of vessels alongside the TDF will face east, towards Stanley airport. Although lights are downwards facing this has the potential to temporarily interfere with the night vision of pilots and the severity is assessed as '**Moderate**'. The potential for disruption to night flights from Stanley Airport is clearly of concern to stakeholders. Therefore, without mitigation, the sensitivity of FIGAS pilots is assessed as '**Moderate**'. The overall significance of laydown yard lighting on FIGAS pilots is assessed as '**Moderate**' and mitigation measures are proposed to reduce the impact, including;

- All lamp units, save those required for safety and navigation aids, will be pointed in-board towards the causeway and barge, to reduce potential light pollution to local residents in Stanley;
- The TDF and laydown yard permanent lighting will be designed and implemented in accordance with the Health and Safety in Ports (SIP009) Guidance on Lighting. This is a document jointly prepared by Port Skills and Safety with assistance from the UK Health & Safety Executive (HSE). This will ensure that the artificial lighting used does not generate light spill or reflection that could be a possible nuisance to local residents or attract wildlife; and
- Premier Oil will continue consultation with FIGAS to ensure that the lighting design minimises any potential issues related to the operations of flights in and out of Stanley Airport.

Light and Local Wildlife

The impact resulting from the drilling campaign will be localised and short-term and in the context of current ambient light levels will have a negligible impact on the species concerned, therefore the severity of the impact has been assessed as '**Minor**'.

The nearest breeding colonies of such species are not in direct line of sight of the TDF and laydown yard most of the campaign activity will be outside the breeding season. The sensitivity of receptors (sooty shearwaters) has been assessed as '**Low'**. The significance of the impact of laydown yard lighting on local wildlife is assessed as '**Low**' and no mitigation measures are proposed.

Noise and Environmental Receptors

The magnitude of noise impact during loading and unloading at the TDF and laydown yard during a calm and dry night for which there is a light easterly wind (worst-case scenario) is considered to be negligible and unlikely to cause any potential impact to local residents (Noble Energy/RPS, 2013). The predominant wind direction is westerly so these conditions occur for a minority of the time. Consultations with local residents indicate that this assessment was overly optimistic. The severity of the impact is therefore assessed as '**Minor**' and the sensitivity of receptors is '**Low**'.

The significance of noise has been assessed as '**Low**', however, the following measures will further reduce the impact on Stanley residents and local wildlife.

- Vessel movements will be reduced where possible through optimised planning, making efficient use of vessel loads;
- All vessel engines shall be switched off whilst not in use and not left to idle, where possible; and
- Loading or unloading operations at night shall not normally occur and if necessary will be minimised where practicable.

This assessment relies largely on the EIA, and associated modelling, that was presented prior to the construction of the TDF (Noble Energy/RPS, 2013). The TDF and laydown yard adds to existing sources of light and noise in the industrialised area to the east of Stanley and therefore the nature of the impact is well understood. However, a degree of monitoring is required to ensure that artificial lights do not interfere with FIGAS flights or local wildlife. Therefore the confidence in the assessment is '**Probable**'.

1.10.8 Demands for accommodation in Stanley.

Throughout the drilling campaign, it is anticipated that approximately 85 additional personnel (representing Premier Oil, Noble Energy, third parties and stand-by crew) will be based in Stanley. The majority of personnel will be based offshore but will pass through Stanley during crew changes. During previous exploration campaigns, personnel have been accommodated in local hotels, guesthouses or rental property. However, there is a limit to the number of available beds and properties in Stanley and therefore a purpose built temporary accommodation unit will be built to accommodate the majority of these personnel during the 2015 campaign. The temporary accommodation unit will also have the capacity to house up to 160 workers, which would be the case in the event that all workers were evacuated from the rig, i.e. it was 'down-manned'.

A small number of additional shore based personnel (five individuals) will be working in Stanley during the 2015 campaign. These personnel will be based in local rented accommodation, and will consequently add some pressure to the local housing market.

At the time of writing, a contract has been awarded to construct the temporary accommodation unit on a brown field site to the south of Stanley. Once plans have been finalised, the unit will go through the planning process and a dedicated EIA will be prepared.

1.11 Waste Management

Any industrial process will produce waste products, some waste is inherently hazardous to the environment but only if it is improperly managed. Modern disposal and recycling techniques can be employed to minimise the impact on the environment, however, appropriate waste management facilities are not available in the Falkland Islands. International legislation (notably MARPOL) and the 'Duty of Care' principle outlined in the UK's Environmental Protection Act 1990 guide much of the Premier Oil's waste management strategy.

Premier Oil's waste management strategy for the drilling campaign will havewaste that can be discharged at-sea under MARPOL regulations (blackwater (sewage), grey water (water from domestic use) and galley food waste) being treated accordingly and disposed to sea. All other waste will be separated into streams, stored securely and transported to Stanley for onward processing. The majority of waste will be shipped back to the UK for recycling, treatment or disposal, but there is the option for certain waste streams to be disposed of in the Falklands, though this will not include landfilling waste at Eliza Cove or Mary Hill Quarry.

The only other discharges that are permissible at-sea are rainwater and bilge water that has passed through the deck drainage system, which is fitted with an oil separator to remove any contaminants that may have been picked-up from the deck or bilge.

Solid waste (sewage and food) will be macerated before being discharged, to achieve no floating solids and no discolouration of surrounding water as per MARPOL requirements. The discharge point is 12.5 m below the surface of the water. The discharge of blackwater, grey water and sewage may lead to localised nutrient enrichment, however, the dynamic nature of the offshore environment will rapidly disperse the additional nutrients with little impact on water quality. Additionally, the activity of bacteria and other marine organisms will rapidly break down organic waste. The assessment indicates that there is no significant impact on the marine environment from the planned discharges at-sea.

The quantities of other waste products produced during the drilling campaign have been estimated from the amount of waste generated in previous exploratory drilling campaigns. Waste will be handled, transported and processed of in accordance with a Project Waste Management Plan. Each stream will be stored separately in containers that are appropriate for preventing the loss of waste while in transit or storage. The provision of hard-standing and bunding within waste storage areas will contain hazardous materials in the event of an accidental release and enable a rapid on site clean-up resulting in a barely detectable impact on the environment or human health. With the appropriate waste handling and storage protocols in place the risk of the accidental release of hazardous waste into the environment is not anticipated to be an issue.

Tenders are currently being sought for the disposal of certain small quantities of waste in the Falklands. Other than that, all waste will be returned to Stanley to be consolidated before shipment to waste processors in the UK.

1.12 Discharge of Drilling Mud and Cuttings

A combination of seawater and water base muds (WBM) (an aqueous suspension of clay or other viscosifiers such as bentonite) will be used during the drilling operations to lubricate the drill bit and to return the rock cuttings from the wellbore bore back to the surface. The mud and cuttings will eventually be discharged to sea at each well site. The majority of WBM chemicals planned for use are considered to Pose Little or No Risk, known as PLONOR chemicals.

During drilling of the top two sections of the well, drill cuttings will be discharged directly onto the seabed, whilst drilling the third section of the well, the mud and cuttings will be returned to the rig through a riser pipe and will be discharged near the sea surface.

Discharges of WBM and drill cuttings result in the suspension of particulates in the water column which may affect the local water quality and the plankton and fish species living within it, from increased turbidity reducing light levels to particulates causing physical damage to gill structures.

Deposition of the material on the seabed, affects the sediment quality through change in particle size, which also leads to habitat modification for animals living on the seabed. Where deposition thickness exceeds 6.5mm this may lead to smothering of sessile organisms and particle overloading of suspension feeders.

The predicted impact for the discharge of mud and cuttings was estimated using the DREAM/ParTrack model, developed by SINTEF (Stiftelsen for industriell og teknisk forskning – The Foundation for Scientific and Industrial Research) in Norway, which calculates the dispersion and deposition of drilling muds and cuttings on the seabed and the dispersion of chemicals and particles in the water column (Genesis, 2014b). The ParTrack model predicted environmental risk to the sediment due to cuttings deposition persisting for approximately five years post drilling, with effect remaining relatively localised within 50 m of each well. Effects relating to changes in sediment grain size were predicted to account for the majority of environmental risk to the sediment, with effects persisting for at least ten years and affecting an area of 0.015 km^2. Risk to the water column was primarily due to dissolved components and was predicted to extend further than risks to the seabed, affecting a volume of approximately 0.025 km^3. However, the effects will be very short-term with risk falling to acceptable levels within several hours of each discharge as particles are dispersed by the currents. The impacts to each receptor are discussed below:

- Seabed Sediment - The severity of the impact to sediment quality is assessed as '**Moderate**' having an effect over a relatively small area, but that will persist for at least ten years. The sensitivity is assessed as '**Very Low**' as the habitat is undesignated and widespread. The overall significance is '**Low**'.
- Water Quality - The increase in turbidity will reduce water quality in a small volume of water in surface waters and near the seabed. The operations would be of short duration with recovery occurring within hours Hence the severity of impact to the water column was assessed as '**Minor**', and the sensitivity as 'Very Low' given the area of affected water column is not very productive in the austral winter. The overall significance is 'Low'.
- Phytoplankton and Zooplankton - The increase in turbidity will affect a very small volume in the upper water column and is predicted to recover within hours, consequently the severity to plankton is assessed as '**Minor**', and the receptor of '**Low**' sensitivity as species are widely distributed throughout the water column. The overall significance is '**Low**'.
- Benthic Fauna - Some organisms close to the well will be buried with re-colonisation commencing within 1-2 years of the end of cuttings discharge. Modification of sediment grain size will account for the greatest percentage of environmental risk and could affect the community structure for at least ten years. Consequently the severity of the impact to the benthic fauna is assessed to be '**Moderate**' and the sensitivity to be '**Very Low**' as no vulnerable species were identified in surveys and the community structure is widespread and typical of the area. The overall significance is '**Low**'.
- Fish and fisheries – Based on the absence of spawning commercial fish species on the Northern Slope, which are the most sensitive life stage; the relatively localised area of effect; short-term impact and reversibility of the effect the severity is assessed as '**Minor**'. The sensitivity of fish and fisheries is assessed as '**Low**', due to the mobile nature and very small proportion of any species population that would be affected. The overall significance is '**Low**'.

The pre-mitigation significance of cuttings discharge is assessed as '**Low**', however good practice measures will be followed during drilling operation to minimise the risk where possible.

1.13 Accidental Events

The following accidental events were identified during the Environmental Impact and Risk Identification (ENVID) process:

- Emergency situation leading to a significant loss of containment or an uncontrolled release;
- Accidental loss of containment during operations leading to small diesel or chemical spills;
- Major rig incident resulting in loss of rig;

- Major vessel incident resulting in a collision with rig or another vessel;
- Loss of containment of drilling mud from riser due to rig failing to maintain station.

1.13.1 Emergency situation leading to a significant loss of containment or an uncontrolled release

There are two main control measures that prevent the uncontrolled release of hydrocarbons during drilling, primary (maintaining hydrostatic pressure in the wellbore) and secondary (a blow-out-preventer (BOP) installed on the wellhead). In the unlikely event that both primary and secondary well controls fail, an uncontrolled release can occur.

A large scale uncontrolled release would have far reaching impacts on the marine, and potentially terrestrial, environment. To investigate the potential impact, an oil spill scenario in which 2,000 barrels (280.7 tonnes) per day for 78 days from the Isobel Deep well site was modelled by Genesis (2014a). Modelling was conducted using the Oil Spill Contingency and Response (OSCAR) model developed by SINTEF. The oil properties adopted for the uncontrolled release modelling are taken from the Sea Lion Field, which is extremely waxy crude. The scenario chosen in this assessment represents the worst-case conditions and the maximum spill possible for the Isobel Deep well, which is closer to the Falkland Islands than the other proposed well sites. The likelihood of an uncontrolled release occurring has been assessed as '**Remote**', it has happened in the industry but on extremely rare occasions.

The environmental impact would affect a wide range of receptors. The severity of impact to each environmental receptor will be different and dependent on the environmental conditions, and subsequent dispersion of oil, experienced in the weeks following any spill. The severity of the impact on each receptor is discussed below;

- Plankton - The results of the model predict that the oil will spread as waxy droplets under the influence of wind and currents, primarily in the surface layers of water. This zone is occupied by planktonic organisms and therefore the severity of the impact on plankton was assessed as '**Moderate**'.
- Benthic fauna - The wax will settle to the seabed about 80 days after the start of the uncontrolled release. At this stage the wax will continue to slowly degrade but with unknown long-term consequences for benthic fauna. Therefore the severity of the impact has been assessed as '**Major**'.
- Seabirds – Due to the spatial extent of the slick (potentially covering important seabird foraging areas) and the potential for chronic impacts on reproductive biology in long lived late reproducing species, the severity of the impact on seabirds is assessed as '**Major**'.
- Marine Mammals - The severity of the impact on marine mammals was assessed as '**Moderate**' because the waxy nature of the oil will mean a lower exposure to volatile and toxic components of the crude.
- Fish and fisheries - The model predicts that the slick will overlap with major fishing grounds, affecting different fisheries depending on the time of the year. An uncontrolled release might result in the closure of the fishing grounds due potential tainting and contamination. For fish and fisheries the severity of the impact is assessed as '**Major**'.
- Northern coastline - The model predicts that there would be a 40% chance of wax reaching the north coast of the Falklands. By the time the wax reaches the coast, it will be much dispersed and in the form of small waxy droplets. As there is still some uncertainly over the longer term chronic impacts on this environment, the severity of the impact on the coastal environment is assessed as '**Moderate**'.
- Tourism - It is likely that a major loss of containment and the media attention that such an event would generate would have long lasting negative impacts on tourism due to the perceived environmental degradation. The severity of this impact is assessed as '**Major**'.

Taking all of the potential receptors into account, the overall impact severity of a major loss of containment on the NFB ecosystem would have be '**Major**'. However, there are many unknowns in the model and the impact on environmental receptors. Although the impact may have serious multi-year consequences for the ecosystem of the NFB, this impact would be reversible. The likelihood of the impact occurring is remote, and hence the overall significance of the impact is '**Moderate**'.

There is a discernible risk to the environment; however, a number of measures to manage the risk are built into standard operating procedures (such as the use of a BOP). Nonetheless, Premier Oil are currently preparing a project specific Oil Spill Response Plan. If a spill occurred, tiered responses would be initiated, proportional to the spill. Key aspects of the response would be;

- Well intervention – these are means of stopping the flow of oil and could include the drilling of a relief well or the use of a subsea capping device;
- Surveillance - it is vital to track the progress of any spill with the aid of aerial surveys and tracking buoys;
- Dispersants - it is unlikely that dispersants would be effective on oil with a high wax content, like Sea Lion crude, and they are unlikely to be used, although they will be available in field in case hydrocarbons encountered are not as anticipated;
- Containment and recovery – under suitable weather conditions, booms and skimming devices can be used to recover oil at-sea. The supply vessels will be appropriately equipped to undertake this;
- Shoreline clean-up – an assessment of the sensitivity has been undertaken to prioritise sites in the event oil approaches the coastline (Premier Oil, 2014);
- Wildlife rescue and rehabilitation – specific response equipment to support wildlife rescue and rehabilitation will be available for the campaign.

With the measures outlined above in place, it is not possible to reduce the likelihood of an uncontrolled release any further; however, an oil spill response will reduce the severity of the impact on the marine environment, in the unlikely event that a spill does occur.

1.13.2 Accidental loss of containment during operations leading to diesel or chemical spills

Diesel fuel will be used to power the rig and all vessels involved in the drilling campaign. Large quantities have to be transferred and stored and accidental events could result in diesel spills. To investigate the likely behaviour of spilt diesel, two scenarios covering worst-case conditions were modelled;

- Scenario 1: Loss of containment during fuel/chemical transfer resulting in 30 tonnes of spilt diesel; and
- Scenario 2: Major loss of containment leading to the loss of the entire rig inventory of diesel (over 4,000 tonnes).

The OSCAR model that was used to describe the behaviour of crude oil following an uncontrolled release was also used to characterise the behaviour of offshore diesel spills, using the same environmental parameters.

Modelling results indicated that diesel fuel is rapidly dispersed but its volatile nature makes it more toxic than heavier crude oils. The areas of significant impact would occur over a relatively small area close to the spill site and within the surface layers of the sea. Potential receptors are plankton, fish and squid, seabirds and marine mammals.

The size of the spill does not necessarily relate directly to the magnitude of the impact, the impact is determined by how many receptors are exposed to the pollutant. Seasonal variations in the distribution of receptors may influence the scale of the impact as much as the size of the spill, although smaller spills will disperse more rapidly. However, it is likely that the presence of the rig will act as a focal point for marine animals and therefore the greatest impact is likely to be close to the rig.

- Plankton –. In both scenarios the diesel remains on or close to the surface of the water throughout the course of the model. Planktonic organisms will be contaminated over a small area for a short period of time and the severity is therefore considered to be '**Minor**'.

- Fish, Squid and fisheries –. As both scenarios are short lived and localised also only small concentrations will enter the water column, the severity is assessed as '**Minor**'.
- Seabirds, Scenario 1 – As diesel will only be on the surface for a matter of hours the impact is short-lived and localised. However, the presence of the rig is likely to attract birds and it is these animals that are at greatest risk of suffering from the chronic impact of small scale leaks and spills and loss of containment events. The severity of scenario 1 to seabirds is assessed as '**Moderate**'.
  Scenario 2 – A far larger diesel spill, indicates that diesel will be on the surface for longer and will spread over a larger area. The potential impact increases in proportion to the size of the spill. Nonetheless, the area covered by the spill is still relatively small (on the scale of the NFB), the slick will be short-lived and any species of seabird impacted would recover relatively rapidly, hence the severity of the impact is assessed as '**Moderate**'.
- Marine Mammals – Scenario 1 –. There is no indication that the presence of a rig attracts associating marine mammals, although they could be attracted by potential prey species that may shelter near the rig. As cetaceans are more vulnerable to inhaling toxic vapour than by contact with skin and the short duration of the spill in surface water the severity is '**Minor**'.
  Scenario 2 – The potential impact from a larger spill increases. However, large diesel spills are short-lived and localised and likelihood of marine mammals being exposed and suffering serious adverse effects is low, therefore the severity is '**Minor**'.
- Coastal Impact – In both scenarios the diesel evaporates quickly biodegrades or is dispersed in the water column, none of the diesel is transported to the coast, therefore the severity is assessed as '**Slight**'.

In order to assess the significance of these events, the likelihood of each scenario occurring has to be considered. Minor spills do occur in the oil and gas industry, however, the quantities involved are usually far smaller (< one tonne) than that modelled in Scenario 1. The likelihood of small spills is assessed as '**Rare**'. Scenario 2 would be far less likely and the likelihood is assessed as '**Remote**'. Although on the scale used in this EIA the significance of Scenario 1 is '**Moderate**' for all receptors, except the coast, and '**Moderate**' in Scenario 2 for seabirds and '**Low**' for all other receptors. Therefore, the greater likelihood of a smaller spill indicates that these are more significant events.

Measures will be in place to minimise the risk of all accidental events, those specific to reducing the risk or severity of small diesel spills are;

- Operating equipment within specified safe limits;
- Conducting maintenance and inspection routines on time and diligently;
- Investigating all leaks to determine root causes and take action to prevent reoccurrence;
- Ensuring that all pipe-work is isolated, drained and purged as required by the permit to work before breaking containment; and
- All hoses used to transfer diesel oil will be fitted with dry-break couplings, which will seal the end of the hose in the event of the hose becoming accidentally disconnected and limit the amount discharged.

In Scenario 2, the most likely cause of a complete loss of diesel inventory is a collision with another vessel. The following measures will be in place to minimise the risk of vessel collisions:

- A 500 m radius exclusion zone will be established around the rig;
- A ERRV will be on permanent standby to ensure the exclusion zone is maintained, and assist in the event of accidental events;
- AIS and radar will monitor vessel traffic in the area; and
- Security radio broadcasts will warn all sea users of the rig's position.

Additionally, in the event that a spill occurs, support vessels will be equipped with oil spill response equipment to respond appropriately to all credible scenarios.

There is little more that can be done to mitigate the risk of these events occurring and therefore an Oil Spill Response Plan is required to reduce the severity of the impact on the marine environment.

The volatile nature of diesel fuel means that any spill will rapidly evaporate, disperse and biodegrade, the impact will be localised and short-lived. The impact will depend on the density of environmental receptors in the immediate vicinity of the rig, which is not possible to predict. The rig itself will influence the distribution of seabirds and may also influence the distribution of marine mammals and their prey. The confidence in the impact assessment of diesel spills on the marine environment is therefore **'Probable'**.

1.13.3 Loss of containment of drilling mud from riser due to rig failing to maintain station.

Damage to the riser (the tube connecting the rig to the wellhead) during drilling operations could result in a loss of the drilling mud and cuttings within the riser, this can happen in the event that the drilling rig loses station in an emergency situation. Reasons for loss of station include; failure of position references, operator error, thruster failure and DP computer failure. The environment could also be a factor here especially in extreme weather conditions.

The loss of drilling mud would impact the water column and the seabed, potential receptors are;

- Seabed sediment – discharge direct to the seabed and settlement of particles through the water column will impact sediment chemistry and particle size over the affected area;
- Water quality – suspension of mud and cuttings in the water column as well as discharge to surface waters will impact water chemistry and turbidity;
- Phytoplankton and Zooplankton – organisms with limited mobility will be impacted by changes in local water quality;
- Benthic organisms – discharge of drill cuttings and mud affects benthic organisms through direct burial, habitat change and sediment suspension at the seabed; and
- Fish – mobile species such as fish may be affected if drilling coincides with certain life history stages such as spawning periods and juvenile stages when they inhabit particular spawning or nursery grounds, or if it coincides with productive feeding season and feeding grounds.

The mud used during the drilling campaign will be Water Based Mud (WBM). The impact of the loss of WBM contained within the riser was modelled using the same DREAM/ParTrack model, used to assess the impact of discharging drill cuttings and mud during drilling operations (Genesis, 2014a). The scenario for the release of WBM following a ruptured riser is based on release quantity of 100 m^3 over one minute and the simulated duration was over one day.

WBM contains a number of chemicals most of which Pose Little Or No Risk (PLONOR) to the environment. In addition to the chemicals the muds contain Barite which due to the angular nature of the particles can damage the gills of marine organisms.

Any impact from the WBM released would be extremely localised and short-term. There is no significant effect on grain size, deposition thickness averages 0.005 mm and particles settle to the seabed within five minutes. The severity of the impact on plankton, fish, water quality, sediments and benthic organisms is assessed as '**Minor**'. The likelihood of a loss of mud containment due to a loss of station is assessed as '**Remote**' and the overall significance of the event would be is '**Low**'.

However, the loss of station is clearly undesirable and a number of practices and procedures will be in place to reduce the risk of loss of station and thus ultimately loss of containment of the riser;

- Redundancy is designed to ensure that DP related equipment are always available;
- DP trials on the rig will be undertaken when the rig reaches location and before operations commence;
- An exclusion zone of 500 m, guard vessel, radar, AIS and radio broadcasts to reduce the probability of vessel collision;

- Iceberg collision. Work to date shows that the risk of significant icebergs in the exploration drilling area is low. However. Premier Oil will have an ice management plan in place for the duration of the drilling campaign; and
- Continual monitoring of long-range and short-range weather forecasts, so that if storm conditions are predicted to exceed the safe weather conditions for the rig, a controlled containment and release from the wellhead could be performed if required.

1.14 Environmental Management

Through a systematic evaluation of the proposed exploration drilling campaign project related activities and their interactions with the environment, a variety of potential sources of impact were identified. The majority of activities were of limited extent and duration and deemed minor.

Those activities that were identified as being of potentially greater concern were assessed further in the main risk assessment chapters. A number of environmental management actions were highlighted for consideration during final project planning and execution. Premier Oil will manage these actions in the framework of their project specific environmental management plan (EMP).

1.15 Conclusion

The overall conclusion of the Environmental Impact Assessment is that with the implementation of the proposed mitigation and risk reduction measures, the proposed exploration campaign will not result in any significant adverse effects on the environment or those who may be affected by potential project environmental impacts.

Figure 4: Summary of Impact and Risk Assessment Process and Outcomes

<table>
<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">All operations</td><td rowspan="3">Greenhouse gas emissions</td><td rowspan="3">Generation of atmospheric emissions from vessel movements, drilling, potential flaring</td><td colspan="4">Combustion of fuel contributing to greenhouse gases (direct CO_2, CH_4, N_2O, indirect NOx, SO_2, CO, VOCs); local air quality (via photochemical pollution formation (NO_X, SO_2, VOCs)); and ocean acidification (CO_2).
Total greenhouse gases generated from the campaign would more than double the annual emissions from the Falkland Islands and therefore represents a significant increase in emissions. Falkland Islands emissions are incorporated under the United Kingdom's emissions inventory for reporting under the Kyoto Agreement, the impact on UK emissions must also be considered. In this context emissions from the campaign amoun to ~0.02% of total UK emissions and campaign flaring emissions would be ~0.7% of UK flaring.
The offshore conditions in the North Falkland Basin would rapidly dissipate any effects on air quality, which would be temporary and localised.
CO^2 generated during the campaign would have a negligible effect on the oceans pH.</td><td rowspan="3">All vessels used during the campign will comply with MARPOL and the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008, which controls the levels of pollutants entering the atmosphere.
Vessel will be audited.
Well schedules will be optimised to minimise time drilling.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
</table>

<table>
<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th>Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td>Rig and Vessel operations</td><td>Underwater noise</td><td>Rig and vessel movements, drilling and VSP</td><td>Vessel activities produce predominantly low frequency (<1,000 Hz) continuous sounds that are less than 190 dB re.1μPa at source. VSP airguns produce high intensity (230-240 dB re.1μPa), low frequency (10-150 Hz) pulsed sounds. Marine mammals are considered to be of the greatest conservation concern in relation to underwater noise pollution, they are protected species that are known to use sound to communicate over large distances, navigate and detect potential prey or predators. Marine animals within 100 m of the airgun could experience hearing loss, which in terms of the North Falkland Basin is a very localised area.<table><tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr><tr><td>Moderate</td><td>High</td><td>MODERATE</td></tr></table></td><td>JNCC guidance will be followed, marine mammal observers will be deployed to search for marine mammals within a mitigation zone (500 m radius) for a period of 60 minutes prior to firing of airguns, soft-start procedures will be followed and VSP activity will commence during daylight hours.</td><td>Low</td></tr>
<tr><td>Rig and Vessel operations</td><td>Disturbacne to seabed</td><td>Temporary use of clump weight for DP system. A clump weight is a relatively small (465 kg) weight that sits on the seabed and is connected to the rig by a tension wire. This system is used to automatically maintain the rig's position.</td><td>The deployment of a clump weight will cause a degree of disturbance to the seabed. This represents such a small area it was regarded as insignificant.<table><tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr><tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr></table></td><td>A Longbase Line (LBL) system will be used, which relies on the accurate positioning of transponders. This also minimises disturbance on the sea bed.</td><td>Negligible</td></tr>
<tr><td>Rig and Vessel operations</td><td>Physical presence</td><td>The presence of the rig and its 500 m radius exclusion zone.</td><td>The rig and exclusion zone could potentially interfere with commercial fishing or shipping. All vessels will be excluded from a 500 m radius of the rig. This will cause virtually no impact as the well locations are not on busy shipping lanes or fishing grounds.<table><tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr><tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr></table></td><td>All vessels in the area will be informed of the rig's position and intentions by radio broadcast and AIS, which will allow vessels to reroute with minimal disruption.</td><td>Negligible</td></tr>
</table>

<table>
<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">Rig and Vessel operations.

Drilling operations</td><td rowspan="3">Generation of artifical light</td><td rowspan="3">During 24 hour operations the rig and support vessels will require lights to ensure safe operations at night.</td><td colspan="4">Attraction of marine life, e.g. plankton, fish, squid and seabirds to artifical light offshore. Subsequent collision risk for seabirds with the rig or vessels. Impact on zooplankton, fish and squid very small and localised - minor severity. Impact on seabirds localised and short-term, less than 1% of the local population at risk</td><td rowspan="3">Heli-deck landing lights will be switched off when not in use (if not required to be left on for safety reasons) to reduce potential impacts of these skyward facing lights on any bird species that may be present. In addition, the ERRV and supply vessel deck lighting will be switched off when not in use (if not required to be left on for safety reasons).
The use of blackout blinds/curtains will eliminate light from living spaces.
The majority of lights on the rig will be directed inwards to allow safe working conditions.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>LOW</td></tr>
</table>

<table>
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<tr><td rowspan="3">Rig and Vessel operations</td><td rowspan="3">Discharges to sea</td><td rowspan="3">Discharges of vessel drainage, firewater, sewage and galley waste from rig and vessels</td><td colspan="4">Release of contaminants leading to deterioration in seawater quality and localised increase in Biological Oxygen Demand (BOD) around the discharge point.
Impact on water quality, plankton, fish and squid will be very small, localised and temporary.</td><td rowspan="3">Sewage will be treated prior to disposal at sea. Vessels will be audited to ensure compliance. Food waste will be macerated as required by MARPOL and The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008.</td><td rowspan="3">Negligle</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Rig and Vessel operations</td><td rowspan="3">Discharges to sea</td><td rowspan="3">Discharge of closed drains following separation, and firewater foam to sea during system test.</td><td colspan="4">Release of contaminants leading to deterioration in seawater quality and localised increase in BOD around the discharge point.
Impact on water quality, plankton, fish and squid will be very small, localised and temporary.</td><td rowspan="3">Main deck, helideck, machinery spaces drainage routes to the closed drains. Drainage water is treated to remove oil content down to 15 mg/l of oil concentration prior to discharge in accordance with MARPOL 73/78 Annex I requirements.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
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<tr><td rowspan="3">Drilling operations</td><td rowspan="3">Discharges to sea</td><td rowspan="3">Discharge of drill cuttings, WBM, cement and chemicals to marine environment.</td><td colspan="4">Increased turbidity in the water column, sedimentation leading to smothering of benthic organisms, modification of sediment particle size and habitat.
Discharges would impact small areas of seabed and small volume of water relative to the available habitat on the Northern Slope. Impacts would be short term, with potential for rapid recovery. Modification of sedments would persist for over 10 years in a very small area.</td><td rowspan="3">Drilling fluids will be recirculated and cuttings separated from the mud for re-use of the mud to minimise discharges. The majority of WBM chemicals will Pose Little Or NO Risk (PLONOR) to the environment, where safety or operational criteria dictates non-PLONOR chemcials use will be monitored and minised.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Low</td><td>Minor</td><td>LOW</td></tr>
<tr><td rowspan="3">Drilling operations</td><td rowspan="3">Use of landfill</td><td rowspan="3">Generation of non-hazardous and hazardous waste for disposal in UK/FI</td><td colspan="4">The majority of waste generated during the campaign will be transported back to the UK in the returning coaster vessels for landfill in the UK.</td><td rowspan="3">Small quantities of waste may be disposed of in the Falkland Islands, in line with Premier Oil's WMP, and will not include direct disposal of waste to Eliza Cove or Mary Hill Quarry.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Drilling operations</td><td rowspan="3">Intake of seawater</td><td rowspan="3">Intake of seawater to make potable water on the rig</td><td colspan="4">Potential organism uptake in seawater intakes. Plankton and possibly fish eggs or larvae could be removed from the ecosystem. This is on such a small scale that it is insignificant, in comparison with the overall egg/larval production, more an issue in terms of the potential for machinery to over heat due to blocked filters.</td><td rowspan="3">Guards and filters are used to reduce the number of marine organisms that enter with seawater.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
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<tr><td rowspan="3">Drilling operations</td><td rowspan="3">Discharges to sea</td><td rowspan="3">Discharge of heated seawater from heating /cooling medium or Reverse Osmosis unit</td><td colspan="4">Warm water or increase saline water discharges have the potential to impact seawater quality and marine organisms.
Discharges to surface waters will dilute and disperse rapidly in the offshore environment. Plankton may experience small, short-term, localised effects (frequent likelihood). Fish are highly mobile species and are expected to avoid temperatures outside their tolerance range.</td><td rowspan="3">Discharges will be in line with all previous drilling rigs in the Falklands and rig's water maker will reduce use of in-country water resources.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Shore based operations</td><td rowspan="3">Physical presence onshore</td><td rowspan="3">Laydown yard east of Stanley</td><td colspan="4">The use of land resources and the impact on native flora and fauna.
Disturbance of native flora within a National Nature Reserve (Stanley Common). A short length of track will has been laid to join the existing road with the TDF.</td><td rowspan="3">The majority of the infrastructure was in place prior to the start of the campaign.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Shore based operations</td><td rowspan="3">Waste</td><td rowspan="3">Generation of domestic waste from operations at the laydown yard</td><td colspan="4">The majority of waste generated during the campaign will be transported back to the UK in the returning coaster vessels for landfill in the UK.</td><td rowspan="3">The majority of waste from the laydown yard will be shipped to the UK with the waste generated offshore. Small quantities of waste may be disposed of in the Falkland Islands, in line with Premier Oil's WMP, and will not include direct disposal of waste to Eliza Cove or Mary Hill Quarry.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
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<tr><td rowspan="3">Shore based operations.

Drilling operations</td><td rowspan="3">Use of electrical and freshwater resources</td><td rowspan="3">Domestic electrical and freshwater use in support of laydown yard activity.

Use of local water supply for preparation of drilling mud.</td><td colspan="4">Emissions from electricity generation, added burden on the freshwater supply. The scale of the electricity and water use is considered insignificant</td><td rowspan="3">The TDF has freshwater storage tanks which will be constantly trickle-fed with water from the Moody Brook reservoir. This will disconnect any peak in campaign demands from the supply to Stanley.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Shore based operations</td><td rowspan="3">Light onshore</td><td rowspan="3">Generation of light during 24hr operations in relation to local population and wildlife</td><td colspan="4">Artifical light can attract and disorientate seabirds.

Stakeholder raised concerns that the potential for east-facing lighting from the TDF and bright lighting on vessels facing into the prevailing westerly winds may affect night-time flying at Stanley Airport. The laydown yard will be located on the outskirts of Stanley, artifical light from the base is not expected to significanlty add to light emitted by FIPASS. Potential for disruption by night flights causes concern for local residents.</td><td rowspan="3">Permanent lighting will be designed and implemented in accordance with the Health and Safety in Ports (SIP009) Guidance on Lighting, prepared by Port Skills and Safety and UK HSE. Consultation with FIGAS to minimise impacts through lighting design.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>LOW</td></tr>
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<tr><td rowspan="3">Shore based operations</td><td rowspan="3">Noise onshore</td><td rowspan="3">Generation of noise during 24hr operations arising from vessel engines moored alongside the TDF, vessel loading/unloading activities and operation of forklift trucks at the laydown yard</td><td colspan="4">Noise modelling undertaken for the TDF indicated operations at the laydown yard and TDF on a calm dry night would have negligible impacts to Stanley residents, approximately one kilometre away.</td><td rowspan="3">Vessel movements will be reduced where possible through optimised planning, making efficient use of vessel loads. All vessel engines shall be switched off whilst not in use and not left to idle, where possible. Loading or unloading operations at night shall not normally occur and if necessary will be minimised where practicable</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>LOW</td></tr>
<tr><td>Shore based operations</td><td>Accomodation</td><td>Demands for temporary accommodation in Stanley</td><td colspan="4">During the campaign approximately 85 additional personnel will be based in Stanley, which will place pressure on the limited number of available beds in Stanley for visitors.

Options are currently being reviewed and the possibility of building a temporary accomodation unit in Stanley is being considered. Although it is likely that a minority of individuals will be accommodated in local hotels and guest houses.</td><td>Plans are still being developed and the location or footprint of a temporary accomodation unit are unknown. Once plans have been finalised an accomodation specific EIA will be prepared to support planning application.</td><td>N/A</td></tr>
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<tr><td rowspan="3">Inshore operations</td><td rowspan="3">Physical presence</td><td rowspan="3">Vessels associated with the campaign will increase traffic in Stanley Harbour. Space for manoeuvering in the harbour is limited and the additional traffic could disrupt exisiting fishing and cargo use of the harbour.</td><td colspan="4">During the campaign an estimated 53 vessel refueling visits will be required at FIPASS, lasting approximately 6-20 hrs each. Consequently the disruption to other users is considered to be moderate given the limited space at FIPASS.</td><td rowspan="3">Premier Oil will appoint a Marine Superintendent to liaise with the Harbour Master, FIPASS management, Stanley Services and other users to keep everyone well informed. A navigational risk assessment will be completed to inform the preparation of a Stanley Harbour Management Plan.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Moderate</td><td>MODERATE</td></tr>
<tr><td rowspan="3">Crew Transport</td><td rowspan="3">Noise onshore</td><td rowspan="3">Generation of noise, flight path over sensitive seabird colonies and local communities</td><td colspan="4">Low flying helicopters over sensitive breeding colonies of penguins can invoke strong responses leading to trampling of adults, chicks and eggs. Helicopters may also be a nuisance to local settlements and disturb livestock on farms.

The impact of a single helicopter is likely to be short-term and rapidly reversible. However the combined impact of numerous daily flights could have serious implications for the survival of moutling birds and young livestock. The severity to local residents is considered to be low and as direct flight lines do not pass over settlements, sensitivity is low. The risk assessment below pertains to seabirds and livestock.</td><td rowspan="3">Premier Oil will use the flight avoidance map as the basis for flight planning, follow the FI Low Flying Handbook Guidance, and brief helicopter pilots in flight avoidance protocols.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>High</td><td>MODERATE</td></tr>
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<tr><td rowspan="3">General presence of industry</td><td rowspan="3">Tourism</td><td rowspan="3">Presence of oil industry could have adverse effect on tourism</td><td colspan="4">The presence of oil and gas activites in the Falkalnd Islands could have an adverse effect on the image as a wilflide destination.

The drilling operation is currently planned to occur over the Falkland Islands winter, within the main drilling activity occuring offshore to the north of the Islands out of view of visiting tourists.</td><td rowspan="3">The campaign is currently scheduled for the winter –spring months which is outwith the prime tourist season.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Moderate</td><td>LOW</td></tr>
<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Introduction of marine invasive species</td><td rowspan="3">Non-native species may be transported and introduced through ballast water and biofouling on the hull of vessels.</td><td colspan="4">Marine invasive species typically impact inshore benthic communities of native species. Invasive species may not be evident for a number of years, but their long-term impacts could be severe and irreversible. Vessel will be required to follow IMO guidelines for ballast water and biofouling</td><td rowspan="3">The Eirik Raude and support vessels will comply with IMO Guidelines. However, there remains a residual risk largely due to uncertainties in the assessment. Monitoring will be required to keep a check on the potential presence of marine invasive species, settlement plates will be attached to the TDF to provide an early warning.</td><td rowspan="3">Moderate</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Major</td><td>High</td><td>Remote</td><td>MODERATE</td></tr>
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<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Dropped object</td><td rowspan="3">Large items that are accidentally dropped overboard during drilling operations could pose a hazard to trawl fishing in the area.</td><td colspan="4">Oil and gas industry historical data indicate that the risk of an incident is relatively low at about 1 incident in 60 drilling campaigns. Annual fishing statistics show that there is very little fishing in the area.</td><td rowspan="3">Premier Oil Golden Rules for preventing serious events will be followed during the campaign and include; secure all tools, material and equipment; take measures to prevent dropped objects when working over grating; remove tools on completion of the job; erect barriers around drop zones; inspect structures and equipment at risk of falling.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Low</td><td>Possible</td><td>LOW</td></tr>
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<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Release to sea</td><td rowspan="3">Accidental minor spill of diesel, oil, chemical during loading operations</td><td colspan="4">Release of contaminants leading to deterioration in seawater quality and toxic impacts on marine life.

Diesel spill would only remain in surface waters for a short time, but releases toxic substances that will have small a localised impact on water quality, plankton, fish and squid. The presence of the rig may attract birds that are more vulnerale to toxic surface pollution and several species in the area are classifed as Endangered.</td><td rowspan="3">All diesel transfer hoses will be fitted with dry-break seals, where possible, which will limit the amount discharged in the event a hose is accidentally disconnected. Additionally Premier Oil and provide working procedures which outline control and preventative measures. Premier Oil will also develop a computer based environmental awareness training package that will taken by all of the work force during their induction.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>Very High</td><td>Remote</td><td>MODERATE</td></tr>
<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Release to sea</td><td rowspan="3">Storm water overwhelming rig deck drains resulting in discharge of contaminated water

Unplanned discharge from rig open or closed drain system</td><td colspan="4">Release of contaminants leading to deterioration in seawater quality and toxic impacts on marine life.

Drainage management will be in place on the rig via processes and procedures to minimise overloading of the oily water separator during storms and heavy rain.</td><td rowspan="3">Premier Oil provide working procedures which outline controls and preventative measures. Premier Oil will also develop a computer based environmental awareness training package that will taken by all of the work force during their induction.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>Remote</td><td>LOW</td></tr>
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<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Marine mammal mortality</td><td rowspan="3">Collision between support or supply vessel with marine mammals</td><td colspan="4">An increase in general shipping traffic throughout the campaign could lead to an increase in the risk of vessel collisions with marine mammals.

Large numbers of marine mammals are present in inshore waters coinciding with the period of the campaign. Of these whales, sei whales are Endangered. The campaign will increase shipping near Stanley by 25%, however lack of historically reported incidents suggests that few collisions occure around the Falkland Islands.</td><td rowspan="3">Mariners should be made aware of the issue and how it relates to the Falkland Islands (see IFAW (2013) leaflet).
Along with the usual duties of a watch keeper, additional vigilance is required to detect cetaceans in inshore waters.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>High</td><td>Remote</td><td>MODERATE</td></tr>
<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Invasive species</td><td rowspan="3">Introduction of terrestrial alien species at laydown yard via equipment import from UK</td><td colspan="4">Risk of introducing invertebrates, seeds and soil (containing micro-organisms) that can adhere to the outside of containers or be hidden in cargo. Species that may be transported in cargo from the UK are very likely to survive.

If invasive species were introduced the impact through parasites, disease, competitors or predators may not be immediately evident. Long-term implications could be severe and difficult to reverse. Vessels will be arriving throughout the campaign and a large amount of cargo will be brought onshore. The introduction of invasive species has happened in industry elsewhere.</td><td rowspan="3">All materials are clean when packed or loaded in the port of origin, particularly items of fresh fruit and vegetables. Personnel will be briefed on the significance of non-native species.
Falkland Islands Biosecurity Guidelines will be adhered to.
Cargo will be inspected on arrival for biosecurity breaches.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>Moderate</td><td>Possible</td><td>MODERATE</td></tr>
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<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Release to inshore waters</td><td rowspan="3">Vessel collision in Stanley Harbour, potential for small leaks or tanks to overflow during re-fueling leading to loss of diesel</td><td colspan="4">Whilst Stanley Harbour is not recognised as a habitat of great conservation value, it is home to steamer ducks and other coastal species, as well as Commerson's dolphin, and is used recreationally by Stanley residents.

Collision with a fully re-fueled vessel could lead to a total inventory loss of 800 tonnes diesel. This would be spread between various segrated tanks and would be very unlikely that all or any would be lost. However as a worst-case this could represent a sizeable spill in sheltered coastal waters.</td><td rowspan="3">The same precautionary measures that apply to all vessels bunkering at FIPASS will apply to the rig supply vessels. A Harbour mangement plan will be in place. The support vessels will be fully equipped to deal with spills offshore and the same equipment would be used to deal with small spills inshore.Oil spill response equipment will also be available at the TDF.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Minor</td><td>High</td><td>Remote</td><td>LOW</td></tr>
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Operation	Aspect	Activity Description	Potential Effects and Significance				Legislation/PMO policy/Mitigation/ Monitoring	Residual Significance
Accidental Event	Major loss of containment of hydrocarbon	Emergency situation leading to a significant loss of containment or an uncontrolled release	Prolonged release of crude oil to the water column which could impact water quality, plankton, benthic organisms, seabirds, marine mammals, fish and fisheries, coastal fauna and tourism. The predicted oil is very waxy and has a high viscosity and is expected to form waxy droplets on the surface following release. However, a lighter oil could be encountered. Impacts to plankton are considered to be short-term and recoverable. Impacts to benthic filter feeders are unknown. Seabirds and marine mammals are not considered significantly at risk due to the semi-solid nature of the wax droplets, although this may differ if a different hydrocarbon is encountered. The direction of the prevailing conditions is likely to spread the spill over fishing areas and could result in short-term closed areas. The coastline of East Falkland is at greatest risk of beaching. The impact to tourism is considered to be major.				The well design will be peer reviewed by Premier Oil's well examiner and the Health and Safety Executive to ensure that the risk of an uncontrolled release is minimised. The well will be fitted with a blow-out preventer that will seal the well in the event of a major incident. Premier Oil are preparing an Oil Spill Response Plan that would initiate a tiered response in the event of a spill.	Moderate
			Severity	Sensitivity	Likelihood	Significance		
			Major	Very high	Remote	MODERATE		

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<tr></tr>
<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Release to sea</td><td rowspan="3">Loss of containment of WBM from the riser due to rig failing to maintain station</td><td colspan="4">Increased turbidity in the water column, sedimentation leading to smothering of benthic organisms, modification of sediment particle size and habitat.

Discharges would impact small areas of seabed and a small volume of water relative to the available habitat on the Northern Slope. Impacts would be short term, with potential for rapid recovery. Modification of sediments would persist for over 10 years in a very small area.</td><td rowspan="3">Redundancy is designed in to ensure DP related equipment are always available. DP trials will be undertaken when the rig reaches location. An exclusion zone of 500m will be maintained. Mariners will be advised of the rig location to avoid collision, Meteorological analysis of extreme weather events will be assessed. Continual monitoring of long-range and short-range weather forecasts.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Very low</td><td>Remote</td><td>LOW</td></tr>
<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Loss of containment</td><td rowspan="3">Emergency situation leading to a significant loss of containment or an uncontrolled release.

Use of clean-up materials following loss of containment during clean-up (oil, contaminated materials, PPE etc.)</td><td colspan="4">If a major spill occurred, the clean-up operation would generate a large volume of hazardous waste, which would have to be disposed of responsibly.
This would potentially have a serious environmental impact in its own right but under the circumstances of a major incident, the impact would be relatively insignificant.</td><td rowspan="3">Contaminated waste from a spill clean-up would be managed in line with Premier Oil's Waste Standard, and a specific Waste Management Plan will be in place in the event of a spill. It is expected that waste of this kind will be exported to the UK</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Low</td><td>Very Low</td><td>LOW</td></tr>
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<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Loss of containment</td><td rowspan="3">Emergency situation leading to a significant loss of containment or an uncontrolled release</td><td colspan="4">Air Quality would be affected by light oils, such as diesel, which evaporate quickly and release noxious compounds into the atmosphere. Heavier crude oil takes longer to breakdown and therefore releases gases slowly over a period of weeks or months.
Following an oil spill, Volatile Organic Compounds, Polycyclic Aromatic Hydrocarbons, Hydrogen Sulphide and other noxious compounds are released, which all impact on air quality. In the offshore environment, atmospheric pollution is rapidly dispersed.</td><td rowspan="3">The impacts of a blow-out would be far reaching but air quality was not deemed to be of great significance.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Release to sea</td><td rowspan="3">Major incident such as collision with another vessel resulting in loss of rig inventory</td><td colspan="4">Loss of the total diesel fuel inventory, 4,631m^3. Resulting in release of contaminants and subsequent deterioration in seawater quality and toxic impacts on marine life.
Spilt diesel only remains in surface waters for a short time, but releases toxic substances that would have a small localised impact on water quality, plankton, fish and marine mammals. The presence of the rig may attract birds that are more vulnerable to toxic surface pollution and several species in the area are classifed as Endangered. The risk to the coastline is slight as diesel quickly evaporates and disperses from surface waters therefore is unlikely to reach the coastline.</td><td rowspan="3">An exclusion zone of 500m will be maintained. Mariners will be advised of the rig location to avoid collision. All vessels in the area will be informed of the rig's position and intentions by radio broadcast and AIS. The ERRV will patrol the 500m exclusion zone and ensure other vessels do not approach.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>Very High</td><td>Remote</td><td>MODERATE</td></tr>
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<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Physical presence</td><td rowspan="3">Major incident resulting in loss of rig</td><td colspan="4">Disruption to shipping in the area. There is very little vessel traffic in the area.</td><td rowspan="3">Mariners and FIGFD will be advised of the rig location to avoid collision. Meteorological analysis of extreme weather events will be assessed.</td><td rowspan="3">Negligible</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Low</td><td>Very Low</td><td>LOW</td></tr>
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2.0 Introduction

This Environmental Impact Statement (EIS) presents the findings of the Environmental Impact Assessment (EIA) conducted by Premier Oil Exploration and Production Limited (Premier Oil) for the 2015 exploration drilling campaign in the North Falkland Basin (NFB).

The project involves the drilling and abandonment of four exploration wells into four separate target locations within the North Falklands Basin to further determine the extent of hydrocarbons in the field, measure their characteristics and gain geological information.

The project is located within Quadrant 14 of the Falkland Interim Conservation Zone (FICZ), in a water depth of 360-450 m in Licence Blocks PL032 and PL004.

2.1 Purpose of the EIA Process and the Environmental Impact Statement

The aim of the EIA process is to assess the potential environmental impacts that could arise from the project and identify measures that will be put in place to prevent or minimise these impacts.

The EIA process is integral to the exploration project, assessing potential impacts and challenging design and operational procedures to ensure that the residual impacts of the project are minimal. The process also provides for the concerns of stakeholders to be identified and addressed as far as possible at an early stage, and ensures that the planned activities comply with environmental legislative requirements and with Premier Oil's environmental policy.

The EIS is a report summarising the EIA process and outcomes. It also includes details of how the project decision-making was undertaken and how environmental criteria were incorporated into that process. The EIS is submitted to the Falkland Islands Government (FIG) to inform the decision on whether or not the project may proceed, based on the acceptability or otherwise of the residual levels of impact, and is subject to formal public consultation.

2.2 Scope of the Environmental Statement

This EIS addresses all environmental aspects of exploration drilling in a remote location on the Falkland Islands continental shelf. The activities associated with the campaign can be summarised into the following categories:

- Drilling operations – physical presence and operation of the drilling rig, *Eirik Raude*; well design; mud system, drill cuttings, cementing and chemical discharge; waste production and management; 24 hour operations.
- Shore base operations – operation of the laydown yard; inshore vessel refuelling and loading activities; onshore workforce; waste production and management; 24 hour operations; onshore transportation.
- Support operations – supply vessel operations; transportation of equipment, supplies and the workforce to the Falkland Islands; helicopter operations.

The potential for unplanned or accidental events associated with all of the campaign activities has been considered to ensure that sufficient mitigation and control measures can be put in place to prevent such events from occurring.

2.3 Regulatory Overview

This section provides a brief overview of the current legislation that governs oil and gas activities in the Falkland Islands. Genesis (2013) conducted a thorough review of the legislation pertaining to the oil and gas industry in the Falkland Islands, on behalf of Premier Oil, this summary draws on the findings of that review.

The FIG Department of Mineral Resources (DMR) is the regulatory body for offshore activities and is responsible for approving all applications. As a UK Overseas Territory, FIG shall also seek advice and consult with the UK Department of Energy and Climate Change (DECC) on proposed developments prior to approval being granted. In the absence of specific FIG guidance, the preparation of required consents shall be based on UK guidance issued by DECC, therefore the relevant legislation and guidelines applicable to oil and gas developments in the UK were also considered as part of the thorough review.

Both the Falkland Islands and the relevant UK regulations that govern Premier Oil's exploration campaign are listed below, the relevant Falkland Islands national legislation are described more fully in the proceeding sections:

Falkland Islands National Legislation

- Offshore Minerals Ordinance 1994 (1997 & 2011 Amendments);
- Offshore Petroleum (Licensing) Regulations 1995 and Offshore Petroleum (Licensing) Regulations 2000 including amendments made in 2004 and 2009;
- Petroleum Survey Licences (Model Clauses) Regulations 1992;
- Marine Environment (Protection) Ordinance 1995;
- Deposits in the Sea (Exemptions) Order 1995;
- Environmental Protection (Overseas Territories) (Amendment) Order 1997;
- Marine Mammals Ordinance 1998;
- Conservation of Wildlife and Nature Ordinance 1999;
- Fisheries (Conservation and Management) Ordinance 2005, and;
- Endangered Species Ordinance 2003.

UK and International Legislation

- The Energy Act, 1976 (Amendment) Regulations 2008;
- The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (amendment) Regulations 2007;
- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (amendment) Regulations 2007;
- Offshore Combustion Installations (Prevention and Control of Pollution) Regulations 2001 (Amendment) Regulations 2007;
- Offshore Chemical Regulations 2002 including amendments made by the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005; The Energy Act 2008 (Consequential Modifications) (Offshore Environmental Protection) Order 2010; and The Offshore Chemicals (Amendment) Regulations 2011;
- The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended Regulations 2011);
- Offshore Installations (Emergency Pollution Control) Regulations 2002;
- Offshore Marine Conservation of Habitat Regulations (2007, 2010);
- The REACH Enforcement Regulations 2008;
- The Fluorinated Greenhouse Gas Regulations 2009;
- The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998;

- Greenhouse Gas Emissions Trading Scheme Regulations 2005;
- The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008;
- The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008;
- Dangerous Substances in Harbour Regulations 1987;
- EU Ozone Depleting Substances (ODS) Regulation (EC) No. 1005/ 2009.

2.3.1 Falkland Islands National Legislation

Offshore Minerals Ordinance 1994 (1997 & 2011 Amendments)

The Offshore Minerals Ordinance 1994 (The Regulations) provides the regulatory framework for requiring and undertaking an Environmental Impact Assessment (EIA) or Environmental Impact Statements (EIS) in the Falkland Islands.

These Regulations were amended by the Offshore Minerals Ordinance Amendment(s) 1997 and 2011 and clarified through the development of “Guidelines Notes for Industry - Guidelines Notes On The Production Of Offshore Environmental Impact Statements For Field Developments – 2012” issued by the Department of Mineral Resources (DMR). Schedule 4 of The Regulations provides further details on the expected content of an EIS.

“The Regulations” relate to the granting and renewal of production consents for field developments, the drilling of wells and the construction and installation of production facilities and pipelines in the Falkland Islands Exclusive Economic Zone (EEZ).

“The Regulations” require that any Operator who wishes to carry out those activities must first make an Environmental Impact Assessment (EIA) of the activity and then present the conclusions in an Environmental Impact Statement (EIS). The Operator must then submit the EIS to the DMR.

On submission, the EIS is subject to formal public consultation. Operators are required to notify the public of the EIS submission by advertising submission in the local press.

Once comments are included to the satisfaction of DMR the EIS shall be considered at Executive Council where a decision on consent will be reached. Consent may be given or refused, or the consent may be subject to conditions that require modification to the activity to reduce impacts to the environment, remedy them or to offset them. The decision will be published including the review of the EIS.

Consent to begin any activity will not be given until the Governor is satisfied with the information provided and that there will be no significant impact on the environment.

Offshore Petroleum (Licensing) Regulations 1995 and Offshore Petroleum (Licensing) Regulations 2000 (as Amended 2004 and 2009)

These Regulations stipulate the licensing requirements for oil and gas exploration and production as well as fees, royalties and working obligations of the licence holder.

It further provides a detailed description on the licensing application process, the required forms, model clauses, fees, and other requirements, such as; maintenance, record keeping and reporting.

The Offshore Petroleum (Licensing) Regulations 2000 provided open invitation for exploration or production licences for specific blocks.

Petroleum Survey Licences (Model Clauses) Regulations 1992

These Regulations describe the regulatory framework governing offshore exploration activities including: field observations, geological and geophysical investigations, the use of remote sensing techniques and sea floor sampling.

These Regulations were made under the Continental Shelf Ordinance 1991 and were enforced by the Offshore Minerals Ordinance 1994. The 1992 Regulations were amended by Offshore Petroleum (Licensing) Regulations 1995.

Marine Environment (Protection) Ordinance 1995;
Deposits in the Sea (Exemptions) Order 1995
Environmental Protection (Overseas Territories) (Amendment) Order 1997;

The Marine Environment (Protection) Ordinance 1995 implements the conditions of the London Dumping Convention 1972 and prohibits, other than under licence, the deposition or incineration of deleterious materials in Falkland Islands waters. This legislation provides a system of licensing and licence offences with strict liability for certain loss or damage in relation to polluting incidents.

The UK Environment Protection (Overseas Territories) Order 1988 was applied to the Falkland Islands by the Environment Protection (Overseas Territories) Order 1997. Although the 1997 Order is largely similar to the Falkland Islands Marine Environment (Protection) Ordinance 1995, if there is any contradiction between the two, the more stringent legislation will be applied.

The Deposits in the Sea (Exemptions) Order 1995 is also largely similar to the Environment Protection (Overseas Territories) Order 1997, however, this order exempts 25 specified operations from the licensing requirements under the Marine Environmental (Protection) Ordinance.

Deposits of sewage, domestic garbage, waste water generated from tank cleaning, ballast water, cooling water originating on the vessel are exempt from licensing requirements. Deposits of any substance during firefighting, normal navigation or maintenance, and salvage operations do not require a licence. Deposit of any chemicals, drill cuttings, or drilling mud in the course of drilling and production are also exempt under this Order but would be subject to regulation through other legislation.

Marine Mammals Ordinance 1998

Harming, taking or killing of any marine mammal (including whales, porpoises, dolphins, otters, seals, sea lions and elephant seals) or using explosives in such a manner that may cause harm to any marine mammal on land or in inland waters, territorial seas or any fishery waters of the Falkland Islands is prohibited under this Order. Falkland Islands waters, in this legislation, correspond to the boundaries of the Falkland Island Outer Conservation Zone (FOCZ).

The import and export of any marine mammal or any part of a marine mammal, living or dead, without a licence is also unlawful according to this Ordinance.

Conservation of Wildlife and Nature Ordinance 1999

This Ordinance repeals the Wild Animals and Birds Protection Ordinance 1964, the Nature Reserves Ordinance 1964 and the Fisheries Ordinance. This legislation protects wild birds, wild animals and wild plants, by prohibiting certain activities and making provision for National Nature Reserves (NNR).

According to this Ordinance it is prohibited to kill, injure, capture, replace, or disturb any protected wild animal, bird or plant without a licence. It also makes provision for the designation of NNRs of the seabed or land or private estate by agreement, and associated regulations for their preservation. Its Schedules also list protected bird, animal and plant species, which may not be killed at any time, as well as relevant species which may be killed, and their closed seasons.

Fisheries (Conservation and Management) Ordinance 2005

The Fisheries (Conservation and Management) Ordinance 2005 extends the influence of the Conservation of Wildlife and Nature Ordinance 1999 beyond territorial waters to cover the entire FICZ and FOCZ. However, the primary role of the Ordinance is to protect fisheries resources to meet the reasonably foreseeable needs of future generations; and avoiding, remedying, or mitigating adverse effects of fishing on the marine environment so far as is reasonably practicable to do so.

The ordinance has the following environmental and information principles:

- associated or dependent species shall be maintained at or above a level that ensures their long term viability;
- biological diversity of the marine environment shall be maintained;
- habitats of particular significance for fisheries management shall be protected;
- decisions shall be based on the best available information;
- decision-makers shall consider any uncertainty in the information available in any case, and;
- decision-makers shall be cautious when information is uncertain, unreliable, or inadequate

Endangered Species Ordinance 2003

The Endangered Species Ordinance 2003 upholds the Convention on the International trade of Endangered Species (CITES) and controls the import and export of species listed under Appendix I, II and III of CITES.

2.3.2 Hydrocarbons Development Policy Statement 2013

In order to plan for the future development of the hydrocarbons industry in the Falklands, a policy statement to provide clarity on the purpose of hydrocarbon development and on how the implications of developments will be managed was prepared. In 2013, the hydrocarbons development policy statement was released with the following eight recommendations:

1. Hydrocarbons in Falkland Islands waters belong to the people of the Falkland Islands and their exploitation must be to the benefit of the people of the Falkland Islands, both those of today and future generations.
2. The Falkland Islands Government will maintain constant supervision and control over all hydrocarbon activities within the Falkland Islands Designated Area.
3. Petroleum discoveries must be efficiently managed and exploited to maximise economic recovery and to ensure the development of a long-term industry presence that will benefit the Islands for decades to come.
4. Development of the hydrocarbons industry must ensure the protection and conservation of the Falkland Island’s environment and biodiversity.
5. Development of the hydrocarbons industry must take into consideration existing commercial activity and promote the development of local business capacity.
6. The exploitation of finite natural resources will be used to develop lasting benefits to society across the whole of the Falkland Islands.
7. Transparency and accountability must be present throughout the hydrocarbon development process from all parties involved.
8. The Falkland Islands will only consider onshore hydrocarbon facilities if they are considered to be in the best interests of the Falkland Islands, and can be proven to satisfy all of the above policy goals.

2.4 Areas of Uncertainty

A number of assumptions have been made to inform the environmental impact assessment process as this EIS has been prepared during the design process for Premier Oil’s 2015 Falkland Islands Exploration Campaign and consequently some areas have not yet been fully defined:

- Final selection of offshore chemicals has yet to be completed;
- The detailed drilling schedule has yet to be confirmed;

- The requirement for well testing, and drilling of an additional option wells has not been confirmed, and the requirement to do so will be made after the results of the firm wells;
- The type of hydrocarbon encountered whilst drilling each of the exploration wells is unknown. For the purposes of this assessment the Zebedee, Jayne East and Isobel Deep wells have been assumed to have similar characteristics to Sea Lion crude; however, it is impossible to know the exact type of hydrocarbon until the wells have been drilled. Additionally, as Isobel Deep is located further to the south of the main Sea Lion Complex than the other wells and consequently has a higher degree of uncertainty. The Chatham well is anticipated to encounter gas.
- Temporary accommodation arrangements on the islands have yet to be confirmed.

Where assumptions have been made the environmentally 'worst-case' option was assessed and where definition is missing worst-case estimates of emissions, discharge and other sources of interaction are used in the consideration of possible effects.

2.5 Scoping Consultation

2.5.1 Introduction

Premier Oil conducted an EIA scoping exercise in July 2014 to raise awareness of the 2015 exploration drilling campaign and to invite comment on the proposed programme and associated activities. Initial consultation meetings were held with the Department of Mineral Resources (DMR), statutory consultees and other interested parties, including:

- Biosecurity, Department of Agriculture
- Environmental Planning Department
- Falkland Islands Residents
- Falklands Conservation
- FIFCA (Falkland Islands Fishing Companies Association)
- Fisheries Department
- Joint Nature Conservation Committee (JNCC) (Local Representative)
- Public Works Department
- Shallow Marine Surveys Group
- SAERI (South Atlantic Environmental Research Institute)

This phase of consultation provided stakeholders with an opportunity to enter into a discussion about the proposed project so that any issues and concerns could be identified at an early stage and be considered within the scope of the Environmental Impact Assessment. Table 1 provides a summary of the comments, issues and concerns raised during the initial consultation meetings (summarised on a non-attributable basis), and the location in the Environmental Statement where those concerns have been addressed.

Table 1: Summary of concerns raised during the preliminary stakeholder consultations

Main Activity	Area of Concern	ES Chapter
Pre-drilling Preparations	Light and noise generation could affect seabirds as well as marine mammals. We had considerable advice previously on potential for seabird species to crash into man-made objects at sea when confused by a combination of artificial light and low cloud/fog. Many such events are documented including in the Falklands and South Georgia. Suggest including references to protocols to reduce light impact.	9.0
Drilling operations	If flaring could occur, considerable detail on this should be included in the ES. Will there be night flaring? There is a high chance of killing seabirds if there is night flaring. What mitigation is in place? Reference previous Rockhopper EIS addendum on flaring.	9.0
Drilling operations	The drilling mud and cuttings dispersion modelling report is of great interest to compare the effect footprint with the main fisheries in the area. Suggested that using the fishing traffic reports could be a good proxy for fish abundance in key areas.	12.0
Drilling operations	Suggested that Premier Oil should coordinate monitoring effort of the effects and distribution of cuttings material with Noble.	14.2
Drilling operations	Advised that water column effects of drilling discharges should not be underestimated. It was suggested that mitigation measures such as fitting a diffuser device to the end of the cuttings discharge caisson, that could aid faster dispersion of the cuttings in the water column, should be considered.	12.0
Logistical support, ERRV & supply vessels	Additional supply vessel traffic could lead to crowding in Stanley Harbour, particularly during refuelling operations at FIPASS. There are many other users of the Harbour, from cruise ships to fishing vessels. Periods of peak vessel movement will need to be considered in the development of a Harbour Management Plan. Depth restrictions in the Harbour could lead to limitations on multiple vessel manoeuvres, particularly through the Narrows. Premier Oil should liaise with the Harbour Master and FIPASS management regarding their vessel requirements to ensure smooth management.	10.2
Logistical support, ERRV & supply vessels	Physical presence of support vessels could impact seabirds and marine mammals by the generation of artificial light.	9.0 and 10.7
Waste Management	Premier Oil should confirm that there is sufficient capacity within the Falkland Islands to handle expected quantities of non-hazardous waste that is intended to be disposed of locally.	11.0
Helicopter operations	Recommend including a reference to avoiding low-flying over sensitive seabird colonies when flying over the Falkland Islands. The MoD range and avoidance map has recommended flying heights over sensitive seabird colonies. Likely areas affected in the Stanley/East Falkland area are Kidney Island and Cochon Island, Volunteer Point area, the Seal Bay area and Eddystone Rock. All have a restriction on flying below 1500ft.	10.5

Table 1 continued: Summary of concerns raised during the preliminary stakeholder consultations

Main Activity	Area of Concern	ES Chapter
Shore Base	It would be advisable to implement an invasive species monitoring plan for the temporary dock facility. There are existing invasive species within Stanley Harbour such as the parchment worm, which has a wide distribution around the Falkland Islands and the vase tunicate which appears to be limited to the confines of Stanley Harbour and East Cove and may represent closed populations. See Shallow Marine Surveys Group (SMSG) Survey Report Invasive Species 2011.	10.4
Additional Data	Suggested that Falkland Island Marine Biological Archive (FIMBAr) would be a useful source of information for species assemblages in Falkland Islands waters.	5.4
Shore Base	Who will be operating the temporary dock facility throughout the campaign?	3.0
Monitoring	The exploration drilling campaign provides opportunity to gather environmental data ahead of further development activities.	14.2
Waste	Could the abattoir incinerator be used for inert non-hazardous waste to minimise waste being transported to the UK?	11.0
Accommodation	At times during the last campaign, it was difficult for visitors to find vacant hotel accommodation in Stanley, due to the number of oil workers based in the town.	10.8
Rig	Premier Oil are advised to inform the Fisheries Department of the rig locations in advance.	3.0 and 14.2
General Public Comments		
Accommodation	The drilling campaign will generate a demand for accommodation, from crew changes to emergency accommodation. Premier Oil should have an accommodation plan in place before the rig arrives and should be able to demonstrate its procedures. Local businesses met the demand for accommodation during the previous drilling campaign, and new houses were built. The new campaign could bring additional pressure on housing; although some pressure would have been there anyway. Is there an expectation that the campaign will bring families in or housesharing? Families will be healthy for the community even though this causes more pressure on resources at the beginning. Pressure on housing could also come from local businesses who may wish to bring in more employees.	10.8
Accommodation	During the previous drilling campaign the operators brought workers in to Shorty's and then sent them straight out to the rig. They also used ‘flotels’ as temporary accommodation vessels during the last campaign.	10.8
Accommodation	If there has to be additional accommodation it would not be different to what happened during the last drilling campaign. People will just have to get their heads together.	10.8
Shore Base	During the previous drilling campaign there were water shortages at the supply yard.	3.0
Local Business	The use of charter flights to supplement flights for local Falkland Islanders on the previous campaign was seen as a benefit to the locals, but affected local business such as loss of booking fees.	3.0
Community	During the last exploration campaign lots of friendships developed.	N/A
Community	During the last drilling campaign the fresh produce brought down to Stanley by the charter flight was very popular with the local community.	3.0

3.0 Project Description

3.1 Introduction

Premier Oil is planning to drill four exploration wells within Licence blocks PL032, PL004a, b & c. The purpose of the drilling campaign is to evaluate exploration targets in the North Falklands Basin that were identified during seismic interpretation. The four well locations named Zebedee, Isobel Deep, Jayne East and Chatham (Table 2 and Figure 5) will be drilled during a 2015 exploration drilling campaign.

Premier Oil has the option to drill additional wells to investigate further targets or appraise new discoveries. The requirement for the additional wells has not yet been confirmed and therefore they are included in this environmental impact assessment for contingency purposes only. If it is decided that option wells are to be drilled, an addendum to this EIS will be submitted.

The exploration wells will be drilled from the *Eirik Raude* drilling rig, which will be transported to Falkland Islands waters to conduct a joint 240 day drilling campaign shared by Premier Oil and Noble Energy.

Table 2: Premier Oil Exploration well location coordinates and sub-surface drilling target location

Well Name	Approx. Water Depth (m)	Well target location Coordinates*	Licence Block Location
Zebedee	423	49° 23' S 59° 06' W	PL004b: Zebedee Location
Isobel Deep	373	49° 38' S 59° 01' W	PL004a: Isobel Deep Location
Jayne East	439	49° 20' S 59° 01' W	PL004c: Jayne East Location
Chatham	447	49° 16' S 59° 08' W	PL032: Chatham Location

*Ellipsoid WGS84	Projection TM Zone 60W
Semi-major axis (a) 6378137.000m Semi-minor axis (b) 6356752.314m Inverse flattening (1/f) 298.25722356 Eccentricity sq. (e2) 0.00669437999021	Projection type Transverse Mercator Origin latitude 00° 00' 00.00" North Origin longitude 060° 00' 00.00" West Origin false easting 500000.0 Origin false northing 10000000.0 Scale factor 0.9996 Grid unit Metres

3.2 Overview of Historical Drilling in the Licence Area

Six exploration wells were drilled within the NFB during the 1998 drilling campaign including two wells in PL032. Whilst no commercial finds were located, five of the six wells had oil shows and live oil was recovered at surface.

During the 2010-2012 Rockhopper drilling campaign, the Sea Lion well (14/10-2) was drilled, and declared an oil discovery. Samples of medium gravity crude oil were recovered from the well.

Since its discovery, Sea Lion has been appraised with a further six wells and extensive coring. In addition to providing more information about the Sea Lion Main Complex (SLMC), the penultimate well and respective sidetrack (14/10-9 and 14/10-9z) confirmed a gas and oil discovery in the Casper target.

The final well drilled during this campaign was in licence area PL004b. This well (14/15-4a) encountered four hydrocarbon-bearing intervals, named Beverley, Casper South, Casper as well as the SLMC. Oil was encountered in the SLMC, Casper and Casper South. Beverley and Casper South encountered gas.

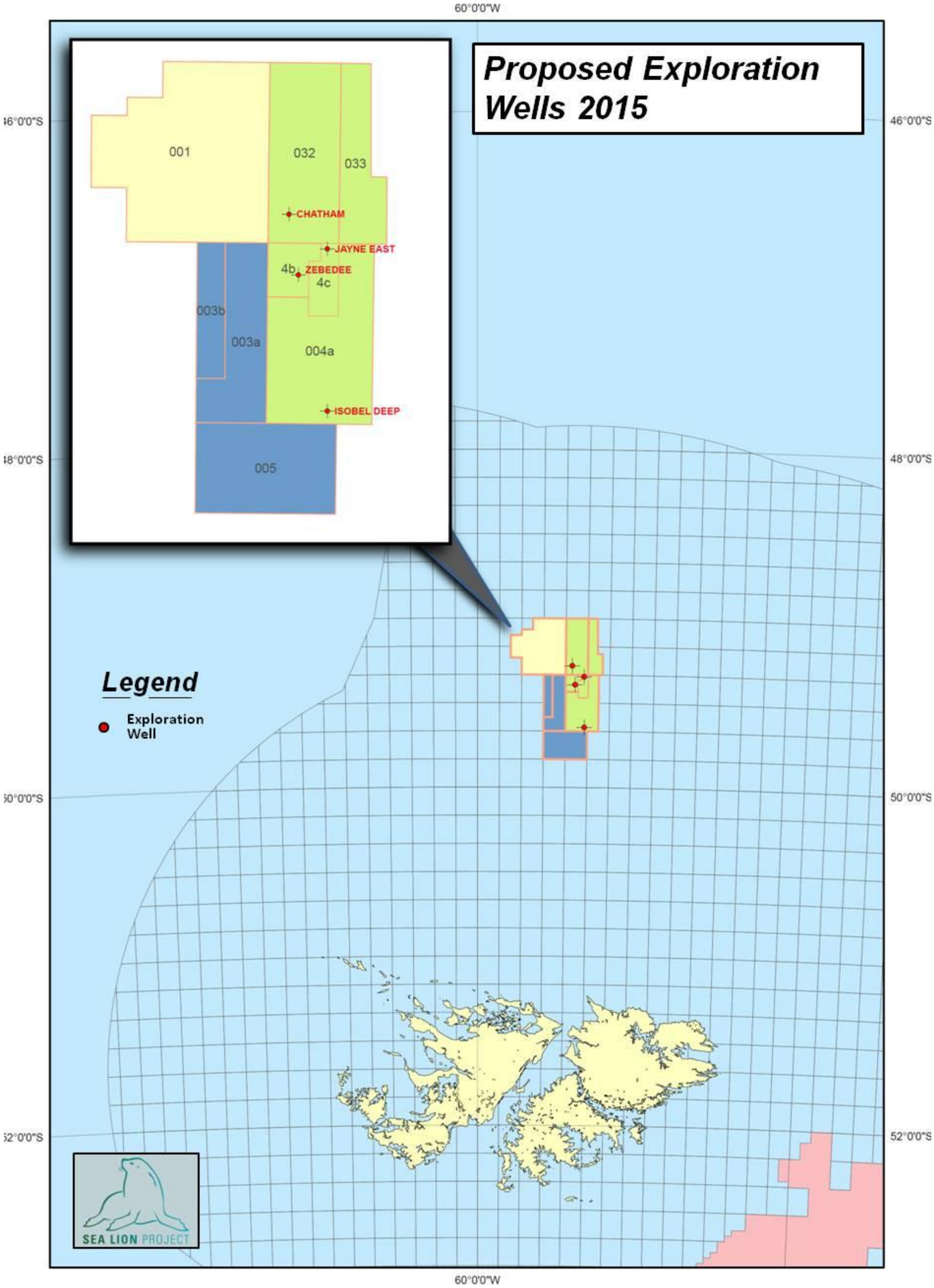


Figure 5: Licence Block Location and Four Exploration Well Locations

The oil characteristics of the proposed prospects are expected to have similar characteristics to the Sea Lion field with a medium gravity crude (low gas to oil ratio ranging between 260 and 450 scf/stb (standard cubic feet / stock tank barrel) The Sea Lion crude also has a relatively high wax content of approximately 20-25% and a corresponding pour point of 30°C, which relates to the minimum temperature at which the oil will flow.

Although it is likely that a hydrocarbon similar to that of Sea Lion crude will be encountered in the Zebedee, Jayne East and Isobel Deep wells, it should be noted that as these are exploration wells it is impossible to know the exact type of hydrocarbon until the wells have been drilled. Additionally, as Isobel Deep is further away from the SLMC than the other wells the degree of uncertainty increases. For the Chatham well, it is anticipated that the well may encounter gas.

3.3 Consideration and Selection of Exploration Concept

An alternative rig was considered for this operation. The rig was not available for the currently scheduled drilling campaign due to market conditions. As such, this option was not taken forward.

3.4 Schedule

Premier Oil has planned the timing of the exploration drilling programme taking the following aspects into consideration:

- The availability of a suitable drilling rig and other vessels for work in Falkland Island waters;
- Noble Energy's schedule constraints who have entered into a consortium agreement with Premier Oil for the hire of the drilling rig; and
- Premier Oil's licence obligations.

The drilling rig has been contracted from March 2015 for a 240 day campaign, which will be split 50%/50% between Premier Oil- Operated Joint Ventures and Noble Energy - Operated Joint Ventures. An outline of the intended schedule is given below although this might be subject to change, dependent on final planning stages between Premier Oil and Noble Energy, and operations. Premier Oil will liaise with the Fisheries Department throughout the drilling programme and will notify the Department of rig moves and the new rig location in advance of the move.

Table 3: Summary of proposed exploration drilling activities

<table>
<tr><th>Activity</th><th>Operator</th><th>Start Date</th><th>Duration</th></tr>
<tr><td>Rig transits from West Africa and arrives in Falkland Island Waters</td><td rowspan="5">Premier Oil</td><td>01 February 2015</td><td>Approximately 38 days</td></tr>
<tr><td>Drill and abandon Zebedee well</td><td rowspan="2">March 2015</td><td rowspan="2">Approximately 30 days</td></tr>
<tr><td>Rig move to next well location</td></tr>
<tr><td>Drill and abandon Isobel Deep well</td><td rowspan="2">April 2015</td><td rowspan="2">Approximately 30 days</td></tr>
<tr><td>Rig move to next well location</td></tr>
<tr><td>Rig move to Noble Energy location</td><td rowspan="2">Noble Energy</td><td rowspan="2">May-August 2015</td><td rowspan="2">120 days</td></tr>
<tr><td>Noble Drilling (2 wells)</td></tr>
<tr><td>Rig move to Jayne East well location</td><td rowspan="4">Premier Oil</td><td rowspan="2">September 2015</td><td rowspan="2">Approximately 30 days</td></tr>
<tr><td>Drill and abandon Jayne East well</td></tr>
<tr><td>Rig move to Chatham well location</td><td rowspan="2">October 2015</td><td rowspan="2">Approximately 30 days</td></tr>
<tr><td>Drill and abandon Chatham well</td></tr>
<tr><td colspan="2">Rig transits from Falkland Island Waters to West Africa</td><td colspan="2">November 2015</td></tr>
</table>

3.5 Drilling Programme

3.5.1 Drilling Rig

The exploration drilling campaign will be conducted from the *Eirik Raude* semi-submersible drilling rig (Figure 6, Figure 7), which is one of the most commonly used design of mobile drilling rigs worldwide. The rig will float at each of the four well locations, maintaining its position by a Dynamic Positioning (DP) system, so that there will be no requirement to anchor the rig to the seabed during drilling operations.

The *Eirik Raude* is designed to successfully operate in harsh environmental conditions and provide a stable platform from which to drill the wells. The hull of the semi-submersible rig comprises six vertical columns, which are designed to reduce the vessel 'heave' (vertical motion of the vessel in response to wave action) by reducing the area of hull in contact with the water. Three columns are fitted along either side of the rig and terminate in two underwater hulls / pontoons (Figure 6) which contain large tanks for ballast, fuel and fresh water. The columns and pontoons provide buoyancy to keep the rig afloat, and some of the tanks can be flooded to lower the vessel to a sufficient depth in the water to maximize stability and minimize effects of wave movement whilst drilling. Measuring 119 m in length by 86 m width the rig is capable of operating in water depth up to 2,500 m, which is well in excess of the water depth at the proposed drilling locations.

The rig is self-propelled and will sail from its current location in West Africa to the Falkland Islands in early 2015 for the start of the campaign. Premier Oil and Noble Energy take the rig on hire once it sails from West Africa, with the hire period finishing when the rig has been returned to West Africa hence its activities from the point of hire until the rig leaves the Falkland Islands designated area falls within the scope of this impact assessment.

Once in Falkland Islands waters the rig will move self-propelled between drilling locations. Whilst at each well location the rig will maintain its position by deploying three transponders and potential for an additional tension line with a 465 kg clump weight to the seabed. The DP system of the rig uses the fixed point of the clump weight to maintain position by ensuring appropriate tension on the line. On completion of drilling operations at each well location the clump weight and transponders will be retrieved back to the rig.

During drilling operations, a 500 m exclusion zone will be established around the rig to ensure safe operations and maintain safety for other users of the area. Unauthorised vessels including fishing vessels will not be permitted access to the area. The drilling rig will be equipped with navigation lights, radar and radio communications. A stand-by vessel will patrol the 500 m zone while the rig is on location. Table 4 gives an overview of the rig systems and utilities.

3.5.2 Wells Design and Drilling

The wells will be drilled using a conventional rotary drilling system (Figure 8). This comprises:

- The derrick mounted on the drill floor
- A hoisting drum or draw works, mounted on the drill floor at the base of the derrick
- A drilling line passing from the draw works to the top of the derrick through a system of pulleys known as the 'crown block', which is attached via another series of pulleys (the travelling block) to the hook.

The system operates like a crane and can be raised and lowered within the derrick.

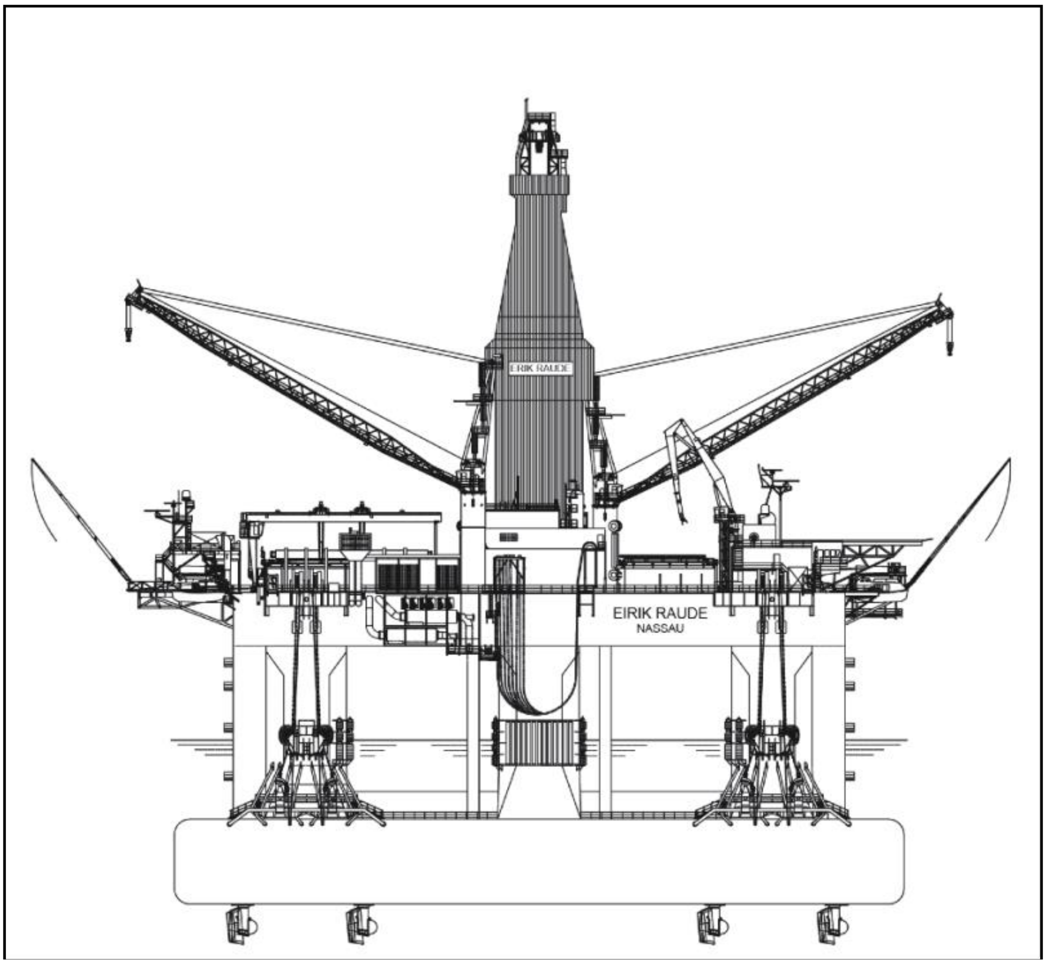


Figure 6: *Eirik Raude* semi-submersible drilling rig side view.

Figure 7: Photo of the *Eirik Raude* semi-submersible drilling

Table 4: Drilling and utility systems on the semi-submersible drilling rig

System	Overview
Operating Parameters	Operating water depth – 2,500m Self propelled transit speed – 6 knots Dynamically positioned – DP Class 3 Helicopter deck Lifesaving – 4 Norsafe lifeboats, 8 life rafts
Drilling mud storage system	Liquid mud tanks – 1,657 m^3 total capacity Bulk mud – 4 tanks, 350 m^3 total capacity Bulk cement – 4 tanks, 350 m^3 total capacity Base oil – 406 m^3 total capacity NOV automatic mud mixing system Free placement cement unit
Drill cuttings treatment	Shale shakers – 5 x VSM 300 units
Well control system	Blow Out Preventer (BOP) – Cameron 4 ram 18 3/4″. 15,000psi. Cameron multiplex BOP control system, with deadman system. BOP equipped with acoustic back-up system and ROV intervention.
Power generation	6 main diesel powered engines
Maximum diesel inventory	4, 631 m^3
Diesel consumption	During transit – 120 tonnes/day Whilst drilling – 50 tonnes/day On-standby – 50 tonnes/day Refuelling approximately once per month dependent on location and activity
Helicopter fuel	Helicopter fuel will be stored in bunded tanks on the main deck. Maximum inventory would be approximately 8.1 m^3
Accommodation	Maximum capacity – 160 persons On-board potable water storage facilities
Operational waste disposal	There will be segregation of hazardous and non-hazardous wastes. Scrap metal and other solid operational wastes will be segregated and stored in designed skips for onshore recycling and disposal in the UK.
Domestic and general waste disposal	General waste from the rig will be sent to shore for treatment and/or disposal. Food waste will be macerated to acceptable levels prior to discharge in accordance with MARPOL 73/78 Annex V requirements.
Sewage treatment	Treatment with an approved marine sanitation until that achieves no floating solids, no discolouration of surrounding water as per MARPOL 73/78 Annex IV requirements.
Drainage and oily water treatment systems	The main deck and helideck have a contained drainage system, which routes to the drains. Drainage water is treated to remove oil content down to 15 mg/l of oil concentration and 20 mg/l of oil in water threshold (monthly weighted average) in accordance to MARPOL 73/78 Annex I requirements. Separated oil will be collected and stored in drums / transit tanks for shipping back to the UK/FI for disposal.
Bilge water	Treated to remove oil content down to 15 mg/l of oil concentration and 20 mg/l of oil in water threshold (monthly weighted average) in accordance to MARPOL 73/78 Annex I requirements.

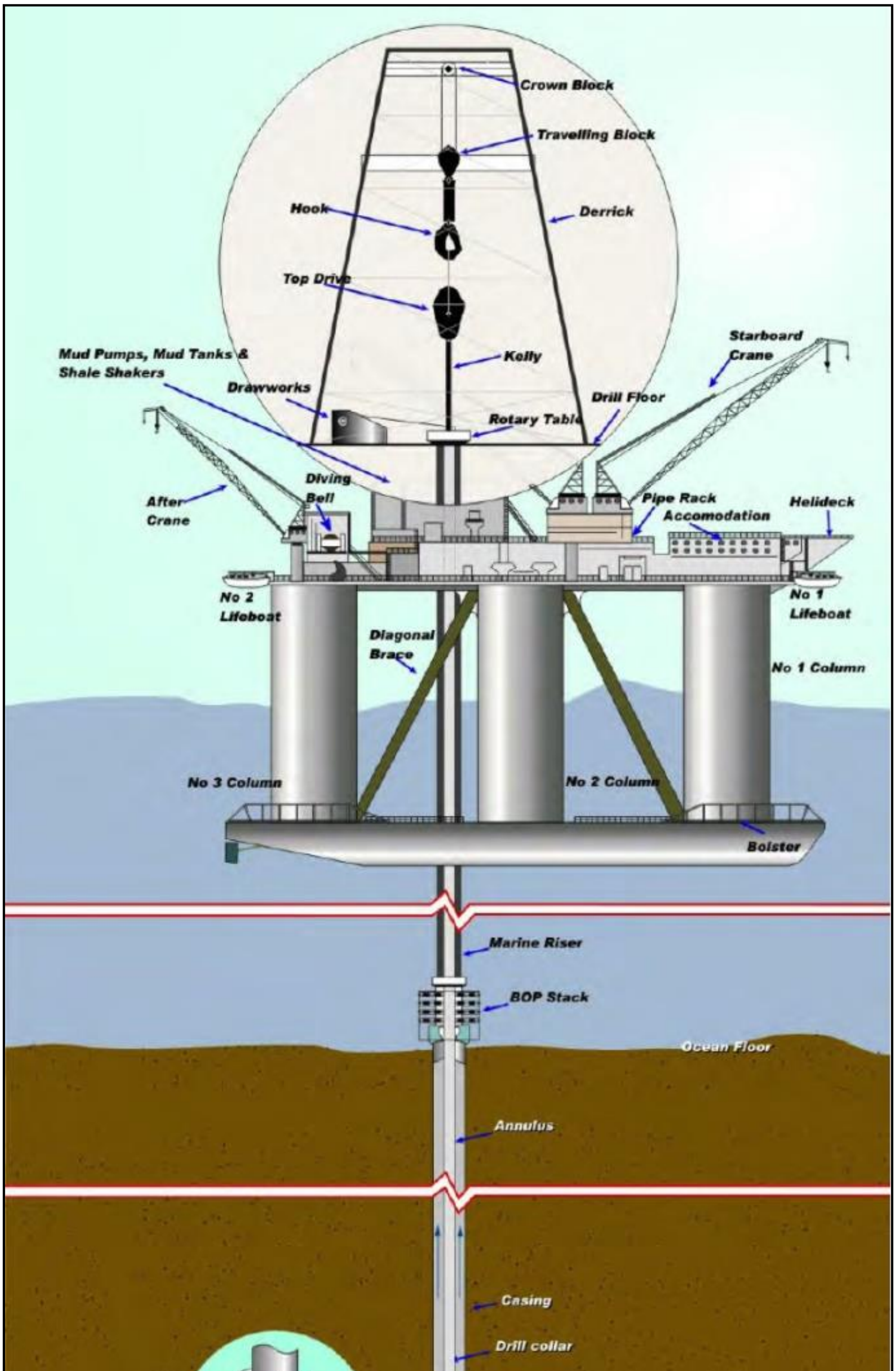


Figure 8: Conventional rotary drilling system diagram

Well Design

The exploration wells will be drilled in three sections with decreasing diameter bore with increasing depth, 42” diameter top section, 17 ½” diameter section and a 12 ¼” diameter section (Table 5, Figure 9).

The lengths and diameters of each section of the well are determined prior to drilling and are dependent on the geological conditions through which the well is to be drilled. Once each section of the well is completed, the drill string is lifted and protective steel pipe or casing lowered into the well and cemented into place.

The casing helps to maintain the structural strength of the hole and also eliminates mud losses from the well bore into surrounding rock formations.

The first two sections of each well will be drilled with the drill string and drill bit left open to the seawater, consequently drilling mud and cuttings will be discharged straight to the seabed as there will be no means of containing them. On completion of the top-hole section (42”) the conductor casing will be cemented in place, this prevents drilling fluids circulating outside the casing and causing surface erosion. Surface casings are cemented into the second well section (17 ½”) to prevent hydrocarbons encroaching into freshwater zones in the formation.

Prior to drilling the third section of each well a pipe known as a ‘riser’ will be run and between the rig and secured to the top-hole conductor casing on the seabed, the drill string will then operate through the centre of the riser. The riser provides a closed system through which the drilling mud can be circulated from the rig into the well (through the centre of the drill string) and subsequently returned to the rig in the space (or annulus) between the drill string and the riser casing / open hole.

Premier Oil have included a contingency well section (8 ½”) that would only be drilled if problems were encountered whilst drilling the 12 ¼” section that meant it could not be completed successfully. In this scenario the contingency section would be drilled to the same total depth as the 12 ¼” section and a further surface casing installed.

All four exploration wells in the Premier Oil campaign will be very similar in design with the same architecture, as an example the design for a typical well is shown below (Table 5).

Table 5: Indicative well design and cuttings produced from the four planned exploration wells

Hole Section (inches)	Depth below seabed (m)	Section Length (m)	Casing diameter (inches)	Casing section length (m)
42	75	75	36 x 30 conductor	75m
17 ½	800	715	13 $^{3}/_{8}$ surface casing	~800m
12 ¼	2,520	1,736	No casing	No casing
8 ½ Contingency	2,520	1,736	9 $^{5}/_{8}$ surface casing	~2300

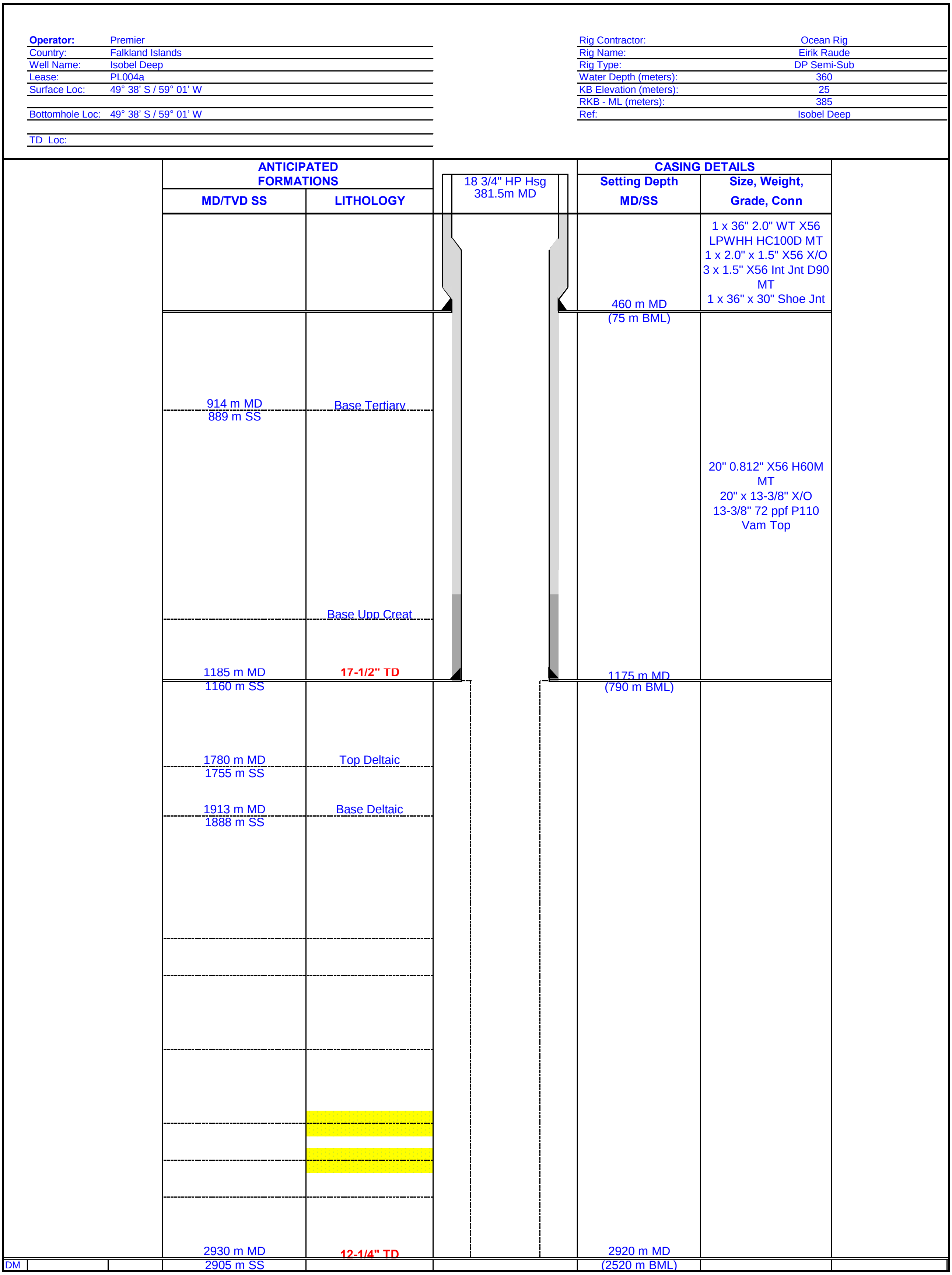


Figure 9: Wellbore Schematic for the Isobel Deep well

3.5.3 Mud System, Cuttings, Cementing and Chemical Discharge

During the drilling operations, drilling mud is pumped through the centre of the drill string down to the drilling bit. Once the riser has been installed the mud can circulate in the closed system and return back to the rig through the annulus between the drill string and riser. The recovered mud is passed through a mud recovery system on the rig, which removes the solid drill cuttings prior to re-use.

Drilling mud is essential to the drilling operation as it performs the following functions:

- The hydrostatic pressure generated by the mud's weight controls the down-hole pressure and prevents formation fluids from entering the 'well bore'.
- It 'sweeps' up the rock cuttings from the bottom of the hole and carries them to the surface.
- It lubricates and cools the drill bit and string.
- It deposits an impermeable cake on the wall of the 'well bore' effectively sealing and stabilising the formations being drilled.

A variety of chemicals may be added to the drilling mud to control a number of conditions:

- Fluid loss control - The layer of mud (wall cake) on the wall of the 'well bore' retards the passage of liquid into the surrounding rock formation. In water-based muds, bentonite is the principal material for fluid loss control although additional additives such as starch and cellulose, all naturally occurring substances, are also used.
- Lubricity - Normally drilling mud alone is sufficient to adequately lubricate and cool the bit. However, under extreme loading, other lubricants are added to prevent the drill string from becoming stuck.
- pH control - Caustic and lime are used to control the alkalinity of the mud to a pH of 9 to 10. This ensures the optimum performance of the polymers in the mud and controls bacterial activity.
- Pressure control - Barite (barium sulphate) is generally used as a weighting agent to control downhole pressure.
- Lost circulation - When drilling through some formations mud can be lost through fissures in the surrounding rock reducing the volume of mud returning to the rig to be cleaned and reused. Naturally occurring fibrous, filamentous, granular or flake materials are used to stop lost circulation when the drill bit enters a porous or fractured formation. Typical materials include ground nut shells and mica.

Two major types of mud are currently typically used in offshore drilling:

- Water based mud (WBM) – water forms the continuous phase of the mud (up to 90% by volume);
- Low Toxicity Oil based mud (LTOBM) – base oils refined from crude oil form the continuous phase of the mud.

For simple vertical exploration wells, WBM is typically used, and will be used in this campaign. These drilling fluids and associated solids may be discharged to sea under permit, and additional volume can also be built on the rig. The drilling fluid system used in previous wells within the Licence Blocks PL032, PL004, was a water / glycol based polymer mud system, which will be very similar to the muds used on the proposed wells. These fluids provided an acceptable level of chemical inhibition for the formations encountered.

Water base mud properties for the 2015 exploration campaign will be selected on the basis of historical drilling experience in the licence blocks. Consequently a water based mud based on the following generic components will be selected:

- KCl based fluid for chemical inhibition;
- Viscosifier for pressure regulation;
- Mud filtrate reduction, and filtrate control agents;
- Oxygen scavenger for corrosion control;
- pH buffer to regulate pH;
- Polymer addition for clay cuttings encapsulation;
- Glycol for hydrate suppression and fluid lubricity;
- Lime, for H_2S neutralisation, should it be present (not expected).

Specific drilling and completion chemicals have not been finalised at the time of writing this EIS (September 2014), however, all chemical additives will be selected to minimise the potential environmental impacts as much as possible. The vast majority (by volume) of planned chemicals have a Harmonised Offshore Chemical Notification Scheme (HOCNS) category of 'E' (which are of low aqua toxicity, readily biodegradable and non-bioaccumulative) and are naturally occurring products (e.g. barite) that are either biologically inert or readily dispersible or biodegradable. The HOCNS is used by the UK and Netherlands governments to manage the chemical use and discharge by their offshore petroleum industries.

Drilling muds for each hole section for the proposed wells are described below and summarised in Table 6.

42" Hole Section and 17½" Hole Section

The two top-hole sections will be drilled with seawater and bentonite viscous sweeps, with drilling mud and cuttings being discharged directly to the seabed. Bentonite viscous sweeps will be circulated to remove debris and residual fluids. Bentonite is the preferred viscous sweep material; this has been selected for its wellbore 'plastering' properties, which reduce the risk of large washouts.

Once the 42" section has been drilled to the total depth, the hole will be displaced to 10.5 ppg mud, to maintain wellbore stability prior to running the conductor. On completion the 17 ½" will be displaced to 11 ppg (pounds per gallon) mud, to maintain wellbore stability prior to running the 13 $^{3}/_{8}$" surface casing.

12¼˝ and 8½˝ Contingency Hole Section

The 12 ¼" section will be drilled with water base mud, which will be recycled and maintained in good condition throughout the operation. The mud and suspended cuttings will be processed on the platform through screens called 'shale shakers' to maximise recovery of the mud.

It is not currently planned to drill an 8½˝ section but if problems are encountered whilst drilling the 12 ¼" section, it may be considered. A contingency 8½˝ section is included here for completeness.

Table 6: Estimated Total Quantity of Mud and Cuttings Discharged per Exploration Well

Hole Section (inches)	Mud type	Mud weight	Cuttings generated (tonnes)	Mud discharged (tonnes)	Cuttings discharge point
42	Seawater with bentonite sweeps	Seawater displaced to 10.5 ppg mud	197.65	41.4	Direct to seabed
17 ½	Seawater with bentonite sweeps	Seawater displaced to 11 ppg mud	327.45	95.6	Direct to seabed
12 ¼	High performance WBM	9.3 – 9.6	389.40	204.7	At sea surface from the rig
8 ½ Contingency	High performance WBM	9.3 - 9.6	238.18	N/A	At sea surface from the rig
Total (contingency section not included)			914.5	341.7	

Cementing Chemicals

Cementing chemicals will be used to seal the well casing in place and provide cement design support by:

- Obtaining a strong casing shoe, and isolating all weaker formations drilled in the previous hole section;
- Providing structural support;
- Providing annular isolation of permeable formations (where allowed by trapped pressure considerations).

As for the chosen drilling muds, all cementing chemicals will be selected to minimise the potential environmental impacts as far as possible. The vast majority (by volume) of planned chemicals have a Harmonised Offshore Chemical Notification Scheme (HOCNS) category of ‘E’ (which are of low aqua toxicity, readily biodegradable and non-bioaccumulative). Standard cement slurries will be used, and an alternative ‘blended’ solution will be developed for 36˝ and 13 $^{3}/_{8}$˝ section. The 12 ¼˝ open hole will be plugged with standard cement, which is commonly used in the North Sea (Table 7).

Table 7: Indicative well design and cuttings produced from the four planned exploration wells

Casing Size (inches)	Cementing Method	Slurry Density (ppg)	Planned Top of Cement	Verification Method
36 x 30 conductor	Inner String	13.2	Seabed	Returns observed with ROV. Possible use of pH meter.
13 $^{3}/_{8}$ Surface casing	Inner String	15.8	Seabed	

3.5.4 Well Control and Blow-out Prevention

In addition to careful monitoring and control of the fluid system and installation of casing in each section of the well, a blow-out preventer stack (or BOP) consisting of a series of individual preventers will be installed on the wellhead at the seabed after the top hole sections have been drilled.

The function of the BOP is to prevent uncontrolled flow from the well by positively closing in the well-bore, if flow from the well-bore is detected. The BOP is made up of a series of hydraulically operated rams and can be operated in an emergency from the drill rig.

The well is not anticipated to encounter any zones of abnormal pressure and the BOP will be rated for pressures well in excess of those that might be encountered in the wells.

During drilling operations small amounts of BOP water-based hydraulic fluid are typically discharged every week, during testing of the BOP.

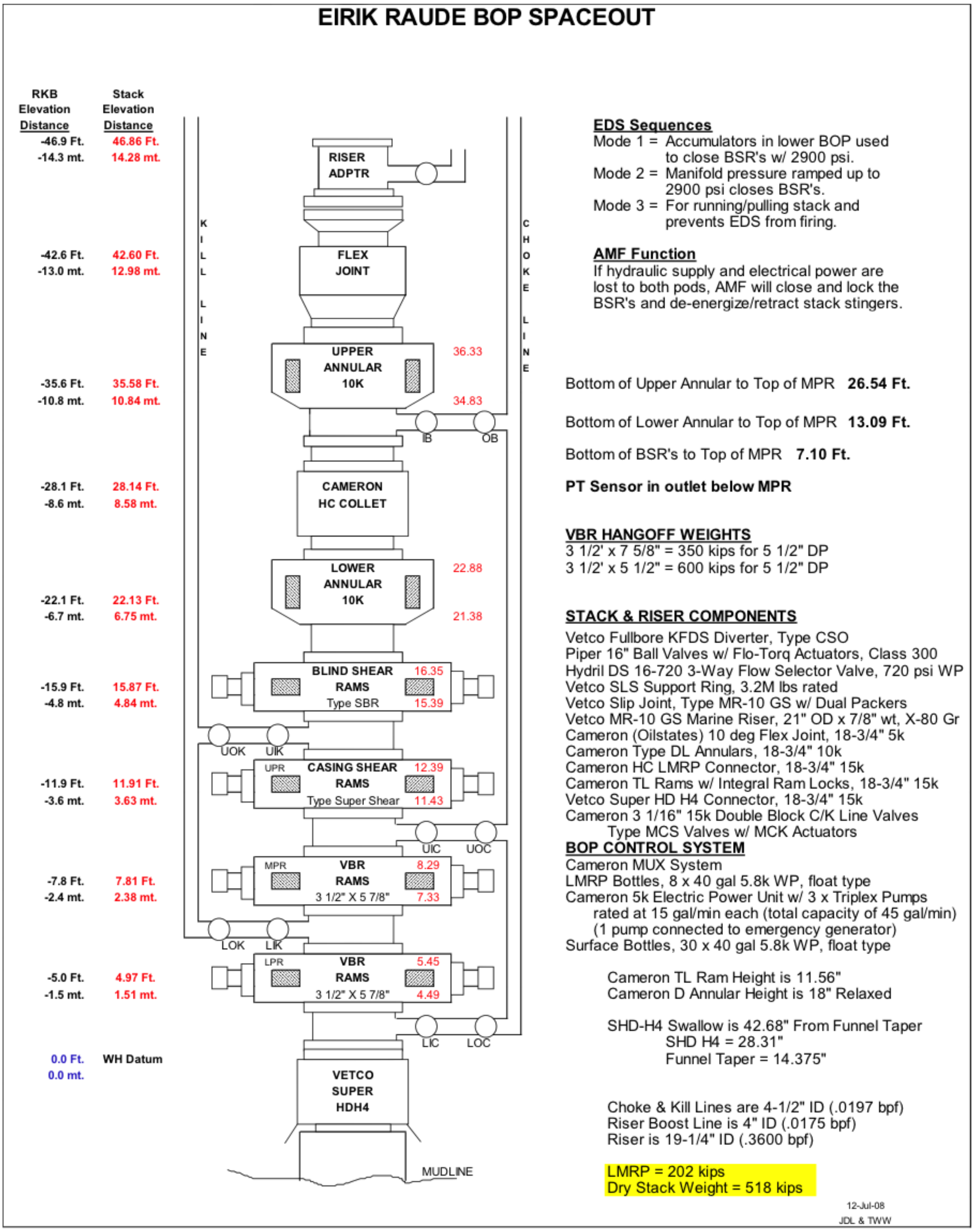


Figure 10: *Eirik Raude* Blow Out Preventer Spaceout Diagram

3.5.5 Well Evaluation

3.5.5.1 Logging and Coring

Formation properties will be measured and logged by tools integrated into the bottom-hole-assembly (lower portion of the drill string including the drill bit). If the results of logging indicate a potential for hydrocarbon bearing formations, it may be considered necessary to test the well to gain further information. As it is currently unknown whether well tests will be undertaken, the potential impacts from this aspect have been included as a precautionary approach. It is planned to take one core on the Zebedee well from the reservoir.

3.5.5.2 Well Testing

Well testing is not part of the base case design for this campaign but may be undertaken and is included here as contingency. During well tests, formation fluids are brought to the surface where pressure, temperature and flow rate measurements are made to evaluate the characteristics of well performance. Following testing, hydrocarbons will be sent to the burner boom for disposal by flaring as this is the only practical handling option for the hydrocarbons. Flaring may be initiated using diesel or a similar fuel to ignite the mixture. If flaring does take place, Premier Oil intend to use a high efficiency burner head to flare the oil during well testing which will minimise, as far as practically possible, the release of un-burnt hydrocarbons and any oil drop-out to sea. Should a visible surface sheen result from hydrocarbon drop-out during flaring, this will be reported to the Department of Mineral Resources and the Department of Natural Resources using the Petroleum Operations Notice No.8 Oil Pollution form.

Should well testing take place it is estimated that the total testing period would be +/- 9 days per well. During this period it is likely that a worst-case of 5000 bbls/day of hydrocarbons would be burnt for a maximum of 2 days per well.

Well testing is carried out in accordance with a Testing Programme and subject to approval by both the Premier Oil well examiner and by FIG. The well testing engineer is responsible for the technical management of the well Test Programme to ensure that the programme objectives are met safely.

3.5.6 Vertical Seismic Profiling

Vertical seismic profiling (VSP) will be conducted as part of the evaluation to correlate the actual data collected by the down-hole well logging process to the surface acquired seismic data. VSP combines the precise lateral control of surface seismic with the fine vertical resolution of down-hole logging techniques, and can be used to 'ground-truth' the historical seismic data.

VSP comprises an airgun (10 to 150 Hz) that will be deployed over the side of the rig using the rig crane and a geophone receiving device. The VSP will take approximately 12-18 hours with guns being fired 3-5 times every 10-15 minutes during that window. JNCC guidelines for seismic surveys will be employed during the survey, with designated spotters on the rig for the presence of marine mammals. The operation will commence with a soft start to ensure that any marine mammals within hearing range of the guns, but not visible to the eye, would be given sufficient warning before the guns reach full capacity and are able to move out of the area.

3.5.7 Well Abandonment

After TD logging, the wells will be plugged and abandoned. The plugging and abandonment will be achieved by setting cement plugs across all open hole permeable formations, and then setting an additional cement plug inside the 13 $^{3}/_{8}$" casing. The abandonment design will comply with the UKOOA Guidelines for the Abandonment and Suspension of Wells, and ensures that independent cemented barriers are provided against all permeable and over-pressured formations. The number of cement barriers placed in the well bore will depend on whether hydrocarbons are encountered, the presence of hydrocarbons requiring more barriers. A maximum of 5 cement plugs would be set in the well if hydrocarbons were found, each plug being 250m in length and comprising approximately 5 tonnes of cement per plug.

Prior to leaving the location, the wellhead will be cut approximately 3 m below the seabed, and recovered to surface. An ROV seabed clearance survey will then be conducted, to confirm that the seabed is clear of debris.

3.5.8 Drilling Support

Drilling operations will be supported by a supply base or laydown yard of approximately 40,000m^2 around Stanley, current laydown yard plans are shown below. Premier Oil expect to share the yard space with Noble Energy during their coinciding drilling campaigns. The exploration campaign supply base is anticipated to comprise: 5-7 Boxer Bridge, 9-13 Coastel Road and 33 Coastel Road as indicated below in Figure 11. The supply base will be supported by workforce of up to 30 workers, comprising a mix of local workers and some workers from the UK.

Figure 11: Laydown Yard east of Stanley

There will be a pool of coaster vessels, which will keep the supply base stocked from the UK and return any waste or equipment no longer required back to the UK. It is expected that each vessel will make one return journey from the UK to the Falkland Islands to deposit and collect cargo.

The drilling rig will also be supported by two platform supply vessels operating out of the supply base, to the East of Stanley, which will keep the rig stocked with the items needed to carry out its operations. Supply boats are expected to transit between the supply base and the rig once a week during operations plus any additional journeys that may be required. The supply vessels will re-fuel at FIPASS following each visit to the rig once a week.

In addition, an Emergency, Response and Rescue Vessel (ERRV) will be stationed in the vicinity of the rig for the duration of the drilling programme. An ERRV must be able to accommodate the entire complement of the rig and, if required, will come alongside the rig to assist.

Three helicopters will be support the rig operations primarily for routine maintenance, crew change transfers, and/or any emergencies that require air-lifts. It is anticipated that the helicopters will be stationed at Stanley airport and that crew changes will be undertaken every two weeks, changing out approximately 60 personnel from the rig to Stanley airport each time.

Crews will then be transported to Mount Pleasant Complex (MPC) via road vehicle, most likely a coach.

A fixed-wing charter flight will run fortnightly to coincide with the crew change from the rig and will depart from MPC travelling to London. Freight options may be available for non-oil field cargo on the charter flight.

Drilling operations will require large quantities of fresh water as potable water for the accommodation on the rig as well as for preparation of the drilling mud. The majority of drill water will come from domestic supply. The Temporary Docking Facility (TDF) contains freshwater storage tanks which will be constantly trickle-fed with water from the Moody Brook reservoir. This will disconnect any peak in campaign demands from the supply to Stanley. Potable water will be 'made-up' on the rig by taking seawater and processing it to make it drinkable.

The Falkland Islands Government are currently progressing plans to supplement the water supply from Moody Brook with a new supply from the Murrell River. This will involve construction of a small barrage across a tributary of the Murrell River, where an off-take will pump to join the existing main from Moody Brook. This new source will offer both reduced energy needs for pumping relative to Moody Brook (due to much reduced pumping head) and also the potential for virtually direct supply of untreated water to the new port via storage tanks placed on the new main pumping route should this be desired. Latest discussions with FIG indicate that the reservoir is likely to be completed be the third quarter of 2015, in time for the summer months when demand levels are increasingly becoming too high during summer relative to the amount of water available from Moody Brook.

Table 8: Approximate rig and support vessel movements during Premier Oil 2015 Exploration Campaign

Vessel/transport movements	Frequency	Duration (days / hours)
Drilling rig operations (*Eirik Raude*)	1	120 days
Drilling rig transit	2	38 days
Platform Supply Vessel (support rig in transit from West Africa)	2	38 days one way
Coaster supply vessels from UK	6	30 days one way
Charter flights to/from UK to MPC	9	36 hrs round trip
Helicopter – rig support and crew change	165	3 hrs round trip
Helicopter – emergency response	20 test flights	3 hrs round trip
Platform supply vessel – from Stanley to rig	96	30 hrs round trip
ERRV – alongside rig	1	120 days
Onshore minibus transport – crew change support between MPC and Stanley	90	2 hrs round trip

3.5.9 Temporary Dock Facility

In support of both the Premier Oil and Noble Energy 2015 exploratory drilling campaign a Temporary Dock Facility (TDF) will be constructed in Stanley harbour. The TDF will be used for loading supplies onto the two rig supply boats.

The TDF has been the subject of a separate environmental and social impact assessment and Environmental Statement prepared by Noble Energy (Ref: 221-13-EHSR-ESH-PA-T4) and consequently any impacts associated with the TDF will not be included in this ESIA. The location of the TDF is shown below in Figure 12.

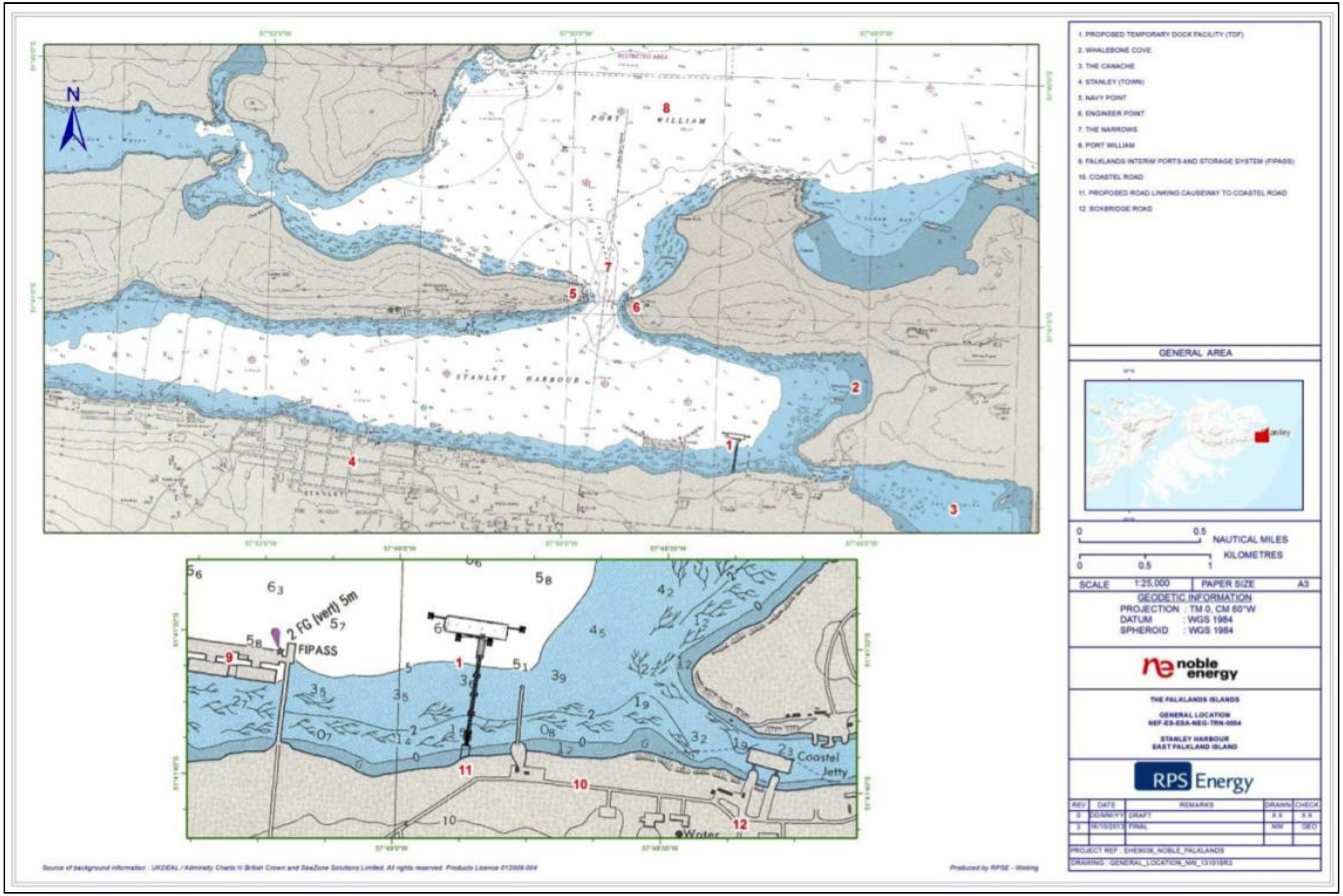


Figure 12: Location of the Temporary Dock Facility

4.0 Environmental Management

4.1 Premier Oil Health, Safety and Environmental Policy

Premier Oil will conduct the exploration drilling campaign in a manner that is consistent with their Corporate Health Safety and Environment Policy (Figure 13), which is endorsed by the Chief Executive Officer of Premier Oil.

The policy acknowledges Premier Oil's HSE responsibilities in relation to its business activities and includes commitments to continual improvement of performance, to assess and manage risks, meet or surpass regulatory requirements, plan and prepare for any emergencies, provide appropriate resources and to encourage open and honest communication. These policies will be implemented through the company's Health, Safety, Environment and Security (HSES) Management System (MS).

PremierOil

HEALTH, SAFETY, ENVIRONMENT POLICY

Premier Oil is committed to operating responsibly and will never knowingly compromise our health, safety or environmental standards to meet our operational objectives. Our goals are to ensure the safety of everyone involved with our operations and to protect the environment.

To achieve this we will:

- *Encourage open and honest communication*
- *Seek ways continually to improve our performance*
- *Assess and manage risks*
- *Provide appropriate resources*
- *Maintain clean, safe and healthy workplaces*
- *Investigate and learn from any incidents*
- *Plan and prepare for potential emergencies*
- *Maintain high quality documented systems and processes*
- *Seek external certification of key management systems*
- *Meet or surpass statutory requirements*

It is the responsibility of everybody involved in Premier to comply with our policies and to assist the Company in their implementation.

Tony Durrant
Chief Executive Officer, Premier Oil plc

July 2014

Figure 13: Premier Oil Health Safety and Environment Policy

4.2 Premier Oil HSES Management System

Premier Oil Falkland Islands Business Unit (FIBU) HSES MS applies to all Premier Oil FIBU business activities associated with Premier Oil FIBU assets, projects and operations.

The Management System has been developed in line with:

- Premier Oil HSES Policy and corporate HSES Management System;
- Internationally recognised standards ISO 14001 and OHSAS 18001;
- Industry organisation's Management System Models (OGP and Energy Institute).

The business unit management system interfaces with the Premier Oil corporate management system and with relevant contractor management systems. Specifically, the business unit management system is aligned with the ten management elements documented in the Premier Oil corporate management system (Table 9), and bridging documents are developed with each key contractor to describe the interface between the two companies' management systems prior to the start of activities (Figure 13).

Within the Premier Oil Falkland Islands Business Unit management system, each of the ten management elements contains a set of compulsory expectations that define how the management system will be implemented and maintained. The elements define 'what' is expected by the business unit in order to manage HSES risk during execution of work activities. The elements are summarised below (Table 9) and described fully in the *FK-BU-HS-ST-0005 FIBU HSES Element Standard*.

A series of business unit specific manuals, standards and procedures, based on the corporate standards and procedures, define how each of the elements should be managed during execution of work activities.

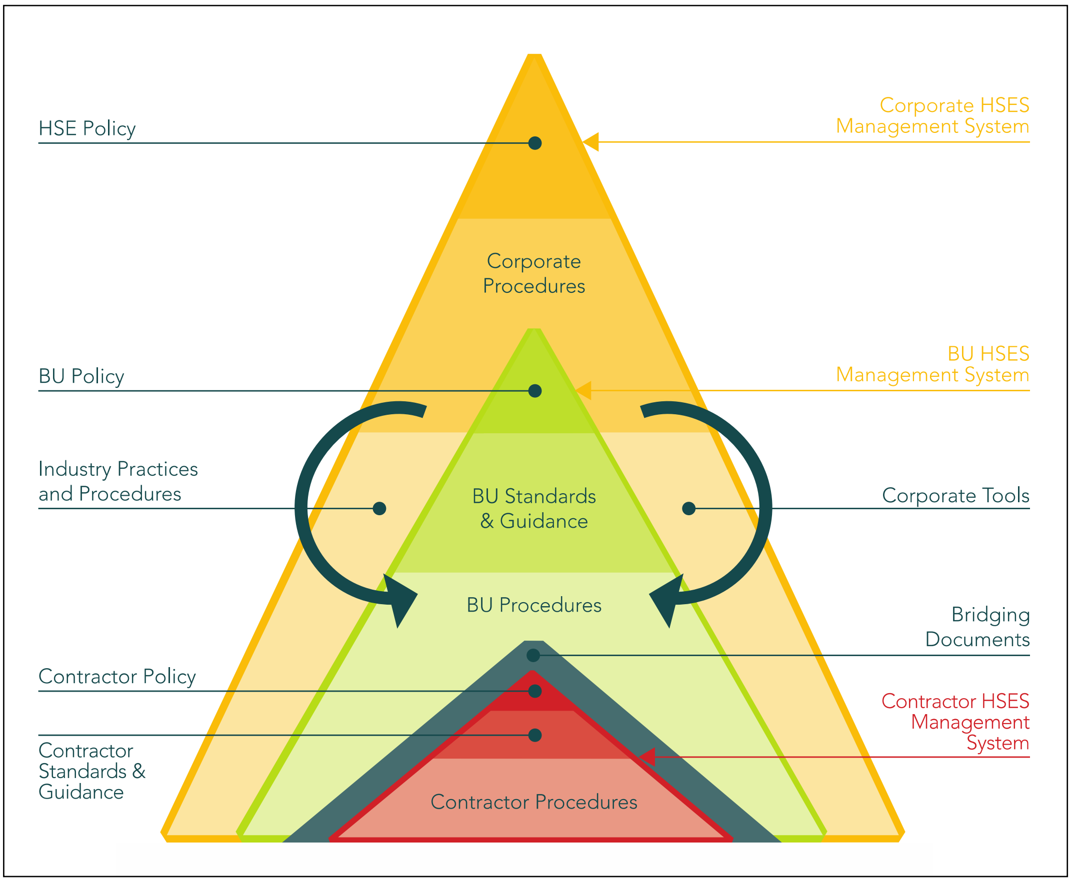


Figure 14: Premier Oil HSES-MS Structure

Table 9: Summary of FIBU HSES Management System Elements

Element	Element Category	Element Description
1	LEADERSHIP: Leadership & Just Culture	Leaders at all levels of the FIBU organization shall demonstrate visible commitment and active participation in HSES management, ensuring the provision of the resources required to implement, control and improve the HSES MS.
2	RISK: Risk Management	The FIBU shall implement a comprehensive risk assessment process that systematically identifies, assesses and then appropriately manages HSES risks arising from its operations to a level that is As Low As Reasonably Practicable (ALARP). Planned changes in design, operations, facilities, procedures, standards, or organization shall be evaluated and managed via a structured process to ensure that HSES risks arising from these changes remain at an acceptable level and are communicated to all those potentially impacted by the change.
3	GOALS: Objectives, Targets & Programmes	HSES objectives and targets relevant to business activities and considering, legal and internal management system requirements shall be established, maintained and documented, at each relevant function and level within the FIBU.
4	ORGANISATION: Organisation, Capability & Communication	A clear organisational structure shall be established alongside defined and documented roles, responsibilities and accountabilities for all those who are involved in managing FIBU's HSES risks.
5	CONTRACTORS: Contractors and Other Operators	FIBU shall develop and maintain a system to ensure that its contractors perform in a manner that is consistent and compatible with Premier Oil's HSES requirements. Systems for HSES contractor management shall define requirements for the effective mobilization, on-going HSES surveillance and close out of contracted work.
6	PROCEDURES: Project and Operational Controls	FIBU shall implement procedures for the management of projects that are understood, available and executed by qualified personnel. Key lifecycle stages in a project will be subject to formal independent HSES review.
7	EMERGENCIES: Emergency Preparedness & Response	Plans and procedures to identify, prepare for and respond to potential emergencies shall be developed, documented, tested and maintained. The effectiveness of emergency response plans shall be routinely assessed via a programme of exercises and drills, and plans shall be revised to address any deficiencies identified.
8	INCIDENTS: Incident Management	All incidents, near misses and potentially hazardous behaviours and situations shall be consistently and promptly reported to statutory bodies, across the FIBU, Premier Oil and wider industry as appropriate. Investigations shall focus on determining root causes, with the objective of identifying corrective actions that minimise the potential for recurrence and broadly sharing lessons learned in a timely manner.
9	CHECKING: Performance Monitoring and Audit	A process shall be established and maintained to measure and monitor the implementation and effectiveness of operational controls, track HSES performance and evaluate the achievement of HSES objectives. Monitoring results shall be regularly communicated throughout the FIBU, Premier Oil and externally as appropriate.
10	REVIEW: Management Review	Periodically, FIBU management shall formally review the FIBU HSES MS, to ensure its continuing suitability, adequacy and effectiveness

The management system elements are based on the recognised Plan-Do-Check-Review model, designed to drive continuous improvement in the company's environmental performance (Figure 15). The HSES MS provides the basis for planning for performance improvement and monitoring the results from this planning process.

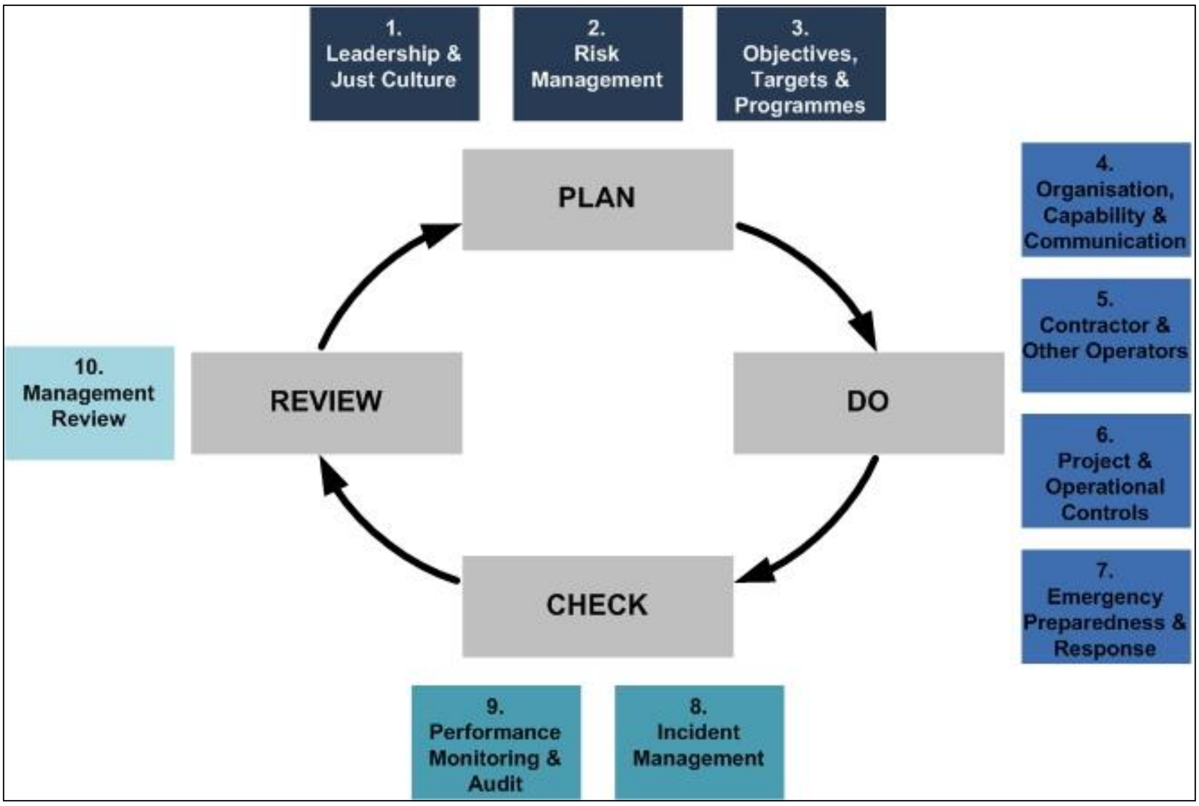


Figure 15: FIBU HSES Management System 10 Element Review and Monitoring Cycle

The Falkland Islands Business Unit's management system formalises the roles and responsibilities of Premier Oil Corporate Management, Falkland Islands Business Unit Line Managers (Business Unit / Functional / Project / Drilling / Operations), the Business Unit HSES Manager and the work force to ensure that they:

- complying with Premier Oil's policy;
- implementing and maintaining the HSES MS;
- monitoring performance and communicating feedback;
- providing support, guidance, training and resources;
- setting and meeting performance targets.

The mitigation and control measures identified in this assessment and in later planning phases will be documented with defined responsibilities for implementation in an environmental management plan (EMP) for the exploration campaign.

4.3 Falkland Islands Business Unit Drilling HSES Standard

The Falkland Islands Business Unit Drilling Health, Safety, Environment and Security Standard is centred around a matrix, plotting the ten elements of the business unit management system against the key stages in the Premier Oil Drilling Process and defining for each process stage and HSES Element, the health, safety, environment and security related activities to be undertaken.

The FIBU Drilling HSES Standard interfaces between the Premier Oil Drilling Management System and FIBU HSES Management System to ensure all required HSES activities are undertaken.

The FIBU HSES Drilling Standard and Drilling Management System documentation will form a key tool in the induction and training of Drilling HSES Advisors employed to support drilling operations as they provide detail of the Premier Oil expectations for HSES management on drilling projects in FIBU.

The FIBU HSES Drilling Standard can also be used as a template to generate a project specific drilling HSES Plan, defining the health, safety, environment and security activities to be performed on a specific drilling project.

4.4 Project Specific Environmental Management Plan

The environmental impact assessment process is the first stage of the project where mitigation measures are identified to avoid or control adverse environmental impacts that may arise as a result of the project activities.

Premier Oil conducted an EIA in parallel with the project planning and design process and identified mitigation measures that could be implemented to reduce, where necessary, the project risks and impacts to acceptable levels. This process allows Premier Oil to ensure itself that there will be no significant impacts associated with the drilling activities, and that identified impacts will be reduced to As Low As Reasonably Practicable (ALARP) before requesting consent for the drilling campaign from the Falkland Islands Government (FIG) (Figure 16).

The monitoring and mitigation measures identified during the EIA process will be incorporated with any licence conditions issued by FIG post-consent and, in conjunction with the drilling rig contractor and other key contractors, into a project EMP (Figure 16). It is essential that mitigation measures incorporated into the EMP are achievable and measurable.

The exploration campaign EMP will refer to specific procedures and standards within Premier Oil's HSES MS, and its contactors' HSE MSs, relating to drilling activities, waste management, control of contractors etc. The contractor will develop specific operational controls to ensure that measures are implemented at the appropriate phase in the project and in an effective manner (Figure 16).

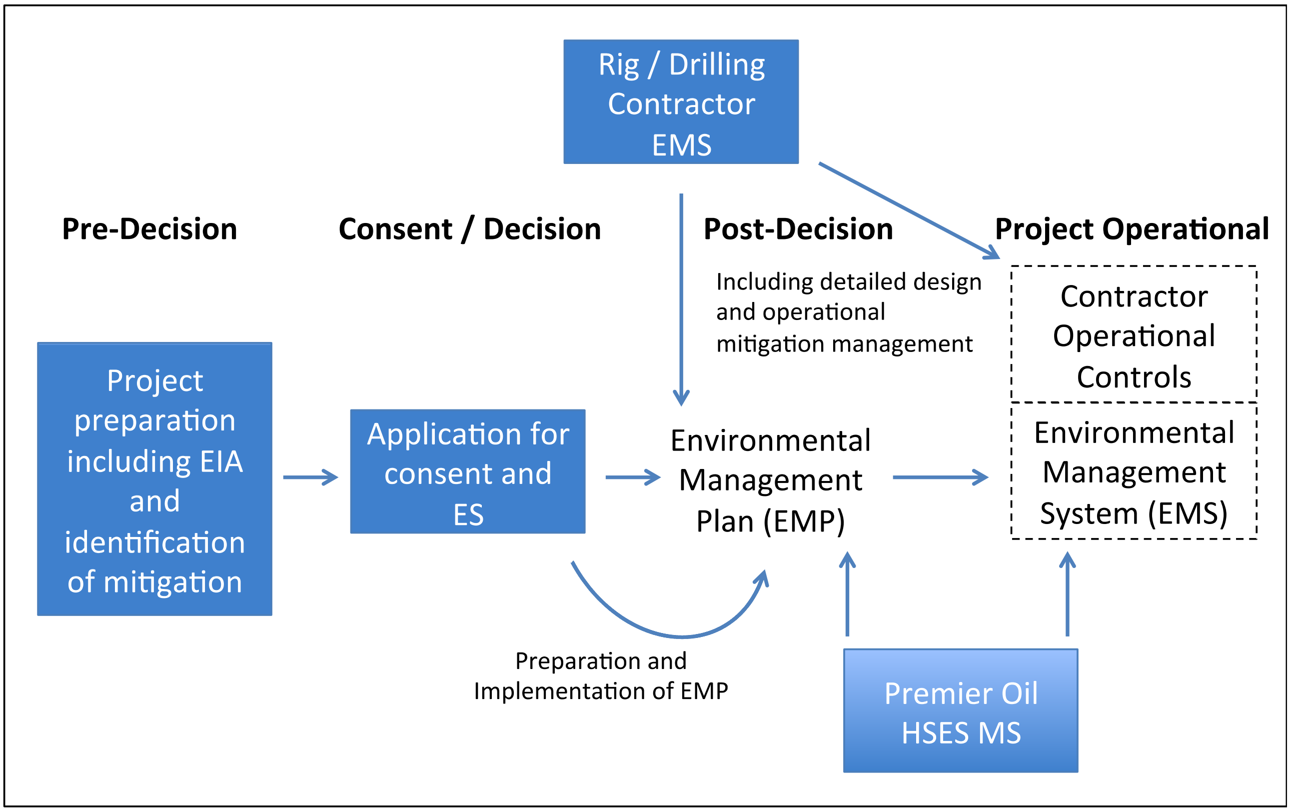


Figure 16: Link between Environmental Impact Assessment, Environmental Management Plan and Environmental Management System (adapted from IEMA, 2009)

4.5 Monitoring Measures

Monitoring is essential in determining the outcomes of the EIA. By incorporating feed-back into the EIA process, monitoring enables continual improvement in environmental performance. Specifically, monitoring is required to enhance understanding of the effectiveness of the EIA process, the knowledge of impacts and the success of mitigation in practice (IEMA, 2008). It is therefore necessary to identify monitoring requirements throughout the EIA process, which will:

- determine compliance with regulatory requirements standards and Government policies;
- provide an early indication should any of the environmental mitigation measures or practices fail to achieve acceptable standards;
- enable the project to take remedial action if unexpected problems or unacceptable impact arises;
- monitor the performance of the project and the effectiveness of mitigation measures:
- provide a database against which any short or long-term environmental impacts of the project can be determined;
- verify the environmental impact predicted in the EIA studies; and
- provide data to enable an environmental audit.

Priorities for monitoring should include:

- Those impacts for which significant impacts were predicted;
- Those impacts for which successful mitigation is essential for avoiding significance impacts; and those impacts for which there is a high degree of uncertainty in the impact predictions or in the likely success of the proposed mitigations.

The EMP will clearly state how the collection of monitoring data is intended to trigger corrective action should monitoring reveal that unacceptable environmental impacts are occurring.

4.6 Change Management

It is important for the EMP and its implementation to be able to accommodate changes and respond to a need for further assessment as it arises throughout the different project stages. Changes are most likely to occur for the following reasons:

- A new environmental sensitivity is identified as a consequence of changing environmental conditions / evolving trends or following further more detailed survey; or
- Changes are introduced to the drilling operations / engineering design.

Premier Oil's FIBU HSES Manager will be responsible continuously developing and improving the HSES MS to ensure it addresses the scope of the FIBU activities. If and when scope changes occur, this will trigger an assessment of the potential environmental effects that could occur as a result of the change, and the subsequent development of any additional EMP actions, if required. The HSES Manager is responsible for providing feedback to the Drilling Superintendent to identify where improvements in HSES performance can be made throughout the project.

5.0 Environmental Baseline Description

5.1 GAP Analyses (Data Gaps)

The Falkland Islands Offshore Hydrocarbons Environmental Forum (FIOHEF) was established in 2011 in order to provide a setting for debate and discussion on environmental issues relating to current and future hydrocarbon activities in the Falkland Islands. FIOHEF established a subcommittee, the GAP Analyses Group, to examine the data gaps that need to be filled in order to better inform and monitor the potential impacts to the environment from offshore hydrocarbon activities operating in the Falkland Islands. It was agreed that the priority areas that need examining include; littoral/sublittoral environments, offshore benthic ecosystems, oceanography in relation to oil spill modelling, seabirds, pinnipeds and cetaceans. This section provides a summary of the Environmental Forum GAP analyses programme.

The Gap analysis programme will be led by the Director of the South Atlantic Research Institute (SAERI), supported by two project officers who will co-ordinate different aspects of the project. One project officer will co-ordinate the seabird and marine mammal aspects of the work and the other will be responsible for review, consolidation and curation of oceanic, benthic, inshore and fisheries related data. It is intended that the project will be Falkland Islands led with the work conducted in the Islands to enable close consultation with stakeholder groups, and that international researchers will be engaged in this process through workshops and collaborative peer review so the work has international standing and transparency.

Data gaps have been identified for each of the priority areas and according to the urgency with which they are required have been classified into one of three categories:

1. High priority data – Immediate action required (<1 year)
2. Medium priority data – short-term action (1-5 years)
3. Low priority data – long-term action (5-10 years).

This data will be ultimately used to inform robust Environmental Risk Assessments (ERA) for proposed operations associated with the oil and gas industry. As much of the data will take a number of years to collect, in the short-term existing data will be collated and used to perform simple qualitative assessments through an expert-led/drive process. These simple assessments could be used to provide initial information for use in upcoming EIAs. Meanwhile the highest priority data gaps (such as targeted tracking) will be simultaneously commenced. A further robust ERA will be conducted on completion of the gap analysis work (or periodically updated as key data becomes available).

The GAP analysis programme will collate a centralised data repository to hold, manage and curate environmental data collected by the Hydrocarbons Industry and other organisations in the Falkland Islands. The Hydrocarbons Industry and other organisations have collected large amounts of information over the last twenty years whilst operating in the Falkland Islands that includes; oceanographic, metocean, seismic, benthic ecology, benthic environmental, multi-beam and RoV footage. Much of these data are held at different locations and the fate/location of some remains unknown. Collation of all of the relevant environmental data will provide wide spatial and temporal coverage for future EIAs; avoid duplication of work effort; increase the likelihood that these data will be used for future research activities and initiatives that could complement and enhance future EIAs; and increase environmental knowledge of the Falkland Islands continental shelf and slope.

5.2 Physical Environment

5.2.1 Licence Location and its Proximity to International Boundaries

The Drilling Campaign Area is located in the NFB, approximately 220 km north of the Falkland Islands, 770 km northeast of Cape Horn and 480 km from the nearest point on the South American mainland (Figure 17).

The Falkland Islands Exclusive Economic Zone (EEZ) extends up to 200 nautical miles from the Islands, and was designated as two successive fisheries conservation and management zones. Initially the FICZ was designated in 1986 and extends 160 nautical miles from the centre of Falkland Sound. The western boundary of the area roughly coincides with the eastern limits of the Argentine EEZ. In 1990 the Falklands Outer Conservation Zone (FOCZ) was designated, this area extends the conservation zone to a distance of 200 nautical miles from the nearest land and defines the eastern perimeter of the Falklands EEZ (Figure 17) (FIG DMR, 2013).

Oil and gas exploration and production licences are granted within the Falkland Islands Designated Exploration Area, the limits of which are based on the EEZ. The Designated Area is subdivided into Quadrants based on one degree of latitude by one degree of longitude (Figure 17), each of which is subdivided into thirty Blocks. The Sea Lion Field is located in Quadrant 14, within the northern boundary of the FICZ in Licence Blocks PL032 and PL04b (Figure 17).

5.2.2 Meteorology

Understanding the meteorology of the Falkland Islands and Drilling Campaign Area is highly important as the weather conditions throughout the year may have an impact on drilling activities or other oil-related activities; such as laying subsea equipment, or shipping to/from oil installations. This impact may be from extreme winds or foggy conditions, thus reducing visibility. There is very little meteorological data for the offshore Falklands waters, including the region of the Drilling Campaign Area (RPS Energy, 2009), however, RPS Energy collated and reviewed data from several sources.

The Falklands have a temperate oceanic climate, with predominantly westerly winds (RPS Energy, 2009; Anatec, 2013). Data collected during the Fugro Metocean Survey (1999) conducted on behalf of FOSA indicate that approximately 28% of prevailing winds are westerly, followed by approximately 24% being north westerly (Anatec, 2013). In general, the weather in the NFB (including the Drilling Campaign Area) is much less extreme than weather conditions south of 50°S, where the frequency of storms and squalls is greater (RPS Energy, 2009). The survey conducted by Fugro (1999) showed that between 65% and 80% of wind speeds measured in the Drilling Campaign Area were over 10 knots. Indeed, wind speeds of over 10 knots persisted for six days during one survey event, and the longest duration of wind speeds above 20 knots was for 38 hours (RPS Energy, 2009). Strong winds will influence sea conditions and wave height, which can make shipping and oil related activities difficult.

The Falkland Islands do not experience a broad range of terrestrial annual temperatures (RPS Energy, 2009). Generally, the mean annual minimum temperature experienced is approximately 3°C and the mean annual maximum temperature is approximately 10°C. Mean monthly temperatures vary throughout the year from -5°C to 20°C, but variability within air temperature over the sea is always much less variable than that over land.

Overall annual rainfall is on average relatively low within the Falkland Islands, however it is also consistent (RPS Energy, 2009). While the mean rainfall in Stanley is approximately 650 mm a year, there is less rainfall further north. Therefore, it is expected that mean annual rainfall within the Drilling Campaign Area should be less than 650 mm. Snow falls, on average, 11 days of each year, with a higher frequency occurring in August. Dense fog causing visibility less than 1 km within the Drilling Campaign Area is likely to occur for approximately 5% of the year (Anatec, 2013).

Due to the lack of weather data available for the Sea Lion area, Premier Oil have developed two hindcast weather models, both covering 20 years. A wind and wave model was developed for a wide area around the Falklands, and a current model was developed for the Sea Lion area only. The results were calibrated and verified against satellite and measured data, and confirmed previous wind, wave and current assumptions.

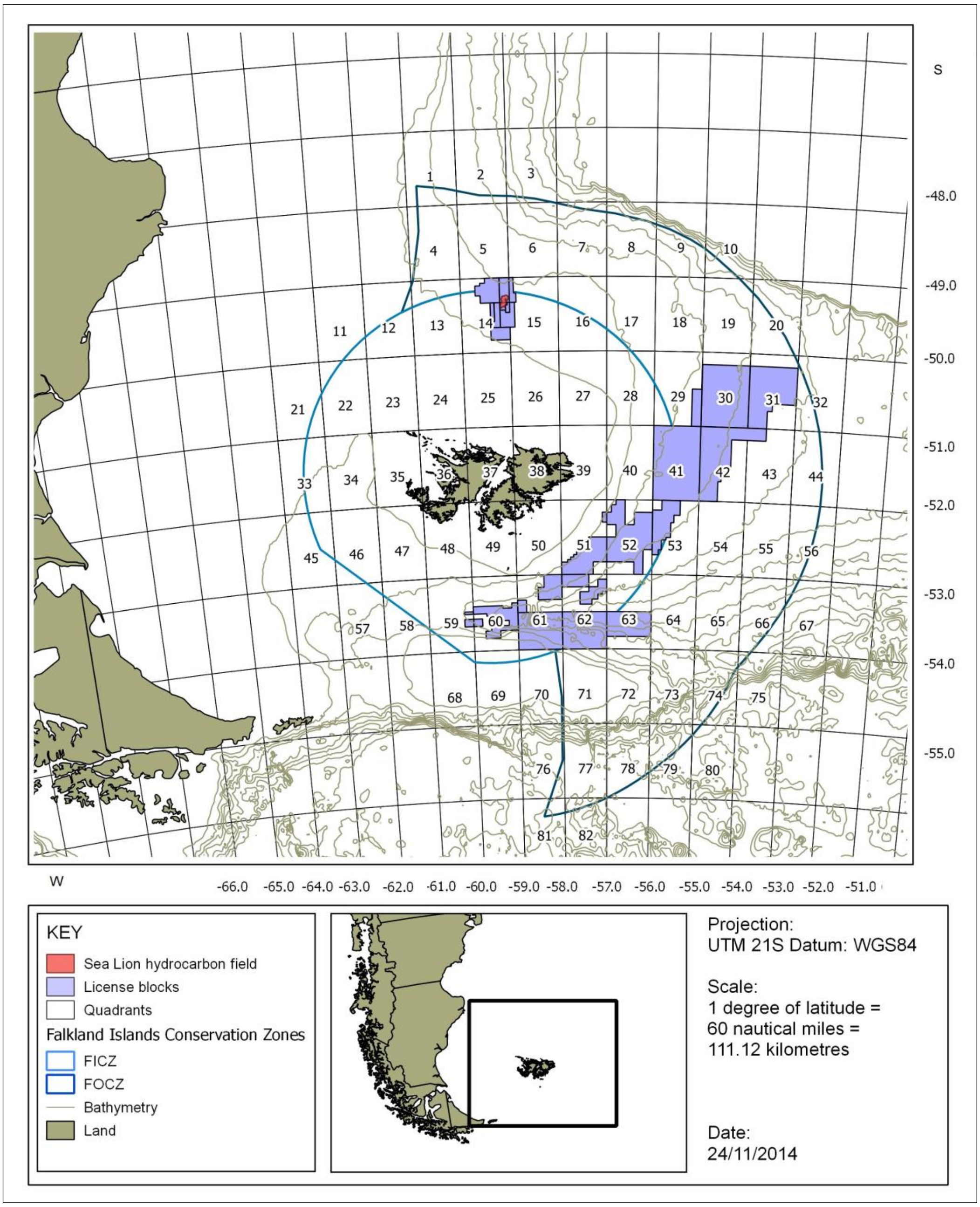


Figure 17**:** Drilling Campaign Area and Licence Block Location

5.2.3 Oceanography

5.2.3.1 Main Oceanographic Features on the Patagonian Shelf

The Patagonian Shelf is one of the most productive areas in the South Atlantic. Two marine ecosystems, the southern temperate ecosystem and sub-Antarctic ecosystem are separated by a transition zone running from the south-west to the north-east of the Patagonian Shelf through the Falkland Islands archipelago (Boltovskoy, 2000).

The productivity of the Patagonian Shelf is enhanced by the existence of several year-round tidal mixing fronts (Valdés Front, San Jorge Front and Bahia Grande Front) and seasonal fronts (Patagonian–Magellan Front and Tierra del Fuego Front) originating from cold fresh water inflows from the Strait of Magellan (Belkin et al., 2009; Alemany et al., 2011). On the eastern flank, the Patagonian Shelf edge is framed by the Falkland/Malvinas Current Front (FMCF, Belkin et al., 2009), which runs along the continental slope from 55ºS to 37ºS and comprises multiple smaller fronts running parallel to the shelf break (Franco et al., 2008). The main oceanographic feature of this front is the cold Falkland Current, which originates from the Antarctic Circumpolar Current (ACC) in Drake Passage and flows northwards (Peterson and Whitworth, 1989). The Current reaches the continental slope to the south of the Falklands and splits into two main northward-flowing branches (Figure 18). The western branch is the weaker with the eastern branch being the strongest (Bianchi et al., 1982). The upper 300 m water column in the Falkland Current consists of the Sub-Antarctic Surface Water mass (SASW) with deeper layers occupied by the Antarctic Intermediate Water mass (AIW) (Peterson and Whitworth, 1989).

5.2.3.2 Oceanographic Features on the Falkland Islands Shelf

A number of oceanographic fronts exist on the Falkland Islands continental shelf, primarily in areas to the south and east of the Falkland Islands. A number of fronts have been identified on the northern shelf, to date. Four frontal areas (Western Offshore Front; Western Inshore Front; Southern Front; North Eastern Front) have been identified in the southern part of the Falkland/Malvinas Current Front (FMCF) (between 54°S and 48°S) with well-resolved temperature and salinity gradients (Figure 18, Arkhipkin et al., 2013), interspersed by areas characterised by relatively smooth gradients (non-frontal zones). The FIG conduct oceanographic transects to monitor the Transient Zone across the frontal systems, and to monitor the strength of the Falkland Current (Figure 18).

The Southern Front is located to the south of the Falkland Islands near Beauchêne Island where the Falkland Current meets the continental slope. It causes a strong upwelling of SASW that mixes with the Shelf water mass forming the Transient Zone (TZ) at depths of between 120-300 m (Zyryanov & Severov, 1979; Arkhipkin et al., 2004a). This front forms one of the most productive areas in Falkland waters and is utilised by squid and fish as a major feeding (Arkhipkin et al., 2004a; Arkhipkin et al., 2003) and spawning ground (Arkhipkin et al., 2010). The location of the Transient Zone on the shelf fluctuates both seasonally and inter-annually due to the variation in the intensity and position of the Falkland Current, which in turn influences the distribution of *Loligo* squid (*Doryteuthis gahi*), (Arkhipkin et al., 2004b).

The Western Offshore Front (WOF) and Western Inshore Front (WIF) represent the areas of mixing of the western branch of the Falkland Current with Patagonian Shelf waters (WOF) and Falkland Shelf waters and TZ (WIF). The Southern Front (SF) and North East Front (NEF), appear when the eastern branch of the Falkland Current meanders onto the shelf and mixes with Falkland Shelf waters. There is also no major counter current in the region, unlike the northern part of FMCF, where the Falkland Current meets with the warmer Brazil Current, creating multiple parallel counter flows along the shelf break (Acha et al., 2004; Belkin et al., 2009).

The northern part of the FMCF (37-38°S) shifts seasonally, offshore in summer and inshore in spring and autumn (Carreto et al., 1995). Similar shifts of at least two fronts (WOF and NEF) were observed in the southern part of FMCF (Arkhipkin et al., 2013). It is suggested that the offshore shifts of those fronts are a result of seasonal offshore movements of shelf waters. WIF and SF are also quasi-stationary throughout the year. The mixing of shelf waters with SASW waters on the western side of the Falkland Current creates a band of increased primary productivity, indicated by higher concentrations of chlorophyll-a (chl-a) especially in spring and summer. This is known as the Patagonia High Chlorophyll Band (PHCB). The distribution of chlorophyll-a in PHCB is patchy and depends on seasonal variability in upwelling intensity along FMCF (Romero et al., 2006).

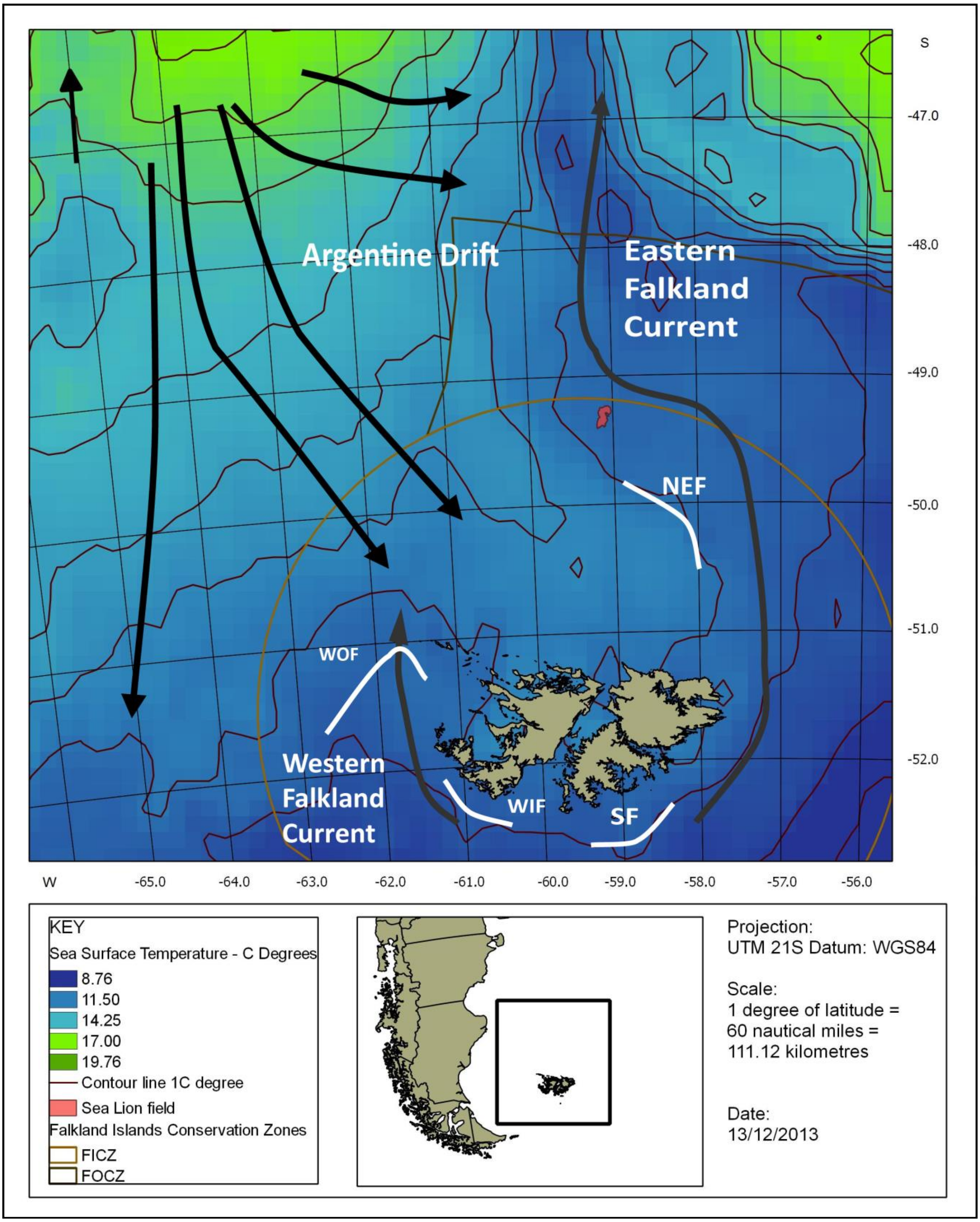


Figure 18**:** Main Patagonian Shelf oceanographic features overlain on Sea Surface Temperature map, March 2008.

WOF = Western Offshore Front; WIF = Western Inshore Front; SF = Southern Front; NEF = North Eastern Front. Adapted from Arkhipkin, A., Brickle, P. & Laptikhovsky, V., (2013).

5.2.3.3 Oceanographic Features in the Drilling Campaign Area

During the environmental baseline survey of the Drilling Campaign Area in March and April 2012 (over a one month period) water column characteristics were measured using a CTD (conductivity, temperature, and depth) probe, over 47 deployments, to produce water column profiles for the field (Gardline, 2013).

Vertical profiles for temperature, salinity and dissolved oxygen from the 47 CTD deployments were interpolated across horizontal depth horizons at 400 m, 200 m, and 10 m. Temperature and salinity were used to identify the main water masses and their derivatives (Bianchi et al., 1982; Peterson and Whitworth, 1989) (Figure 19). It is acknowledged that water column dynamics and the dynamics of water masses in the area can change over time so this is an illustration of the general water mass pattern in the area.

The Drilling Campaign Area is located within the near shore area of the Northern Slope (NS), this region is covered by a transition zone between Patagonian Shelf waters and the superficial sub-Antarctic surface water (SASW) mass of the Falkland Current. Temperature-Salinity profiles highlight the SASW water mass of the Falkland Current (Figure 19). There is only slight seasonal variation in temperature (4.8–5.5°C with the maximum observed in April to May) and salinity (34·06–34·11 parts per thousand (ppt)). The offshore deeper part of the NS is covered by the SASW mass with small variations in near-bottom temperatures (4.1–4.3°C) and salinities (34.1–34.2 ppt) (Arkhipkin et al., 2012a).

Generally, a well-mixed surface layer was observed in the CTD data for the Drilling Campaign Area to a depth of c.40 m. Below 40 m depth a distinct thermocline was observed to approximately 80 m, below which temperature decreased gradually to the seabed. Broad trends were observed for temperature, dissolved oxygen and pH, which decreased with depth. Turbidity was slightly higher in the mixed surface layer than the body of water below, immediately below the thermocline (Gardline, 2013).

During the course of 2014 Premier has taken steps to improve on the existing oceanographic data sets on which predicted oil spill modelling has been based. A new coupled inshore tidal and oceanographic circulation model is under development and is due to be fully completed in 2015. This has been undertaken by collaboration between BMT Argoss, BMT WBM and the UK Met Office. A Specification Report is available on request (SeaLion Hydrodynamic Modelling Model Specification, Ref: A14043, Sept 2014). The Fisheries Dept and other stakeholders have reviewed the model set up and are collaborating with PMO by providing historic data for model ground truthing.

PMO is committed to continuing to improve the model when new oceanographic data becomes available from third parties and to also seek cost effective solutions to gather further data themselves for model validation.

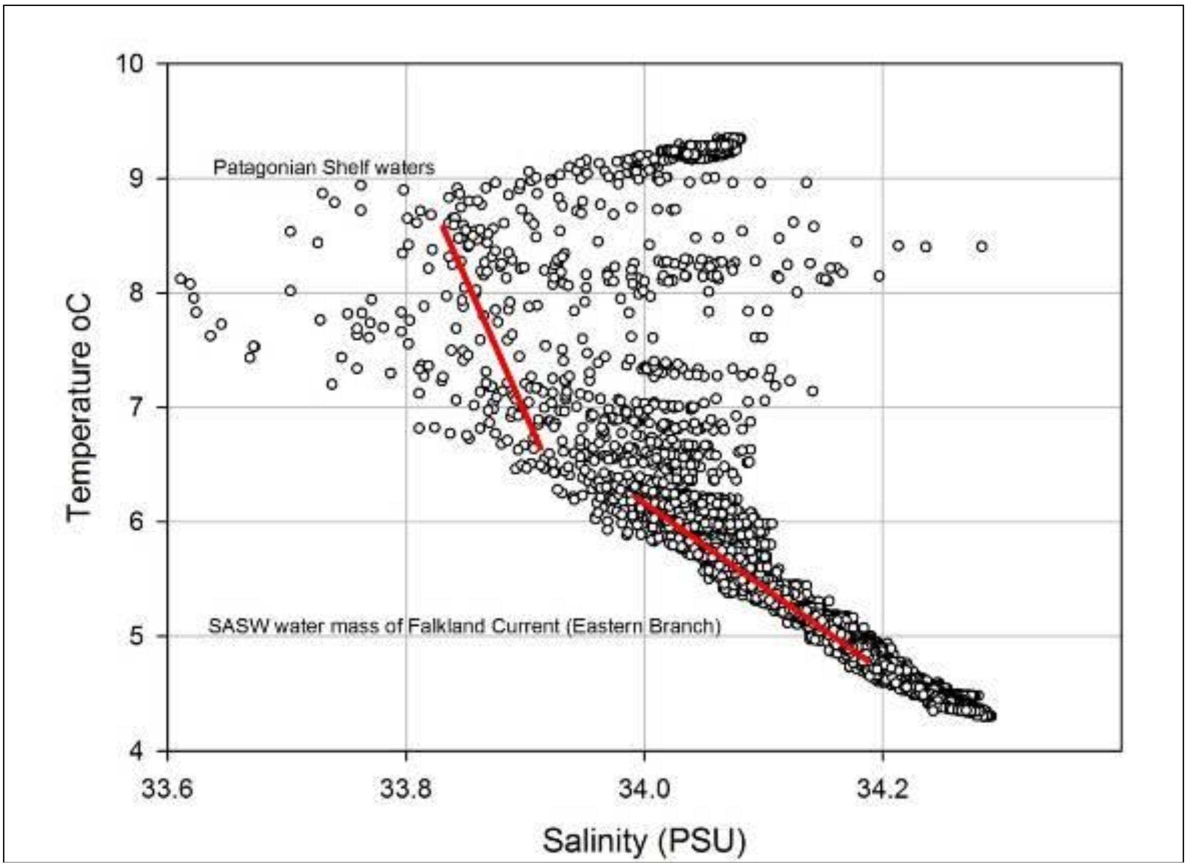


Figure 19**:** Temperature –Salinity plot from CTD Data Collected in the Drilling Campaign Area in March and April 2012 (Gardline, 2013)

5.2.4 Bathymetry

The Patagonian continental shelf is one of the largest and flattest continental shelves in the world. Its width varies from a few kilometres at 55°S, south of Staten Island on the tip of Tierra del Fuego, to 850 km width along the latitude of 51°S (Martos and Piccolo, 1988). The Falkland Islands are situated on the Patagonian Shelf approximately 700 km off the Argentine coast, between latitudes 52°53'S and 51°S (Figure 17).

To the south and east of the Islands the shelf slopes steeply into the Falkland Trough (Platt and Philip, 1995), which is a west-east trench reaching depths greater than 3,000 m and extending 1,300 km from the South American continental shelf to the Malvinas Outer Basin (Cunningham et al., 2002). South of the Falkland Trough is the Burdwood Bank, which is a large plateau rising to 50 m below the surface and forms part of the regionally dominating Scotia Ridge. There are two major channels crossing the Scotia Ridge that facilitate inflows of the Falkland Current from the ACC. The western channel is 80 km wide and 400 m deep connecting the Scotia Basin with the Falkland Trough between Staten Island and the western Burdwood Bank. The eastern channel connects the Falkland Trough to the Scotia Basin at 55°W east of the Burdwood Bank; the channel is 130 km wide and 1,800 m deep (Guerrero et al., 1999).

The area to the west of the Falkland Islands is a north western extension of the Falkland Trough that gradually narrows and reduces in depth as it moves northwards onto the shelf break at the northwest tip of the Falkland Islands.

To the north the continental shelf extends for approximately 200 km beyond the Falkland Islands, representing its widest point, and leads into the steep sloping Falkland Escarpment. The NFB is the area of continental shelf located between the Falkland Islands and the Escarpment. The NFB is characterised by a gently sloping gradient that increases in water depth from 150 m in the southwest to 1,500 m to the northeast (Otley et al., 2008). The Drilling Campaign Area lies within the central area of the NFB in water depths ranging from 330 m to 463 m (Gardline, 2013a; MG3, 2014).

The seabed in the NFB is characterised by numerous indentations, troughs and trenches. Bathymetric surveys conducted over the NFB indicated the presence of poorly preserved iceberg keel scars, numerous depressions between 4 and 11 m deep, trenches 30 m deep and 500-600 m wide, and furrows or channels commonly up to 1.5 km wide and extending up to 210 km long (Gardline, 1998a-h).

The bathymetric survey of the Drilling Campaign Area indicated that historic iceberg keel scars and seabed pitting were prevalent throughout the area. A larger trench runs from the southwest to the east of the Drilling Campaign Area survey area (Figure 20).

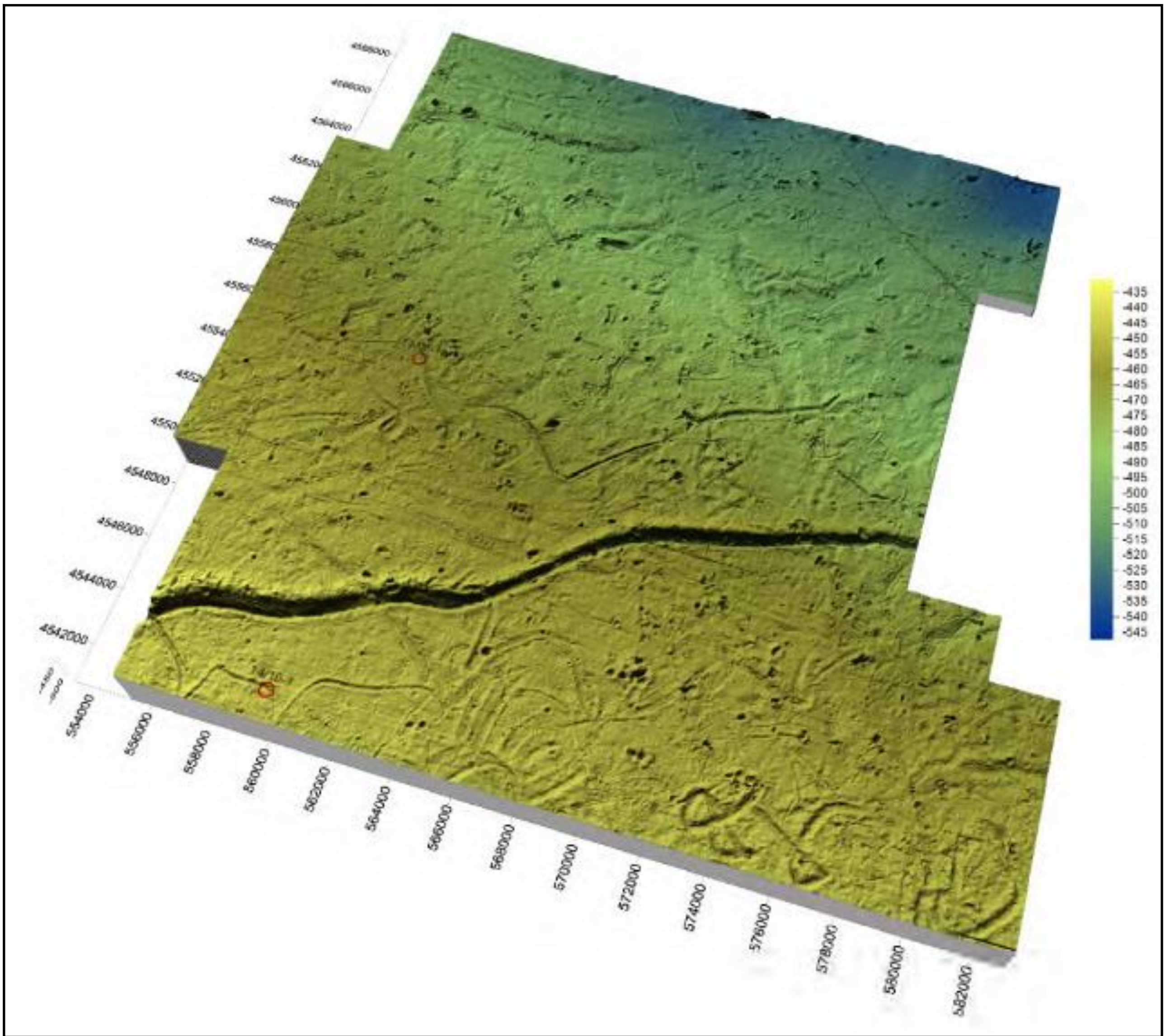


Figure 20: Drilling Campaign Area and Licence Block Location

5.2.5 Geology

Subsurface Description

The NFB is the name given to the set of sedimentary basins that lie to the north of the Falkland Islands (Richards and Fannin 1997). It consists of two main sub basins; A Northern Rift Basin (NRB) in which the predominant strike of the structural elements is N - S in orientation and a Southern Rift Basin (SRB) in which the predominant strike of the main structural elements is NW - SE in orientation. The main graben of the NRB is about 150 km long and 50 km wide at its northern end.

The NRB is an Early Cretaceous rift basin in which the east to west extension is related to Pacific margin subduction and Gondwana break-up (Atlantic opening) (Underhill and Lhor 2013). The basin is infilled by Berriasian to Hauterivian syn-rift fluvio-lacustrine sediments, overlain by post-rift (Barremian to Aptian) lacustrine organic claystones and shales interspersed with turbidite sandstones. This in turn is overlain by transitional marine to marine Late Cretaceous and Tertiary sediments. It is the Early Cretaceous post-rift sequence that forms the prospective interval being targeted by the 2015 exploration drilling campaign.

The exploration Drilling Campaign Area is located on the northeast margin of the NRB approximately 220 km north of the Falkland Islands in close proximity to the Sea Lion Field. The Sea Lion Field was discovered in May 2010 by Rockhopper Exploration with well 14/10-2 which encountered oil reservoired in good quality Lower Cretaceous turbidite sandstones that form a series of deep water basin floor fans deposited into a stratified anoxic lake (Richards and Hillier 2000, Holmes et al 2011). Following discovery of the Sea Lion Field, the area was appraised by eight wells (and two sidetracks), which helped delineate the extent of the Sea Lion accumulation and in addition proved the presence of hydrocarbons in three younger fans (Casper, Casper South and Beverley). The main sediment source for the fans originated from flanking basement highs (primarily to the east), which connect into the main graben depo-centre via a series of feeder canyons or channels. Fans are highly sand-prone and were constructed by intrusive density flows. Deposition occurred from both turbidity currents and mass flows (for example, fluidized sediment-gravity flows).

The same play is being targeted in the 2015 exploration drilling campaign. Based on 3D seismic data, the exploration prospects have similar geometries and depositional characteristics to the existing discoveries. The charge of the prospects is believed to be from the same lacustrine source rock as Sea Lion via similar migration pathways; accordingly the predicted hydrocarbon phase for the exploration targets is oil with a similar quality and gas oil ratio (GOR) to the Sea Lion discovery.

5.3 Sea Lion Environmental Surveys

5.3.1 Environmental Survey Review

Premier Oil and their partner, Rockhopper Exploration, conducted an area wide environmental baseline survey of the Sea Lion Field component of Drilling Campaign Area in the NFB in 2012 to determine the physical, chemical and biological character of the environment in support of future development of the area. In addition to the area wide survey, specific well site surveys comprising 6-8 stations each were conducted for five historic well sites drilled in Quadrant 14 of the Sea Lion Field component of the area.

Several other environmental surveys have been conducted in the vicinity of Drilling Campaign Area and further afield on the Falklands continental shelf, which provide background and contextual data for comparison with the Sea Lion area. Table 10 provides a summary of survey and drilling activities conducted on the Falkland Islands waters to date.

Table 10: Summary of Falklands Islands Drilling and Environmental Survey Activities

Year	Activity - Survey / Drilling	Region	Operator/Reference
1998	Environmental baseline survey – pre-drilling 'Little Blue' 14/09; 'B1' 14/05; Well 14/14, Well 14/23; 'Braela' 14/24, Well 14/19a; 'Minke' 14/13-B; 'Galapagos' 14/09.	NFB	FOSA, Gardline 1998 a-i
1998	Drilling campaign – 6 wells	NFB	FOSA
1998	Post-drilling environmental survey – 1 well site 'Little Blue' (14/09)	NFB	FOSA, Gardline 1998h
2008	Regional environmental baseline survey – pre-drilling. SFB: Quadrants 61 and 62. Southern NFB: Quadrants 25 and 26.	SFB, southern NFB	Desire Petroleum Plc., Benthic Solutions, 2008
2009	Environmental baseline survey four proposed well sites – EFB: Endeavour (31/13), Loligo (42/02), Nimrod (41/29), SFB: Toroa (61/05)	EPB, SFB	BHP Billiton, Fugro Survey 2009
2010-2011	Drilling campaign – 16 wells Drilling – 1 well	NFB FPB	Rockhopper, Desire BHP Billiton
2011	Environmental baseline surveys five proposed well sites – Hero (31/18), Inflexible (60/15), Loligo NW (42/02), Scotia East (31/13), Vinson West (53/16	EPB, SFB	FOGL, Gardline Survey 2011
2012	Drilling campaign 2 wells Drilling campaign 2 wells	SFB EPB	Borders and Southern FOGL
2012	Sea Lion Pre-development area wide survey, Sea Lion Post-drilling environmental survey – 5 historic well sites	NFB	Rockhopper, Gardline 2013 a and b

Figure 21 and Figure 22 show the location of the 2013 Sea Lion environmental baseline and post-drilling survey locations, and the majority of the other environmental survey on the Falklands continental shelf.

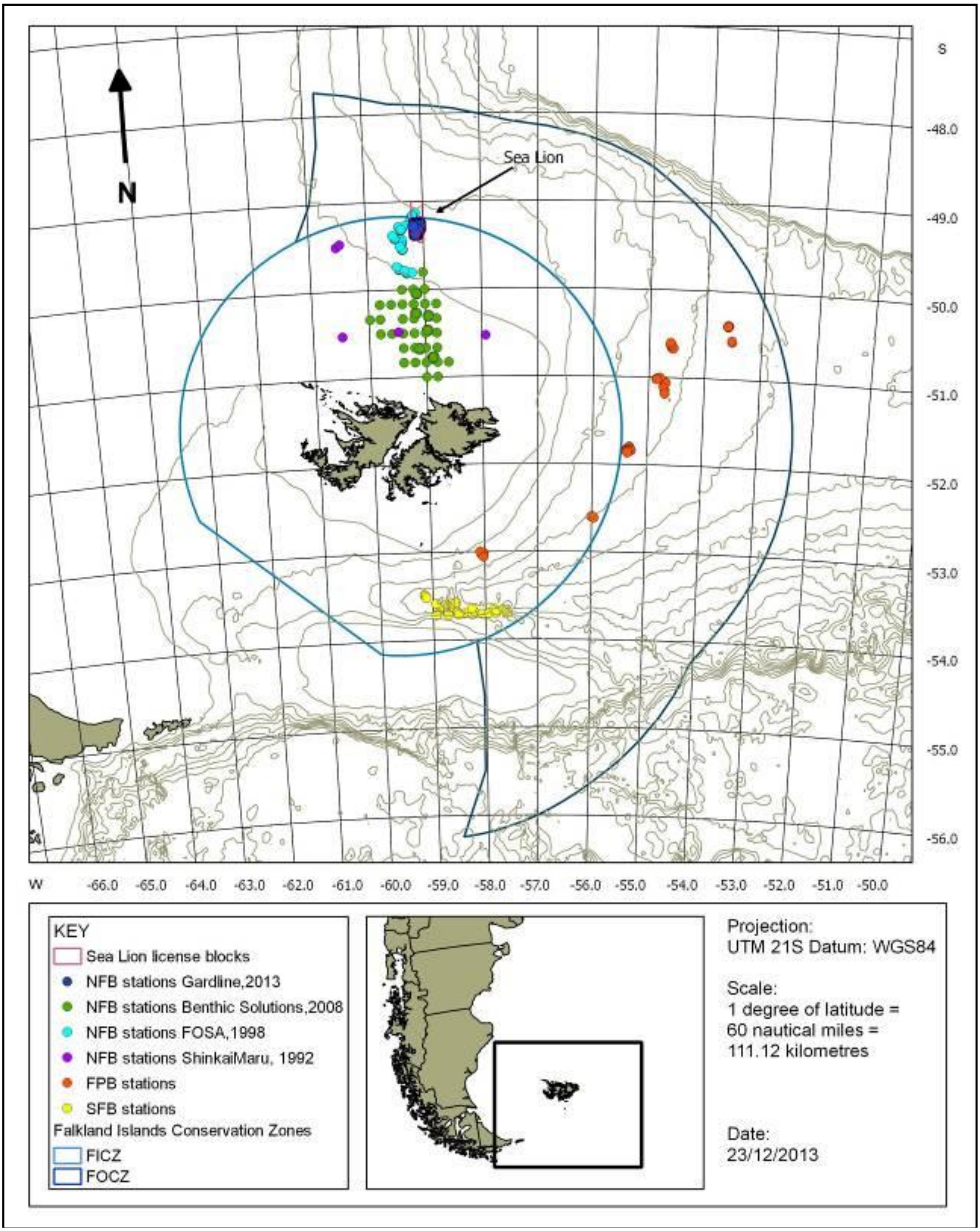


Figure 21: Summary of Environmental Survey Locations on the Falklands Continental Shelf

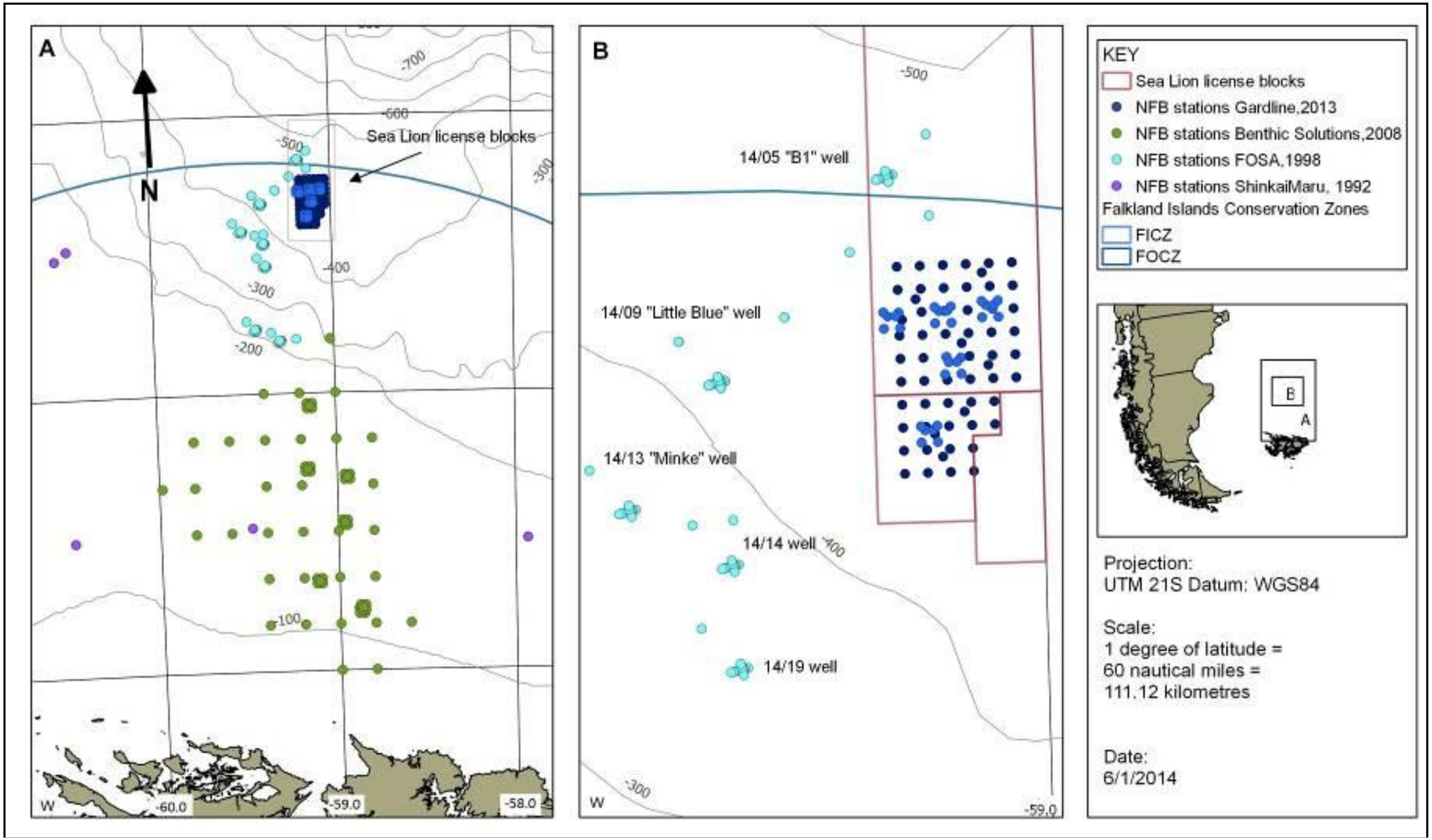


Figure 22: Environmental Survey Locations in the Exploration Drilling Area and the North Falkland Basin

5.3.1.1 Sea Lion Pre-Development Environmental Baseline Survey and Post Drilling Survey (2013)

Nine wells were drilled in Licence Blocks PL032 and PL004 during the 2010-2011 NFB drilling campaign, which subsequently led to the discovery of the Sea Lion Field. In 2012, Gardline Environmental Limited were commissioned to conduct an area wide environmental survey of the Sea Lion area to characterise the current environment prior to further drilling and field development being undertaken (Gardline, 2013a). In addition to the area wide pre-development survey, Gardline also conducted a post-drilling survey around five historic well locations within the licence area (four Rockhopper wells 14/10-2, 14/10-6, 14/10-9, 14/15-4a, and one Shell well 14/10-1) (Gardline 2013b). The objective of the post-drilling survey was to assess the extent and severity of the impact of previous exploration drilling activities to the seabed sediments and associated benthic community.

The pre-development survey area was divided into a grid covering a total area of 140 km^2, with 54 sample stations positioned at 2 km intersections (Figure 22). Each post-drilling well site survey comprised 12-14 stations in a cross formation centred over the well site, with two stations positioned on each of the northwest and northeast arms of the cross and one station positioned on each of the southwest and southeast arms of the cross (Figure 22). Where possible, stations from the 2 km grid were used as additional post-drill stations and included in the post-drill survey report. Each station was sampled for a suite of environmental parameters including: CTD casts to profile the temperature, salinity, dissolved oxygen, turbidity and pH of the water column; chlorophyll, to measure primary productivity in surface waters; photographs of the seabed to identify potentially sensitive habitats; box core samples to identify macrofauna, sediment hydrocarbon, heavy metal concentrations and particle size. Table 11 summarises the samples collected from both the pre-development area and the post-drilling well sites.

Table 11: Summary of Environmental Sampling Parameters

Survey	Total No. Stations	CTD	Chlorophyll	Habitat Assessment	Box Core Sub-Sample			
					Fauna	Hydrocarbon	Metals and Organics	Particle Size
Pre-development Grid	54	16	10	54	54	54	54	54
Post-drilling well site	32	30	0	0	32	32	32	32

5.3.1.2 North Falkland Basin FOSA Pre-Drilling Survey (1998)

Exploration drilling in the NFB was first conducted in 1998, by a consortium of licence holders under a joint operating agreement, FOSA (Falklands Offshore Sharing Agreement). Seven exploration wells were drilled in the NFB during the 1998 campaign. Prior to the drilling campaign, Gardline (1998a) (on behalf of FOSA) conducted an environmental baseline survey at each of the proposed well locations to describe the natural sediments and benthic communities prior to drilling activities and to provide a basis for future monitoring (Figure 21 and Figure 22). Twelve sample stations were positioned along a standard cruciform template, centred on each well location with the long axis aligned with the dominant current direction. Between one and three reference stations were sampled at >8,000 m from each of the proposed well locations. All stations were sampled using a Day grab, with three grab samples taken for macrofaunal analysis and one for physico-chemical analysis including granulometry, hydrocarbon and metal analysis.

The FOSA well sites and corresponding survey locations were generally located in a north-south orientation across the NFB, in water depths ranging from 215 m in the south to 482 m in the north. Whilst these surveys were not taken directly within the campaign drilling area, they were conducted within 48 km of the area, and therefore provide information for indicative background sediment chemistry and wider faunal community for the area. Of the FOSA survey sites the ‘B1’ Block 14/05 well was located approximately 8 km from Sea Lion, and the ‘Little Blue’ Block 14/09 well and the Block 14/14 well were both located within 16 km of the Sea Lion Field (Figure 22).

One of the historical well sites (‘Little Blue’) was re-surveyed post drilling activity to assess the impacts from drilling related discharges at the site (i.e. water based mud and cuttings). The survey concluded that there was no evidence from species composition to suggest that the area was polluted. Whilst most physico-chemical sediment parameters had increased slightly since drilling, these did not fall outside the range indicative of uncontaminated sediments for the area. The report concluded that drilling activity had had little if any impact on the fauna at the site (Gardline, 1998i).

5.3.1.3 Southern North Falkland Basin (2008)

In August and September 2008, Desire Petroleum PLC, Rockhopper Exploration PLC and Arcadia Petroleum Limited commissioned Benthic Solutions Limited, to conduct an environmental survey over a regional area of the southern NFB in water depths ranging from 140 m to 285 m (Figure 21 and Figure 22). Benthic sampling was undertaken at a total of 77 stations relating to seven proposed exploration well sites. The survey design comprised 38 near-field stations around the well locations and 32 regional stations. The objective of the survey was to analyse and interpret physico-chemical properties of the sediments and macrofaunal communities to provide a regional baseline and context from which to later compare well-specific surveys. Sediments were collected using a double Van Veen grab (comprising two grabs within a single frame). Two grab deployments were made at each station to collect the required four samples, of which three were processed for macrofaunal analysis and one for physico-chemical parameters, including granulometry, hydrocarbon and metal analysis.

5.3.1.4 Other Surveys Around the Falkland Islands

A number of environmental baseline surveys have been conducted around other areas of the Falklands Conservation and Management Zones. In particular, Benthic Solutions conducted well site environmental surveys in the Burdwood Bank area of the South Falkland Basin (SFB) on behalf of Boarders and Southern Petroleum, in 2008. Water depths over the survey area ranged from 1,200 m to 2,100 m.

Environmental baseline surveys were conducted at three proposed well locations in the East Plateau Basin (EPB) and one location on the SFB during 2009 and an additional three locations in the EPB and one in the south during 2011.

During 1978 and 1979, several exploration surveys were conducted throughout the Argentine Continental Shelf including the region around the Falkland Islands. Analyses of benthic samples from these surveys were used to describe the main faunal assemblages on the continental shelf from which three main biogeographic provinces were identified. The provinces comprised the Argentine, Patagonian and Malvinean province, the latter is primarily influenced by the Falklands Current (Bastida et al., 1992).

Detailed results of these surveys have not been considered in the baseline assessment of the Drilling Campaign Area. The sampling stations on the Falkland Islands continental shelf were between 95 and 157 km from the Drilling Campaign Area and located in <200 m of water and as such were not considered to be representative of the habitats and communities at 450 m in the Drilling Campaign Area (Figure 21).

5.3.2 Benthic Soil Characteristics

The Falkland Islands are relatively immature in terms of oil and gas production and whilst 24 exploration wells have been drilled there is currently no oil and gas production underway in the region, hence typical background sediment chemistry datasets have not been formally characterised. However, 20 environmental surveys have been conducted within the three main Falklands basins (Appendix A). These surveys cover a range of depths from 140 m to 2,100 m and a range of metocean conditions predominantly influenced by the East Falklands Current as it flows northwards to the east of the Falkland Islands. These datasets have been used to provide comparative data for the campaign drilling area.

A summary of the mean chemical composition of Sea Lion sediments and comparable datasets from around the Falklands continental shelf is presented in Appendix A, results indicated that Sea Lion sediments were comparable to those within the wider Falkland Islands waters. Full chemical analysis is available in the Environmental Baseline and Post-drilling Survey Report (Gardline, 2013a and b).

5.3.2.1 Sediment Types

Sediments across the NFB typically exhibit a south-north gradient of decreasing mean particle size (Gardline, 1998a). The proportion of fine material, defined as material with a diameter less than 63 µm, generally increases with increasing depths, and the sediment types ranged from very fine sand in shallower waters (225 m depth) to the southwest, to coarse silt in deeper waters (464 m depths) to the northeast (Gardline, 1998a).

The Drilling Campaign Area lies in the northern sector of the NFB. During the 2012 environmental baseline area wide survey in the Sea Lion area, mean grain sizes ranging from 18 µm to 39 µm were recorded throughout the field, indicating that sediment types were generally homogenous (Gardline, 2013a). Sediments were predominantly classified as medium silt, with the exception of seven stations generally located in the northern part of the survey area that were classified as coarse silt.

The percentage of fine material was high (61.6 – 79.7%) at all stations across the Sea Lion area wide survey. These results were comparable to the sediment types recorded during the 1998 FOSA pre-drilling surveys conducted at ‘B1’ 14/05 and ‘Little Blue’ 14/09 wells (approximately 8.5 km and 16 km west of Sea Lion respectively) where fines accounted for 65.8% to 76.1% of sediment material (Gardline, 1998a, b). Results of the 1998 FOSA pre-drilling survey found similar proportions of gravel (0.0% to 3.1%) and suggested that the coarser material fraction was primarily attributed to pea sized sub-surface gravel originated from glacial drop-stones (Gardline, 1998a).

Post-drilling well site surveys across the Drilling Campaign Area contained similar proportions of fines, sands and gravels to the area wide survey (Gardline, 2013a and b). Whilst the highest variation was associated with the gravel fraction (>2 mm), which ranged between 0.1% and 10.3% contribution, this was attributed to natural variation across the area, and may originate from glacial drop-stones as found in the FOSA area, as analysis of other parameters did not indicate any disturbance from previous drilling activities. In the shallower waters of the southern NFB (140-285 m depths) the sediments were dominated by coarser sand particles, with a mean grain size of 156.5 µm (Benthic Solutions, 2008).

5.3.2.2 Total Organic Matter and Organic Carbon Analysis

Organic matter in marine sediments is generally dominated by the flux of surface derived phytodetritus (decomposing phytoplankton and other plant material) to deeper water sediments. Terrestrial inputs from rivers and other marine biogenic material also contribute to the organic matter and composition of continental shelf sediments. Sediment total organic matter (TOM) and total organic carbon (TOC) were measured in samples from the Sea Lion area of the Drilling Campaign Area as a percentage of total sample weight. Both parameters were generally found to be homogeneous across the Sea Lion area with measured mean TOM values of 5.6% ±0.5 SD, and mean TOC 0.9% ±0.1 SD (Gardline 2013). Both TOM and TOC were found to positively correlate with particle size, with higher proportions of organic matter recorded at stations with higher percentage of fines ($P<0.001$). This relationship is linked to both the rate of sedimentation (detrital rain) from surface waters and the hydrodynamic regime, whereby lower concentrations of organic matter are generally found in sandier sediment where surface sediments indicate some mobility and consequently reduced percentage fines.

The level of organic matter showed low variation across Sea Lion area post-drilling well site surveys with an overall TOM mean of 5.4% (±0.4 SD) and TOC mean of 0.9% (±0.1 SD) (Gardline, 2013b), which are comparable to the levels from the area wide survey. Both TOM and TOC were also found to positively correlate with the percentage fines, suggesting that organic matter content was associated with natural variation in the proportion of fines in the sediment.

Values for TOM were similar to those recorded during the FOSA 1998 pre-drilling survey for the 'B1' 14/05 well and the 'Little Blue' 14/09 well (mean 5.7% ±0.5 SD and 4.3% ±1.9 SD respectively) (Gardline, 1998a, b), which were the closest to the Sea Lion Field and located in comparable depths (415-482 m), further indicating the homogeneity of this area of the NFB. In the southern NFB the level of total organic matter remained consistently low throughout the survey area (1.7% ±0.4 SD) perhaps reflecting the reduced proportion of fines and mobile sandy sediments of the shallower waters (Benthic Solutions, 2008). Survey data from similar depths on the South Falklands Basin (SFB) at the proposed Toroa well site (571-702 m) indicated comparable levels of TOM and TOC (6.0 ±0.8 SD and 0.73% ±0.05 SD respectively) to the Sea Lion Field area.

5.3.2.3 Seabed Chemistry

Total Hydrocarbon Concentrations

Hydrocarbons in marine surface sediments may have originated from a number of sources, including terrestrial run-off in coastal areas, vessel spills and discharges, plant origin, natural seeps and hydrocarbon extraction.

Total Hydrocarbon Concentrations (THC) ranged between 4.7 $\mu g.g^{-1}$ and 15.5 $\mu g.g^{-1}$ (mean 9.7 $\mu g.g^{-1}$ ±2.7 SD) across all stations in the Sea Lion pre-development area wide survey. Samples collected during the post-drilling survey exhibited THC levels within a similar range as the area wide survey, ranging between 3.5 $\mu g.g^{-1}$ and 17.2 $\mu g.g^{-1}$ with a mean of 8.5 $\mu g.g^{-1}$ (±2.9 SD). Overall no spatial trends were observed and the survey report indicated that THC levels were considered to be within natural ranges exhibited by background variation (Gardline, 2013a, b).

When comparing the results from the Sea Lion 2013 surveys (mean 9.7 $\mu g.g^{-1}$ ±2.7 SD and 8.5$\mu g.g^{-1}$ ±2.9 SD) to the adjacent 'B1' 14/05 well and the 'Little Blue' 14/09 well from the FOSA 1998 pre-drilling baseline survey, (mean 0.3 $\mu g.g^{-1}$ ±2.9 SD, and mean 0.1 $\mu g.g^{-1}$ ±0.1 SD respectively), mean THC levels from the 2013 surveys were notably higher than those from the 1998 surveys (Gardline, 1998a, b). Post-drilling survey results for the 'Little Blue' 14/09 well indicated an increase in THC in comparison to pre-drilling baseline levels but mean values were also notably lower (0.6 $\mu g.g^{-1}$ ±0.4 SD) than those from the Sea Lion survey.

Generally, the results from all seven FOSA survey locations exhibited low THC with the exception of the 'Minke' 14/13 well, located approximately 24 km southwest of Sea Lion, which recorded a mean THC 4.6 $\mu g.g^{-1}$ (±4.1 SD) (Gardline, 1998h). Similar levels were also recorded in shallower water depths (140-285 m) during the southern NFB survey in 2008 located >50 km south of Sea Lion (mean 4.3 $\mu g.g^{-1}$ ±1.4 SD) (BSL, 2008), although mean THC in both areas were low in comparison to Sea Lion.

Comparison of Sea Lion results to sediment means from other regions of the Falklands continental shelf, indicated that deeper (1,200-2,100 m), sandier sediments from the regional survey in the SFB recorded mean THC of 12.8 $\mu g.g^{-1}$ (±5.1 SD), and comparable water depths to Sea Lion (620 m) recorded a mean of 8.7 $\mu g.g^{-1}$ (±1.1 SD). Whilst mean THC ranging from 0.3 $\mu g.g^{-1}$ (±1.0 SD) to 5.4 $\mu g.g^{-1}$ (±1.0 SD) were recorded in sediments from the EPB in water depths of 1,300 m, suggesting that levels within the Sea Lion area were not above typical background levels for this region.

Hydrocarbon Composition

Unresolved Complex Mixture (UCM) is a fraction of hydrocarbons, which are not fully separated during gas chromatography (GC) and appear as a 'hump' on the GC trace. This unresolved fraction consists of a number of individual components, which remain after substantial weathering and biodegradation of petrogenic inputs (Farrington et al., 1977), and can provide an indication of the origin of contamination or the natural source. At the majority of stations across the Sea Lion component of the Drilling Campaign Area UCM accounted for the majority of hydrocarbons within the sediments, which is indicative of well-weathered hydrocarbon sources and suggests that the majority of the material did not originate from fresh hydrocarbon inputs from drilling activities (Gardline, 2013).

Of the resolved hydrocarbon fraction, n-alkanes account for the largest proportion of material. n-alkanes are straight chained, single bond saturated hydrocarbons ranging from 10 to 35 carbon chain lengths. The distribution of n-alkanes can be indicative of the hydrocarbon origin, typically the small n-alkanes (nC_{10}-nC_{20}) are derived from petrogenic sources, whilst the larger n-alkanes (nC_{21}-nC_{35}) are derived from biogenic sources. Total n-alkane concentrations were within similar ranges across both the Sea Lion pre-development survey and the post-drilling survey with means of 0.55 $\mu g.g^{-1}$ (±0.1 SD) and 0.67 $\mu g.g^{-1}$ (±0.4 SD) respectively. These values were moderately high in comparison to all of the FOSA 1998 pre-drilling baseline survey locations, and in particular for the adjacent 'B1' 14/05 well and the 'Little Blue' 14/09 well (mean 0.3 $\mu g.g^{-1}$ ±0.03 SD, and mean 0.02 $\mu g.g^{-1}$ ±0.01 SD respectively). As with THC, the mean levels of total n-alkanes at Sea Lion were more comparable to survey locations within deeper waters of the SFB (1.17 $\mu g.g^{-1}$ ±0.41 SD) and the EFB, which ranged from a mean of 0.25 $\mu g.g^{-1}$ (±0.06 SD) to 4.1 $\mu g.g^{-1}$ (±0.06 SD) for deeper water depths and a mean of 0.65 $\mu g.g^{-1}$ (±0.09 SD) in similar water depths to Sea Lion.

Individual n-alkanes were typically dominated by the heavier weight range (nC_{25} to nC_{37}), peaking in odd numbered carbon compounds nC_{29} and nC_{31}. Within the lower weight range (nC_{10}-nC_{21}), odd number n-alkanes were also dominant, albeit in lower concentration. This distribution suggests the presence of terrestrial derived n-alkanes from the wax layer covering the external surfaces of higher plants, which typically comprise the long-chain, odd carbon number n-alkanes (Eglinton et al., 1962); and a lower contribution of biogenic material from marine organisms (phyto- and zooplankton), which preferentially synthesize short-chain, odd number n-alkanes nC_{15} to nC_{21} (Blumer et al., 1971).

Sea Lion sediments exhibited a prevalence of odd over even numbered alkanes indicative of a mixture of biogenic and petrogenic hydrocarbon inputs, with a predominance of biogenic inputs. These biogenic inputs were likely to be derived from marine organisms associated with the highly productive surface water in this area of the South Atlantic and diffuse terrestrial plant sources (Gardline, 2013a). Petrogenic hydrocarbons may have been derived from various anthropogenic activities, such as the historic exploratory drilling activity in the area (Gardline, 2013b).

Polycyclic Aromatic Hydrocarbons

Monitoring the aromatic hydrocarbon type and content is particularly important due to the toxic nature (mutagenic/carcinogenic) of several of Polycyclic Aromatic Hydrocarbons (PAHs) even at very low concentrations.

PAHs and their alkyl derivatives have been recorded in a wide range of marine sediments (Laflamme & Hites, 1978) with the majority of compounds produced from what is thought to be pyrogenic sources. These are the combustion of organic material such as forest fires (Youngblood & Blumer, 1975), the burning of fossil fuels and, in the case of offshore oilfields, flare stacks, etc. The resulting PAHs, rich in the heavier weight 4-6 ring compounds, are normally transported to the sediments via atmospheric fallout or river runoff. Another PAH source is petroleum hydrocarbons, often associated with localised drilling activities. These are rich in the lighter, more volatile 2 and 3 ring PAHs (NPD; naphthalene, phenanthrene and dibenzothiophene).

Mean total PAH concentrations across the Sea Lion area were 0.12 $\mu g.g^{-1}$ (±0.02 SD), whilst mean PAH ranged from 0.10 $\mu g.g^{-1}$ (±0.03 SD) to 0.15 $\mu g.g^{-1}$ (±0.01 SD) at the post-drilling survey stations. Mean total NPD concentrations across the Sea Lion area were 0.05 $\mu g.g^{-1}$ (±0.01 SD), and mean NPD ranged from 0.04 $\mu g.g^{-1}$ (±0.01 SD) to 0.065 $\mu g.g^{-1}$ (±0.01 SD) at the post-drilling survey stations.

When compared to the FOSA 1998 pre-drilling baseline survey, the Sea Lion development area and post-drilling PAH and NPD concentrations were marginally higher than the FOSA stations, with the exception of the Minke well location, which exhibited mean PAH of 0.72 $\mu g.g^{-1}$ (±0.01 SD) and

NDP of 0.2 $\mu g.g^{-1}$ (±0.01 SD). Comparison on a wider regional basis indicated that samples from the SFB Burdwood Bank and Toroa surveys both PAH and NPD were approximately double the mean values recorded from the Sea Lion survey, whilst samples from the EFB were broadly comparable to those from the Sea Lion area (Appendix A, Table 1).

Analysis of PAH composition in Sea Lion area sediments indicated that they predominantly comprised the heavier molecular weight 4-6 ring fraction (the mean ratio of NPD to 4-6 ring PAH ranged between 0.65-0.75) and suggesting that they primarily originate from pyrogenic sources (Gardline, 2013 and b). Whilst there was no evidence of any point source contamination at any of the Sea Lion area stations, the presence of the lighter, more volatile 2-3 ring hydrocarbons is indicative of a minor source of petrogenic hydrocarbon, which may be associated with the relatively recent exploratory drilling activity, or natural diffuse hydrocarbon seeps (Gardline, 2013b).

Heavy Metals

Metals occur naturally in the marine environment and are widely distributed in both dissolved and sedimentary forms. Anthropogenic inputs of metals to the marine environment are primarily as components of industrial and municipal wastes and of particular relevance to the offshore oil and gas industry are drilling discharges, which can contain substantial amounts of barium sulphate (barite) as a weighting agent (NRC, 1983). Barite also contains measurable concentrations of heavy metals as impurities, including cadmium, chromium, copper, lead, mercury and zinc (NRC, 1983).

Generally concentrations of heavy metals across the Sea Lion area and from the post-drilling survey were within background levels observed at other locations on the Falklands continental shelf and therefore considered to be within natural variability for this region (Appendix A, Table 2). Lead (Pb) was the only exception where values from Sea Lion area were higher than those from the FOSA 1998 pre-drilling baseline survey, which were generally found to be below the levels of detectability.

When normalised to 5% Aluminium (Al), several of the metals (Copper - Cu, Nickel - Ni, Lead - Pb and Zinc - Zn) recorded significant negative correlations with mean particle size and sand, and positive correlations with fines. This suggests the metal concentrations within the survey area were largely associated with natural variation in physical sediment characteristics and therefore should be considered as background in concentration for this area of the Southern Atlantic (Gardline, 2013a).

Conclusions

There was no direct evidence of seabed disturbance or elevated concentrations of hydrocarbons and metals associated with historical drilling activity within the Sea Lion area, although some fractions of hydrocarbon may have been derived from contamination associated with the previous drilling activity. Subtle differences between stations were evident in the multivariate analyses associated with natural spatial variation across the area. Hydrocarbon, TOM, TOC and metal concentrations were considered typical of the medium and coarse silty sediments recorded in the Sea Lion survey area (Gardline, 2013b).

5.4 Biological Environment

Information and data for this section came from a number of sources including scientific peer reviewed literature, scientific reports, grey literature and data provided by a number of organisations. In addition the Falkland Islands Marine Biodiversity Archive (FIMBAr) was consulted. FIMBAr was a collaboration between the Marine Biological Association (MBA), the Shallow Marine Surveys Group (SMSG) and the South Atlantic Environmental Research Institute (SAERI). The project aimed to establish a marine biodiversity data archive for the Falkland Islands is supported by a Darwin Challenge Fund Award and ran from April 2012 until February 2013. By collating information from recent surveys and historical datasets it established a baseline dataset that can be used to map species distributions and inform future management of the marine environment (Davidson et al., 2013).

5.4.1 Marine and Inter-tidal Vegetation

Understanding the marine and inshore vegetation of the Falkland Islands is important as algae are one of the major primary producers in the marine environment. It is necessary to determine whether there are any species present that may be at risk from any oil-related activities or pollution. As yet, the marine environment, marine habitats and species of flora and fauna that exist within Falklands waters are poorly described and understood. It is possible that there are new, endemic species yet to be discovered.

There are many seaweed species around the Falkland Islands, primarily in inshore waters. Seaweeds within the Falkland Islands fall into one of three categories: brown algae (Phaeophyta), green algae (Chlorophyta) and red algae (Rhodophyta). The red algae include coralline, or encrusting, algae that secrete calcium carbonate. The most common species of macro algae within the Falklands are the giant kelp (*Macrocystis pyrifera*) and the tree kelp (*Lessonia* spp.), both of which are classed as brown alga, and are common in inshore, between 0.5 m to approximately 40 m depth. Only red algae are able to live and grow at greater depths than other seaweeds because their red pigmentation means they are able to absorb the blue light available at greater depths (max 30 m).

5.4.1.1 Giant Kelp (Macrocystis pyrifera)

Giant kelp is one of the largest seaweeds, classed as a “brown algae”, and most abundant in the Falkland Islands forming extensive beds along the coastlines (Tussenbroek, 1989). It has been recorded as growing up to 60 m in length and commonly grows in “forests”, primarily found in more inshore waters, at depths between 3 – 6 m and usually within 1 km of the shore. Many marine invertebrate and fish species are known to use these forests for both habitat and food, it is thought to be particularly important habitat for the Peale’s dolphin (*Lagenorhynchus australis*), and spawning habitat for *Loligo* squid, which appears to preferentially lay eggs on solitary strands of kelp (Brown et al., 2010). Inshore waters are also important foraging grounds for many seabird species (White et al., 2002).

Giant kelp is found in more temperate climates, where sea temperatures are less than 20°C. It is found in areas with rocky, or hard, substrate, which the kelp is anchored to via a holdfast. The stipe grows out of the holdfast and this then leads into the leaf-like fronds, which are buoyed by small gas-filled bladders. Research shows that giant kelp may grow at a rate of 60 cm per day (SMSG, 2013).

The waters of the Falkland Islands are particularly productive and nutrient rich and giant kelp flourishes in the area. Large kelp fronds may become detached from the seabed, as a result of grazing from benthic herbivores or during storm events, to form large rafts that float freely on the sea surface. During the Environmental Baseline Survey of the Sea Lion area of the Drilling Campaign Area in 2012, some algal litter believed to be giant kelp was observed on the seabed at some sample locations within the northern part of the Sea Lion area (Gardline, 2012). The kelp observed was quite deteriorated and undoubtedly drifted into these deeper waters from a near-shore area before settling onto the seabed.

Distribution of free-floating kelp patches in Falkland Islands waters was reported from the at-sea surveys carried out between February 1998 and January 2001 (White et al., 2002). Floating kelp patches were particularly important foraging habitat for grey-backed storm-petrel (*Garrodia nereis*) with an additional 21 seabird species also recorded as associating with free-floating patches of kelp (Gillon et al., 2001).

5.4.1.2 Tree kelp (Lessonia spp.)

There are four species of tree kelp that have been identified within Falklands waters: *Lessonia flavicans* (the most common of the four), *L. nigrescens*, *L. frutescens* (although this is suspected to be a local form of *L. nigrescens* (Skottsberg, 1921)) and *L. vadosa*. Tree kelp is often found intertwined with giant kelp growing between 3 and 20 m. Broad blade tree kelp (*L. flavicans*) inhabits slightly deeper waters than some of the other tree kelp species, from 2 to 20 m, inhabiting silty sediments and forms dense canopies. Conversely, the shallow tree kelp (*L. vadosa*) inhabits depths between 0.5 to 2 m and grows in areas of harder substrate.

5.4.2 Other Algal Species

Many species of algae have been identified in the near-shore waters of the Falkland Islands, the vast majority of which will only grow in shallower waters. Table 12 (SMSG, 2013) provides a list of the most common algae found in the Falklands.

Table 12: Most Common Algae Species Found within the Falkland Islands Waters (SMSG, 2013)

Phylum	Common name	Latin name
Phaeophyta (brown algae)	Giant kelp	*Macrocystis pyrifera*
	Shallow tree kelp	*Lessonia vadosa*
	Broad blade tree kelp	*Lessonia flavicans*
	Bull kelp	*Durvillaea antarctica*
	Creeping ring algae	*Herpodiscus durvillaea*
	Bladder algae	*Adenocystis utricularis*
	Sea potato	*Leathesia marine*
	Rope algae	*Desmerestia chordalis*
	Fur algae	*Desmerestia distans*
Chlorophyta (green algae)	Cushion algae	*Codium effusum*
	Dead man's fingers	*Codium fragile*
	Sponge weed	*Spongomorpha arcta*
	Sea lettuce	*Ulva lactuca*
	Gutweed	*Ulva intestinalis*
	Ruffled sea lettuce	*Ulva linza*
Rhodophyta (red algae)	Rock-leaf algae	*Lithophyllum falklandicum*
	Encrusting coralline algae	*Corallina spp.*
	Feathered coralline algae	*Corallina officinalis*
	Blood algae	*Hildenbrandia lecannellieri*
	Coiled algae	*Ahnfeltia plicata*
	Iridescent algae	*Iridaea spp.*
	Red sheet algae	*Gigartina skottsbergii*

5.4.3 Plankton

5.4.3.1 Phytoplankton

The planktonic community is composed of a range of microscopic plants (phytoplankton) and animals (zooplankton) that drift with the oceanic currents. These organisms form the basis of marine ecosystem food chains and many species of larger animals such as fish, seabirds and cetaceans are dependent upon them via smaller fish and zooplankton up the food chain. The distribution of plankton therefore directly influences the movement and distribution of other marine species. The distribution and abundance of plankton itself is heavily influenced by salinity, nutrients, water depth, tidal mixing and thermal stratification within the water column (NSTF, 1993). The majority of phytoplankton occur in the photic zone (the upper tens of metres, which receives enough light for photosynthesis to occur) and are unicellular organisms, such as diatoms and dinoflagellates.

There may be as many as 5,000 species of marine phytoplankton with diatoms, cyanobacteria and dinoflagellates amongst the most prominent groups. Historic samples within the vicinity of the Falkland Islands indicated that there were relatively few phytoplankton species and high diatom abundance south of 44°S, whilst the northern waters were comparatively dominated by dinoflagellates and ciliates and crustaceans (Hendley, 1937; Rodhouse et al., 1992).

5.4.3.2 Zooplankton

The oceanography and topography of the southern Patagonian Shelf, with the strong Falkland Current deriving from the ACC moving northwards both west and east of the Falkland Islands, creates an area of very high zooplankton productivity immediately to the north of the Islands and as such supports complex communities of zooplankton (Tarling et al., 1995; Boltovskoy, 2000), which in turn support complex pelagic and demersal ecosystems (Agnew, 2002).

A recent study by Padovani et al. (2012) examining the role of *Themisto gaudichaudii* on the Patagonian Shelf concluded that the species contributes greatly, both directly and indirectly, to supporting the fish community in the area. They proposed that *T. gaudichaudii* plays a key role in the sub-Antarctic region, similar to that of Antarctic krill (*Euphausia superba*) in Antarctic waters, channelling the energy flow and enabling a short and efficient food chain.

Also important to the Falkland Islands offshore ecosystem is the role of gelatinous zooplankton, such as jellyfish. Arkhipkin and Laptikhovsky (2013) found that gelatinous plankton occurred in diets of seven species, with two species, southern rock cod (*Patagonotothen ramsayi*) and spur dogs (*Squalus acanthias*), having >10% ctenophores (comb jellies) in their diet. They found that the consumption of gelatinous plankton was important in rock cod but was extremely seasonal, with the greatest occurrence in late summer to autumn. Comb jellies were most abundant in rock cod of 25–34 cm total length, whereas salps (planktonic tunicates) were more frequent in larger individuals. In winter and spring, occurrence of gelatinous plankton in diets was reduced, reflecting their overall seasonal abundance in the ecosystem.

Other important components of the zooplankton community include the shrimp-like crustaceans, euphaudiids *Thysanoessa gregaria*, *Euphausia vallentini* and *E. lucens* (Tarling et al. 1995; Boltovskoy 2000). These coupled with the hyperiid amphipod *T. gaudichaudii* are important prey items to two of the Falkland Islands most abundant finfish species (hoki (*Macruronus magellanicus*) and southern blue whiting (*Micromesistius australis australis*)) and Argentine shortfin squid (*Illex argentinus*) (Mouat et al., 2001; Agnew, 2002; Brickle et al., 2009).

In contrast, the near-shore environment is dominated by the lobster krill, *Munida gregaria*. This is a very abundant species in the Falkland Islands near-shore environment and it is critical to this ecosystem (Agnew, 2002). It is also important in deeper water areas on the shelf where it forms important prey for seabirds, (Quillfeldt et al., 2011; Clausen et al., 2005; Michalik et al., 2010; Arata and Xavier, 2003) fish and baleen whales (Matthews, 1932; Arkhipkin et al., 2001; Laptikhovsky and Arkhipkin, 2003; Laptikhovsky, 2004; Brickle et al., 2009; Brickle, personal observation).

5.4.4 Benthic Flora and Fauna

Understanding the benthic fauna present within the Drilling Campaign Area is crucial as drilling activity will directly impact on the benthos, and any drilling cuttings and other potential pollutants may also have a detrimental effect on the species present. If there are any rare or protected species present within the area, this may also have an impact on potential drilling activities. Anthropogenic disturbances (such as from the oil industry) to the environment and the benthos can alter species diversity, abundance and even assemblage.

Although the historical results are useful in a broad sense, it is important to mention that historically there have been significant inaccuracies and inconsistencies with the survey design, sample processing, and species identification. Indeed this is a main feature of the current GAP Analyses Project. Precision and quality control with regards to taxonomy is being developed in conjunction with the Natural History Museum, UK to ensure that inconsistencies are not an issue in the future. The GAP project will also work with companies to ensure adequate design methodologies for Environmental Baseline studies.

Seven baseline surveys were conducted by FOSA within the licence blocks of the Drilling Campaign Area during 1998, and one post-drilling survey at one well location later in the year; a further survey was conducted by Benthic Solutions in 2008 in the southern NFB (Licence Blocks PL032 and PL033); and Gardline conducted an environmental baseline survey and post-drill survey within the Licence Blocks PL032, and PL04, in 2012. The methodology of each of these surveys is very similar, with sediment samples being collected with grabs and then sorted using a 0.5 mm mesh. All species found were generally sorted then preserved for taxonomic identification. As there are still many unknown and unidentified marine species within the Falkland Islands waters, quite often the level of identification was not specific and often only to the Phyla level. It is also possible that the species resolution is greater in the later surveys than those conducted in 1998, as more species were identified in the interim period. Some surveys (for example, the Gardline surveys in 2012) removed specific taxonomic groups from the subsequent analyses (e.g. Copepoda, Mysidae, and Porifera) (Gardline, 2013).

5.4.4.1 Isobel/Elaine (now called Isobel Deep) Survey (2014)

This survey was conducted on the Isobel/Elaine (now called Isobel/Deep) prospect area in blocks 14/20, approximately 30 km to the south of the previously surveyed Sea Lion Development area and proposed Drilling Campaign Area. The survey was conducted by MG3 Environmental Ltd on board the *MV Poseidon* between April and May 2014. The full report from this survey is due in November 2014 and will be reported in and EIS addendum. Environmental and taxonomic expertise was provided by Benthic Solutions Limited. The Isobel/Elaine survey area was located in a polygon approximately 10 km x 7 km surrounding the potential prospect area. Ten sites were investigated with environmental sampling based on a pre-determined grid format. An additional location (ESL-09B) was also investigated using camera and grab sampling in order to ground-truth a channel feature for habitat information that was recorded during the acoustic survey. Another camera transect, undertaken at station ESL-01 in the north of the survey area to survey a similar feature (see MG3, 2014).

The water depths in the areas vary from 330 m to 431 m. Habitat was assessed using a mix of acoustic and benthic ground truthing stations. The acoustic data was gathered using a ship mounted multibeam echo-sounder and a sub-bottom profiler. Benthic ground truthing was undertaken using a combination of high resolution imagery and a double grab sampler.

The survey revealed one general seabed type with two minor habitat variations recorded around relic ice modified features. The dominant sediment type was relatively homogeneous fine sediment with a Holocene sedimentary drape of sandy silt and occasional gravel. There were two variations with regards to seabed features which were interpreted to be iceberg groundings from the Pleistocene or older. These features comprised pronounced lay outcrops at the base of depressions with coarser material and boulders near the sides and shoulders of the features.

The noticeable biology in the area was the high densities of brittle stars – these were seen at all stations in the areas. Generally the survey area was fairly uniform and showed no evidence of habitats potentially considered as Annex I (European Habitats Directive). The presence of scleractinian (hard) corals in the form of an occasional cup coral over the softer sediments suggests a presence of some CITES Appendix II listed species in the area although these are not currently Red listed (IUCN). There were no records of geogenic or biological reefs or coral gardens, although isolated examples of octocorals are likely to be found on the larger individual drop stones located across the survey area.

When the final report from the Isobel/Elaine Environmental Baseline Survey has been received and reviewed, an addendum to this EIS will be submitted to FIG to assess the potential impact from the planned well on the benthos present at the location.

5.4.4.2 Sea Lion area Pre-Development Environmental Baseline Survey and Post Drilling Survey (2013)

These surveys were conducted in March and April, 2012 in Licence Blocks PL032 and PL04. In total, 90 stations were sampled: 54 in the environmental baseline survey, and 28 (four of which were replicated from the development survey) were conducted in areas where drilling had previously taken place, and eight random QA/QC stations. Samples were collected using a Box corer, and three sub-samples were collected at each sample location. The ten most dominant species were calculated, as were the Shannon-Wiener diversity index, Simpson's dominance index, and Pielou's evenness index (full results are presented in Gardline, 2013a).

The entire survey area in the baseline survey was considered to be rich in species assemblage, diversity and abundance, with a total number of taxa of 471 (minimum at any one station: 56; maximum at any one station: 144) (Gardline, 2013a). Of these 471 taxa, 81 were found at only one station. The total number of individual animals present was 41,527, with a range of 320 to 1,434 at each station. The results and analyses showed that the entire survey area was fairly homogeneous and the benthic community was typical of silt and mud benthic environments in the area. The community structure also indicates one that is undisturbed and unpolluted by anthropogenic activity.

Overall, polychaetes were the most abundant taxonomic group in terms of the number of taxa present, in most stations and overall, making up 53% of the taxa found throughout the survey area. crustaceans were the next most abundant group, making up 23% of the total taxa. The molluscs were the next most abundant group, followed by echinoderms. "Other" taxonomic groups made up the remainder. With respect to individual animals, overall crustaceans were the most abundant, making up 38% of the total number of individuals and polychaetes made up 37% of the total. molluscs were the next most abundant group. There appeared to be a slight degree of spatial differentiation, with slightly more Crustacean species found in the southern part of the survey area.

In the post-drill survey, the benthic community was again found to be rich in species diversity, assemblage and abundance. No evidence of anthropogenic disturbance as a result of drilling activities was found, and the community was typical of those found in undisturbed/unpolluted medium to coarse silt environments. Species diversity and abundance was relatively uniform across the survey area. The number of taxa found in this survey was 468 (minimum at any one station: 104; maximum at any one station: 127). Of these taxa, 119 were found at only one station. The total number of individuals present was 26,280, with a range from 392 to 1,222 at one station.

As in the baseline survey, polychaetes were the most abundant taxonomic group in terms of number of taxa present, accounting for 43% of the total number of taxa found, followed by crustaceans, which made up 32% of the total number of identified taxa. These were followed by molluscs, then echinoderms, and the "other" taxonomic groups making up the remainder. In terms of numbers of individuals, however, crustaceans were again the most numerous, accounting for 39% of the total number of individuals, followed by polychaetes which were 43% of the total. Molluscs were the next most abundant group.

The ten most abundant species were almost exactly the same in both the environmental baseline survey and the post-drilling survey, with the only differences being the ninth and tenth most dominant species: the ninth was a different amphipod species in each survey and the tenth was a different gammarid amphipod species (Appendix B, Table 1). In the baseline survey, eight of the species present made up 41% of the total number of individuals found.

The ten most abundant species were similar in both the environmental baseline survey and the post-drilling survey, however, notable differences include the demotion of *Allotanais hirsutus* (crustacean) and promotion of *Yoldiella* spp. (mollusc), the loss of Amphipod sp. D and Gammaridae sp. Z in the top 10. (Appendix B, Table 1). In the baseline survey, eight of the species present made up 41% of the total number of individuals found.

5.4.4.3 North Falkland Basin FOSA Pre-Drilling Surveys (1998)

In total, seven baseline surveys were conducted at different proposed well sites in the NFB in February/March 1998, and a post drill survey was conducted at the "Little Blue A" well in October 1998. Each sample station was considered to be rich in species diversity and abundance, with between 124 to 179 taxa being recorded at each site. It was also clear that they were undisturbed sites with taxonomic assemblages typical of undisturbed and unpolluted silts and muds (which were the sediment types found at each location). No clear spatial resolution was evident within the survey area; i.e. the stations sampled were fairly homogeneous with respect to the species present at each.

Consistently, across all survey locations annelids (polychaetes) were the most abundant group, followed by crustaceans, then molluscs, and echinoderms (Appendix B, Table 2). Only at the "Minke" location were echinoderms more abundant than molluscs, and at location 14/23-A echinoderms and molluscs were present in equal numbers of species (Appendix B, Table 2). All of the species that were noted among the most dominant species at each survey site (Appendix C, Table 3) were all considered to be active or filter detrital feeders.

The Little Blue well (called "A" and "I" in Appendix B, Table 2) was surveyed both prior to- and post- drilling, with eight months between each survey. At the post drilling survey, ten more taxa were found (increasing from 144 to 154 (Appendix B, Table 2)). However, this increase in the number of taxa found is believed to be due to normal seasonal effects than as a result of any disturbance caused by drilling. Otherwise, the dominant species were exactly the same both pre- and post- drilling. Therefore, it is evident that the drilling activities did not cause any disturbance to the benthic community, and the location can still be regarded as "undisturbed and unpolluted".

However, it should be noted that the lack of taxonomic resolution in these surveys may pose a problem when comparing with later survey data. It is also possible that some species were misidentified (Gardline, 2012a).

5.4.4.4 Summary

The community throughout the survey area, both pre- and post- drilling, is that of a typical silt/mud benthic environment, and also appears to be undisturbed and unpolluted. Drilling activities appear to have had no effect on the benthic community within the affected areas. One point of concern is that the lack of taxonomic resolution may make comparison between each data set more difficult and earlier work may have misidentified some species. However, both sets of surveys have brought new species to light and have led to more marine benthic species within Falkland Islands waters being identified. This work continues in collaboration with the Natural History Museum in the United Kingdom.

The full survey report for the Isobel/Elaine area is not available until November 2014 so it was not possible to draw and comparisons or conclusions; this will be addressed in an addendum to this EIS

5.4.5 Fish Ecology (Commercial and non-commercial species)

This section provides a summary of the most abundant fish and squid species within Falkland Islands waters, describes their seasonal abundances in relation to the Drilling Campaign Area, their seasonal spawning migrations and their principal diet. The wider area of continental shelf and slope in the vicinity of the Sea Lion Field provides important feeding grounds for a number of species throughout all seasons of the year, with a slight decrease in the number of species present during the spring months. Whilst a number of these fish and squid species spawn within the Falkland Islands inner shelf and deep slope waters, none of the commercial species are known to have spawning grounds within the area of the Sea Lion Field and many species migrate outside of Falkland Islands waters to spawn (Arkhipkin et al., 2012a). A number of skate species are known to spawn in this area based on the evidence from the occurrence of hatchlings and reproductively active females (Pompert, 2011).

5.4.5.1 Patagonian Shelf Habitats

The Patagonian Shelf and Slope are amongst the two most biologically productive areas in the southwest Atlantic. As the Falkland Current meets the continental slope it results in an area of strong upwelling of Sub-Antarctic Surface Water (SASW) that forms a highly productive frontal zone as it mixes with shelf waters. Due to its high primary productivity, the Patagonian Shelf ecosystem is characterised by abundant pelagic and demersal organisms that support rich squid and fish resources. Many species of fish and squid within the Patagonian ecosystem, such as Argentine shortfin squid, common hake (*Merluccius hubbsi*) and hoki, migrate seasonally to the productive frontal zones (between two water masses) for feeding and back to non-frontal zones during spawning periods, resulting in seasonal changes in the fish assemblages across the ecosystem. The convergence of the SASW and Patagonian Shelf waters at the Falkland Islands shelf break forms the transition between the temperate and sub-Antarctic ecosystems, and consequently species belonging to both temperate and sub-Antarctic taxa are found within the area.

The Falkland Islands Conservation and Management Zones (FICZ and FOCZ) delineate the extent of commercial fishing in the Falkland Islands EEZ, and six main habitat zones have been identified within this area characterised by bottom topography, bathymetry, water structure and hydrodynamics (Arkhipkin et al., 2012a). These zones are represented by:

- Inner Shelf (IS);

The outer shelf is subdivided into two habitats,

- North-Western Outer Shelf (NWOS);
- South-Eastern Outer Shelf (SWOS).

The upper continental slope partitioned at latitude 51° S into two habitats:

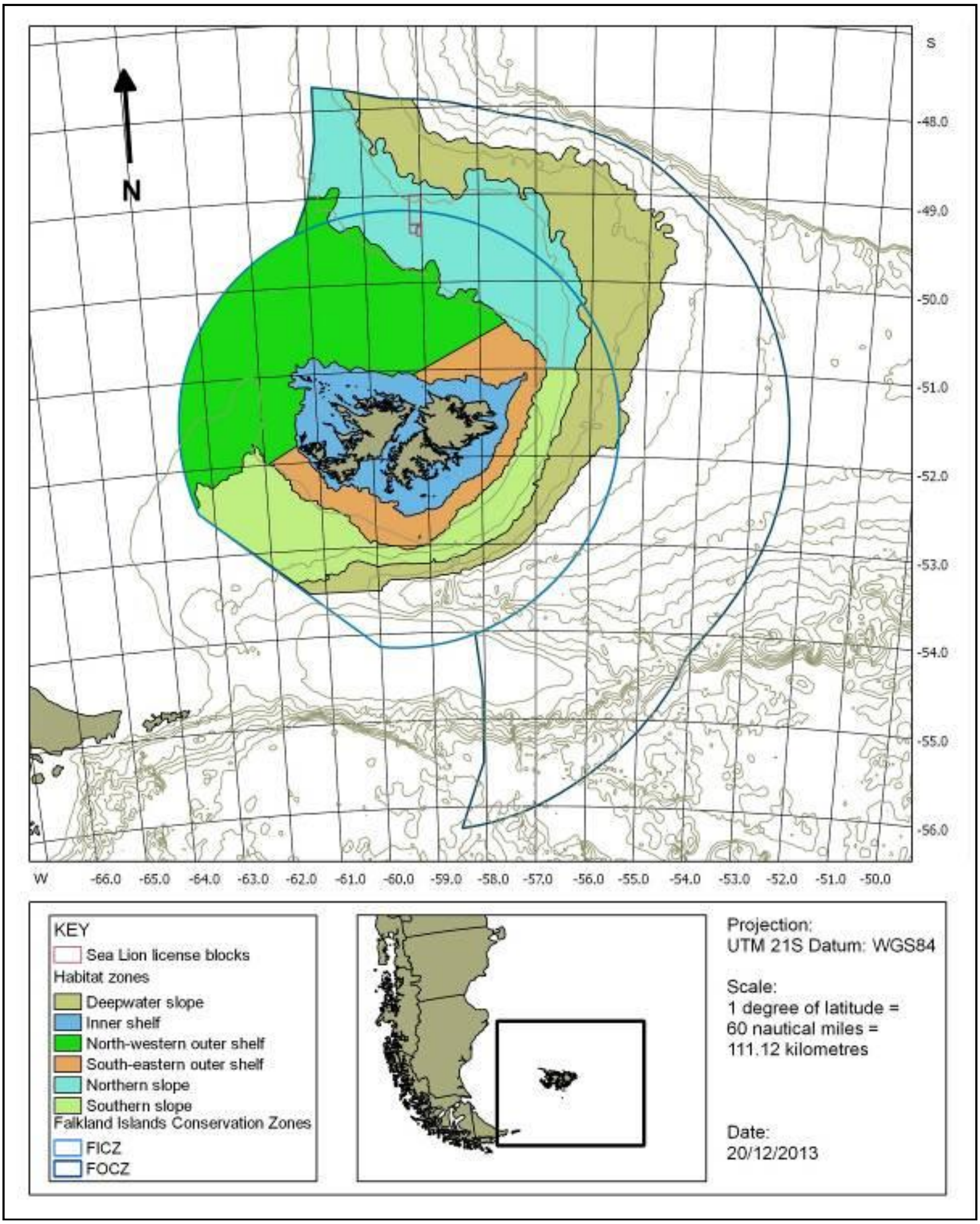
- Northern Slope (NS);
- Southern Slope (SS); and
- Deepwater Slope (DS) at depths between 600 and 1,200 m.

The Sea Lion Field sits in the North Slope area in the FICZ (Figure 23).

The NS covers an area of 50,686 km^2, with an average depth of greater than 400 m. The shallow-water area (250–350 m) of NS is mainly flat with sandy or muddy bottom topography and is heavily trawled throughout the year for finfish and skates. The deep-water area to the northeast of the NS has rough bottom topography and is covered with corals to the north and is therefore difficult to work by trawlers. The shallower part of the NS is covered by the transition zone of Patagonian Shelf waters mixing with the SASW. There is only slight seasonal variation in temperature (4·8–5·5°C with the maximum observed in April to May) and salinity (34·06–34·11 ppt). The offshore deeper part of the NS is covered by the SASW mass with practically constant near-bottom temperatures (4·1–4·3°C) and salinities (34·1–34·2 ppt) (Arkhipkin et al., 2012a).

5.4.5.2 Seasonal abundances around the Falkland Islands

Despite the productivity of the Falkland Islands waters only a small number of predators (fish and squid) spend all year around the eastern Patagonian Shelf and only consume a relatively small proportion of this bounty. Most of the productivity is exploited by non-resident migrating species that move to the area from distant spawning grounds to take advantage of the highly productive waters (Arkhipkin et al., 2012b). Sharks, skates, squid, tunas and gadoids migrate to the area at different times of the year to feed. A number of deep water species of fish and squid feed within the area as juveniles and move to deeper waters as they mature and become adults. Arkhipkin et al. (2012b) hypothesized that the high abundance of intermediate sized predators prevents most higher-trophic level predators (such as sharks, squid and tuna) from establishing spawning populations in the area, as their larvae and fry would be overwhelmed by predation. Instead, the higher-trophic level predators establish spawning and nursery grounds elsewhere and utilise resources in and around the Falkland Islands when they reach adulthood and therefore less vulnerable to predation.



Source: Arkhipkin et al. 2012a. Inner shelf (IS), north-western outer shelf (NWOS), south-eastern outer shelf (SEOS), northern (NS) and southern slope (SS) and deep water slope (DS).

Figure 23: Map Delineating Habitat Zones within Falkland Islands Waters

5.4.5.3 Migration patterns around the Falkland Islands

This was summarised from Arkhipkin et al (2012b). Data for this study were collected by Falkland Islands Government Fisheries Department (FIGFD) Scientists and Scientific Observers from 13,044 commercial bottom and pelagic trawls between 2000 and 2010 and from 1,272 research trawls between 1999 and 2011. Relative abundances were calculated as catch per unit effort (kg trawl-h^{-1}).

Sub-Antarctic fauna

Southern blue whiting is an abundant pelagic migratory species associated with sub-Antarctic waters. Its spawning grounds are to the southwest of the Falkland Islands where it congregates during the spring (Appendix E). Once spawning is complete the Southern blue whiting migrate onto the South-Eastern Outer Shelf (SEOS), and to a lesser extent in the Southern Slope (SS), where they feed on the abundant plankton resources (Brickle et al., 2009). During the summer (Dec-Feb), the main proportion of southern blue whiting migrates to the NS, and then further north with the Falkland Current beyond the southern Patagonian Shelf.

Southern hake (*Merluccius australis*) is a large bentho-pelagic predator consuming prey both in the water column and near the seabed, particularly smaller fish. Its greatest abundance observed in Falkland Islands waters is during the austral summer when it migrates to forage in the SEOS, North-West Outer Shelf (NWOS) and SS. In autumn they almost disappear from the NWOS but remain abundant in the SS. The lowest biomass is observed during winter when they migrate into Chilean waters to spawn (Arkhipkin et al., 2003; Payá and Ehrhardt, 2005; Bustos et al., 2007; Brickle et al., in press) (Appendix E).

Hoki or whiptail hake is one of the most abundant fish in the seas around southern South America. Spawning typically occurs during the winter months in areas outside of southern Patagonian Shelf waters (Appendix E). During spring hoki migrate to their feeding areas on the Falklands continental slope where it occurs in significant numbers in the NS and also in the SS and NWOS. Hoki is an opportunistic predator primarily consuming zooplankton, small fish and squid (Brickle et al., 2009). It has been suggested that approximately 20-25% of the population migrate to the warm waters of the NWOS during the spring and summer. During autumn, the majority of hoki return to the upper slope and are found in large numbers over the NS. In winter, most of the population migrates outside the southern Patagonian Shelf to spawn with low numbers remaining on the SS. Unlike southern blue whiting, hoki appear both in shallow waters of IS and deep waters of the slope (DS); especially in autumn.

Patagonian toothfish (*Dissostichus eleginoides*) is a near bottom predator that has a wide distribution around the sub-Antarctic. The overall seasonal distribution of toothfish does not change significantly between the various habitat zones. The seasonal dynamics within habitat zones suggests that in winter toothfish stay mainly in deepwater (DS) and slope region (NS), and start to migrate to shallower waters of the NWOS, SS and SEOS in spring. In summer, toothfish migrate to the warmer waters of NWOS and NS to forage on southern rock cod, moving back to the slope regions (mainly NS) in autumn (Arkhipkin et al., 2012a).

The greater hooked squid (*Onykia ingens*) is an abundant species throughout the Southern Ocean and feeds predominantly on fish species (Arkhipkin et al., 2012b). It is a relatively large squid (maximum reported mantle/body length of 61 cm) found from the surface to the deep waters (at 1,100 m; Jackson, 1993). Although abundant, this species is not commercial due to the high concentrations of ammonia in its flesh; however, it is one of the main prey items for shelf and slope cetaceans (Clarke, 1980). Following the winter spawning period the adults die, and in spring the juveniles move from the deep-water spawning area to shallower waters on the NS and SS. In summer, the maturing juveniles forage mainly on the NWOS, NS and SS to depredate on southern rock cod. By autumn, the now fully mature greater hooked squid make their migration back to deep waters to spawn, gradually disappearing from shelf and upper slope areas, and reaching their highest abundance in DS (Arkhipkin et al., 2012a).

Red cod (*Salilota australis*) is a relatively large demseral fish. On the Falkland Islands Shelf red cod's abundance is highest in spring in the SEOS, SS and NWOS, during their spawning and post spawning period. In the summer they disperse mostly over the NWOS to feed (Arkhipkin et al., 2001). In autumn they are mainly dispersed across the shelf and then in winter adult fish start to migrate back to the SEOS to spawn (Arkhipkin et al., 2010 and 2012b, Brickle et al., 2011).

Patagonian long-finned squid (typical mantle length of 13–17 cm), locally known as loligo, is an important domestic commercial species that spends its whole life cycle in Falkland Islands waters (Arkhipkin et al., 2012b). The loligo population comprises two different spawning groups, the first spawning during spring and the second spawning during the autumn season. This small loliginid squid's abundance is high in winter, when pre-spawning animals forage for zooplankton in SS, SEOS and less significantly on the NS. During the spring the abundance is very low as many animals move to inshore areas to spawn and die. The population increases again during summer as the newly hatched juveniles move from inshore waters to the SEOS and SS to feed on the abundant zooplankton, whilst avoiding depredation pressure from the larger fish (Arkhipkin et al., 2012b). During August the second spawning group migrates into inshore waters to spawn, whilst the maturing juveniles from the spring spawning group replace them on the SEOS feeding grounds.

Temperate fauna

Common hake (*Merluccius hubbsi*), like the austral hake, is a near bottom predator that inhabits the temperate waters of the Patagonian Shelf and slope (Cohen et al., 1990). During the autumn and winter, common hake migrate to their main foraging grounds in the NWOS, and to a lesser extent in the NS, to feed on southern rock cod. During spring and summer common hake abundance decreases significantly in the FICZ as they migrate northwest to their spawning grounds on the northern Patagonian Shelf (Arkhipkin et al., 2003; Arkhipkin et al., 2012a) (Appendix E).

Kingclip, also known as the pink cusk eel (*Genypterus blacodes*), is a large eel-like benthic predator that occurs in the temperate shelf and slope waters of southern South America (Renzi, 1986). The greatest abundances were found in the NWOS, SS and SEOS, which are the main foraging area of this species. During the summer approximately 60% of the adult population migrate to their spawning grounds in the northern Patagonian Shelf outside Falkland Islands waters. In autumn, their abundance is at a minimum with remaining individuals possibly skipping spawning in the NWOS and SS. In winter, kingclip migrates back to the Falkland Islands to forage primarily on southern rock cod with increased abundances in NWOS, NS and SS. They then move from the NS further south to SS to continue feeding during spring (Arkhipkin et al., 2012b) (Appendix E).

The southern rock cod (*Patagonotothen ramsayi*) is a bentho-pelagic species consuming prey both in the water column and near the seabed on the shelf and upper slope (50-500 m depths). The abundance of southern rock cod has increased several fold in recent years and it is now the most abundant finfish on the Falkland Islands shelf and has become one of the most important finfish fisheries in the Falkland Islands (FIG FIFD, 2013). It is hypothesised that the regional decline in southern blue whiting is a factor in rock cod's increased abundance (Laptikhovsky et al., 2013). Southern rock cod is itself an important prey species for all predatory fish (Laptikhovsky et al., 2013) and juvenile phases of loligo squid. This temperate species has a flexible diet with the ability to switch between main food sources as their abundance varies with the seasons (Arkhipkin and Laptikhovsky, 2013). During the spring and summer months, rock cod feed primarily on zooplankton crustaceans and benthic organisms in the NWOS and NS coinciding with peak zooplankton production during these months (Arkhipkin et al., 2012b). During the late summer and autumn months gelatinous plankton form an important part of their diet (up to 46% of stomach contents), reflecting their overall seasonal abundance in the oceans (Arkhipkin and Laptikhovsky, 2013). The abundance of rock cod decreased particularly in the upper slope areas (NS and SS) during autumn, due to a migration out of Falkland Islands waters in preparation for the winter spawning period. A small proportion of the stock remains on the SS during the winter months (Appendix E).

The Argentine shortfin squid is medium-sized (typical mantle length of 35 cm), has an annual life cycle (Hatanaka, 1986) and is the most abundant squid species in the southwest Atlantic. It is mostly associated with the temperate waters of the Patagonian Shelf and highest abundances are recorded on the NWOS and NS during the summer where it migrates to the southern part of its range to forage on zooplankton, in particular krill (e.g. *Thysanoessa gregaria, Euphausia vallentini and E. lucens*) and pelagic amphipods (such as *Themisto gaudichaudii*). In autumn, they make their way north along the slope as part of their pre-spawning migration and abundances in the NWOS and NS decreases. During the rest of the year this species is absent from the Patagonian Shelf and slope (Arkhipkin et al., 2012b).

The yellownose skate (*Zearaja chilensis*) is a relatively large skate that reaches 120 cm total length. It is moderately abundant in water depths between 100 and 300 m on the temperate shelves around southern South America (Nakamura et al., 1986) but rarely found in depths >500 m. A migratory species, the yellownose skate makes long spawning migrations out of Falkland Islands waters to warmer waters in the summer (Arkhipkin et al., 2013). The skate returns in autumn during their feeding migration to prey on other fish and squid, which are abundant in Falkland Islands waters. The yellownose skate reaches maximum abundance around the Falkland Islands in austral winter (July to September) primarily on the NWOS (Arkhipkin et al., 2013). Throughout the spring, their abundance gradually decreases in the northern regions with some movement likely to the southern slope. This species has been assessed as Vulnerable on the IUCN Red List and the population is thought to be in decline. The yellownose skate is one of the four species dominating the multispecies skate fishery in the Falkland Islands, which is currently managed by limiting the fishing effort and numbers of licences. The late maturation of females at 14 years old and low reproductive capacity makes this species vulnerable to overfishing.

The spur dog (*Squalus acanthias*) is a small shark that is associated with temperate waters of the Patagonian Shelf (Nakamura et al., 1986). The spur dog reaches its maximum abundance in Falkland Islands waters in the NWOS during spring with smaller aggregations in the NS. In summer through to autumn this species migrates out of Falkland Islands waters onto the Argentine Shelf and into international waters (Arkhipkin et al., 2012b). This species has been assessed as Vulnerable on the IUCN Red List and the population is thought to be in decline. Although naturally abundant, it is vulnerable to over-exploitation by fisheries due to its late maturity, low reproductive capacity, longevity, long generation time (25 to 40 years) and hence a very low rate of population increase (2-7% per year).

The slender tuna (*Allothunnus fallai*) is a medium sized tuna growing to a maximum total length of approximately 100 cm. It has the most southerly distribution of tunas in the South Atlantic. This species feeds predominantly on zooplankton and is recorded in the IS in summer with the greatest abundance appearing in autumn in the NS. During the winter and spring months the slender tuna is completely absent from the Falkland Islands waters (Arkhipkin et al., 2012b).

5.4.5.4 Species sensitivity within the NS

The six sub-Antarctic and seven temperate fish and squid species found in abundance in Falkland Islands waters primarily utilise these areas as productive feeding grounds, migrating around and out of these waters as food availability changes and to follow seasonal spawning migrations. The Northern Slope (NS) area, where the Sea Lion development is located, is an important feeding area for a number of these species, whose abundance in the NS varies with season.

Table 13 summarises the relative abundance of the main fish species throughout the six main habitat zones over the four ‘seasons’. The habitats are identified in order of abundance of each species, and cell highlighting relates only the relative abundance within the NS, with darker turquoise highlighting indicating higher abundances, and pale blue indicating relatively lower abundances in the NS. The summary in Table 13 indicates that the NS provides an important foraging area for some species throughout the year, with the spring season showing lowest species abundance with only hoki and yellownose skate found in higher abundances. Most species have relatively wide distributions being present in several habitat areas within each season, suggesting that no species is solely reliant on the NS area as a feeding ground. However, during the autumn and spring greater than 50% of the hoki population inhabit the NS over other areas (Arkhipkin et al., 2012b); similarly southern blue whiting predominantly inhabit the NS during summer, slender tuna during autumn and the yellownose skate during winter.

While the productive Falklands waters support the foraging of a diverse, abundant assemblage of fish and squid, a more unusual aspect of Falklands waters is the migration of the majority of higher trophic species to spawn elsewhere, like southern and common hake, hoki and kingclip. Only a few large predators such as red cod (SEOS), several skates and the loligo (IS) and greater hooked squid (DS) spend their entire life cycle in the shelf ecosystem (Arkhipkin et al., 2012b).

5.4.5.5 Other Commercial and Non-commercial fish species on the Northern Slope

Although not commercial currently, grenadiers, particularly the Ridge scaled rattail (*Macrourus carinatus*), are abundant in the area and may be subject to a future fishery (Payá, 2009). Other species not mentioned above include a number of skate species (some examples are mapped in Appendix E), morid cods and psychrolutid fish. Lantern fishes (Myctophidae), the black smelts (bathylagids) and other bentho-pelagic fish also contribute to the fish community on the Northern Slope. Little is known about their biology and life history in the Falkland Islands but they likely play a significant role in the ecology, through the consumption of primary consumers and vertical migrations, which could play a major role in exporting carbon from the surface layers to deeper water. These are important features of the ecosystem on the North Slope (P. Brickle pers. obs). They were also evident in many of the drop down camera surveys undertaken in the Sea Lion area (Gardline, 2013).

Table 13: Summary of Seasonal Abundance of Fish Species in Relation to Sea Lion Field in the Falklands Islands Northern Slope (NS) Habitat Zone

	Spring (Oct – Dec)	**Summer (Jan – Mar)**	**Autumn (Apr – Jun)**	**Winter (Jul – Sept)**
Sub-Antarctic species				
Southern blue whiting	SEOS / SS / NWOS	**NS**/ SS/ NWOS/ SEOS	**NS** / SS / DS	SEOS / SS / NWOS
Southern hake	SS/ NWOS/ NS/ DS	NWOS / SS / DS	SS / NWOS	SS / NWOS / **NS**
Hoki (whiptail hake)	**NS**/ NWOS/ SS/ SEOS			SS / **NS** / NWOS
Patagonian toothfish	DS/ SS / SEOS/ **NS**/ NWOS	NWOS/ **NS**/ DS/ SS	**NS**/ DS/ SS/ NWOS	DS/ SS/ **NS**/ NWOS/ SEOS
Greater hooked squid	DS / **NS** / SS	DS/ NWOS/ **NS**/ SS/ SEOS	DS/ SS/ NWOS/ SEOS/ **NS**	DS / SS / **NS**
Loligo squid	IS / SS	IS / SEOS / SS	SEOS / IS	SS / SEOS / **NS**
Temperate species				
Common hake	NWOS / **NS**	NWOS / **NS**	NWOS / **NS**	NWOS / **NS**
Kingclip	NWOS/ SS/ **NS**/ SEOS	NWOS / SS / **NS**	NWOS / SS / **NS**	NWOS / **NS** / SS
Southern rock cod	NWOS / SEOS / **NS**	NWOS/ **NS**/ SS/ SEOS	NWOS / **NS** / SS	NWOS/ SS/ **NS**/ SEOS
Argentine shortfin squid	Absent	NWOS / **NS**	NWOS / **NS**	Absent
Yellownose skate	**NS**/ NWOS/ SS/ SEOS	NWOS	**NS** / SS / NWOS	**NS** / NWOS / SS
Spur dog	NWOS / **NS** / IS	NWOS	NWOS	NWOS / **NS**
Slender tuna	Absent	IS / SEOS / NWOS	**NS** / NWOS / SEOS	Absent

Note: High abundances in the NS highlighted in turquoise. Low abundances in NS highlighted in light blue.
Habitat Zones: IS - inner shelf, NWOS - north-western outer shelf, SEOS - south-eastern outer shelf, NS - northern slope, SS - southern slope and DS - deepwater slope.

Based on data from Arkhipkin et al., 2012b.

5.4.6 Marine Mammals

Marine mammal species comprise whales, dolphins and porpoises (cetaceans) and seals (pinnipeds). Cetaceans can be divided into two main categories: baleen whales (Mysticeti) such as the humpback whale (*Megaptera novaeangliae*), which feed by extruding plankton from seawater through baleen plates; and toothed whales (Odontoceti) such as killer whales (*Orcinus orca*) and dolphins, which have teeth for prey capture. Pinnipeds are fin-footed, semi-aquatic marine mammals that spend part of their time hauled out on land where they rest, moult and breed.

The Falkland Islands support a diverse range of marine mammal species. Much of the information regarding the status of species comes from anecdotal reports and records of stranded animals (Otley, 2008). However, there have also been a number of at-sea surveys. Over a three year period between 1998 and 2001, a team of Joint Nature Conservation Committee (JNCC) observers systematically surveyed the seabird distributions around the Falkland Islands (White et al., 2002). Although the methodology used was not specifically designed to survey the distribution of marine mammals, all animals sighted were recorded. White et al. (2002) remains the most comprehensive account of the at-sea distribution of marine mammals within Falkland Islands waters. In recent years, marine mammal observers on seismic vessels (Polacus, 2011; Geomotive and MRAG, 2011) and the deployment of acoustic monitoring devices (Hipsey et al., 2013) have added to our knowledge of the distribution and abundance of marine mammals in the region. The dispersion of marine mammals within Falklands waters remains poorly understood but the data available suggests that most of these species are present on a seasonal basis (see Figure 25).

Confirmed sightings and stranding records indicate that 25 species of cetacean occur within Falkland Islands waters. Many of these species are rare and inconspicuous, some are only known from stranded animals, however, from the available evidence it is possible to summarise the status of these species within Falkland Islands waters Appendix C Table 1. Of the 25 species listed as occurring in the southwest Atlantic, two species are listed as Endangered on the IUCN Red List, fin *Balaenoptera physalus* and sei whales *B. borealis*, and one species, the sperm whale *Physeter macrocephalus*, is listed as Vulnerable.

At least, six pinniped species have been recorded in the Falkland Islands in recent years. There are three breeding species (South American fur seal (*Arctocephalus australis*), southern sea lion (*Otaria flavescens*) and southern elephant seal (*Mirounga leonina*) one seasonal visitor (Antarctic fur seal (*Arctocephalus gazella*), one occasional visitor (leopard seal, *Hydrurga leptonyx*) and one vagrant (Ross seal, *Ommatophoca rossii*). It is possible that other species from the Antarctic or sub-tropics occur as rare visitors or vagrants, for instance sub-Antarctic fur seal, *Arctocephalus tropicalis*. The fur seals and sea lion are eared seals (Otariidae), while the elephant, leopard and Ross seals are earless or 'true seals' (Phocids), which are less agile on land than eared seals, due to their less flexible hind limbs.

The abundance and availability of prey, including plankton, fish and squid, can be of prime importance in determining the number and distribution of marine mammals. Although cetaceans are not tied to land to breed, many species return to specific areas to calve and reproduce each year. During the non-breeding period, many of the larger species make ocean-wide migrations to exploit specific feeding grounds, often at high latitude. It is believed that many of the cetaceans recorded within Falkland Islands waters are on passage through the area to and from these feeding/breeding grounds. Changes in the availability of principal prey species could result in local changes of marine mammal numbers (SMRU, 2001).

5.4.6.1 Mammals recorded during JNCC seabirds at-sea surveys

It is generally considered that there is insufficient data available for most marine mammal species in the Falkland Islands; in particular information on foraging and breeding areas, seasonal distribution and abundance and diet is particularly scarce (Otley et al., 2008). The JNCC seabirds-at-sea team (SAST) described the distribution of marine mammal species in Falkland Islands waters from the results of surveys conducted between February 1998 and January 2001 (White et al., 2002). The JNCC survey represents the most comprehensive visual survey of marine mammals in this area to date. Visual surveys were conducted during 91 cruises covering a total area of 20,907 km^2. Figure 24 shows the area covered and the total survey effort between 1998 and 2001, and the location of the Sea Lion area in the northern sector of the survey area. Although marine mammals were recorded whenever sighted, the methodology used in these surveys was not specifically designed to record marine mammals, it was designed to record seabird distribution. Since the end of the JNCC supported project, some additional seabird and marine mammal surveys have been conducted within Falkland Islands waters, using the same methodology. To date, these datasets have not been collated and analysed as a whole.

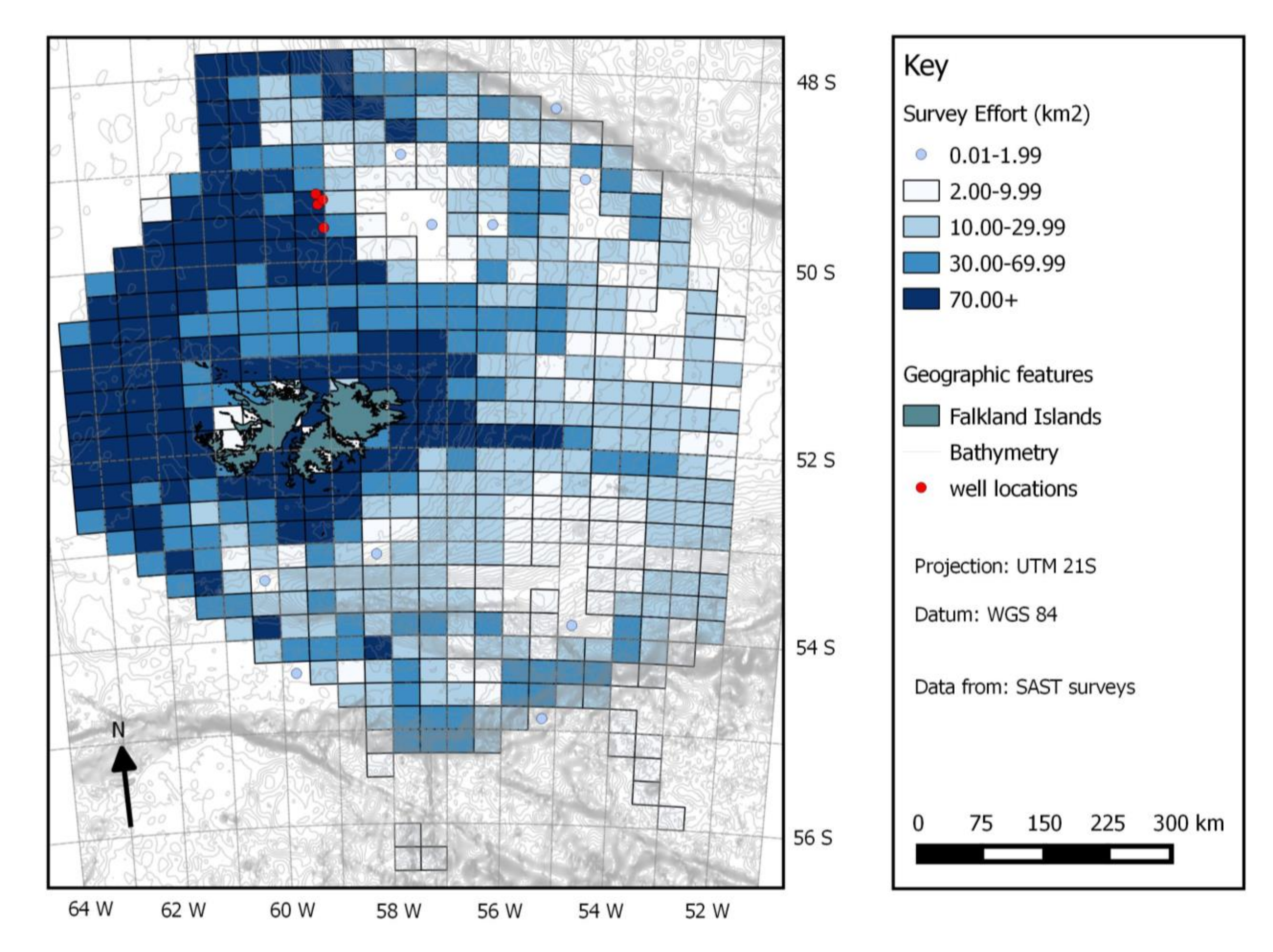


Figure 24: Total survey effort achieved during JNCC surveys between February 1998 to January 2001 (White et al. 2002)

The JNCC survey documented 6,550 individuals, identifying 17 species of marine mammal, including 14 cetacean and three pinniped 'species' (Appendix C, Table 1).

Survey effort was generally greatest during the summer months when daylight hours allowed for more surveying (the months of January, September and November, produced annual means of 817, 912 and 897 km^2, respectively). Lower survey effort was obtained during the autumn months when the survey bases (Fishery Patrol Vessels, FPVs) were required elsewhere. The lowest monthly effort was achieved in February, April, and May, with respective annual mean survey efforts of 448, 493 and 465 km^2.

Figure 25 shows the relative occurrence of sightings for each species throughout the year. These data are adjusted to account for the differences in monthly survey effort. Although several species appear to be present year-round (for example, sperm whales and Peale's dolphins), others exhibited a marked seasonality (for instance, hourglass dolphin *Lagenorhynchus cruciger* and southern bottlenose whale *Hyperoodon planifrons*). Baleen whale sightings were comparatively low between May and September, which is likely to be explained by the migratory behaviour of these species.

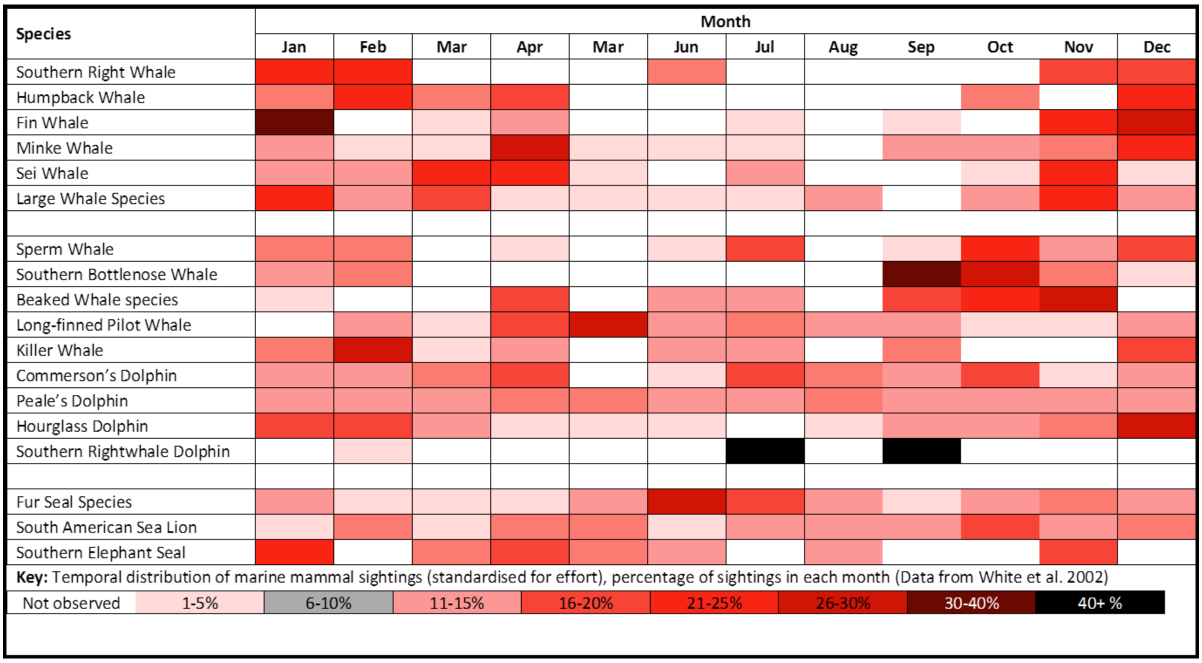


Figure 25: Relative incidence of marine mammal sightings, by species, adjusted for monthly survey effort (data from White et al. 2002).

It is possible to broadly describe the seasonal occurrence and general distribution of most species of cetacean. Combined with more recent survey data, a better understanding of Falkland Islands cetacean populations is developing but much remains to be learnt regarding the rarer species.

The three commonest species recorded during the JNCC surveys were all dolphins and accounted for 68.4% of all cetacean records. The most commonly recorded species was Peale's (644 sightings) with hourglass (150 sightings) and Commerson's dolphins *Cephalorhynchus commersonii* (84 sightings) also regularly recorded while southern right whale dolphins *Lissodelphis peronii* were only observed on five occasions. The three most frequently recorded dolphin species each exhibited a distinct spatial pattern of dispersion with very restricted overlap in their ranges (see species accounts below). There was evidence of seasonal variation in the dispersion pattern of hourglass dolphin.

The JNCC survey did not record all the species that are known or believed to occur around the Falkland Islands. Appendix C, Table 1 also lists species that have been found stranded in the Falkland Islands (Otley et al., 2012) but were not observed during the JNCC survey (White et al., 2002). In addition to seven beaked whale species (Otley et al., 2011), dusky (*Lagenorhynchus obscurus*) and bottlenose dolphins (*Tursiops truncatus*), spectacled porpoise (*Phocoena dioptrica*), and pigmy right whale (*Caperea marginata*) each have between 1-4 stranding records in the Islands (Otley et al., 2012). The majority of the stranded species that were not recorded during JNCC surveys are beaked whales. These animals are notoriously difficult to observe at-sea and even more difficult to identify to species level. Apart from southern bottlenose whale, which is reasonably easy to identify, the majority of beaked whales sighted were recorded as 'beaked whale species'. None-the-less, Gray's (*Mesoplodon grayi*) and strap-toothed beaked whales (*M. layardii*) have been positively identified during at-sea surveys in the southwest Atlantic, outside Falkland Islands waters. All 17 of the 'unidentified beaked whales' recorded within Falkland Islands waters during the JNCC surveys were encountered in waters greater than 1,000 m deep to the east of the Islands.

There are some limitations of visual surveys, which should be considered whenever using this data. Experienced and skilled observers are required and many species spend considerable periods of time below the surface, where they are undetectable. However, the use of multiple observers and distance sampling survey techniques can increase the reliability of the data. As previously stated, the JNCC methodology was not specifically designed to record the distribution of marine mammals and although the same three observers were used throughout the project they usually worked alone. Sea state and visibility will also affect the reliability of visual surveys. Acoustic methods may help to quantify the abundance of marine mammals but these methods also have some limitations. The vocal range of many of the species encountered within Falkland Islands waters is unknown and the audible range of vocalisations is dependent on frequency and the orientation of the animal, relative to the hydrophone. The combination of visual and static acoustic monitoring can provide a more rigorous survey methodology through amalgamation of both datasets.

5.4.6.2 Marine Mammal Surveys within the vicinity of the Drilling Campaign Area

Rockhopper Exploration conducted a one year static acoustic monitoring programme during 2012 and 2013 in the Sea Lion Field, using wideband acoustic recordings in order to examine the spatial and temporal distribution of resident and transitory marine mammal populations (Hipsey et al., 2013) from their vocalisations. Full details of the monitoring survey are described in Hipsey et al., 2013 and have been summarised in this report.

The acoustic survey was intended to significantly enhance the existing marine mammal dataset collected during a three-year JNCC visual survey of the Falkland Islands Conservation Zones and to provide a comprehensive dataset for assessing potential impacts from future development of the area. A persistent, autonomous passive acoustic monitoring programme was selected as it provides an almost continuous survey methodology, which is not hampered by factors restricting the effectiveness of visual surveys, (such as, nightfall, poor visibility (rain and fog), long mammal dive periods) and the approach does not require the permanent presence of vessels with trained human observers. Additionally, since sound can travel significant distances underwater, the spatial coverage of a static recording programme typically extends much further than the visual horizon. Acoustic detection ranges vary by species but low-frequency cetaceans (mostly baleen whales) can be detected tens to hundreds of kilometres away from a suitably sensitive recording instrument (Stafford et al., 2007). Signals from species vocalising and echo-locating at higher frequencies may also be detected but usually at shorter ranges of hundreds to thousands of metres (Zimmer et al., 2008, Kyhn et al., 2009).

The one-year acoustic monitoring programme was split into three, four month recording phases, with mooring and recording equipment deployed at the beginning and retrieved at the end of each phase (Table 14). During each of the three recording phases, five moorings were laid in 413 to 423 m of water, two moorings deployed a deep-water Autonomous Multichannel Acoustic Recorder (AMAR, JASCO Applied Sciences) and three a deep-water variant C-POD cetacean click detector (Chelonia Ltd.).

Table 14: Summary of the annual marine mammal activity detected by the AMARs from July 2012 to July 2013 (Hipsey et al., 2013).

Mooring	Recording Depth	Phase 1 Deployed 30 Jul 12		Phase 2 Deployed 01 Dec 12		Phase 3 Deployed 21 Mar 13	
		Record stop	Days Recorded	Record stop	Days Recorded	Record stop	Days Recorded
AMAR 1	399	18 Nov 12	109.9	19 Mar 13	108.2	26 Jul 13	Unreliable
AMAR 2	409	10 Oct 12	71.4	21 Mar 13	110	24 Jul 13	125.2
C-POD 1	181	01 Dec 12	123	21 Mar 13	110	05 Jul 13	106.4
C-POD 2	192	20 Nov 12	121	16 Mar 13	105	19 Aug 13	151
C-POD 3	192	01 Dec 12	123	21 Mar 13	110	19 Aug 13	151

The two AMAR moorings were spaced 9.6 km apart, and the three C-POD moorings 6.3 and 6.9 km apart (Figure 26).

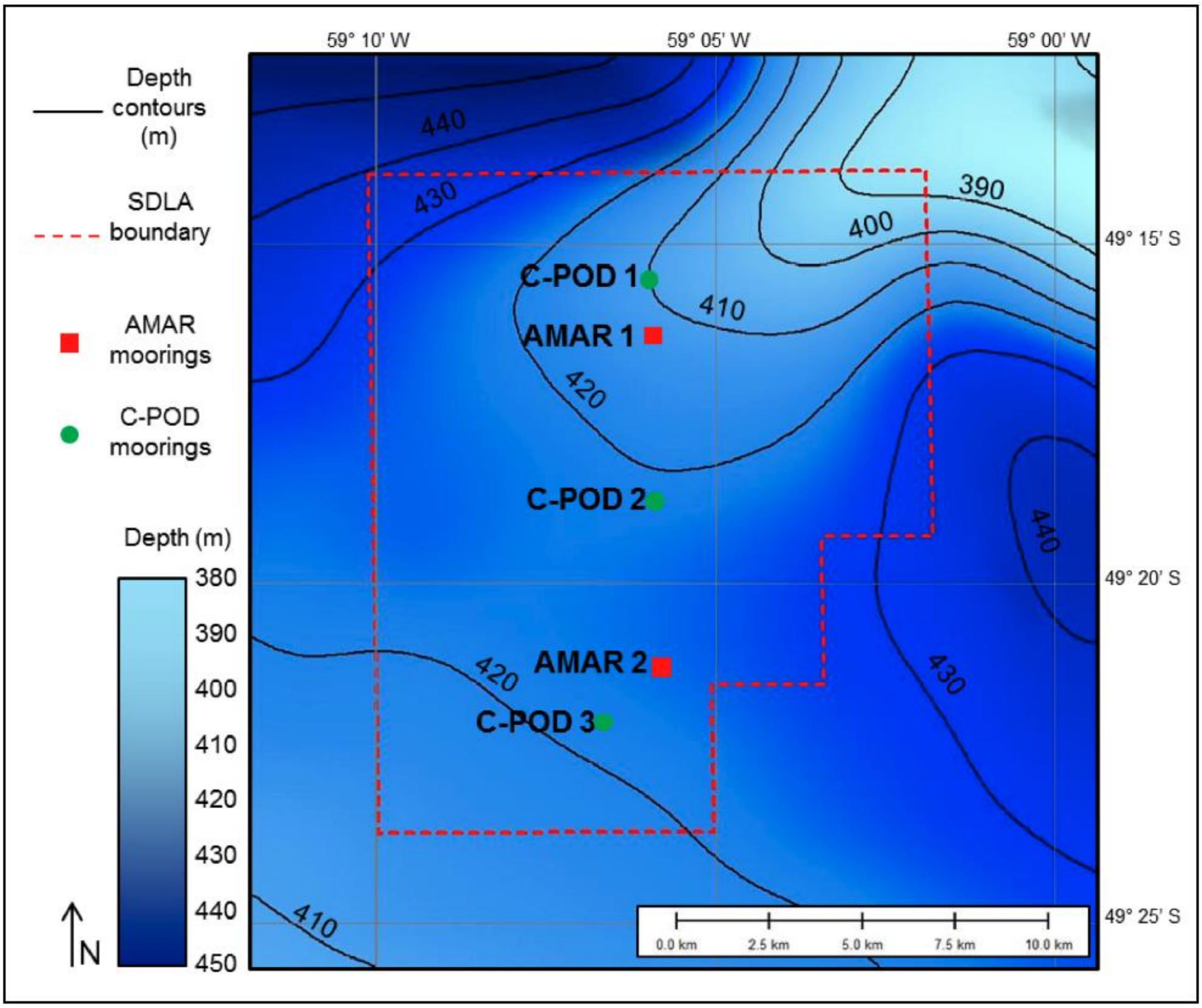


Figure 26: AMAR and C-POD Mooring Locations (Hipsey et al., 2013).

Whilst acoustic monitoring provides a number of advantages for marine mammal detection, there are also some limitations. Click detection instruments detect sounds that typically occur between 20 and 160 kHz and suffer a high degree of intensity attenuation in seawater (Hipsey et al., 2013). This results in relatively short detection ranges, especially at the higher end of this band. For instance, porpoise clicks between 120 and 140 kHz cannot usually be detected beyond 400 m and dolphin clicks are predominantly limited to ranges less than 1,000 m. Conversely, large baleen whales may be detected at ranges of hundreds of kilometres.

Given the relatively short range of higher frequency clicks and the depth of water, there was a risk that a C-POD positioned close to the seabed would not capture higher frequency near-surface clicks. Conversely, at a very shallow deployment depth a C-POD would be more prone to effects of sea surface and weather noise and may not detect clicks from deeper-diving species, such as beaked whales. To optimise performance in this water depth, the C-PODs were therefore moored at a mid-water column depth. The expected detection capability of a mid-water column deployed C-POD. A near-seabed recording position for the two AMARs was chosen to minimise noise interference from the surface and potential multipath effects.

The effectiveness of click detectors and acoustic recorders is also limited by the highly directional nature of the clicks emitted by most delphinids. Horizontal and vertical beam-widths for these species are typically in the region of ±20° (Au and Hastings, 2010). Consequently, echo-location clicks will only be audible or detectable if the foraging mammal is 'looking' virtually at or very close to the instrument.

5.4.6.3 Acoustic Data Analysis

Data was uploaded from the retrieved AMARs and C-PODs on completion of each of the three recording phases. The AMAR data were auto-processed with JASCO's Acoustic Analysis software suite to calculate ambient noise levels and to detect acoustic events and mammal vocalisations and clicks. Ambient noise levels from each AMAR were examined to document baseline underwater sound conditions in the Sea Lion area.

Recorded ambient noise levels were generally consistent with a remote, deep continental shelf location in a temperate climate with occasional fishing activity but little or no regular mercantile shipping traffic (Hipsey et al., 2013). The results from the analysis of both AMARs were generally very similar throughout the recording period, which would be expected given the generally homogenous environmental and bathymetric conditions across the Sea Lion area.

The spectral distribution of sound levels recorded at both AMAR sites suggested a general absence of anthropogenic noise, and that the ambient noise spectrum was heavily influenced by weather conditions. Noise events such as vessels were infrequent and sporadic, except during the second half of February. During this period an increased but small number of detections were made at both AMAR sites (Hipsey et al., 2013).

Impulsive sounds indicative of distant seismic survey activity were recorded throughout the recording period, being detected on 37-38% of days. The greatest activity occurred during August 2012, December 2012 to February 2013 and June 2013. However, there are not any seismic survey cruises planned to coincide with the 2015 drilling campaign.

5.4.6.4 Marine Mammal Observations during Seismic Surveys in the NFB and PL001

In addition to the year-long acoustic monitoring programme in the Sea Lion Field, Marine Mammal Observations (MMO) were conducted as mitigation to minimize the potential impacts of seismic surveys being conducted in the NFB. A seismic survey was conducted in the NFB between 11th January 2011 and 2nd May 2012 for Argos Resources and Rockhopper Exploration (Geomotive and MRAG, 2011); a second seismic survey was conducted in Licence Block PL001 between 25th November 2010 and 5th May 2011 for Desire Petroleum and Rockhopper Exploration (Polarcus, 2011). MMO were made for 60 minutes at the start of each seismic activity, before the use of any airguns. A total observation effort of 1,310 hours and 11 minutes was recorded in the NFB during which there were 142 encounters of 12 different marine mammal species (Geomotive and MRAG, 2011); a total observation effort of 794 hours and 29 minutes was recorded in PL001 during which marine mammals were sighted on 109 occasions corresponding to 462 individuals representing 11 species (Polarcus, 2011). The data from these seismic surveys gives additional information relating to the presence of marine mammals in the NFB and PL001 during the austral summer and autumn, which complement the acoustic monitoring data for the Sea Lion Field. While both methods have recognised limitations in their data collection, referring to both datasets may provide a better overall picture.

5.4.6.5 Results of Marine Mammal Surveys within Falkland Islands waters

The results of the JNCC surveys are published in White et al. (2002), a summary of the number of individuals recorded by species can be found in Appendix C, Table 1, along with a number of marine mammal stranding's on the Falkland Islands (Otley, 2008).

Appendix C, Table 2 summarises the marine mammal sightings from MMO during the seismic survey campaigns in the NFB (Geomotvie and MRAG, 2011) and PL001 (Polarcus, 2011).

Appendix C, Figures 1-7 illustrate the number of call detections on each day during the year-long monitoring programme and indicate each species' relative seasonal abundance.

Acoustic surveys recorded six species of marine mammal, a summary of the results is presented in Table 15.

Table 15: Summary of the annual marine mammal activity detected by the AMARs from July 2012 to July 2013 (Hipsey et al., 2013).

Species	Winter - Spring 31 July - 18 Nov 2012		Austral Summer 1 Dec 2012 - 21 Mar 2013		Autumn - Winter 21 Mar - 24 Jul 2013	
	AMAR 1	AMAR 2	AMAR 1	AMAR 2	AMAR 1	AMAR 2
Leopard seal	0	0	685	744	-	632
Sperm whale	297	208	364	333	-	577
Fin whale	84	48	111	169	-	21
Killer whale	10	15	11	17	-	7
Pilot whale	2	10	30	33	-	100
Southern right whale	9	6	6	4	-	1
Unidentified odontocetes	519	301	165	123	-	245

5.4.6.6 Summary of Marine Mammal distribution in the North Falkland Basin

IUCN status is shown in parenthesis (DD=Data Deficient, LC=Least Concern, VU=Vulnerable, EN=Endangered).

Southern right whale *Eubalaena australis* (LC)

The JNCC surveys recorded southern right whales on four occasions over three years (White et al., 2002). Southern right whale up-calls were recorded in the Sea Lion area on 11 different days during the year-long monitoring period (Hipsey et al., 2013). Individual southern right whales were also recorded during the MMO of the seismic surveys with 10 individuals sighted in PL001 and four individuals during the wider NFB survey (Geomotvie & MRAG, 2011; Polarcus, 2011). These results suggest that this species may be more common than suggested by JNCC visual surveys, with animals present within the NFB in low numbers throughout most of the year. The migratory behaviour of southern right whales suggests that there will be peaks in numbers as these animals travel between their Patagonian spring breeding grounds and summer feeding grounds near South Georgia and Antarctica. There is evidence that the population of southern right whales that breed off Peninsula Valdes, Argentina, is increasing, with a doubling time of 10-12 years (Reilly et al. 2013).

Blue whale *Balaenoptera musculus* (EN)

Historically, blue whales would have been present within Falkland Islands waters, at present they are extremely rarely sighted and, to date, this species has not been recorded by visual or acoustic surveys. Whaling in the Atlantic sector of the Southern Ocean killed many thousands of blue whales (Moore et al., 1999). The paucity of blue whale sightings in the wider Scotia Sea indicates that the population of these animals has not yet recovered.

Fin whale *B. physalus* (EN)

Acoustic monitoring recorded fin whales in the Sea Lion area during late August 2012, and consistently in the late winter and early spring (August and September) period, but appeared to peak in March (early austral autumn) (Hipsey et al., 2013). Detections stopped abruptly in April and did not resume before the end of the monitoring period in July. Fin whales were not sighted in August and October during the JNCC surveys (White et al., 2002). Five individuals were observed in September but most sightings occurred in November, December, and January (White et al., 2002). Fin whales were sighted by MMO during both of the seismic surveys in the NFB, with greater numbers (12 individuals) recorded in waters adjacent to but west of the Sea Lion area (Geomotive and MRAG, 2011).

The acoustic monitoring program indicated that fin whales were present in the Sea Lion area from September until March, suggesting that past visual surveys (White et al., 2002) underestimated the occurrence of fin whales north of the Falkland Islands or that there is inter-annual variation in the occurrence of fin whales in this area. In the nearby waters of the Scotia Sea (southeast of the Falkland Islands), large numbers of fin whales have been observed in recent years (A. Black pers obs). However, most of these sightings are offshore and the exact location of these animals can show considerable inter-annual variation, which is likely to be linked to the distribution of food resources. The presence of these animals in waters to the south of the Falklands is seasonal and therefore it is reasonable to assume that many migrating animals will pass through Falkland Islands waters. Fin whales are listed as Endangered on the IUCN Red List and are also afforded conservation status and management under CITES and CMS.

Fin whales have been detected acoustically in the Scotia Sea and off the western Antarctic Peninsula starting in February and peaking in late summer and the autumn (Širović et al., 2009). Large aggregations of feeding fin whales were also observed in the autumn (March–April 2012) off Elephant Island at the tip of the Antarctic Peninsula (Burkhardt and Lanfredi, 2012). The peak in Falklands recordings in March followed by the cessation of all detections could therefore indicate a pulse of migrating whales from those feeding grounds.

Sei whale *B. borealis* (EN)

JNCC surveys recorded 45 sei whales, however, few of these came from waters to the north of the Falkland Islands, most were off the east coast of the Islands (White et al., 2002). Sei whale was the most frequently sighted, and third most abundant, species recorded during the MMO of the PL001 seismic survey with 67 individuals recorded (Geomotive and MRAG, 2011), and the third most frequently sighted, fourth most abundant, species recorded during the NFB seismic survey (Polarcus, 2011). Analysis of the acoustic data from the Sea Lion area did not contain any confirmed sei whale calls. Due to the potential overlap in calls from sei and fin whales (Watkins, 1981, Baumgartner et al., 2008) and the absence of sei whale call description for the South Atlantic, it is possible that the fin whale detection records included some sei whale calls (Hipsey et al., 2013).

For many years large numbers of sei, and possibly fin, whales have been observed in inshore waters around the Falkland Islands (White et al., 2002, A. Black pers. comm., P. Brickle pers. comm.). These animals are only present on a seasonal basis and are likely to pass through the NFB on migration. A project to survey the distribution of cetaceans in inshore waters is currently underway (Thomson and Munro, 2014). The preliminary results and anecdotal observations indicate that sei whales are frequently encountered in inshore waters during the summer and autumn months. Sei whales are listed as Endangered on the IUCN Red List and are also afforded conservation status and management under CITES and CMS.

Antarctic minke whale *B.bonarensis* (DD)

Antarctic minke whales were encountered widely within Falklands waters and recorded throughout the year, although most animals were recorded between September and April (White et al., 2002). Minke whales were recorded during both of the marine mammal surveys conducted during seismic operations in the NFB (Geomotive and MRAG, 2011; Polarcus, 2011) but were not detected by acoustic surveys (Hipsey et al., 2013).

Humpback whales *Megaptera novaeangliae* (LC)

Humpback whales have been rarely recorded within Falklands waters. JNCC surveys encountered seven animals, all between October and March, in Patagonian Shelf waters. Acoustic monitoring and marine mammal observations from seismic vessels did not record humpback whales in the NFB.

Satellite tracking (Zerbini et al. 2006) and photo-identification indicate that animals from the population breeding off the coast of Brazil migrate to feed off South Georgia and the South Sandwich Islands in the summer months. Satellite tracks and the lack of sightings of these animals suggests that few of these whales pass through Falklands waters *en route*.

Sperm whale *Physeter macrocephalus* (VU)

This species was observed on 21 occasions in the JNCC surveys, the highest number of sightings occurring in October. About half of the sightings occurred in an area just north of the Sea Lion area. While this seems to be a small number of sightings over a three-year survey, the distribution of the records indicates that animals are present in the deeper waters of the FOCZ year-round. A single sperm whale was observed during the MMO in PL001 and four individuals were observed during MMO in the NFB seismic survey (Geomotive and MRAG, 2011; Polarcus, 2011; Appendix C, Table 2). The low number of sightings is likely to be due to the behaviour of the animals, which spend much of their time below the surface, and the limited survey effort in their preferred habitat type. Nevertheless, because sperm whales echolocate almost continuously while diving and dive for extended periods of time, acoustic monitoring is a powerful survey method for this species (Whitehead, 2003). Hipsey et al., (2013) found sperm whales were the most commonly recorded species during their year-long study. Detections occurred throughout the acoustic monitoring period without any obvious seasonal trend, with highest numbers of detections recorded in May.

Sperm whales are notorious for depredating Patagonian toothfish in the local longline fishery (White et al., 2002; Yates and Brickle, 2007). All the available evidence suggests that sperm whales, likely to be mature males, are present within the deeper waters of the Falklands Conservation Zones throughout the year.

Southern bottlenose whale *Hyperoodon planifrons* (LC)

The JNCC surveys recorded southern bottlenose whales between September and February. All encounters occurred in waters over 1,000 m deep. This species was apparently absent from Falklands waters in the winter months. This species was not detected during acoustic monitoring and a single animal was observed during seismic operations (Geomotive and MRAG, 2011).

Unidentified beaked whales *Mesoplodon* species (DD)

Beaked whales are notoriously difficult to identify at-sea and none of the 15 animals recorded during JNCC surveys were specifically identified. All sightings occurred in waters over 1,000 m deep, with the majority coming from the region of the Falkland Trench to the south east of the Islands. Stranding records indicate that a number of *Mesoplodon* species could be present within Falkland Islands waters (Otley et al., 2011).

Killer whale *Orcinus orca* (DD)

Killer whales were detected in the Sea Lion area on ten different days during the year-long acoustic monitoring period, with seven of the records between July and mid-October (Hipsey et al., 2013). The JNCC surveys recorded seven killer whale sightings over three years, primarily on the Patagonian Shelf, (White et al., 2002). Killer whales were observed during the PL001 and NFB seismic surveys on two and one occasion respectively (Geomotive and MRAG, 2011; Polarcus, 2011). Killer whales are known to regularly depredate longlines in the Falkland's Patagonian toothfish fishery when vessels are fishing in the north of the FOCZ, relatively close to the Licence Blocks (White et al., 2002; Yates and Brickle, 2007). Observers on fishing vessels recorded killer whales only to the northeast of the Islands despite a considerable amount of fishing in other areas throughout the year (Yates and Brickle, 2007). The evidence suggests that a small resident population of killer whales may occur in the region of the shelf-break to the north of the Falkland Islands.

Satellite tracking indicates that Type B killer whales migrate just east of the Falkland Islands when travelling between the Antarctic Peninsula and sub-tropical waters of the South Atlantic (Durban and Pitman, 2012). These animals appear to travel rapidly through the region but they could account for some of the acoustic detections and sightings.

Long-finned pilot whale *Globicephala melas* (DD)

Long-finned pilot whale sightings primarily occurred between February and September during the JNCC surveys (White et al., 2000). Acoustic detections from the Sea Lion area also indicated the presence of pilot whales during the austral autumn and winter, with the majority of detections occurring from mid-February until late August (Hipsey et al., 2013). Pilot whales were recorded on approximately 35 days throughout the year-long monitoring period (Hipsey et al., 2013). Several small groups of pilot whales were also observed during the seismic survey MMO, with a total of 88 individuals over three sightings in PL001 and 75 individuals over four sighting occasions in the NFB survey (Geomotive and MRAG; 2011, Polarcus, 2011).

The high number of pilot whale stranding's on the Falkland Islands (Otley, 2012) hints that there is a sizable population associated with Falklands waters. This species is regularly sighted in large groups from fishing vessels operating over the deep water slope (A. Black pers. obs.). White et al., (2002) often recorded other species of cetacean in association with pilot whales, in particular, hourglass dolphin and to a lesser extent southern right whale dolphin were recorded in association with pilot whales.

Peale's dolphin *Lagenorhynchus australis* (DD)

Peale's dolphin was the most commonly recorded marine mammal species during the JNCC survey period with 1,952 animals recorded during 644 encounters. Peale's dolphins were almost exclusively restricted to Patagonian Shelf waters and were only regularly recorded in waters deeper than 200 m to the west and south-west of the Falkland Islands (Figure 27). Peale's dolphins were regularly recorded at the western boundary of the survey area, a strong indication that the distribution of the species is continuous between the Falkland Islands and mainland South America. There was no clear evidence of any seasonal changes in the abundance, distribution or behaviour of these animals.

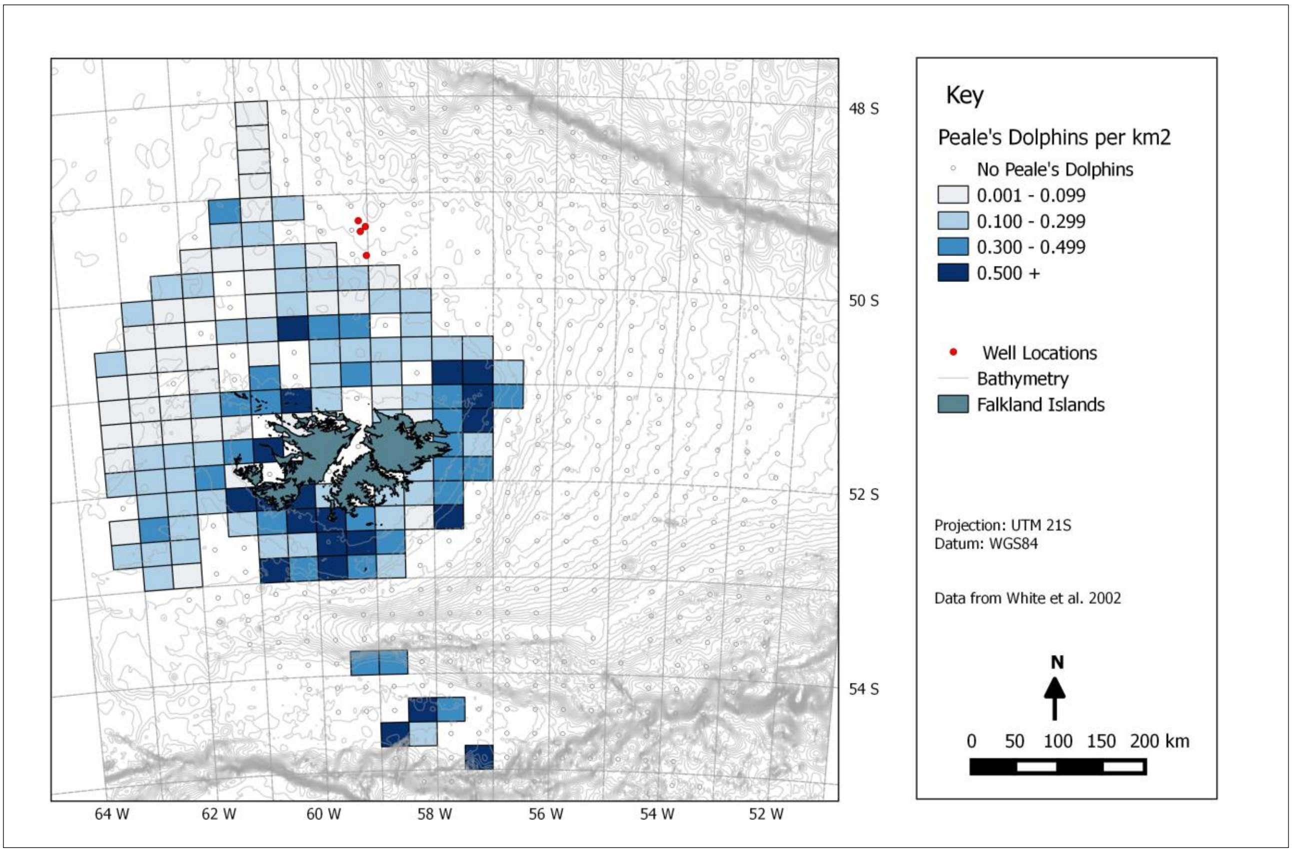


Figure 27: Peale's dolphin distribution recorded during JNCC surveys, all months

Peale's dolphin was also the most frequently recorded marine mammal on both seismic vessel surveys (Geomotive and MRAG, 2011; Polarcus, 2011).

Hourglass dolphin *L. cruciger* (LC)

A total of 150 sightings of 792 animals was recorded, during JNCC surveys. Between September and February, hourglass dolphins were recorded frequently during surveys in oceanic waters. Outside this period, hourglass dolphins were only rarely recorded, suggesting that they occur seasonally within Falklands waters. The majority of hourglass dolphin records were in continental shelf slope and oceanic waters (Figure 28). The JNCC surveys clearly identified spatial segregation between Peale's and hourglass dolphins; there was virtually no overlap in the ranges of these two species (White et al., 2002). Hourglass dolphins were also one of the most frequently recorded species from seismic vessels (Geomotive and MRAG, 2011; Polarcus, 2011).

The acoustic monitoring survey recorded an unidentified odontocete species (toothed whale; including killer whale and dolphins), which could not be definitively identified to species level (Hipsey et al., 2013). The occurrence of the odontocete calls closely matched the dolphin C-POD detections and the click characteristics and habitat preferences suggest the hourglass dolphin as the potential source (Hipsey et al., 2013).

It is likely that hourglass dolphins would predominate in the deeper waters surrounding the Sea Lion area.

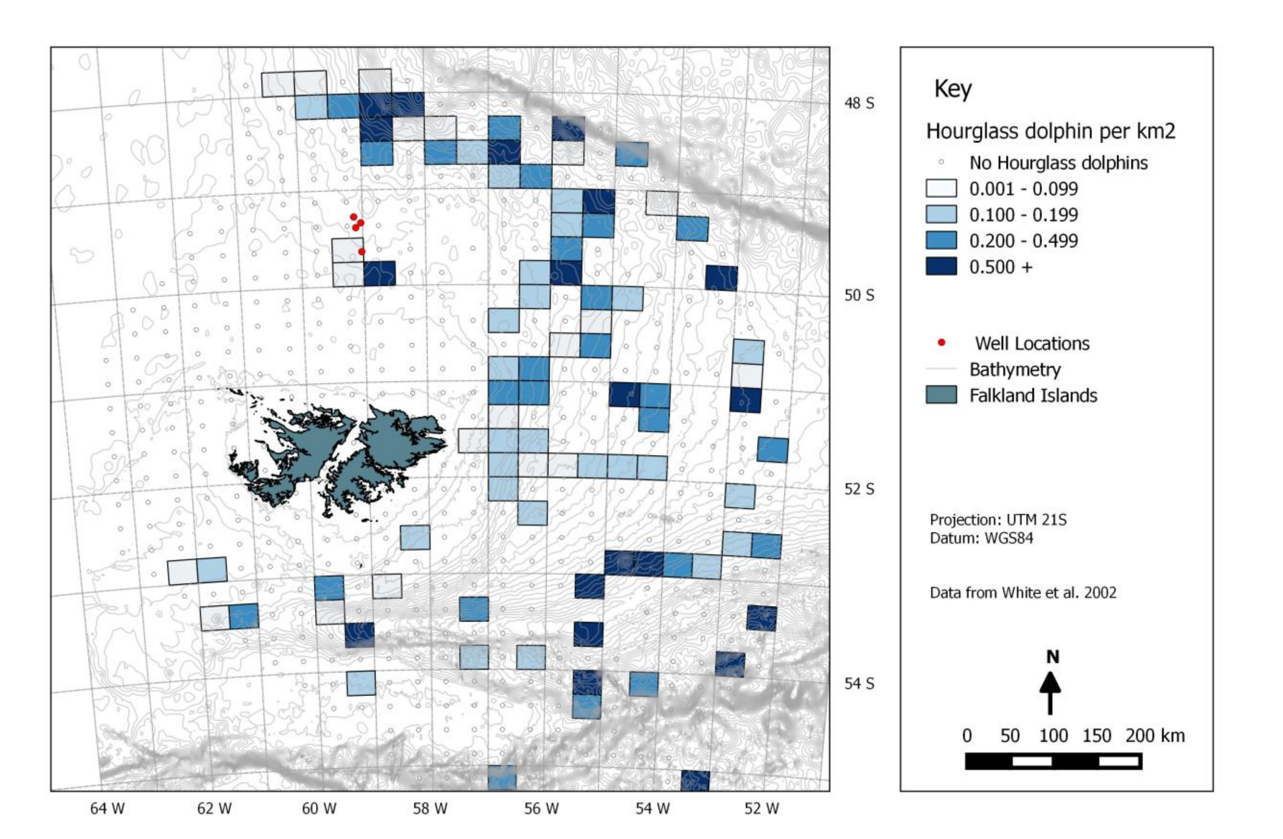


Figure 28: Hourglass dolphin distribution recorded during JNCC surveys, all months

Commerson's dolphin *Cephalorhynchus commersonii* (DD)

Commerson's dolphins were recorded during JNCC surveys in every month except May. A total of 276 animals was recorded in 84 encounters. All records of Commerson's dolphins were from either partially enclosed or coastal waters in the immediate vicinity of the Falkland Islands. This species was most frequently recorded from the waters within, or close to, the north and south entrances to Falkland Sound (Figure 29). There was no evidence of seasonal variation in the distribution or abundance of Commerson's dolphin - the apparent decreases in some months, for example May, is believed to be due to variation in the distribution of survey coverage rather than changes in the distribution of the dolphins.

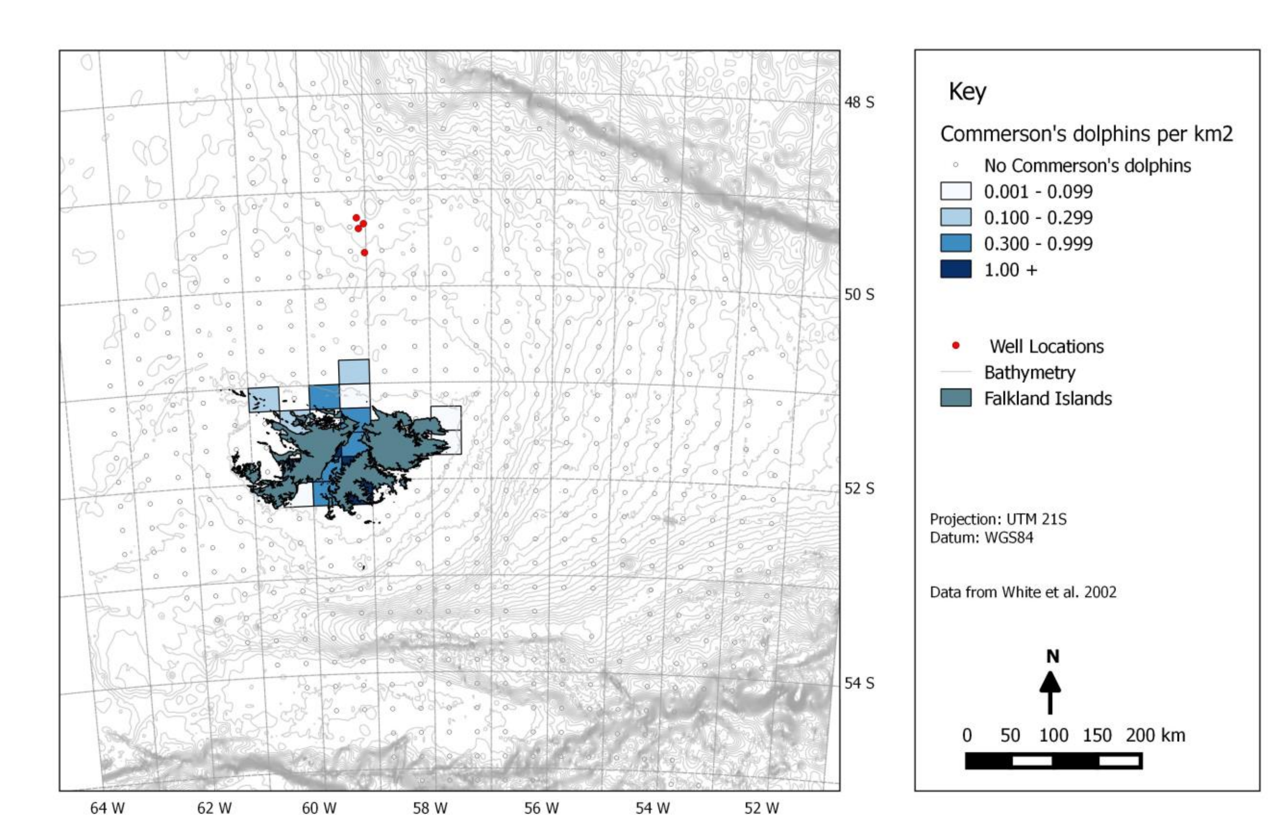


Figure 29: Commerson's dolphin distribution recorded during JNCC surveys, all months

Southern right whale dolphin *Lessodelphis peronii* (DD)

Southern right whale dolphins were only recorded on five occasions during JNCC surveys, all in waters over 200 m deep. However, the tendency for this species to occur in large groups resulted in a total of 231 animals recorded. Over half of these were in a single group of 120 animals, the largest group of any dolphin species recorded during surveys. On all five occasions when southern right whale dolphins were recorded they were in the company of long-finned pilot whales.

South American sea lion *Otaria flavescens* (LC)

Sea lions were recorded in all months but the majority of records came from inshore waters (White et al., 2002). Sea lions were also recorded in low numbers during surveys from seismic vessels (Geomotive and MRAG, 2011; Polarcus, 2011).

Fur seal species *Arctocephalus* species (LC)

Fur seals were the most numerous pinniped recorded during JNCC surveys. Although the observers were aware that South American and Antarctic fur seals were both present, it was not possible to reliably identify all fur seals to species level and therefore all fur seals were recorded as ‘fur seal species’. They were recorded in all months but there was a distinct peak in the number recorded during the winter. It was thought that this marked an influx of Antarctic fur seals into Falklands waters from the South Georgia breeding population, this is supported by tracking data (Staniland et al., 2012).

Southern elephant seal *Mirounga leonina* (LC)

Southern elephant seals spend the majority of the time below the surface, and therefore visual surveys are unlikely to accurately record the distribution of the species. White et al., (2002) recorded 13 southern elephant seals. No other surveys have recorded this species. Most of the records were clustered along the shelf break to the north of the Islands.

Leopard seal *Hydrurga leptonyx* (LC)

In total, Leopard seals accounted for the greatest number of detections throughout the acoustic monitoring study with the majority of leopard seal detections occurring in March and April (Appendix C, Table 6), and all detections concentrated in late austral summer and autumn (Hipsey et al., 2013). In contrast, there were no sightings of this species during the JNCC surveys or during the MMO on the seismic vessels in the NFB (White et al., 2002; Geomotive and MRAG, 2011; Polarcus, 2011). The characteristics of the recorded calls indicate the calling animals were sexually immature males (Hipsey et al., 2013). During the summer, leopard seals occur in the Antarctic pack ice and disperse northward with the advancing pack during the winter. Leopard seals are known to be more numerous around sub-Antarctic islands, such as South Georgia, in the winter months (Walker et al., 1998; Rodríguez et al., 2003). In the Falklands, individual leopard seals are seen from time-to-time but they are not regarded as anything more than occasional visitors (Strange, 1992). Records elsewhere in the world indicate that this species, particularly young males, have a tendency to wander far from their Antarctic breeding grounds (Aguayo-Lobo et al., 2011; Rodríguez et al., 2003; Hamilton, 1939).

5.4.7 Seabirds and Seabird Vulnerability

The waters around the Falkland Islands are highly productive and provide globally important feeding areas for significant aggregations of seabirds (White et al., 2002). The Islands themselves hold internationally important breeding populations of several seabird species and productive coastal and offshore waters support numerous species of non-breeding visitors (BirdLife International, 2014a). Of the 82 species of seabirds recorded in the Falkland Islands, 22/23 breed in the Islands, 24 are annual non-breeding visitors and the remainder are rare visitors or vagrants. (White et al., 2002; Woods and Woods, 2006). Over 70% of the global population of the near threatened black-browed albatross (*Thalassarche melanophris*) breed on the Islands (Wolfaardt, 2012). After New Zealand, the Falkland Islands support more penguin species than any other region in the world. For most of these species, the population breeding in the Falkland Islands is a significant proportion of the global total. Approximately 33% and 36% of the global population of gentoo (*Pygoscelis papua*) and rockhopper penguins (*Eudyptes chrysocome*) breed in the Falkland Islands, respectively (Baylis et al., 2013 a and b). Furthermore, a significant proportion (possibly 10%) of the world population of Magellanic penguins (*Spheniscus magellanicus*) breed on the Islands (Woods and Woods, 1997). The small breeding population of king penguins (*Aptenodytes patagonicus*) is at the limit of the species' range in the Falkland Islands, and its population is almost entirely concentrated at Volunteer Point, on the east coast of East Falkland. In addition to the large number of seabirds that breed on the Islands, many non-breeding seabirds have been observed (White et al., 2002) or tracked migrating into the waters of the Falkland Islands from elsewhere, particularly South Georgia (Croxall and Woods, 2002; Phillips et al., 2006)

The avifauna of the Patagonian Shelf region is well studied and documented, and seabird distribution, breeding and foraging patterns are relatively well understood (Croxall et al., 1984; Woods 1988 and 1997; Strange, 1992; White et al., 2001 and 2002; Otley et al., 2008; BirdLife International, 2014b).

This section provides a summary of Falkland Islands seabird species, their abundance, distribution, feeding and breeding ecology and sensitivities. In addition to drawing on the papers listed above, identification of abundant seabird species within the Sea Lion area has been based on at sea surveys conducted by Rockhopper Exploration and Desire Petroleum during seismic survey campaigns in licence area PL001 (Geomotive and MRAG, 2011) and NFB licence blocks (Polarcus, 2011).

5.4.7.1 Joint Nature Conservation Committee's (JNCC) Seabirds at-Sea Team (SAST)

In response to the impending start of exploratory drilling for oil within Falkland Islands waters, the JNCC were commissioned to conduct seabird and marine mammal surveys. Surveys commenced in 1998 and continued for three years, three dedicated observers were employed throughout this period. The project achieved over 20,900 km^2 of survey effort and recorded over 399,700 individual birds of 57 species. These data were published in the form of distribution maps, to display the seasonal dispersion of all species recorded (White et al., 2002). This work represents the most comprehensive survey of the at-sea distributions of seabirds within Falkland Islands waters and should be considered as the baseline to which additional information can be added.

There are a number of advantages and disadvantages associated with visual at-sea surveys of seabirds, and marine mammals.

- The data is only as good as the observer, therefore, experienced highly skilled observers are required, it is preferable to have two observers working in tandem.
- Some species are cryptic, their small size and/or behaviour make them difficult to see. For instance, penguins spend long periods out of sight, underwater. However, the data is recorded in distance bands and therefore it is possible to apply a correction factor to species that are less likely to be observed at distance.
- The distribution of survey effort is dependent on the survey base's activity. The majority of the SAST data was collected from Fishery Patrol Vessels (FPVs) and therefore effort is not evenly distributed. Following several years of work, some gaps in survey coverage were filled and all observations are standardised for survey effort, presented as the number of animals per unit of survey effort. However, it is difficult to detect seasonal and inter-annual variation in areas that are infrequently visited.
- In contrast to remote tracking, at-sea surveys record 'all' species of seabird and marine mammal encountered.
- The use of vessels of opportunity make at-sea surveys a relatively cheap monitoring tool.

With permission from Falklands Conservation (FC) and JNCC, the data was re-examined to highlight the species recorded in the vicinity of the Sea Lion area. An imaginary 'box' (between 49-50°S and 58.5-59.5°W) was drawn. The number of birds recorded per km of survey track, on a seasonal basis, was calculated to indicate relative abundance and is presented in Table 16. For the purposes of this analysis, the months of March, April and May are considered to be autumn, June, July and August are winter, September, October and November are spring and December, January and February are summer. As in White et al. (2002), clear seasonal patterns of abundance, and therefore risk from oil and gas related activity, were identified for most species recorded in the region.

Table 16: Relative abundance of seabird species recorded in the vicinity of the Sea Lion area during each season (JNCC data)

	Autumn (M,A,M)			Winter (J,J,A)			Spring (S,O,N)			Summer (D,J,F)	
Rank	Species	Birds/ km		Species	Birds/ km		Species	Birds/ km		Species	Birds/ km
1	BBA	1.172		Pr	1.417		BBA	0.415		Pr	0.940
2	GS	0.576		BBA	0.315		Pr	0.252		GS	0.440
3	WCP	0.342		AF	0.239		SS	0.126		BBA	0.379
4	CP	0.168		CP	0.124		CP	0.098		WP	0.124
5	WP	0.108		SRA	0.031		R/M	0.059		WCP	0.083
6	AF	0.054		GHA	0.030		WP	0.054		MP	0.079
7	GBSP	0.045		SGP	0.019		WCP	0.049		GBSP	0.077
8	SPP	0.045		NGP	0.013		GBSP	0.031		SS	0.053
9	SS	0.042		NRA	0.011		AF	0.031		SGP	0.022
10	Pr	0.039		KP	0.011		SGP	0.018		LTS	0.020
11	SRA	0.033		DP	0.010		DP	0.018		SRA	0.010
12	SGP	0.030		WP	0.008		MP	0.013		SPP	0.010
13	MP	0.030		KG	0.008		NGP	0.013		WA	0.008
14	GHA	0.027		GPsp	0.007		GPsp	0.010		GPsp	0.008
15	LTS	0.024		GBSP	0.007		AS	0.010		AS	0.008
16	WA	0.018		MDP	0.002		NRA	0.005		DP	0.006
17	AS	0.018		SS	0.002		WA	0.003		NRA	0.002
18	NRA	0.009		Dio Alb	0.001		SRA	0.003		CP	0.002
19	AtP	0.009		WCP	0.001		KG	0.003		RP	0.002
20	GPsp	0.009								BBSP	0.002
21	DP	0.009									
22	R/M	0.009									
23	MDP	0.006									
24	NGP	0.006									
25	LS	0.003									
26	RP	0.003									
27	BBSP	0.003									

Survey effort: Autumn 333.5 km, Winter 829.7 km, Spring 388.1 km, Summer 508.6 km

GPsp = giant petrel species, Dio Alb = *Diomedea* albatross species. The species codes in Table 16 are found in the text below.

A greater diversity of species was recorded during the autumn than during any other season. Below, a brief account is given for each species, ranked in order of autumn abundance. IUCN status is shown in parenthesis (LC=Least Concern, NT=Near Threatened, VU=Vulnerable, EN=Endangered).

Black-browed albatross (BBA) *Thalassarche melanophris* (NT)

The Falkland Islands are home to the world's largest breeding population of Black-browed albatross. The most recent census in 2010 recorded 500,000 breeding pairs, which is equivalent to approximately 74% of the global population (Wolfaardt, 2012).

During SAST surveys, black-browed albatross were regularly recorded throughout the year in the vicinity of the Sea Lion area (Table 16) and were ranked in the top three species recorded in all seasons. In the autumn (March to May), the number of birds recorded per km travelled was substantially higher than in other seasons. This period coincides with the fledging of young birds, which migrate northwards.

Great shearwater (GS) *Puffinus gravis* (LC)

Great shearwaters are largely a non-breeding visitor to Falkland Islands waters, although there is a very small local population (50-100 pairs, Woods and Woods, 1997). Virtually the entire global population, five million pairs, of this species breed on the Tristan da Cunha group (BirdLife International, 2014b). Following breeding, the population embarks on a circum-Atlantic migration, in a clockwise direction. It is these birds that are recorded within Falkland Islands waters.

Great shearwater was the second most numerous species recorded in the summer and autumn. The presence of this species within Falklands waters was consistent from year-to-year, although the number of birds can vary inter-annually (White et al., 2002).

White-chinned petrel (WCP) *Procellaria aequinoctialis* (VU)

Like great shearwater, white-chinned petrel has a very small Falklands breeding population, estimated at 55-100 pairs (Reid et al., 2007). Most of the birds present within Falkland Islands waters come from the far larger South Georgian breeding population (Berrow et al., 2000; Phillips et al., 2006), which is estimated to be 900,000 pairs (Martin et al., 2009).

White-chinned petrels were one of the most regularly recorded species throughout most of the year in the vicinity of the Sea Lion area, except for the winter months, when their numbers are considerably reduced.

Cape petrel (CP) *Daption capense* (LC)

Cape petrels are non-breeding visitors to Falkland Islands waters from their Antarctic breeding grounds. Although recorded in every season, Cape petrels do not arrive in large numbers until May and numbers start to decline in September and are virtually absent during the summer months (White et al., 2002).

Wilson's storm-petrel (WP) *Oceanites oceanicus* (LC)

Wilson's storm-petrels are extremely widespread and abundant in the southern hemisphere. The Falklands are thought to support a modest breeding population of something in excess of 5,000 pairs (Woods and Woods, 1997). Although present throughout the year, the number of these birds observed during the winter months was greatly reduced. In the summer months, high densities of Wilson's storm-petrel were found over the Patagonian Shelf to the northeast of East Falkland, close to the Sea Lion area (White et al., 2002).

Antarctic fulmar (AF) *Fulmarus glacialoides* (LC)

Like Cape petrels, Antarctic fulmars are non-breeding visitors to Falkland Islands waters from their Antarctic breeding grounds. Antarctic fulmars were one of the most common species recorded during the winter months but were almost entirely absent during the summer.

Grey-backed storm-petrel (GBSP) *Garrodia nereis* (LC)

Like Wilson's storm-petrel, the Falklands support what is thought to be a small breeding population (1-5,000 pairs) of grey-backed storm-petrels (Woods and Woods, 1997). During the summer months, high densities of this species were encountered over the shelf break to the northeast of the Islands, which extends close to the Sea Lion area.

Grey-backed storm-petrels were the most frequently recorded species feeding in association with patches of free floating kelp (Gillon et al., 2001).

Soft-plumaged petrel (SPP) *Pterodroma mollis* (LC)

Soft-plumaged petrels are regarded as summer and early autumn visitors to Falklands waters. The nearest breeding location of this species to the Falklands is on the Tristan da Cunha group. Soft-plumaged petrels were one of the few species recorded by White et al. (2002) that showed inter-annual variation in the number of birds recorded within Falklands waters. Like several other species with breeding populations in the Tristan da Cunha group, the majority of soft-plumaged petrels recorded were encountered over oceanic waters to the north east of the Falklands.

Sooty shearwaters (SS) *Puffinus griseus* (NT)

Sooty shearwaters have an estimated breeding population of 10-20,000 pairs within the Falkland Islands (Woods and Woods 1997). Although present throughout the year, the majority of the breeding population are absent from Falklands waters from April to August (White et al., 2002). Generally, the highest densities of sooty shearwaters were recorded over inshore waters, where large flocks raft on waters adjacent to breeding colonies.

Prion species (Pr) *Pachyptila* species (LC)

Several species of prion are known to frequent Falkland Islands waters, however, they are notoriously difficult to identify to species level at-sea and therefore most prions were recorded as 'prion species'. Throughout most of the year, prions are one of the most numerous 'species' encountered within Falklands waters, however, there is a distinct drop in numbers during the autumn.

Two species of prion breed within the Falkland Islands, thin-billed (*P. belcheri*) and fairy prions (*P. turtur*). The population of thin-billed prions is estimated to be two million pairs on New Island alone (Catry et al., 2003) with other smaller colonies elsewhere in the Islands, making thin-billed prion the most numerous breeding seabird in the Falklands. Fairy prions have a far smaller breeding population and one confirmed breeding site, on Beauchêne Island (Woods and Woods, 1997). Additionally, Antarctic prions (*P. desolata*) are likely to visit Falkland Islands waters.

Locally high densities of prions can be found close to the Sea Lion area in the summer months but generally densities of this 'species' are much higher elsewhere within Falklands waters, to the west and southwest of the Islands (White et al., 2002).

Southern and Northern royal albatrosses (SRA and **NRA)** *Diomedea epomophora* (VU) and *D. sanfordi* (EN)

Southern and northern royal albatrosses are both non-breeding visitors to the south west Atlantic from their breeding sites in New Zealand. They are classed as Vulnerable and Endangered respectively under IUCN guidelines. Both species are recorded throughout the year in Falklands waters but the number of birds recorded was highest between March and June (White et al., 2002). At this time, royal albatrosses were found in highest densities over Patagonian Shelf waters to the west of the Falklands. At other times, royal albatrosses appear to disperse throughout Falklands waters.

Southern giant petrels (SGP) *Macronectes giganteus* (LC)

The Falklands support the largest breeding population of southern giant petrels in the world, with approximately 19,500 breeding pairs (Reid and Huin, 2005) or approximately 33% of the global population. The presence of white morph birds (white plumaged birds) during the winter months indicates that some birds that bred in higher latitudes move to Falklands waters during the winter (White et al., 2002).

Southern giant petrels were recorded in all months and were noted for being extremely persistent ship associates. The true density of birds within Falklands waters is likely to have been underestimated as birds in close attendance to fishing vessels were not recorded. This species was not recorded in high numbers in the vicinity of the Sea Lion area but the presence of an oil rig, platform or supply vessels may attract these scavenging birds, and consequently increase their presence in the area.

Magellanic penguin (MP) *Spheniscus magellanicus* (NT)

Magellanic penguins are regarded as summer breeding visitors to the Falkland Islands, which support approximately 10% of the global population (Woods and Woods, 1997). While breeding highest densities of Magellanic penguins were recorded in inshore waters but patches of locally high density were also encountered over Patagonian Shelf and shelf-break waters. Following the post-breeding moult, Magellanic penguins migrate northwards in the autumn to over-winter on the northern Patagonian Shelf (Pütz et al., 2002). They do not start to return to the Falklands until September. It is during these migrations that many birds will pass through the North Falklands Basin.

Grey-headed albatross (GHA) *Thalassarche chrysostoma* (EN)

Grey-headed albatross are non-breeding visitors to Falkland Islands waters. The closest breeding populations are on islands off the southern coast of Chile and South Georgia, with approximately 50% of the global population of this Vulnerable species breeding on the later (ACAP, 2014).

The presence of this species within Falklands waters is highly seasonal, with the majority of birds recorded between May and September. At this time, most of the birds recorded were encountered over the shelf-break to the south and east of the Islands (White et al., 2002).

Long-tailed skua (LTS) *Stercorarius longicaudus* (LC)

Long-tailed skuas breed in the Arctic during the boreal summer and spend the non-breeding season in the South Atlantic and South Pacific. The vast majority of birds were recorded in the vicinity of the Falklands between December and March. As the Falklands lie towards the southern limit of this species' range, the majority of sightings took place over oceanic and shelf-break waters to the north of the Islands. Like several other non-breeding summer visitors to the Falkland Islands, considerable inter-annual variations in the number of this species were recorded by White et al. (2002).

Wandering albatross (WA) *Diomedea exulans* (VU)

Wandering albatross are classed as Vulnerable under IUCN guidelines and are non-breeding visitors to Falkland Islands waters. The closest breeding site is at South Georgia where approximately 1,400 pairs breed per annum (Poncet et al., 2006). Observations of banded individuals at-sea indicate that a large proportion of the South Georgia population utilise Falklands waters at some point during the year (Croxall et al., 1999; Otley et al., 2007).

Wandering albatross are found in low numbers throughout the year, primarily over the shelf-break waters surrounding the Falkland Islands. Few birds were recorded in the vicinity of the Sea Lion area but it is likely that many birds pass through this area during the course of a year.

Antarctic skua (AS) *Stercorarius antarctica* (LC)

The presence of Antarctic skuas within the study area is highly seasonal, with the vast majority of birds recorded between November and April. The density of birds recorded was highest over coastal waters, close to breeding sites. However, locally high densities were encountered at-sea throughout the remainder of the Falklands Conservation Zones (White et al., 2002).

Atlantic petrel (AtP) *Pterodroma incerta* (EN)

Despite a large breeding population of 1.8 million pairs, the breeding population of these birds is restricted almost entirely to Gough Island, Tristan da Cunha group, where the population is in decline due to mouse depredation (BirdLife International, 2014b). For these reasons, Atlantic petrel is classed as Endangered. This species was recorded in every month but there was a distinct peak in numbers during the spring, which corresponds to the post breeding period of this winter breeding species. Most encounters with Atlantic petrel came while surveying oceanic waters to the north east of the Falklands.

Diving-petrel species (DP) *Pelecanoides* species (LC)

Two species of diving-petrel are regularly encountered within Falkland Islands waters; common diving-petrel *Pelecanoides urinatrix* and Magellan diving-petrel *P. magellanicus*, and a further species (Georgian diving-petrel *P.georgicus*) has been recorded. Given reasonable views, Magellan diving-petrels can be readily identified at-sea but the other species are difficult to separate and therefore most birds were recorded as 'diving-petrel species'.

In general, far more diving-petrels are recorded during the spring and summer than during the autumn and winter months. The highest densities of birds were recorded to the west and south of the Falklands (White et al., 2002). Diving-petrels were only recorded in low numbers in the vicinity of the Sea Lion area.

Southern rockhopper and Macaroni penguins (RP, MAC, R/M) *Eudyptes chrysocome* (VU) and *E. chrysolophus* (VU)

The Falklands support approximately 40% of the global population of southern rockhopper penguins (Baylis et al., 2013b). Outside the breeding and moulting periods, between May and August, these birds were only encountered in low numbers within Falklands waters. During the spring, rockhopper penguins were dispersed throughout Falklands waters, it was at this time that the highest number of birds were recorded in the vicinity of the Sea Lion area. During the austral summer months, the distribution of rockhopper penguins was linked to the shallower waters of the Patagonian Shelf.

During the austral winter months, some macaroni penguins from the breeding population on South Georgia move into the oceanic waters of the Falklands Conservation Zones (White et al., 2002; Ratcliffe et al., 2014). These observations are supported by satellite tracking of birds from South Georgia (Ratcliffe et al., 2014). It was not always possible to be certain of the identity of *Eudyptes* penguins when encountered at-sea and therefore many birds were recorded as rockhopper/macaroni penguins. It is likely that some of these birds were in fact macaroni penguins.

Northern giant petrel (NGP) *Macronectes halli* (LC)

Northern giant petrels are non-breeding visitors to Falkland Islands waters. The closest breeding sites are found on South Georgia, which supports the world's largest breeding population of this species. Satellite tracking during the breeding season indicates that these birds visit the Patagonian Shelf on foraging trips (Gonzáles-Solís et al., 2000). Like southern giant petrels, this species was recorded in all months but in lower numbers. During the autumn and winter months, highest densities of this species were recorded over the Patagonian Shelf. In the spring and summer, birds were dispersed throughout the waters surveyed (White et al., 2002).

Little shearwater (LS) *Puffinus assimilis* (LC)

Little shearwaters are rare non-breeding visitors to Falkland Islands waters, the nearest breeding population is found on the Tristan da Cunha group. White et al. (2002) only recorded this species during the summer and autumn months with a peak in sightings during March. The majority of records came while surveying waters to the north of the Islands.

Black-bellied storm-petrel (BBSP) *Fregetta tropica* (LC)

Black-bellied storm-petrels are non-breeding visitors to Falklands waters. The presence of this species is almost entirely restricted to the summer months, when they are most frequently sighted over oceanic waters to the north of the Islands (White et al., 2002). Very few birds were recorded in the vicinity of the Sea Lion area.

Two additional species were recorded during austral winter and spring surveys but not during the austral autumn.

King penguin (KP) *Aptenodytes patagonicus* (LC)

Although there is a small resident breeding population of king penguins in the Falkland Islands, encounters with king penguins at-sea were highly seasonal. Virtually all of the birds recorded were seen between June and September. The timing of these sightings and the number of birds encountered suggest that many of the king penguins present within Falklands waters originated from South Georgia. This is supported by data from birds tracked from South Georgia in the winter.

Most of the king penguins records within Falklands waters come from oceanic and shelf-break waters to the north of the Islands (White et al., 2002).

Kelp gull (KG) *Larus dominicanus* (LC)

Kelp gulls are resident breeders in the Falkland Islands. During the austral ‘summer’ (November to April), kelp gulls are confined to inshore waters. In the austral ‘winter’ (May to October), kelp gulls were recorded in far higher numbers but the majority of sightings still occur over inshore waters. However, birds also range much further offshore; it is at this time that they are recorded in the vicinity of the Sea Lion area.

3.6.2 Satellite tracking studies

At about the same time as SAST surveys were starting in the Falklands, satellite tracking projects on a number of species; black-browed albatross (Huin, 2002), Magellanic (Pütz et al., 2000 and 2002a), rockhopper (Pütz et al., 2002b) and gentoo penguins (Clausen and Pütz, 2003) commenced. In subsequent years, tracking projects have continued on a number of species at various sites around the Islands. Appendix D (Table 1) summarises the tracking data collected to date. Additionally, some species that breed elsewhere, particularly on South Georgia, have been tracked to Falkland Islands waters (for instance, Berrow et al., 2000; Phillips et al., 2006; Ratcliffe et al., 2014). The main limitation of the tracking data is the comparatively small sample sizes that are currently available. This applies to priority taxa, age-classes, breeding stages and sites, but is particularly the case for immature/juvenile birds and periods outside of the breeding season. So, although there has been a considerable and increasing focus on tracking seabirds in recent years, there remain substantial data gaps. Generally, small sample sizes limit the ability to obtain statistically meaningful and biologically relevant results. Work is ongoing to improve the scope of satellite tracking data in the Falklands.

BirdLife International manages the Global Procellariiform Tracking Database (BirdLife International, 2004), which serves as a central repository for albatross and petrel tracking data from all over the world. However, there is no such repository for penguin data. There is a need to review all the relevant data as a whole, this work is currently underway.

5.4.7.2 Seabird Surveys from seismic vessels within the vicinity of the Drilling Campaign Area during 2011

Seabird surveys were conducted from January 2011 until May 2011 during a 3D seismic survey in the licence area PL001, in which the Sea Lion area is partly located (Geomotive and MRAG, 2011). A larger area wide seabird survey covering many of the NFB licence blocks was also conducted during the 2011 summer period, from the end of November 2010 to May 2011 (Polarcus, 2011). Survey methods were based on standardised protocols developed by the JNCC and used by SAST in the Falklands. The objective of these surveys was to increase the knowledge of seabird abundance and distribution within the PL001 licence area during the summer season. However, it is difficult to compare the data presented in Geomotive and MRAG (2011) and Polarcus (2011) with that in White et al. (2002) as it is presented in a different format. Nonetheless, there are similarities in the rank of species abundance from all three datasets. Table 17 lists the 20 most abundant seabird species recorded during the Geomotive and MRAG survey, the corresponding rank of abundance of those species recorded during the Polarcus survey, and their status on the IUCN Red List of threatened species. Details of all of the birds recorded during both surveys, their Falkland Islands and global breeding populations and protection status under ACAP and IUCN Red List guidelines are listed in Appendix D, Table 1.

Table 17: Number of Seabird Sightings during the PL001 and NFB Surveys, including Status on the IUCN Red List and Population Trend

Bird Species Common name	PL001[1]			NFB[2]		IUCN Red List Category[3]	Population Trend[3]
	Rank	No. of Birds	No. of group sightings	Rank	No. of Birds		
Black-browed albatross	1	3118	1790	1	5043	**NT**	Decreasing
Great shearwater	2	2106	1325	3	1004	LC	Stable
Soft-plumaged petrel	3	1257	1000	6	318	LC	Stable
White-chinned petrel	4	1100	1011	2	1633	**VU**	Decreasing
Prion spp. (inc Blue petrel)	5	552	454	5	488	LC	Stable
Giant petrel species	6	411	370	4	574	LC	Increasing
Sooty shearwater	7	338	144	11	17	**NT**	Decreasing
Wilson's storm-petrel	8	229	213	7	262	LC	Stable
Atlantic petrel	9	173	161	23	2	**EN**	Decreasing
Southern royal albatross	10	172	138	12	16	**VU**	Stable
Cape petrel	11	170	105	20	4	LC	Stable
Manx shearwater	12	158	9	NR	NR	LC	Decreasing
Southern giant petrel	13	132	127	NR	NR	LC	Increasing
Northern giant petrel	14	125	111	NR	NR	LC	Increasing
Falkland Islands skua	15	78	62	NR	NR	LC	Stable
Large albatross species	16	65	49	13	14	n/a	n/a
Large skua	17	64	47	16	7	n/a	n/a
Wandering albatross	18	59	58	10	20	**VU**	Decreasing
Antarctic fulmar	19	52	42	9	22	LC	Stable
Grey-backed storm petrel	20	44	40	NR	NR	LC	Decreasing

Note: NR – not recorded. IUCN categories: LC – Least Concern, NT – Near Threatened, VU – Vulnerable, EN - Endangered

[1] Geomotive and MRAG 2011. 11/01/11 - 02/05/11.
[2] Polarcus 2011. 25/11/10 - 05/05/11.

During the survey of Geomotive and MRAG, a total of 242 individual surveys were conducted, comprising 308 hours and covering approximately 1,350 km. Over 7,300 sightings were made comprising 10,500 individual birds of 38 different species / species groups. There was little variation in species abundance over the four months of the survey period, with the same species present in similar numbers in each month (Geomotive and MRAG, 2011).

Throughout the Polarcus surveys, a total of 226 individual surveys were conducted over a period of 79 days and a total duration of 233 hours. Over 4,000 sightings were made comprising 9,638 individual birds of 30 different species / species groups. Some limitations were identified with the survey such as low vessel speed, high levels of seabird association with the vessel and seismic streamer array (Polarcus, 2011), which limit the comparison with other survey data.

The most abundant families of seabirds recorded during the surveys were albatross, shearwater, petrel, skua and fulmar (Table 17). Additionally, three species of penguin (Magellanic, gentoo and rockhopper) were recorded in low numbers during both surveys (Appendix D, Table 1). During both the PL001 and the NFB survey the black-browed albatross was the most commonly encountered species, with high-density rafts of birds recorded on the water during the NFB survey (Polarcus, 2011). The great shearwater, soft-plumaged petrel, white-chinned petrel and giant petrel species were also frequently encountered species, and are all known to follow and be attracted to vessels (Polarcus, 2011).

Of the 20 most abundant seabirds, four are classified as Vulnerable or Endangered on the IUCN Red List, meaning that there is an increased risk of extinction. A further two species are in the Near Threatened category (Table 17). Of these six species, five are recorded as having a currently decreasing population trend, and one as stable.

The JNCC survey methodology is designed to record birds that are actually present at the time of the survey. The presence of a rig or platform and associated support vessels is likely to influence the distribution of birds in the immediate vicinity. Seabird densities have been recorded between 19 and 38 times higher in the immediate vicinity of a rig, than surrounding waters (Wiese et al., 2001). Additionally, prey species may aggregate around the platform and influence the seabird assemblage in the immediate vicinity. Several species are known to persistently associate with ships (such as, black-browed albatross, giant petrels, Cape petrels and Antarctic fulmars), it is these that are most likely to associate with the in-field infrastructure and supply vessels.

5.4.7.3 Seabird Ecology

Many seabird species are incredibly mobile, travelling thousands of kilometres across international waters and multiple Exclusive Economic Zones and only return to land to breed. They face many serious conservation challenges throughout their migratory range and across all phases of the lifecycle and are now the most threatened group of birds (BirdLife International, 2014). Understanding seabird ecology is essential to assessing how marine and terrestrial operations may pose a threat to these species, and how these potential impacts may be avoided and mitigated. Table 18 and Table 19 provide summaries of the key ecological characteristics of the most abundant seabird species, identified within the NFB and particularly the Sea Lion area.

Falklands Conservation conduct an annual seabird monitoring programme across the Falkland Islands and currently monitor gentoo penguins at 11 breeding sites (16 colonies), Magellanic penguins at one site (single colony) and rockhopper penguins at five sites (13 colonies). King penguins and black-browed albatross are monitored at single, but key sites in terms of population numbers, and southern giant petrels are monitored at one site (three colonies) (Stanworth, 2014). Data from these monitoring sites give information on the breeding success and population trends over a number of years, indicating the current status of the population.

The estimated number of gentoo penguin breeding pairs at monitored sites decreased in the 2013/2014 season by 13% to 26,241 pairs from a high of 30,146 pairs during the 2012/2013 season. The largest drop in number was found at colonies in the south east of the Islands, in the west and north, breeding numbers were stable or increasing. Overall, breeding success was below average at 0.84 chicks per pair.

The number of pairs of rockhopper penguin increased by 6.7%, in line with the trend recorded over past seven years. Breeding success declined slightly on the previous year to 0.48 chicks per pair, which is below the long-term average of 0.66 chicks per pair.

Estimated numbers of pre-fledged king penguin chicks varies considerably from one year to the next. The last count in 2013 recorded a little over 600 pre-fledged chicks, down 14.9% from the previous season (Stanworth 2014).

The estimated breeding pairs at three of the black-browed albatross colonies remained stable during the 2012/13 season, whilst the fourth colony declined by 11.5% following a severe storm during 2010 (Stanworth, 2013). In the 2013/2014 season, the number of breeding pairs increased at monitored sites to just below 3,000 pairs, close to the long-term (since 2005) average. Most of this increase is accounted for by the recovery in numbers at the site impacted by the storm.

The number of southern giant petrel breeding pairs at the monitored sites was stable, although breeding success was down by about 8% from the previous year (Stanworth, 2014).

It was noted that there was high variability in breeding success for gentoo and rockhopper penguins between and within monitoring sites and that local factors are also driving breeding success. Additionally the single monitoring site for Magellanic penguins is not considered to be representative of Island wide trends or the population as a whole owing to its proximity to Stanley and status as a popular tourist destination.

Data from the 2013/2014 seabird monitoring season and historic trends demonstrate the spatial and annual variability in seabird breeding success and the need for more detailed and widespread data to inform population trends and global breeding success.

Table 18: Key Ecological Characteristics of Some of the Most Abundant NFB Seabirds

Species	Migration patterns	Breeding cycle	Diet	Falkland breeding site	Falklands Population
Black-browed albatross (*Thalassarche melanophris*)	Out with breeding adults entirely at sea over Patagonian Shelf, between Drake Passage and 30°N (~100,000 km^2)	Start breeding at 7 yrs Annual breeder Adults return to nest Sept 1 egg laid mid Oct 70 day incubation Chicks brooded for 25 days Chicks fed mid Apr Chicks fledge after 122 days	Variety of prey, predominantly fish and squid, with some jellyfish, octopus, lobster krill and other crustaceans.	17 inland sites, large colonies on Jason Islands and Beauchêne Island.	500,000 breeding pairs. 76% global population
Great Shearwater (*Puffinus gravis*)	Most frequent between Dec and April over shelf slope and oceanic waters to east and north of Falkland Islands	Adults return Sept 1 egg laid end Oct Chicks and adults depart late April Most birds non-breeding visitors	Diving seabird foraging on squid, fish, crustaceans	Kidney Island and offshore tussac islands	20 pairs <0.1% global population
Soft-plumaged petrel (*Pterodroma mollis*)	Primarily in deep waters north of the Falkland Islands. Nov – Apr, peak Jan.	Non-breeding visitor	Primarily squid, also crustaceans and fish from surface	Tristan da Cunha, Gough Island	Non-breeder
White-chinned petrel (*Procellaria aequinoctialis*)	Widespread in shelf and oceanic waters in winter, shallower waters in spring summer	Adults return Sept 1 egg laid Oct/Nov 7 week incubation Chicks and adults depart April/May Most birds non-breeding visitors	Squid, fish and crustaceans from surface or by diving	Kidney Island, New Island, Bottom Island	55-100 pairs <0.1% global population
Southern giant petrel (*Macronectes giganteus*	Recorded in all months, highest densities March-June over Patagonian Shelf waters, west and south of Falkland Islands	Adults return Sept 1 egg laid Oct/Nov Chicks fledge Mar	Scavengers, of seals, seabirds and fishing discards	38 locations, primarily Falkland Sound, west of West Falkland	19,810 breeding pairs 41% global population
Northern giant petrel (*Macronectes halli*)	Recorded in all months with slightly higher density recorded from March to August, over Patagonian Shelf waters	Non-breeding visitor	Scavengers, of seals, seabirds and fishing discards	South Georgia	Non-breeder
Sooty shearwater (*Puffinus griseus*)	Migrate to northern hemisphere outside breeding season	Start breeding at 4 yrs Adults return Sept 1 egg laid late Nov Chicks fledge April Adults depart Mar	Squid, crustaceans, small fish and fishing discards	Kidney Island	100,000 pairs 0.1% global population
Wilson's storm-petrel (*Oceanites oceanicus*)	Migrate to northern hemisphere Apr-Aug, few remain	Adults return Nov 1 egg laid Nov-Jan 6 week incubation Chicks fledge Feb/Mar	Small shrimp, squid and fish offal from fishing discards	Jason Islands and Beauchêne Island.	No data
Atlantic petrel (*Pterodroma incerta*)	Recorded in all months, majority Oct – March during post-breeding dispersal. Deep waters to northeast, and southeast.	Non-breeding visitor	Primarily squid, some crustaceans and fish.	Tristan da Cunha, Gough Island	Non-breeder
Southern royal albatross (*Diomedea epomophora*)	High densities Patagonian Shelf northwest of Islands Mar-Jun. Locally high densities Jul-Sept, Low to moderate density	Biennial breeder. Non-breeding visitor	Primarily squid and fish, also salps, crustacea and carrion.	New Zealand	Non-breeder
Wandering albatross (*Diomedea exulans*)	Throughout the year in Falklands waters in small numbers offshore.	Biennial breeder. Non-breeding visitor	Squid and fish	South Georgia	Non-breeder

Source: BirdLife International, 2014b; Otley et al., 2008; White et al., 2002; Woods, 1988; Reid et al., 2007; Reid and Huin, 2005; Wolfaardt, 2012.

Table 19: Key Ecological Characteristics of Most Abundant NFB Penguins.

Species	Migration patterns	Breeding cycle	Diet	Falkland breeding site	Falklands Population
Gentoo penguin (*Pygoscelis papua*)	Resident, primarily within 10 km up to 300 km in winter	Nest building Sept 1-2 eggs laid late Oct 34 day incubation	Varies by location, primarily fish, also crustaceans and squid	Primarily West Falkland and outer islands	121,500 pairs, 39% global population
Rockhopper penguin (*Eudyptes chrysocome*)	Winter foraging between Straits of Magellan & 39°N (1,400km)	Mating Oct 2 eggs laid mid Nov Chicks fledge Mar Adults depart April	Crustacean, primarily krill. Squid.	Primarily outer islands of West Falkland	320,000 pairs 36% global population
Magellanic penguin (*Spheniscus magellanicus*)	Absent during winter, feeding Patagonian Shelf and shelf break, Argentine coast	Adults arrive Sept 2 eggs laid Oct 40 day incubation Chicks fledge Mar Adults depart Apr	Varying proportions of fish and squid, smaller amounts of lobster krill	Over 90 locations on the Falkland Islands	c.140,000 pairs 10% global population
King penguin (*Aptenodytes patagonicus*)	May-June migrate south of Polar Front	12 mo - Mating Oct 1 egg laid Nov-Mar 55 day incubation	Lantern fish and squid	Volunteer point	<1,000 pairs 0.04% global population

Source: BirdLife International, 2014b; Otley et al., 2008; White et al., 2002; Woods, 1988; Baylis, 2012

5.4.7.4 Threats to Seabirds within Falkland Islands Waters

Seabirds may be affected by anthropogenic factors in a number of ways, such as competition with commercial fisheries, scavenging fisheries discards, habitat modification, mortality resulting from fishing interaction and contamination from various forms of pollution. Within Falkland Islands waters, negative impacts on seabird productivity through competition for food with commercial fisheries was not identified in in the early years of the fishery (Thompson, 1992; Thompson and Riddy, 1995) and indeed to date there has been little further evidence gained to show this. However, mortality due to interactions with fisheries within Falkland Islands waters have been identified (Sullivan and Reid, 2003; Reid and Sullivan, 2004). Following the implementation of the National Plan of Action–Seabirds (NPOA-S) by the FIG in 2004, the introduction of effective mitigation measures significantly reduced the likelihood of incidental seabird mortality during longline fishing (FIG, 2007). In recent years, the trotline system has been adopted to prevent cetacean depredation but this method of fishing also reduces the risk of seabird mortality to virtually zero. Since 2007, there have been no reported seabird mortalities in the longline fishery (FIG, 2013).

Similarly, the FIG also adopted a NPOA-Tr for the trawl fishery in 2004, from which it was shown that there was significant levels of mortality in seabirds feeding off the offal discharge of the finfish fishery (FIG, 2007). Extrapolation of recorded seabird mortalities during 2012 estimates that 0.19 seabirds per day were killed in Falkland Islands waters, mostly black-browed albatrosses, equating to a total of 621 birds killed each year (FIG, 2013).

In recognition of the threats of fisheries related mortality and land-based threats at breeding sites a multilateral Agreement for the Conservation of Albatrosses and Petrels (ACAP) was established in 2004, which seeks to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to their populations. ACAP is a daughter agreement to the Convention on the Conservation of Migratory Species of Wild Animals (CMS), which the Falkland Islands are signatories to. CMS's objective is to conserve migratory birds throughout their range; it identifies migratory species threatened with extinction (Appendix I) and strives to strictly protect these species. CMS also acts as a framework Convention for other regional agreements for migratory species that need international co-operation (Appendix II) to conserve them over their entire range, such as ACAP.

Currently, ACAP covers 30 species, which comprise 22 albatrosses, seven petrels and one shearwater. Of these species, 12 were recorded within Falklands waters during JNCC surveys (White et al., 2002), three of which have breeding populations. Table 20 lists the species listed under ACAP that occur within Falkland Islands waters. ACAP aims to stop or reverse population declines by co-ordinating action between States within migratory ranges to mitigate known threats to albatross and petrel populations. To achieve this ACAP promotes an Action Plan which describes a number of conservation measures including research and monitoring, reducing incidental mortality in fisheries, eradicating non-native species at breeding sites and reducing disturbances, habitat loss and pollution.

Of the species recorded during the PL001 and NFB seabird surveys at-sea eight are listed under ACAP. No species are currently listed on CMS Appendix I as threatened with extinction.

Table 20: ACAP species found within Falklands waters

Common name	***Scientific name***	**Local status**	**IUCN status**
Black-browed albatross	*Thalassarche melanophris*	Common breeder	NT
Grey-headed albatross	*Thalassarche chrysostoma*	Regular visitor	EN
Grey petrel	*Procellaria cinerea*	Regular seasonal visitor	NT
Light-mantled sooty albatross	*Phoebetria palpebrata*	Regular visitor	NT
Northern giant petrel	*Macronectes halli*	Common visitor	LC
Northern royal albatross	*Diomedea sanfordi*	Regular visitor	EN
Sooty albatross	*Phoebetria fusca*	Rare visitor	EN
Southern giant petrel	*Macronectes giganteus*	Common breeder	LC
Southern royal albatross	*Diomedea epomophora*	Common visitor	VU
Wandering albatross	*Diomedea exulans*	Common visitor	VU
White-capped albatross	*Thalassarche steadii*	Rare seasonal visitor	NT
White-chinned petrel	*Procellaria aequinoctialis*	Rare breeder/Common visitor	VU

5.4.7.5 Area Vulnerability Scores

To date, reports of oiled seabirds in the Falkland Islands are rare, however globally millions of seabirds have been killed by oil pollution (García-Borboroglu et al., 2006 and 2008; Wolfaardt et al., 2009). With the development of the oil and gas industry in the Falkland Islands, the risk posed to seabirds is an important consideration due to the global importance of this area to seabirds and the logistical challenges associated with responding to an oil spill.

Birds are vulnerable to oiling from surface oil pollution, which can cause direct toxicity through ingestion, and hypothermia as a result of a bird's inability to waterproof its feathers. Oil pollution can also impact birds indirectly through contamination of their prey (National Research Council, 2003). Seabird species vary greatly in their responses and vulnerability to surface pollution, therefore in assessing their vulnerability it is important to consider species-specific aspects of their feeding, breeding and population ecology (White et al., 2001). Species that spend a greater proportion of their time on the sea surface are considered to be more at risk from the effects of surface pollution; for example, penguins are more likely to be affected than the highly aerial petrels. Species that are wholly dependent on the marine environment for feeding and resting are considered more vulnerable to the effects of surface pollution than species that use offshore areas only seasonally or move offshore only to rest or roost. Additionally, the potential reproductive rate of a species will influence the time taken for a population to recover following a decline. Other factors such as natural mortality rate, migratory behaviour, species abundance and conservation status (e.g. globally threatened) will also determine the effects of an oil spill on seabird populations.

To assess the relative risk to different species, the JNCC developed an index to assess the vulnerability of bird species to the threat of oil pollution (Williams et al., 1994). One of the main outputs of the SAST surveys was the production of an Oil Vulnerability Atlas (White et al., 2001). This analysis scores each species on four factors to produce an Oil Vulnerability Score (OVS). The OVS is applied to the density of that species recorded within each ¼ ICES square, this data is summed to give the Area Vulnerability Score (AVS) for each ¼ ICES square. The AVS's for each square were plotted on a monthly basis to highlight areas that support vulnerable assemblages of seabirds. The results of the original analysis were published in White et al. (2001) and the vulnerability maps for each month are presented in Figure 30 to Figure 35. These maps place the areas of oil exploration into the wider context of Falkland Islands waters.

Throughout the year, the highest areas of seabird vulnerability are generally found in coastal and Patagonian Shelf waters. High densities of resident species, such as gentoo penguin, rock and imperial shags (*Phalacrocorax magellanicus* and *P. atriceps*) and black-browed albatrosses are found in coastal waters year-round. During the summer, these are joined by breeding populations of seabirds that spend the winter elsewhere, which results in the very high vulnerabilities. Generally, seabird density and consequently Area Vulnerability Scores decreased with increasing water depth.

In the austral autumn (March to May), the immediate area around the Drilling Campaign Area received relatively low survey effort. In March, the area was regarded as moderate to high vulnerability, due to the presence of high densities of black-browed albatrosses, Magellanic penguins and great shearwaters with lower densities of rockhopper penguins, Wilson's and grey-backed storm-petrels and white-chinned petrels. In April and May, the area received lower survey coverage. At this time, low to moderate densities of Cape petrels and black-browed albatrosses were recorded with lower numbers of grey-headed albatrosses, Antarctic fulmars and prions also present.

During the austral winter months (June to August), the area of the Drilling Campaign Area is classed as an area of moderate vulnerability. A patchy distribution of species typical of the Patagonian Shelf in winter, were recorded. The most numerous species in this area at this time were; prion species, black-browed albatross, Antarctic fulmar and Cape petrel.

Surveys during the austral spring (September to November), recorded relatively lower densities of seabirds than at other times of the year. The area of the Drilling Campaign Area is therefore classed as moderately vulnerable. The seabirds present include; rockhopper/macaroni penguins, prion species, Wilson's storm-petrels, black-browed albatrosses and Magellanic penguins.

During the austral summer (December to February), the vulnerability of the area in the immediate vicinity of the Drilling Campaign Area increased, from low in December to high in February. The species contributing most to this relatively high score were; prion species, black-browed albatrosses, Magellanic penguins, Wilson's and grey-backed storm-petrels and great shearwaters. Areas to the north and west of the Field were low and moderate respectively, however, an area of very high vulnerability was identified to the south east in January.

5.4.7.6 Data Limitations with Seabird Distribution and Vulnerability Data (White et al. 2001, 2002)

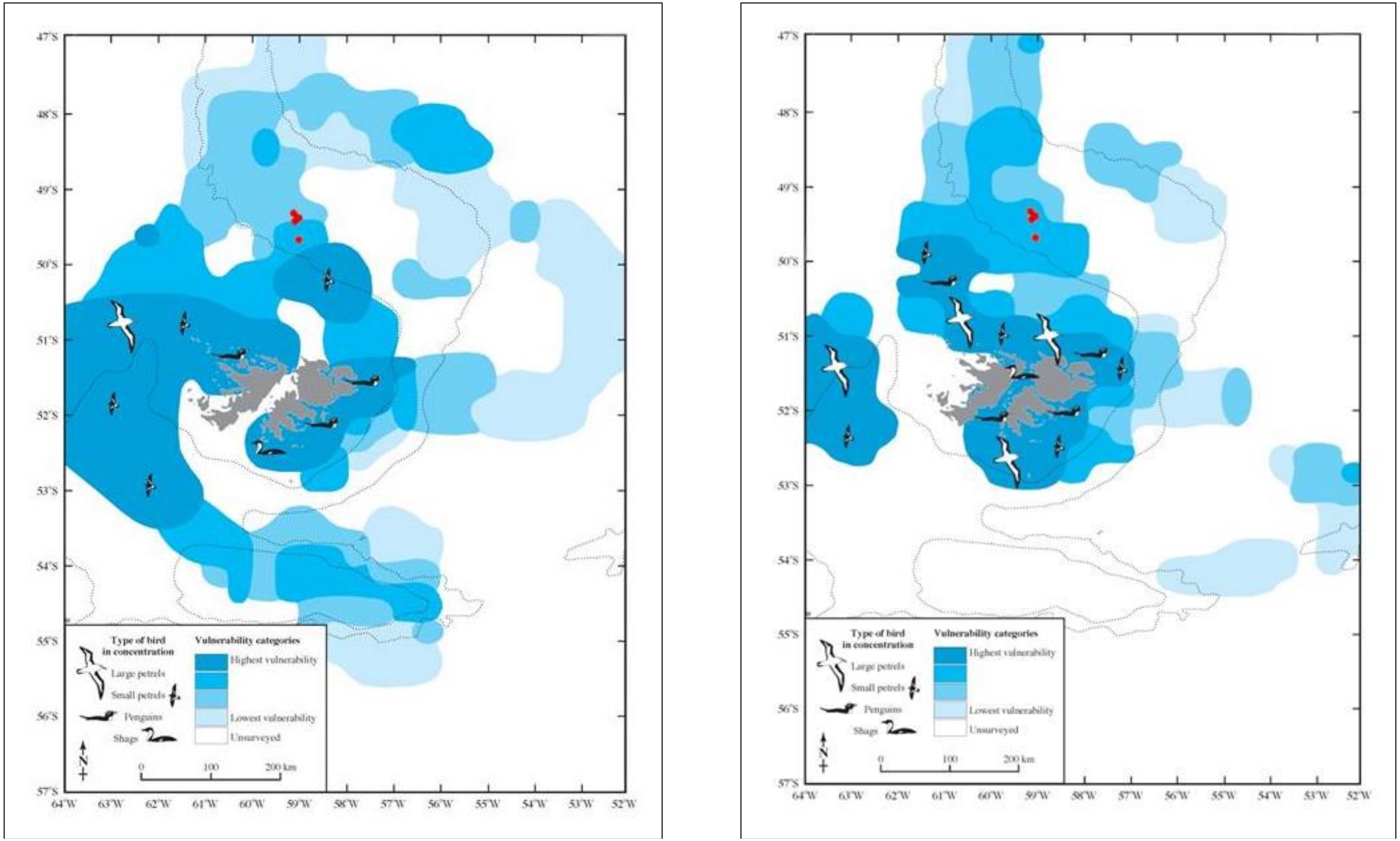
There are a number of limitations associated with the SAST surveys, which must be taken into consideration when interpreting the data. The SAST surveys were conducted opportunistically; therefore distribution of survey effort was closely linked to the activity of patrol vessels. Occasionally, some vessel time was dedicated to covering the NFB but there remain some gaps in coverage. As a result, coverage within some of the key Licence Blocks was not as high as had been hoped at the outset of the project (White et al. 2001 and 2002). In particular, the Drilling Campaign Area was not covered during April, May and September.

The detection and identification of cryptic species, such as penguins and diving-petrels (*Pelecanoides* spp), at-sea was highlighted as one of the most significant challenges for observers, as these birds can be difficult to spot from vessels (White et al., 2002). However, simultaneous projects to satellite track penguins were conducted, to complement at-sea observations and fill any gaps. The recorded distribution of penguins during SAST surveys are supported by satellite tracking data (for example Pütz et al., 2000 and 2002). Additional penguin tracking has been carried out in subsequent years (see Appendix D).

Now in 2014, the SAST data was collected over ten years ago. Whether this influences the validity of the data is a matter for debate. During the three years of the project major inter-annual variations in species distribution were not identified, however, the study covered a relatively short time frame.

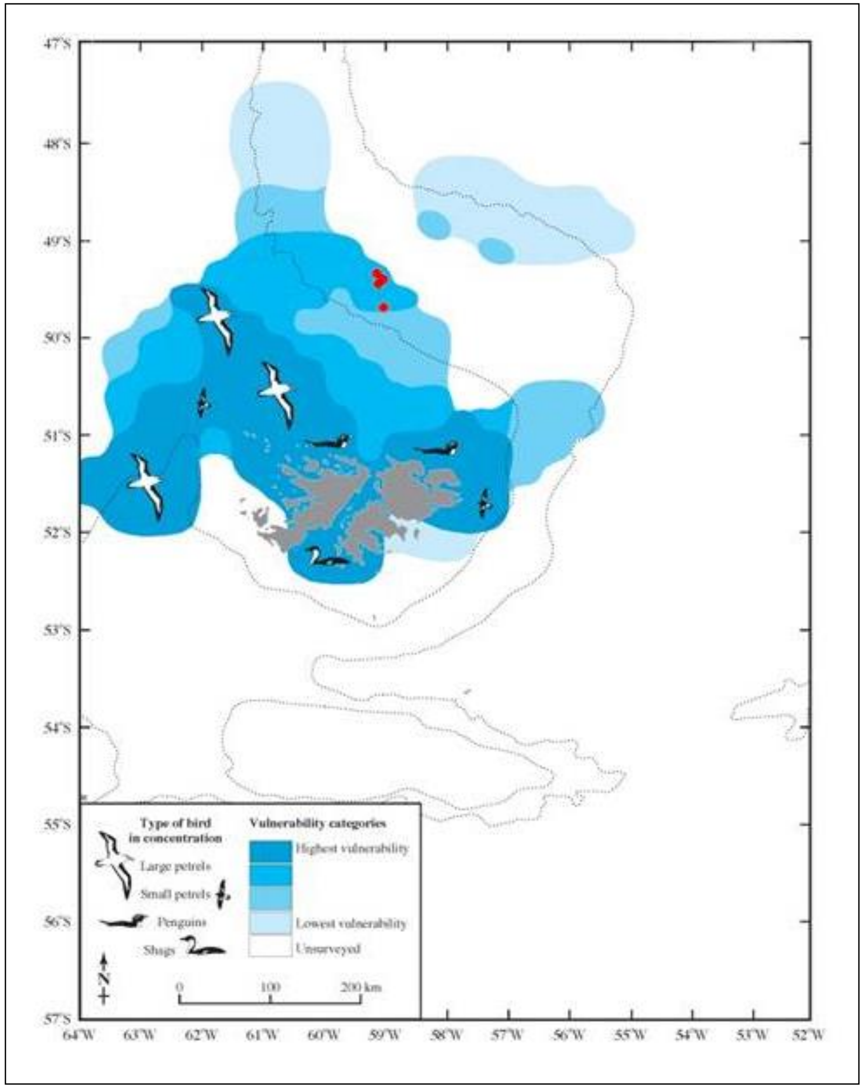
One of the great advantages of at-sea surveys is that all species are recorded. Therefore, it is possible to assess the risk to species that have not been tracked. None of the smaller species of petrel have been tracked, yet they are vulnerable to oiling and light induced bird strikes.

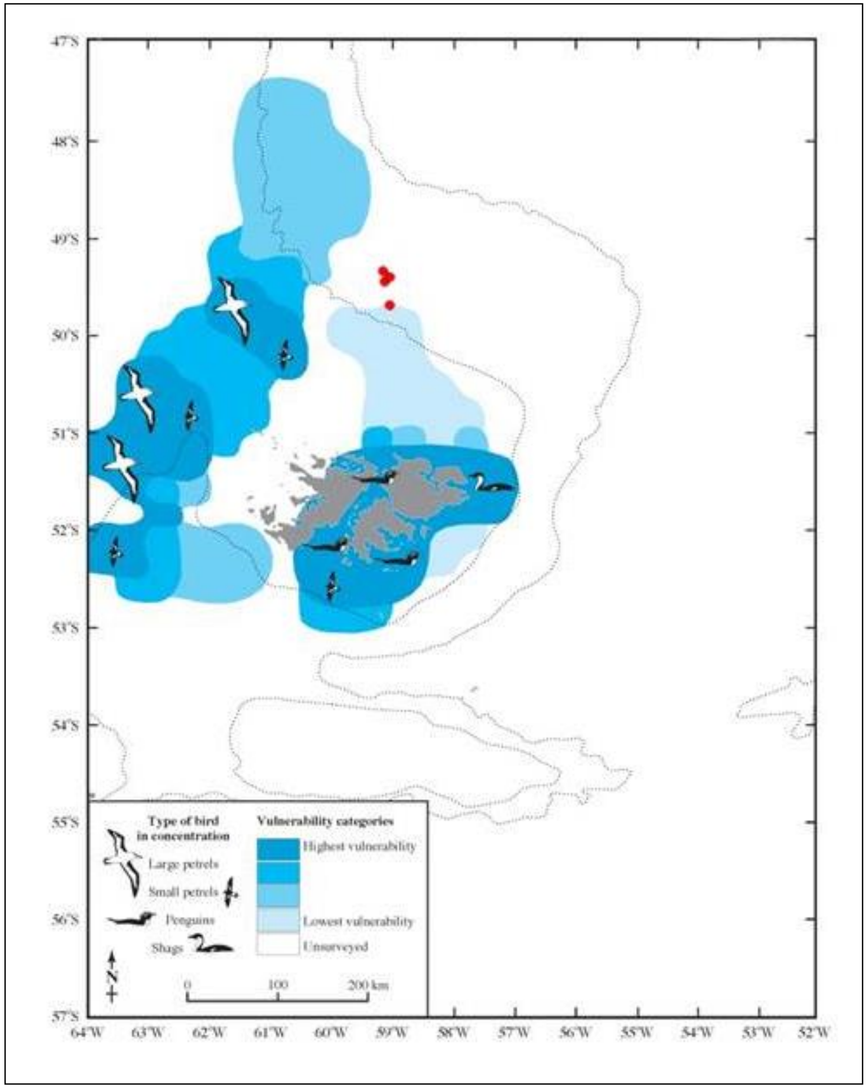
Recent studies suggest that there may be significant inter-annual and spatial variation in foraging and migration patterns, for individuals of the same species breeding on the same island (Masello et al., 2010) and on island breeding sites that are in close proximity (Granadeiro et al., 2011; Catry et al., in prep). This is likely to be the case for individual birds but whether this is reflected in the foraging ranges of populations as a whole remains to be seen. The three years of SAST surveys did detect some inter-annual variation but most of these concerned non-breeding visitors to Falkland Islands waters. Species such as great shearwater and soft-plumaged petrel are likely to show greater inter-annual variation than those breeding on the Falklands. A combination of satellite tracking and at-sea observations is likely to give the best overview of seabird distribution within Falklands waters.



*Red dots indicate exploration well locations

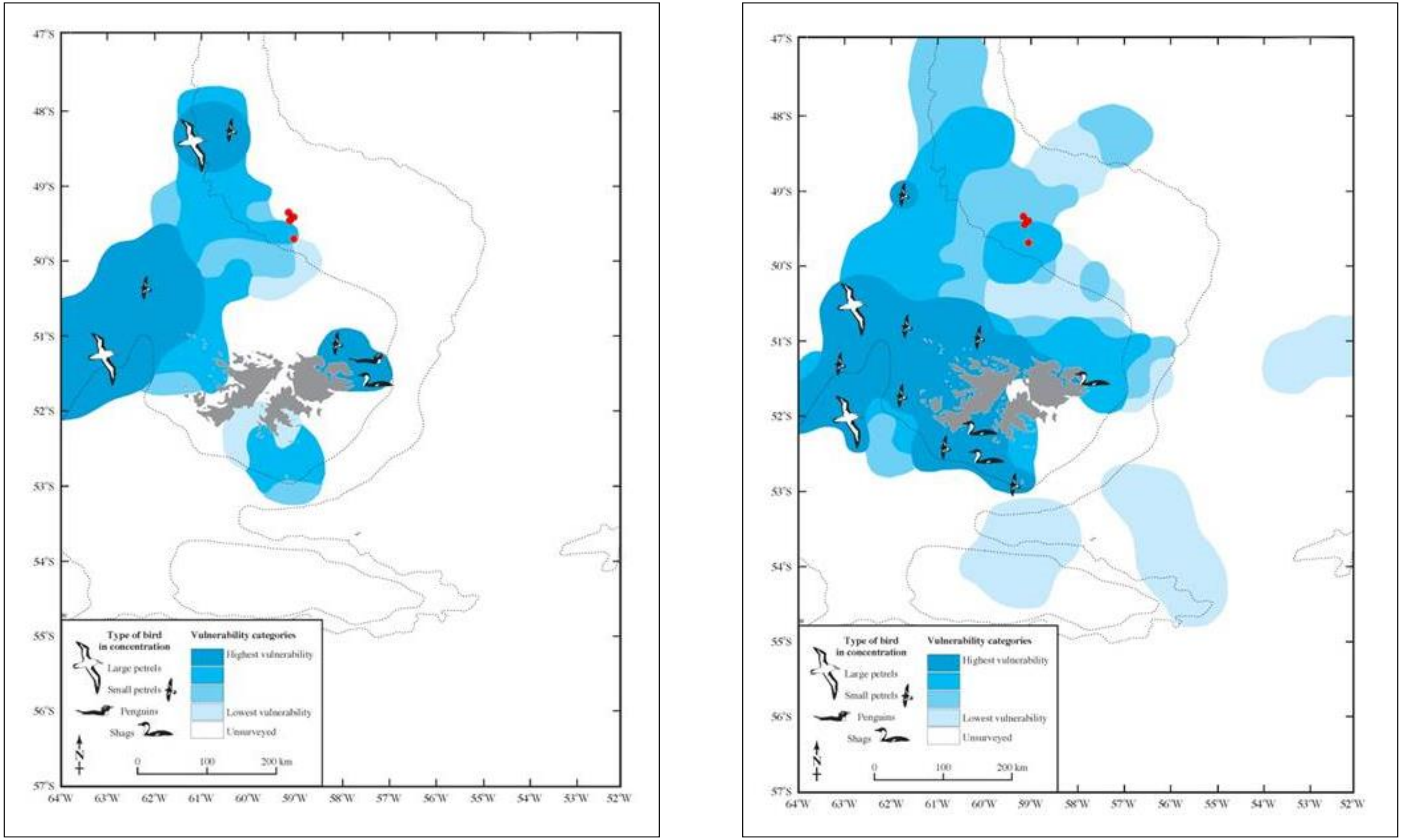
Figure 30: Seabird Vulnerability Maps for January (left) and February (right), from White et al. (2001)





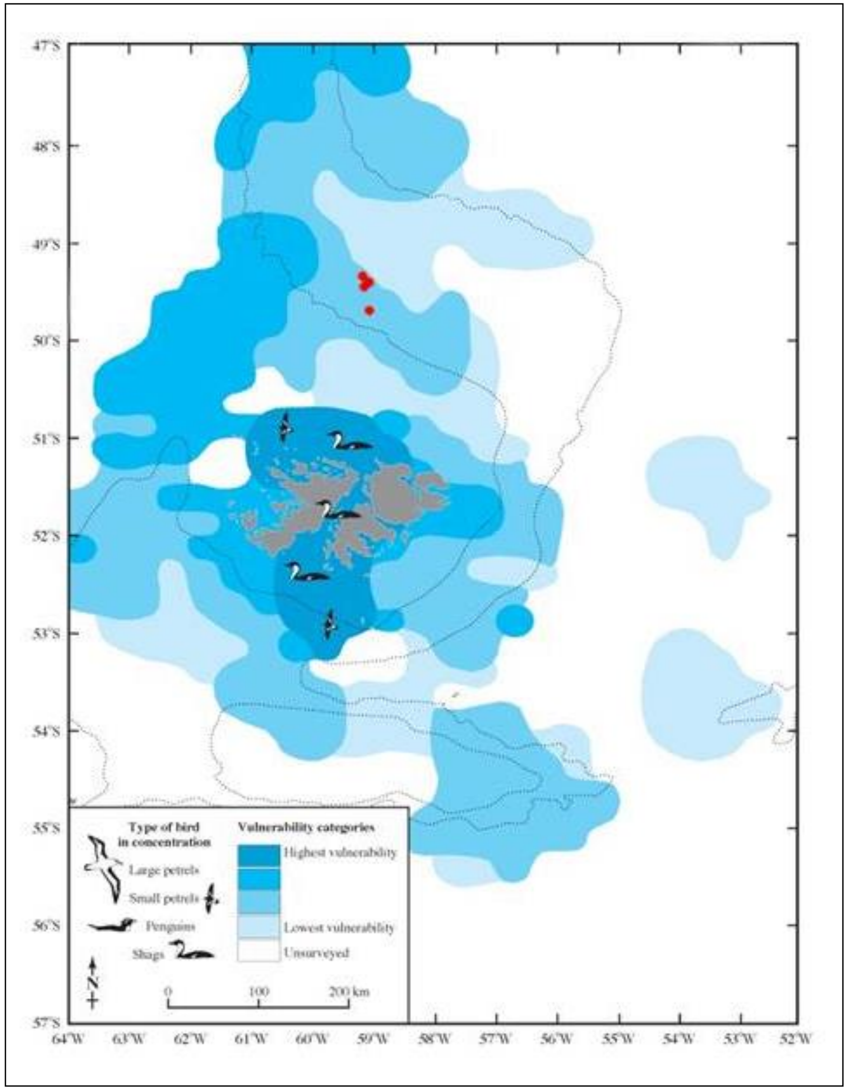
*Red dots indicate exploration well locations

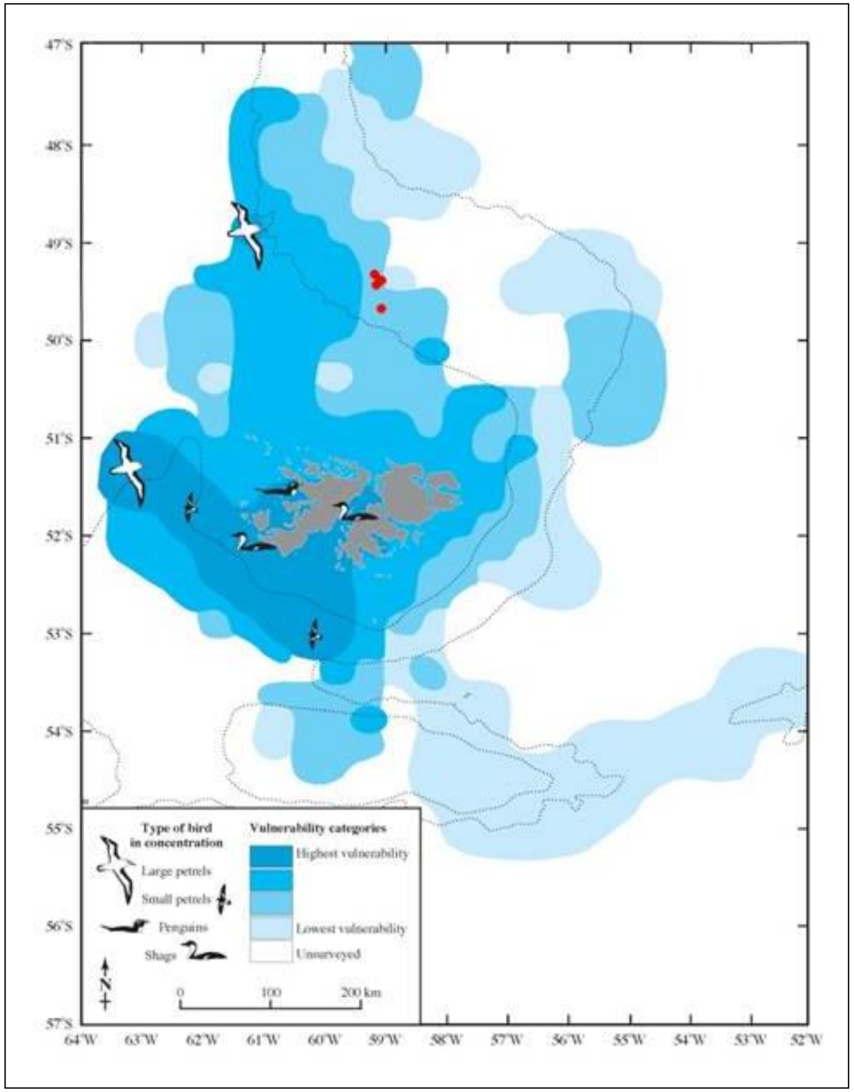
Figure 31: Seabird Vulnerability Maps for March (left) and April (right), from White et al. (2001)



*Red dots indicate exploration well locations

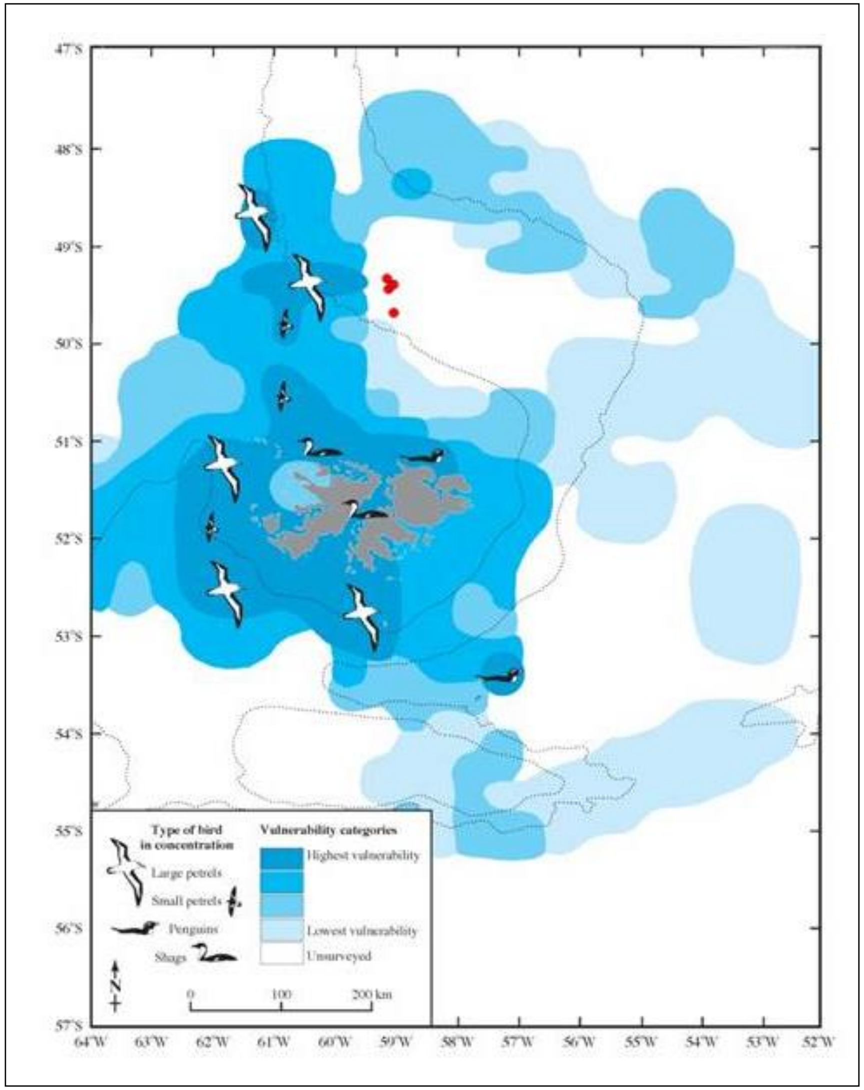
Figure 32: Seabird Vulnerability Maps for May (left) and June (right), from White et al. (2001)

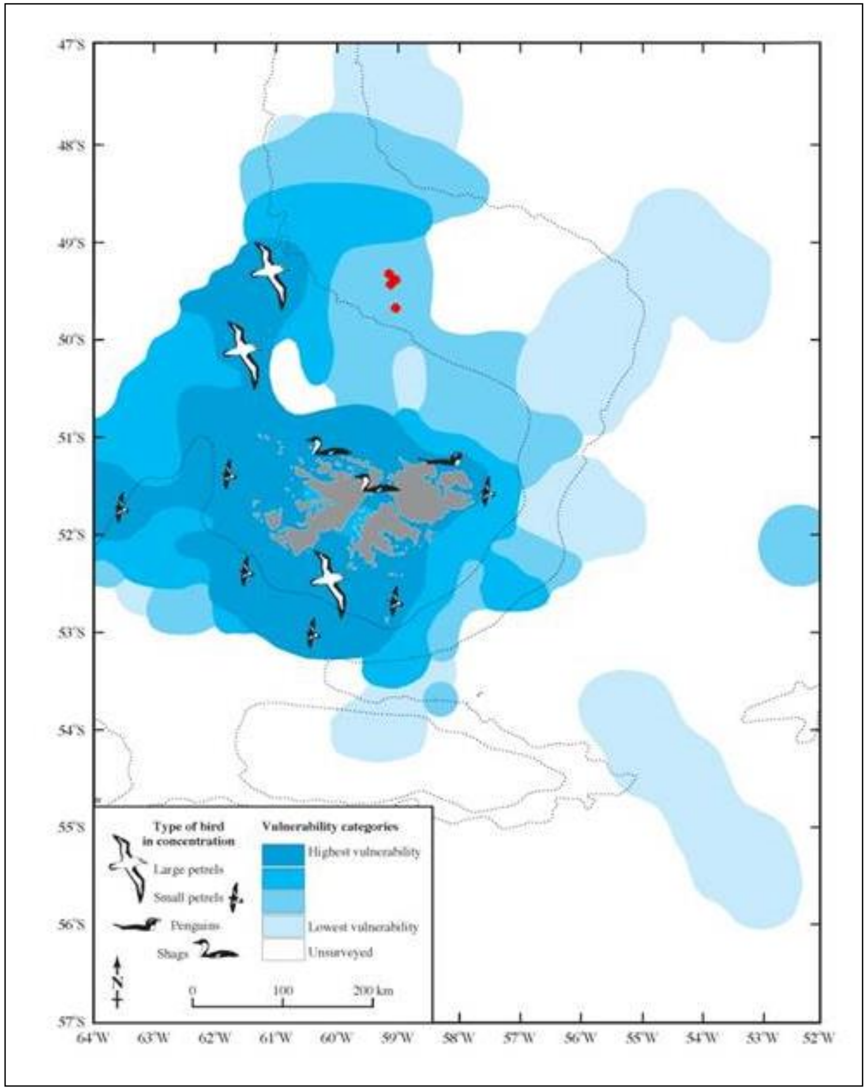




*Red dots indicate exploration well locations

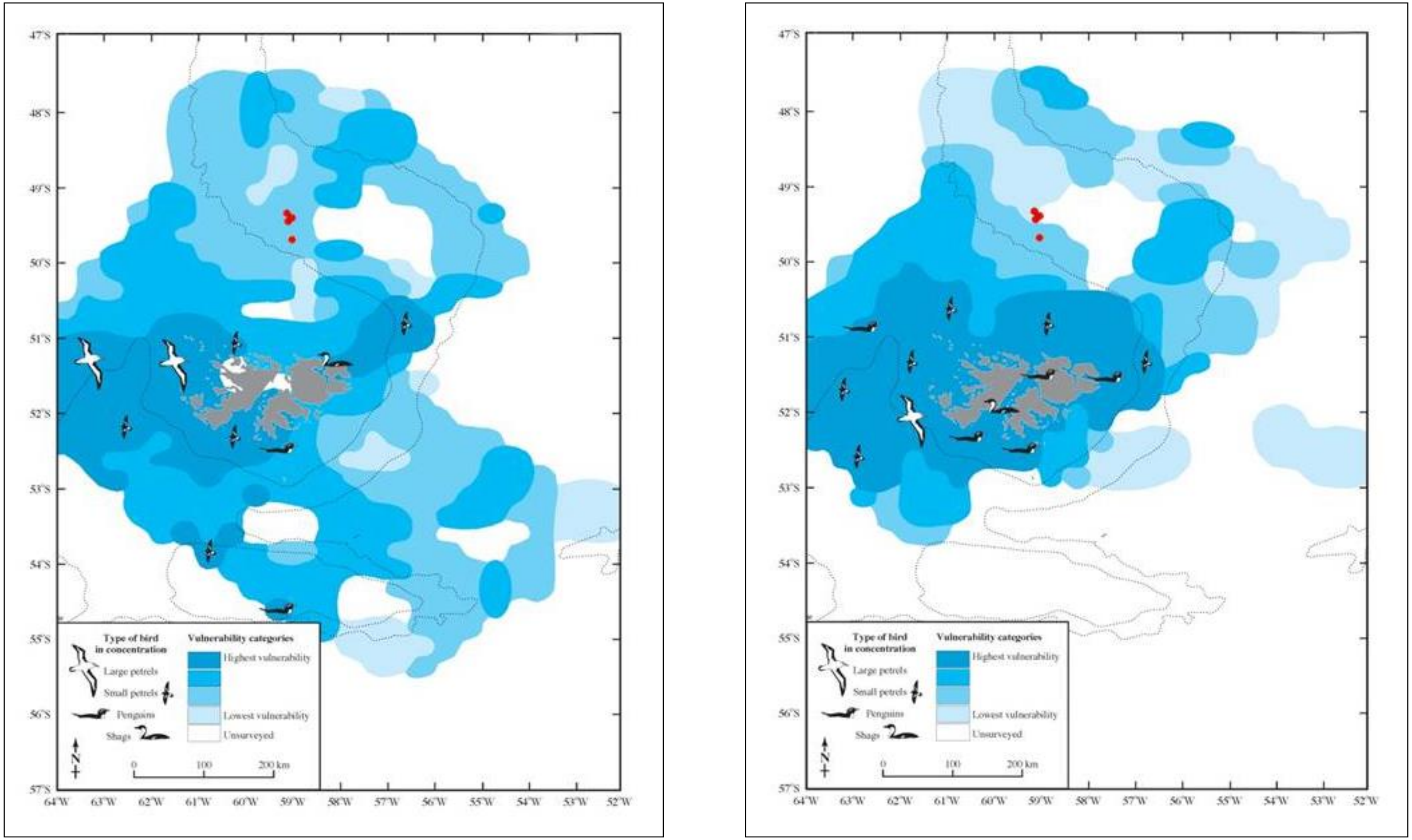
Figure 33: Seabird Vulnerability Maps for July (left) and August (right), from White et al. (2001)





*Red dots indicate exploration well locations

Figure 34: Seabird Vulnerability Maps for September (left) and October (right), from White et al. (2001)



*Red dots indicate exploration well locations

Figure 35: Seabird Vulnerability Maps for November (left) and December (right), from White et al. (2001)

5.4.8 Threatened Habitats / Species

5.4.8.1 Protected bird species

The majority of native wild birds are protected under the Conservation of Wildlife and Nature Ordinance, which was put in place in 1999. The exceptions include: the Upland goose (*Chloephaga picta*) and feral domestic goose, which may be hunted and killed at any time of the year, and Patagonian crested duck (*Lophonetta specularoides*) and yellow-billed (speckled) teal (*Anus flavirostris*), both of which cannot be killed during the closed season (1 July to 31 March). The Ordinance bans the collection of eggs, birds and animals; however a permit holder may still collect eggs from some species, including Magellanic and gentoo penguins. More recent amendments to the Ordinance forbid the collection of black-browed albatross and rockhopper penguin eggs. The Ordinance extends to cover the territorial waters of the Falklands (up to 12 n miles offshore).

The Fisheries Ordinance 2005 provides a framework for the management of fisheries resources within the Falklands EEZ in a sustainable manner. It also extends the influence of the Conservation of Wildlife and Nature Ordinance 1999 to 200 n miles offshore, which protect all wild birds and animals.

5.4.8.2 Protected plant species

Under the Conservation of Wildlife and Nature Ordinance (1999), there are 19 plant species that are under protection, six of which are endemic to the Falkland Islands and are vulnerable to extinction, mostly due to their small population sizes and restricted ranges: Antarctic cudweed (*Gamochaeta antarctica*), Falkland rock-cress (*Phlebolobium maclovianum*), false plantain (*Nastanthus falklandicus*), the hairy daisy (*Erigeron incertus*), Falkland nassauvia (*Nassauvia falklandica*), and Moore's plantain (*Plantago moorei*) (Upson, 2012). Surveys conducted in the 1980s and 1990s show the distribution of these plant species to be as follows: Atlantic cudweed was only found in approximately six locations over the entire Falkland Islands; Falkland rock-cress is distributed across the Islands, although none have yet been found in the south of East Falkland; false plantain has only been found in the south of West Falkland; the hairy daisy is found in several locations along the west of West Falkland and in four locations on East Falkland; Falkland nassauvia and its distribution is still being studied; and Moore's plantain is also only found at a few locations in the south of West Falkland (Upson, 2012).

5.4.8.3 Vulnerable terrestrial habitats

There are five threatened terrestrial habitats: bluegrass acid grassland, bluegrass dune grassland, native Boxwood scrub, Fachine scrub, and mainland Tussac. However, this list of threatened habitats is only preliminary as it is based on the current, limited knowledge of these habitats and their extent and degree of threat that they face. A variety of wetland sites may also be under threat, however this requires further investigation. The main threat to and degradation of certain terrestrial habitats has been through the introduction of grazing herbivorous animals for farming (RPS Energy, 2009; Upson, 2012).

5.4.8.4 Vulnerable marine species and habitats

There exists a reasonably high level of legal protection to the marine species and the marine environment through legislation, such as the Marine Mammal Ordinance 1992 and the Fisheries (Conservation and Management) Ordinance 2005.

The Marine Mammal Ordinance 1992 protects all marine mammals within Falkland Islands waters, it is an offence to take, wound or kill any marine mammal. According to the IUCN Red List, which assesses the conservation status of all species, there are three cetacean species that occur within Falkland Islands waters that are Endangered; sei, fin and blue whales and one Vulnerable species; sperm whale.

The Fisheries Ordinance 2005 includes the use of closed areas (to protecting spawning sites), a three mile no-take zone around the entire coastline (Figure 39) and mitigation measures to prevent the incidental capture of seabirds in longline and trawl fisheries.

There is little specific protection for benthic marine species or marine habitats within Falkland Islands waters. Partly the issue is that the marine environment and species assemblage is relatively poorly described. Work is on-going in order to address this. Surveys conducted within the Sea Lion area by Gardline (2012) found that the habitats and species found within the area were of no conservation concern when compared with the UK's Offshore Marine Conservation (Natural Habitats, &c.) (Amendment) Regulations 2010.

5.4.8.5 Protected Habitats

There are currently four levels to designate areas of environmental and wildlife significance within the Falkland Islands: NNRs (through the Conservation of Wildlife and Nature Ordinance (1999); Important Bird Areas (IBAs), Important Plant Areas (IPAs), and Ramsar sites.

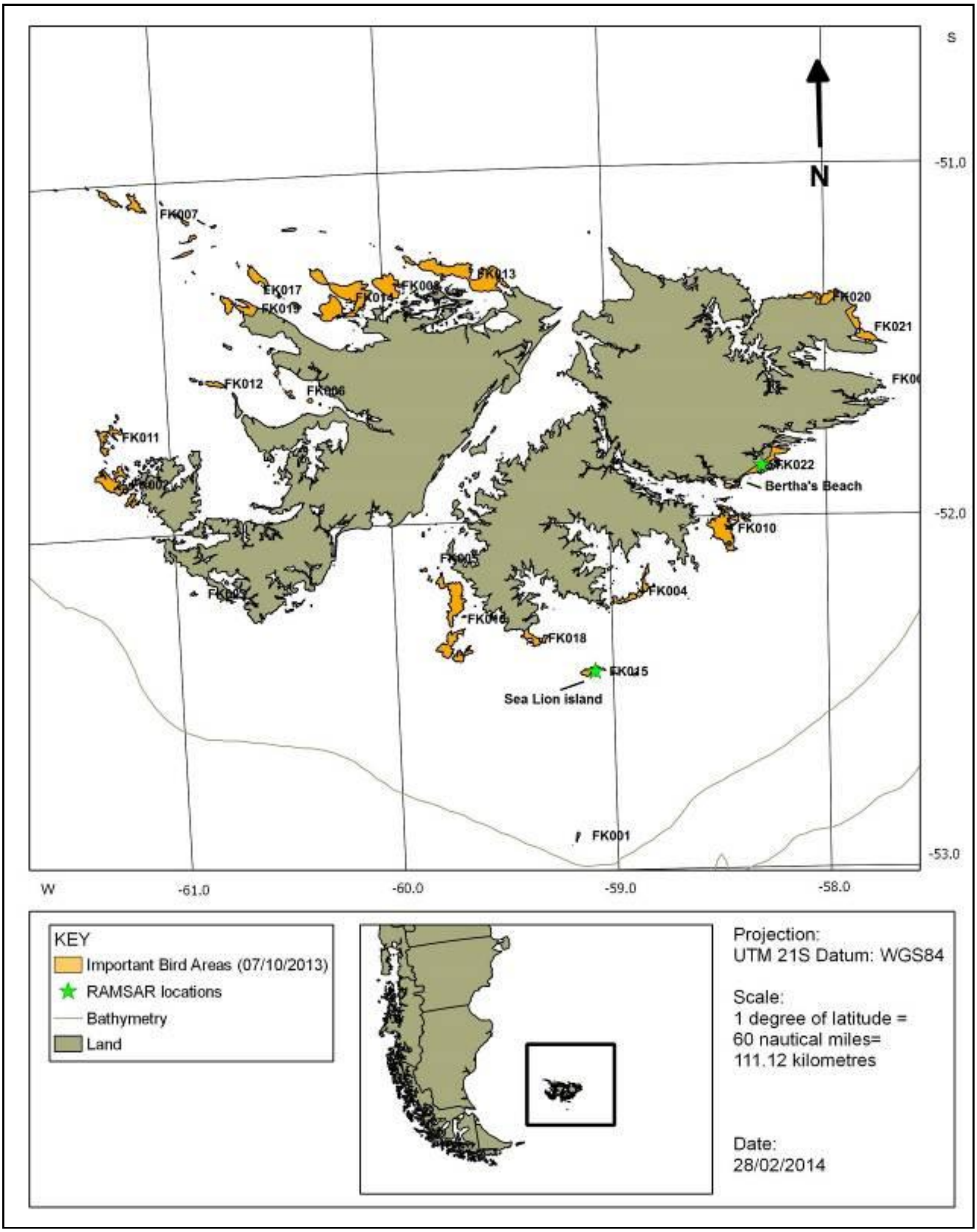
Important Bird Areas

Important Bird Areas (IBAs) are a global directive that was introduced and created by BirdLife International, an international consortium of conservation organisations. They were introduced as a means of protecting and conserving bird species that are becoming threatened by anthropogenic activities, such as habitat destruction and therefore fragmentation. IBAs are created based on a set of criteria that apply globally. Within the Falkland Islands, Falklands Conservation is responsible for describing and cataloguing IBAs. Currently within the Falkland Islands, there are 22 IBAs, 17 of which are islands or island groups, and the other five are found on the mainland of East or West Falkland (Table 21; Figure 36). Any terrestrial based IBA may be extended by 15 miles into the offshore environment. However, there are currently no marine IBAs established, though there are 17 candidate marine IBAs that are currently being considered (Table 22; Figure 37). The level of legal protection associated with IBAs varies from country to country. In the Falklands, IBA status does not infer any legal protection.

Table 21: Confirmed Important Bird Areas - Breeding

IBA Code	Site Name	Area (km^2)	IBA trigger seabird Species, life-cycle	Distance from Sea Lion Licence Block (km)
Confirmed IBA – Terrestrial breeding areas				
FK001	Beauchêne Island	1.7	MC, GP, RP, BBA, FP, SS: breeding	291
FK002	Beaver Island Group	59.6	GP, MP, SGP: breeding	303
FK022	Bertha's Beach, East Falkland	33.0	GP, MP: breeding	274
FK003	Bird Island	1.2	RP, BBA, TBP, SS - breeding	331
FK004	Bleaker Island Group	21.5	GP, RP, MP, SGP, IS – breeding	305
FK018	Bull Point, East Falkland	15.0	GP, MP - breeding	324
FK005	Elephant Cays Group	2.5	MP, SGP – breeding	293
FK019	Hope Harbour, West Falkland	17.6	GP, RP, MP, BBA – breeding	241
FK006	Hummock Island Group	6.7	RP, IS – breeding	257
FK007	Jason Islands Group	33.7	MC, RP, MP, BBA, SGP – breeding	223
FK008	Keppel Island	36.3	GP, RP, MP, BBA – breeding	218
FK009	Kidney Island Group	0.4	MP, WCP, SS - breeding	262
FK010	Lively Island Group	67.9	GP, MP, SGP - breeding	288
FK011	New Island Group	25.5	GP, RP, MP, BBA, TBP, WCP, IS - breeding	290
FK012	Passage Islands Group	8.8	GP, RP, SGP – breeding	268
FK013	Pebble Island Group	109.6	MC, GP, RP, MP, SGP, SS – breeding	208
FK014	Saunders Island	124.0	GP, RP, MP, BBA – breeding	222
FK015	Sea Lion Islands Group	10.3	GP, RP, MP, SGP, SS – breeding	337
FK020	Seal Bay, East Falkland	31.0	GP, RP, MP, SS – breeding	230
FK016	Speedwell Island Group	0.9	GP, MP, SGP, SS – breeding	308
FK021	Volunteer Point, East Falkland	40.6	GP, MP – breeding	240
FK017	West Point Island Group	35.0	GP, RP, MP, BBA - breeding	229

IBA trigger species: BBA – black-browed albatross, FP – fairy prion, , GP – gentoo penguin, IS – imperial shag, MC – Macaroni penguin, MP – Magellanic penguin, RP – rockhopper penguin, SGP – southern giant petrel, SS – sooty shearwater, TBP – thin-billed prion, WCP – white-chinned petrel.
Source: BirdLife International, 2014a.



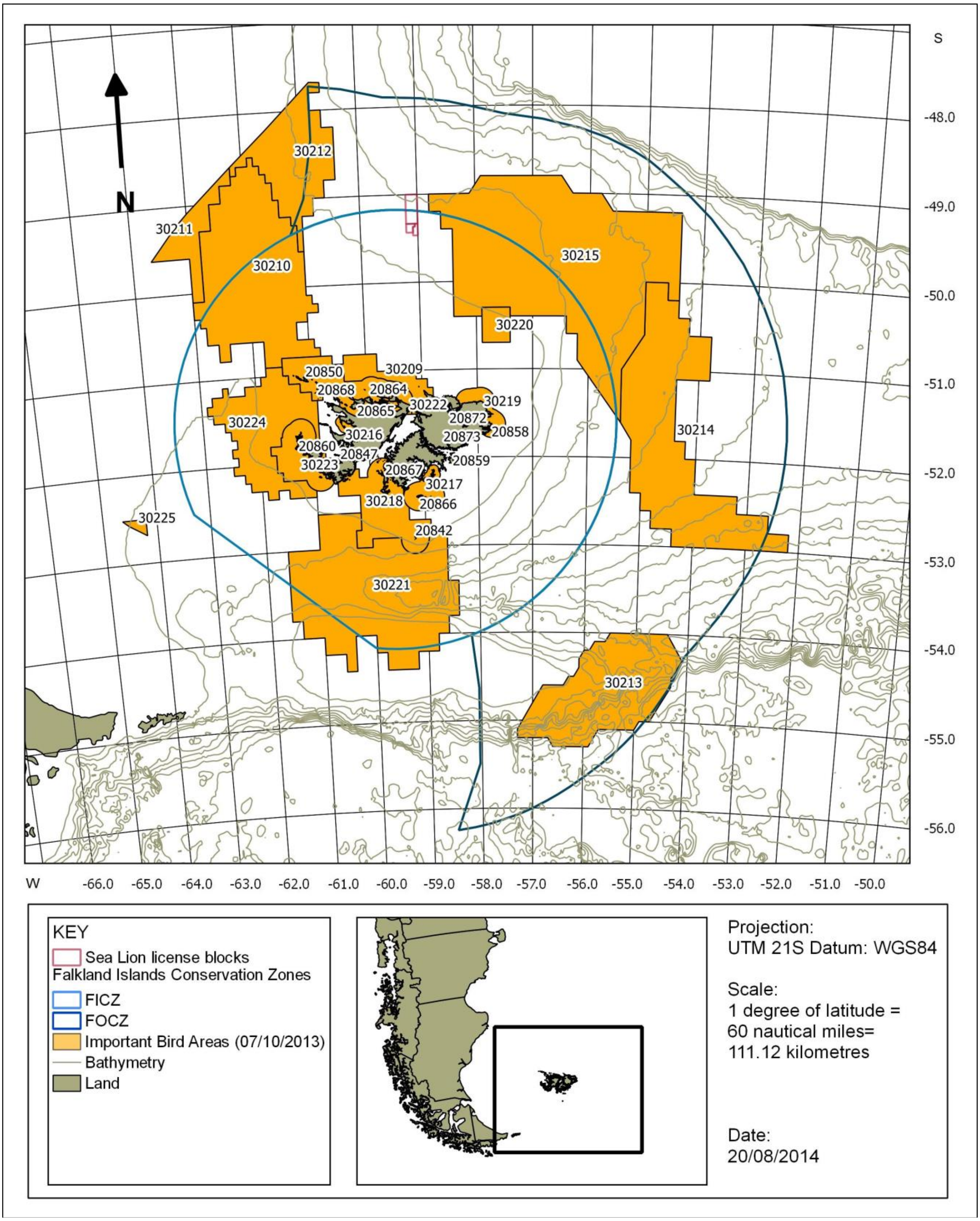
Source: BirdLife International, 2014a.

Figure 36: Confirmed Important Bird Areas and RAMSAR Sites around the Falkland Islands

Table 22: Candidate Marine Important Bird Areas.

Site Name	Area (km^2)	M-IBA ID	IBA trigger seabird Species, period, life-cycle	Distance from Sea Lion Licence Block (km)
Candidate IBAs – Marine				
Atlantic, Southwest 1 - Marine	26,250	30210	BBA: Oct-Jan, incubation, non-breeding	135
Atlantic, Southwest 2 - Marine	28,259	30214	WA: Dec-Jun, sabbatical, juvenile	300
Atlantic, Southwest 3 - Marine	51,316	30215	GHA & NGP: Jan-Oct, Dec, non-breeding	17
Atlantic, Southwest 4 - Marine	29,221	30221	SS: Dec-Jan, pre-egg, incubation	364
Atlantic, Southwest 5 - Marine	12,013	30224	BBA: Jan-Feb, brood-guard	236
Atlantic, Southwest 7 - Marine	1,578	30220	BBA: Jan-Jun, post-guard	132
Atlantic, Southwest 9 - Marine	18,139	30213	WA: Jan-Apr, incubation	569
Atlantic, Southwest 11 - Marine	11,886	30212	BBA: May-Aug, non-breeding	102
Atlantic, Southwest 13 - Marine	4,388	30211	NRA: Jan-Dec, non-breeding	227
Atlantic, Southwest 38 - Marine	324	30225	BBA: Jan-May, post-guard	495
Atlantic, Southwest 49 - Marine	2,942	30209	BBA: Jan-Dec, incubation; SS: Jan-Dec breeding	163
Beauchêne Island - Marine	7,041	30218	BBA: Jan-Dec, post-guard SS: Jan-Dec, breeding, incubation	291
Bird Island / New Island Group - Marine	3,849	30223	BBA: Jan-Dec, brood-guard, post-brood WCP & SS & IS: Jan-Dec, breeding	273
Bleaker Island Group / Sea Lion Islands Group - Marine	1,912	30217	SS & IS: Jan-Dec, breeding	300
Hummock Island Group - Marine	293	30216	IS: Jan-Dec, breeding	251
Kidney Island Group - Marine	1,686	30219	WCP & SS: Jan-Dec, breeding	213
Pebble Island Group - Marine	5,998	30222	BBA: Jan-Dec, incubation, brood-guard SS: Jan-Dec, breeding	187

Marine IBA trigger species: BBA – black-browed albatross, GHA – grey-headed albatross, IS – imperial shag, NGP – northern giant petrel, NRA – northern royal albatross, SS – sooty shearwater, TBP – thin-billed prion, WA – wandering albatross, WCP – white-chinned petrel.
Source: BirdLife International, 2014a.



Source: BirdLife International, 2014a.

Figure 37: Candidate Marine Important Bird Areas around the Falkland Islands

Ramsar sites

The Ramsar convention was established in 1971 in an international summit in Ramsar, Iran (www.ramsar.org). It allows for the protection of all habitats that fall under the umbrella description “wetlands”, which includes marshes, peat bogs, oases, ponds, lakes and the marine inshore environment (www.ramsar.org). There are currently two Ramsar sites within the Falkland Islands: Sea Lion Islands and Bertha’s Beach, both of which are also designated as IBAs and Sea Lion is also an NNR. There are currently two further sites which are being considered for Ramsar designation: Pebble Island East and East Bay.

National Nature Reserves (NNRs)

As previously mentioned, the NNRs are established under the Conservation of Wildlife and Nature Ordinance (1999). There are currently 19 NNRs within the Falkland Islands (Table 23, Figure 38), which are either owned by FIG, are privately owned, or are owned by Falklands Conservation. It has been agreed throughout the Falkland Islands community that solely using legislation to protect these areas is ineffectual, therefore management plans are agreed upon and implemented by both the FIG and landowners/stakeholders. The FIG are able to designate marine NNRs but there are none established to date, though there are some sites currently under review. Terrestrial NNRs may also be extended out by 15 miles offshore from the coast.

Important Plant Areas (IPAs)

IPAs were established by Plantlife International and the IUCN with a view to identifying locations that will allow the best protection of threatened plant species. The IPAs are chosen based on whether the location has one or more species that are of global conservation concern, or has a rich population of regional flora (Upson, 2012). There are currently 17 IPAs within the Falkland Islands (Upson, 2012). Figure 38 shows the NNRs and IPAs around the Falkland Islands. The NNRs range between 208 km and 389 km from the Drilling Campaign Area, and the IPA range between 221 km and 332 km from the Drilling Campaign Area.

Marine Protected Areas (MPA)

The Falkland Islands EEZ is rich in marine biodiversity, including globally threatened seabirds and marine mammals. The Fisheries Ordinance 2005 does afford protection to the marine environment and designates a number of no-take zones (Figure 39). However, to date no MPA’s have been officially designated in the seas surrounding the Falkland Islands. There is already risk to the Falkland Islands marine environment from resource extraction; such pressures are likely to intensify and include new developments and related changes to coastal land-use. Existing practice and legislation need to be improved to manage current and potential future threats, to protect threatened species, sites and habitats.

The Falkland Islands Biodiversity Strategy 2008-18 sets out the Falkland Islands Government vision with regards to biodiversity namely to *‘conserve and enhance the natural diversity, ecological processes and heritage of the Falkland Islands, in harmony with sustainable economic development*’. Under this plan the main threats to local biodiversity are prioritised and mitigation measures identified. However, the lack of integrated land/sea zoning and management was identified as one of the highest priorities that need addressing in the Falkland Islands in the 2012 workshop report from the FCO/JNCC funded project “Environmental Mainstreaming”.

SAERI and partners have recently been awarded a Darwin Plus grant to redress this. The project started in April 2014 and will include a series of reviews, stakeholder meetings and workshops together with creating a GIS for data analysis and visualisation relating to habitats, coastlines, fauna/flora, fisheries and hydrocarbon resource extraction. The outcome will be to provide advice on appropriate policies, practices and frameworks for marine spatial planning in the coastal, inshore and offshore waters of the Falkland Islands. This will include specific advice on the establishment of potential provisions for areas of environmental, ecological and biological sensitivity.

Table 23: Falkland Islands National Nature Reserves

Date	Order	Designated Area	Landowner	IBA/IPA Ramsar Status	Distance from Sea Lion Licence block (km)
1973	Jason Islands	Flat Jason 51º 06'S 60º 53'W (Designated separately, 1966) Elephant Jason 51º 09'S 60º 51'W South Jason 51º 12'S 60º 53'W North Fur Is. 51º 08'S 60º 44'W South Fur Is. 51º 15'S 60º 51'W Jason East Cay 51º 00'S 61º 18'W Jason West Cay 50º 58'S 61º 25'W The Fridays 51º 03'S 60º 58'W White Rock 51º 17'S 60º 53'W Seal Rocks 51º 07'S 60º 48'W	FIG	IBA	224
1964	The Twins Islands	51º 15'S 60º 38'W Northwest of Carcass Island	Falklands Conservation	IBA	230
1964	Low Island	51º 19'S 60º 27'W Southeast of Carcass Island	Private	IBA	235
1966	Middle Island	51º 38'S 60º 20'W King George Bay, West Falkland	FIG	IBA	263
2009	Chartres Horse Paddock	51º42'S 60º 03' W East of Chartres Farm Settlement, West Falkland	Private	IPA	265
1998	Narrows	51º 41'S 60º 19'W Narrows Farm, West Falkland	Private	-	267
1998	East Bay	51º 48'S 60º 13'W East Bay Farm, West Falkland	Private	-	277
1993	New Island South	51º 43'S 61º 18'W	Private	IBA	302
1978	Sea Dog Island	Sea Dog Island 52 00'S 61 06'W	FIG	-	321
1969	Bird Island	Bird Island 52º 10'S 60º 54'W	FIG	IBA	333
1978	Arch Islands	Big Arch Island 52 13'S 60 27'W Natural Arch Clump Island Tussac Island Pyramid Rock Last Rock and Albemarle Rock	FIG	-	325
1964	Beauchêne Island	52º 54'S 59º 11'W	FIG	IBA	390
1970	Bleaker Island	52º 18'S 58º 51'W Bleaker Island north of Long Gulch	Private	IBA	310
2012	Sea Lion Island	Sea Lion Island 52º25'S 59º 05'W	Private	IBA Ramsar	338
1973	Stanley Common	51º 43'S 57º 49'W	FIG	IPA (Cape Pembroke)	269
1964	Kidney & Cochon Islands	Cochon Island 51º 36'S 57º 47'W Kidney Island 51º 38'S 57º 45'W	FIG	IBA	262
1968	Volunteer & Cow Bay	51º 29'S 57º 50'W East Falkland	Private	IBA	260
1968	Cape Dolphin	51º 15'S 58º 51'W	Private	-	208
1996	Moss Side	51º 23'S 58º 49'W, Pond and sand-grass flats behind Elephant Beach	Private	-	222

Source: Falkland Islands Government, 2014.

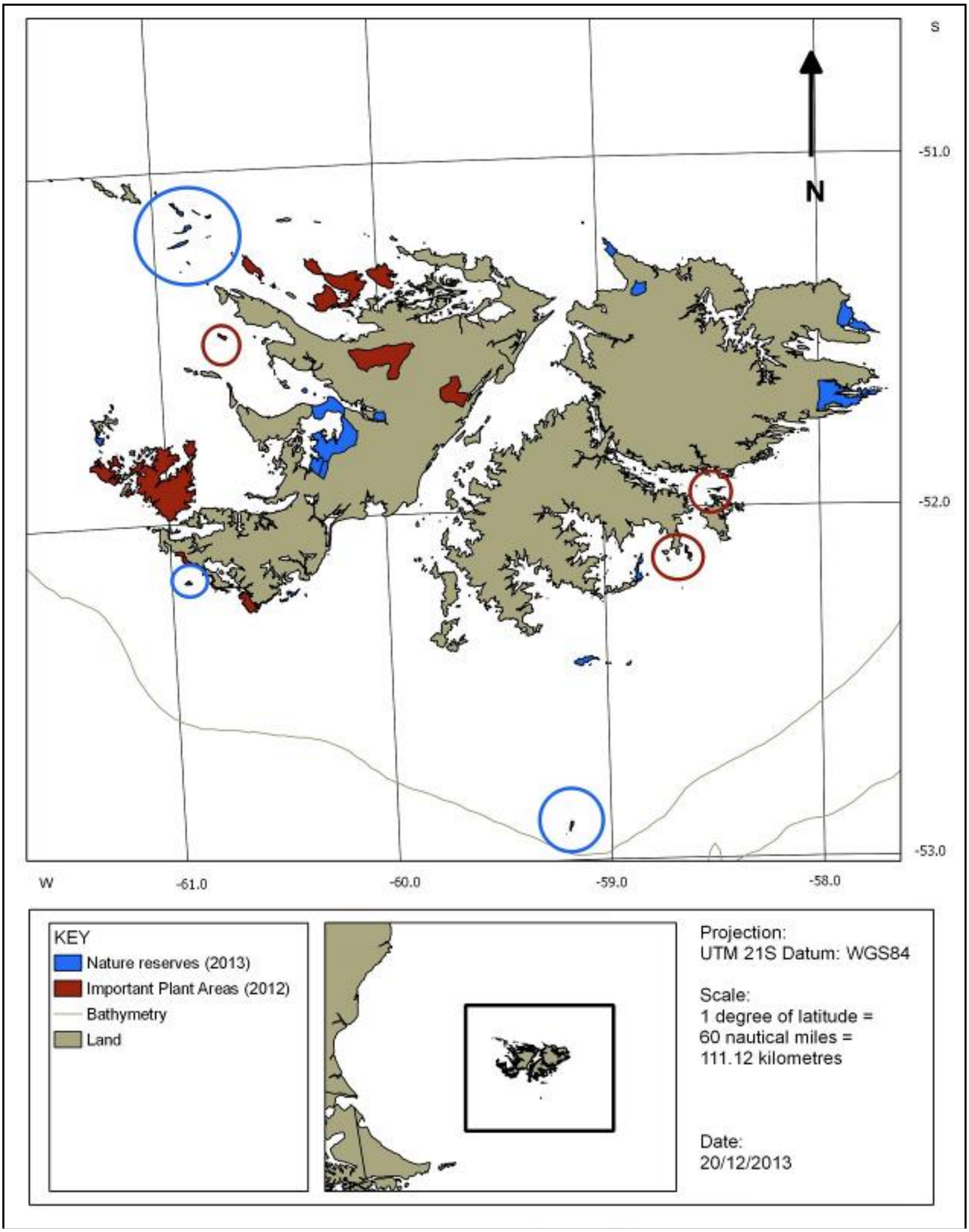


Figure 38: Falkland Islands National Nature Reserves and Important Plant Areas

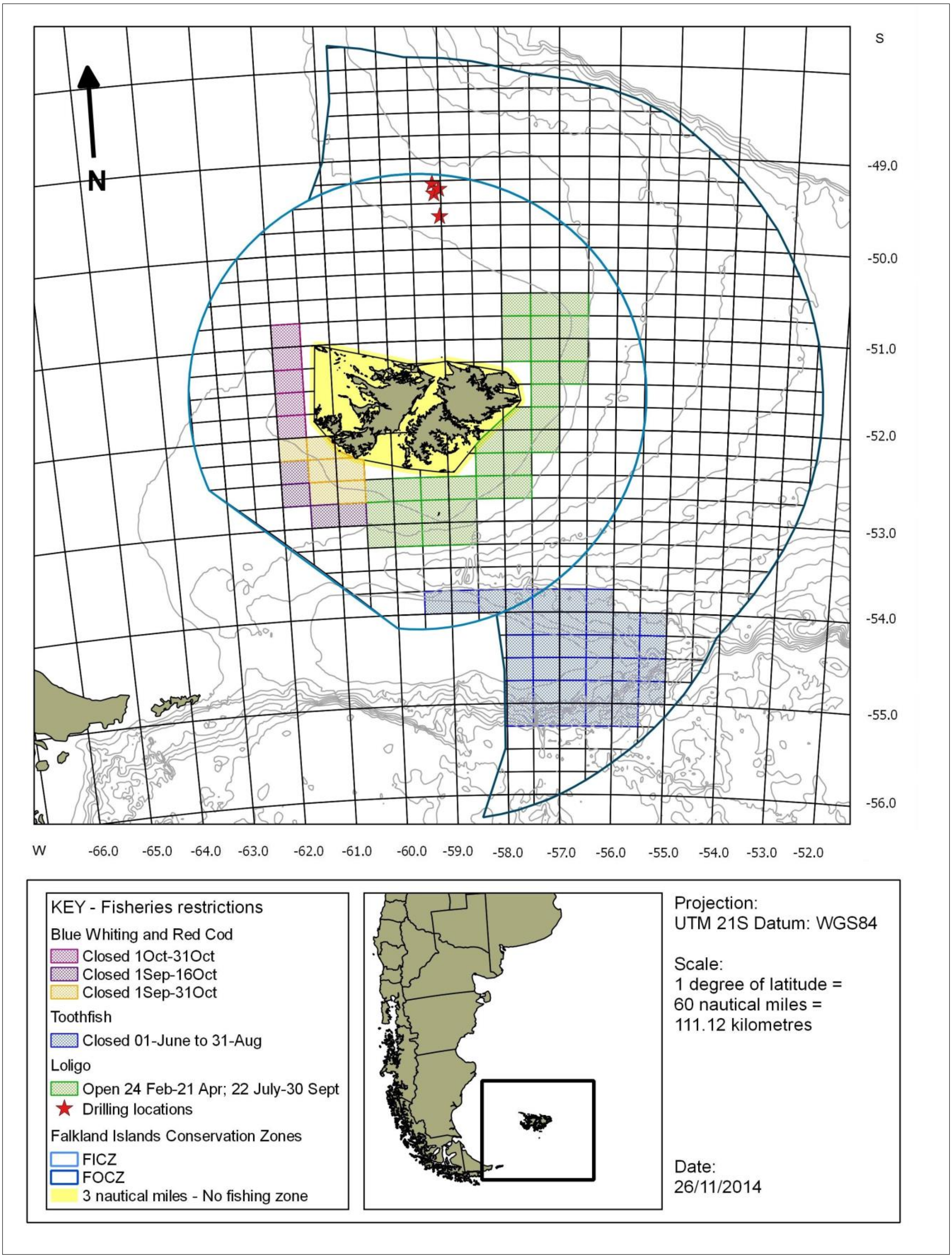


Figure 39: The Falkland Islands Conservation Zones showing permanent and seasonal no-take zones

5.4.8.6 Coastal Sensitivity

Premier Oil have completed a study of the north Falklands coastline to ascertain, using industry developed techniques the environmental sensitivity along the coastline to a spill of hydrocarbons (Premier Oil, 2014). This work was initiated following conceptual oil spill modelling studies for the Sea Lion Development, which modelled the potential distribution of oil in the unlikely event of a worst-case oil spill from the proposed Development location, 220 kilometres north of the Falkland Islands. This modelling showed a risk of oil beaching in along the NFB.

For this exploration campaign, further oil spill modelling has been conducted at the Isobel Deep well location, the closest in distance to the Falkland Islands. Results are presented in Section 12. Although some risk to the north Falklands coastline is also predicted by the exploration campaign modelling, potential volumes of beached oil are much lower than those predicted for the Sea Lion Development, due to the simpler well design and lower predicted flow rates from the exploration wells.

Nevertheless, despite the lower predicted risk of coastal impact, the Falklands Coastline Environmental Sensitivity study is relevant as it highlights the most sensitive sites along the north Falklands coastline in the event that a shoreline oil spill response operation does needs to be initiated.

The exploration modelling predicts that following a loss of well control, under worst-case metocean conditions during the period simulated, the highest probability of some hydrocarbons reaching the shoreline is 40% with a worst-case mass of 860 tonnes reaching the shoreline after 42 days at sea.

The average mass predicted to reach the shore is a much lower value of 39 tonnes after a total of 72 days – any hydrocarbon will also arrive at the coast in a highly dispersed state. In the event of a Sea Lion type crude (which has been modelled) the resultant solid waxlets are predicted to be non-adhesive and non-cohesive and will present a relatively low risk of direct impacts to avifauna. East Falkland has a higher probability of waxlets beaching than islands to the west, with the most northerly headlands of Cape Dolphin, Cape Bougainville and Seal Bay / McBride Head showing the highest overall probabilities, up to 40% under the worst-case scenario. The likelihood of waxlets reaching shore declines to the west across West Falkland, reaching a minimum on the western Jason Island chain. Likewise, to the east and south of McBride Head, towards Volunteer Point and Cape Pembroke, the likelihood of waxlets beaching declines.

Table 24: Adaption of the Gunlach & Haynes (1978) and IPIECA (2011) coastline classification of ESI for the Falkland Islands.

ESI	Estuarine	Lacustrine	Riverine
1A	Exposed rocky shores	Exposed rocky shores	Exposed rocky banks
1B	Exposed, solid man-made structures	Exposed, solid man-made structures	Exposed, solid man-made structures
1C	Exposed rocky cliffs with boulder talus base	Exposed rocky cliffs with boulder talus base	Exposed rocky cliffs with boulder talus base
2A	Exposed wave-cut platform in bedrock/mud/clay	Shelving bedrock shores	Rocky shoals, bedrock ledges
2B	Exposed scarps and steep slopes in clay (unconsolidated sediment)		
3A	Fine to medium-grained sand beaches		
3B	Scarps and steep slopes in sand (unconsolidated sediment)	Eroding scarps in unconsolidated sediment	Exposed, eroding banks in unconsolidated sediments
3C	Tundra cliffs		
3D	Scarps / steep slopes in bedrock or flat rocks		
4	Coarse-grained sand beaches	Sand beaches	Sandy bars and gently sloping banks
5	Mixed sand and gravel beaches	Mixed sand and gravel beaches	Mixed sand and gravel bars and gently sloping banks
6A	Gravel beaches Gravel beaches (granules and pebbles)*	Gravel beaches	Gravel bars and gently sloping banks
6B	Riprap Gravel beaches (cobbles and boulders)*	Riprap	Riprap
6C*	Riprap		
7	Exposed tidal flats	Exposed tidal flats	
8A	Sheltered scarps in bedrock, mud, or clay Sheltered rocky shores (impermeable)*	Sheltered scarps in bedrock, mud, or clay	
8B	Sheltered, solid man-made structures Sheltered rocky shores (permeable)*	Sheltered, solid man-made structures	Sheltered, solid man-made structures
8C	Sheltered riprap	Sheltered riprap	Sheltered riprap
8D	Sheltered rocky rubble shores		
8E	Peat shorelines		
8F			Vegetated, steeply-sloping bluffs
9A	Sheltered tidal flats	Sheltered sand/mud flats	
9B	Vegetated low banks	Vegetated low banks	Vegetated low banks
9C	Hypersaline tidal flats		
10A	Salt- and brackish-water marshes		
10B	Freshwater marshes	Freshwater marshes	Freshwater marshes
10C	Swamps	Swamps	Swamps
10D	Scrub-shrub wetlands; Mangroves**	Scrub-shrub wetlands	Scrub-shrub wetlands
10E	Inundated low-lying tundra		

* A category or definition that applies only in Southeast Alaska.
** In tropical climates, 10D indicates areas of dominant mangrove vegetation

The classification does not quantify the exact level of impact but within each habitat considers the potential vulnerability to oil spill damage based upon shoreline interaction with the physical processes controlling oil deposition, observed persistence of the oil in that environment, ease of cleaning operations, and the extent, duration of and recovery from likely biological damage. Exposed rocky shores are considered the most robust to oil impacts whilst sheltered coastal mudflats are considered the most vulnerable to longer-term impacts.

The results of the study highlighted that the north Falklands coastline is exposed and rocky with wave cut platforms and deep scarps which are considered to be of low sensitivity (ESI 1-3) to oil impacts. High sensitivity areas (ESI 8 – 10) include inland tidal creeks, and sheltered tidal flats and were identified as: Volunteer Lagoon, Swan Pond (Port Louis), Salvador Waters, Brazo del Mar, Limpet Creek, Little Creek, Smylies Inlet, Inner White Rock Bay, Inner Tamar Pass (N&S), Inner Port Purvis, Victor Creek (Pebble Island), Justice Inlet (Keppel), NE Bay Saunders, Brett Harbour (Saunders), Penguin Island (Saunders) (See Figure 40 and Figure 41). On top of the general sensitivity of the coastline there are a range of IBAs, IPAs, NNRs and Ramsar Sites that were considered along with sites of known environmental importance with significant concentration of wildlife. Whilst a range of taxa may be impacted by an oil spill, the assessment was predominantly based upon colonial seabirds for which census data is available.

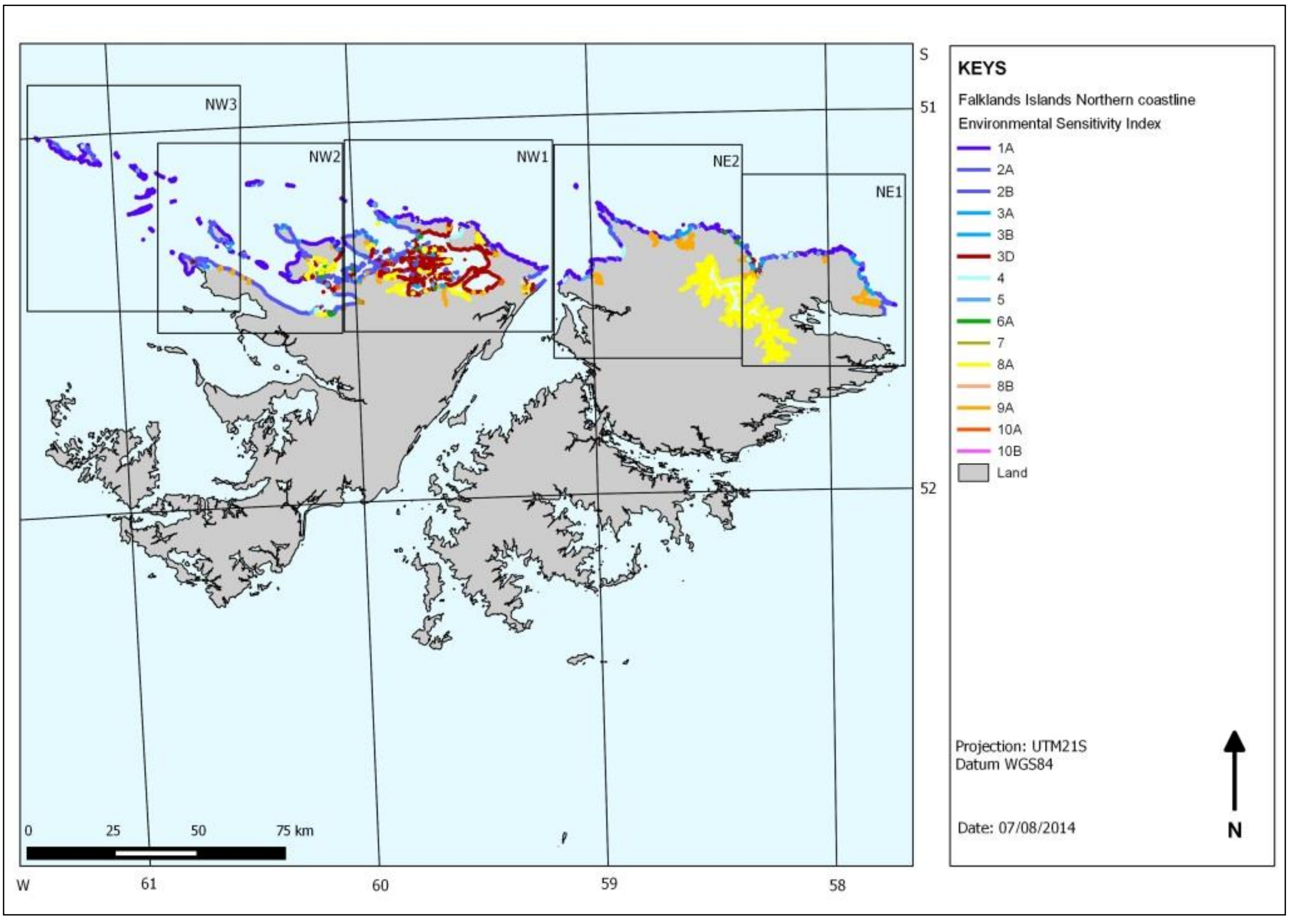


Figure 40: ESI North Falklands Coastline. Oil Spill Vulnerability categorized by Environmental Sensitivity Index 1-10 [from Gunlach & Haynes (1978) & IPIECA (2011)].

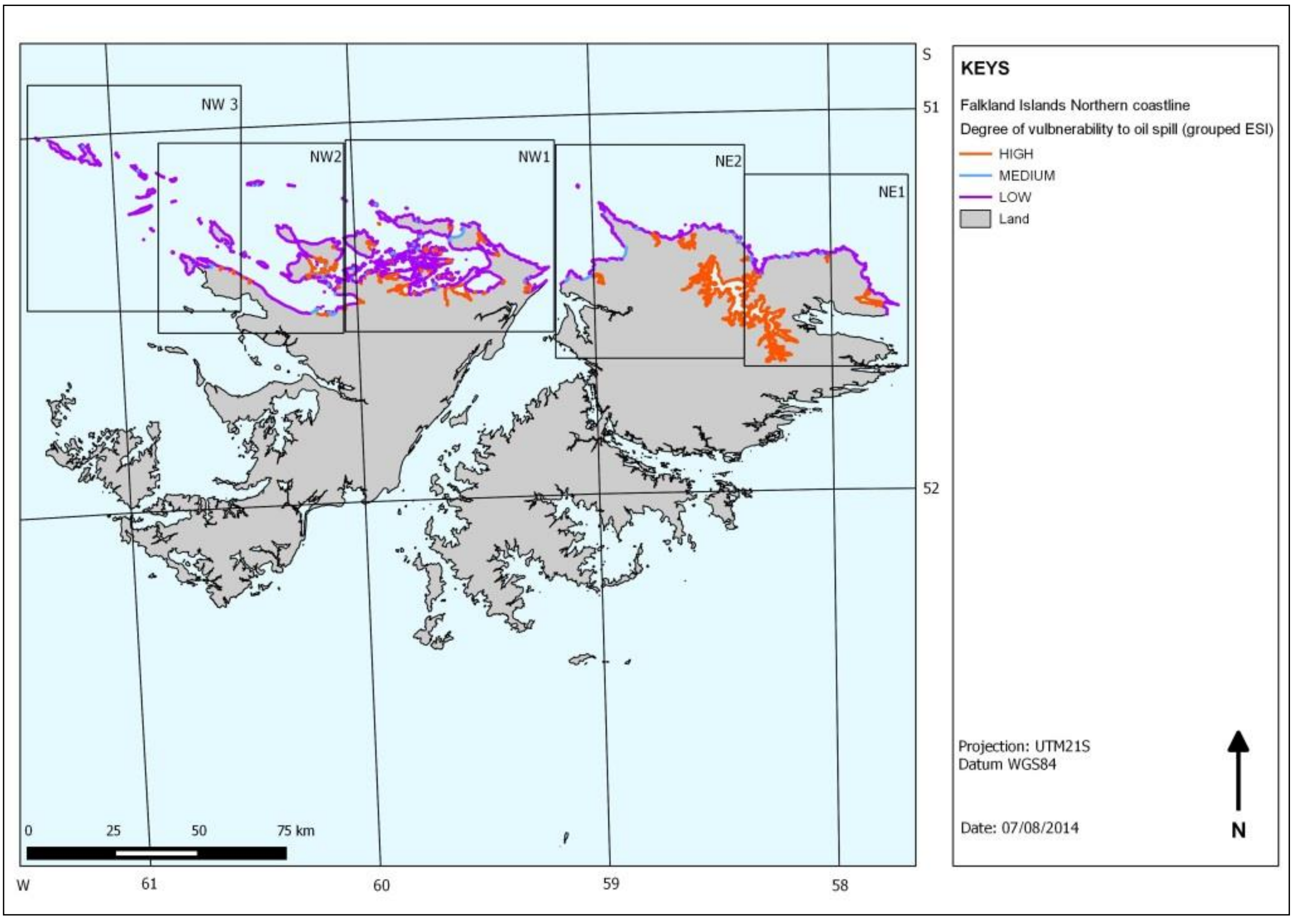


Figure 41: North Falklands Coastline. Environmental Sensitivity Mapping (ESI) categorized as Low (ESI 1-3), Moderate (ESI 4-7) and High (ESI 8-10) Vulnerability to Oil Spill.

A review of the colony locations with respect to coastline type, the seasonality of occurrence and the Oil Vulnerability Index (OVI) of the species would suggest that gentoo penguin may be the most vulnerable to impacts and would be suitable to use as a ranking proxy. Gentoo penguins showed the greatest overlap with sensitive coastline types (ESI), associate with breeding colonies through-out the year, and have a high OVI sensitivity.

The conservation importance of black-browed albatross and rockhopper penguins was recognised. Due to the tendency of these species to utilise more exposed rocky coastlines of low sensitivity, sites were not prioritised in the first instance. Real-time monitoring during an incident should determine the need for any subsequent re-prioritisation or response intervention on site.

Additional species and taxa were not considered either due to a lack of quantitative data that could be extrapolated to un-surveyed coastlines or to a widespread distribution across the coastal habitat types which gave little differentiation between coastlines for ranking purposes.

Socio-economic factors were considered and the relative level of tourism utilised to further differentiate the environmental and socio-economic sensitivity of sites. The occurrence of fine-grained sand beaches in proximity to penguin colonies was identified as an important tourism resource, albeit that these sites are of relatively low sensitivity (ESI 3).

The study also investigated and mapped the location of infrastructure that might assist a response and mobilisation to the northern coastline. For example, the location of road, tracks, jetties (and ramps), ports, airstrips, settlements and out-houses was detailed and mapped, along with their condition where appropriate. This will enable Premier Oil to define the level of resources required to affect an appropriate response.

Due to the spatial extent of the North Falkland Islands coastline and the associated issues with regards to access, response time etc. will mean that some prioritisation is required. This will focus response on those areas where capacity can be best deployed to tackle the maximum extent of sites which are most at risk of biologically significant or socio-economic impact. A pragmatic compromise must be reached that balances the importance of a site with the level of resources that must be committed. This may mean that some important sites that would lead to over commitment of resources may not be tackled in favour of other more accessible sites where remedial actions will be able to be conducted over a greater spatial area.

The final long-listing of sites utilised the coastal ESI, location of notable scenic beaches, occurrence of gentoo penguins, overlap with an environmental land designation and relative level of tourism activity.

The long listed sites for prioritised response included the following main sites.

The highest ranked sites for response are located at;

- Volunteer Point;
- Pebble Island;
- Saunders Island;
- Carcass Island.

Important and secondary ranked sites for response are located at;

- Swan Pond & Seal Bay coastline;
- Brazo del Mar and entrance to Salvador Waters;
- Bougainville, Concordia & Limpet Creek coastline;
- Cape Dolphin Swan Pond Beach;
- Smylies Inlet and Paloma Beach;
- Grave Cove, Dunbar;
- Steeple Jason.

The grouping of sites into geographical areas will assist in the mobilisation of resources, and may permit some secondary ranked sites to be tackled with adjacent higher priority sites. Geographic groupings with multiple sites would include;

- Volunteer Point and Cow Bay;
- Swan Pond and Seal Bay;
- Entrance to Salvador Waters;
- Limpet Creek & Concordia;
- Cape Dolphin and Elephant Beach;
- Paloma Beach, Smylies and Race Point;
- Pebble Island;
- Saunders Island.

The ESI classification and location of significant wildlife sites provides the background and basis for prioritising sites for oil spill response. It is however recognised by IPIECA (2011) that the relative importance of ranking criteria will be influenced by local perceptions and that ranking should not rely solely upon a quantitative analysis. A consultative approach incorporating local stakeholders into the planning process and final prioritisation should be conducted.

5.5 Social and Economic Environment

5.5.1 Falkland Islands Socio-economic Description

To date, oil and gas exploitation within the Falkland Islands has been limited to exploration and appraisal drilling. However, following the recent commercial discovery in the Sea Lion area, planning to develop the field for oil production is currently underway. Supporting an oil and gas development and production operation will be new to the Falkland Islands, and consequently there may be significant impacts on the local community and the socio-economic landscape of the Islands.

Rockhopper Exploration commissioned an independent socioeconomic impact assessment to identify potential impacts and mitigation measures to minimise any negative impacts that could be associated with the project (Plexus Energy, 2012). The FIG also recently commissioned an independent socio-economic study of oil and gas development in the Falkland Islands (Regeneris, 2013). This section outlines the current socio-economic baseline for the Falkland Islands and draws on both of the above reports as well as FIG data, including the recent 2012 Falklands Census.

5.5.1.1 Administration and Governance

The Falkland Islands are one of 14 British Overseas Territories under the British Overseas Territories Act 2002. The Basic Law is the 2008 Constitution, which deals with all aspects, with the exception of defence and foreign affairs, which are the responsibility of the UK. The UK is also responsible for internal security, the public service and the offshore financial sector. In other areas, executive power is exercised at island level. The Falkland Islands are located almost 8,000 miles from the United Kingdom, its primary economic partner (Regeneris, 2013).

The Falkland Islands enjoy almost crime free status with an annual police detection rate of over 95% on average.

5.5.1.2 Population

The Falkland Islands were first inhabited in 1764, and the current permanent population of the Islands stands at 2,840 (FIG Policy Unit, 2012). The majority of the Falkland Islands population (74.7%) live in the capital Stanley, which is the only town on the Islands and is based on East Falkland.

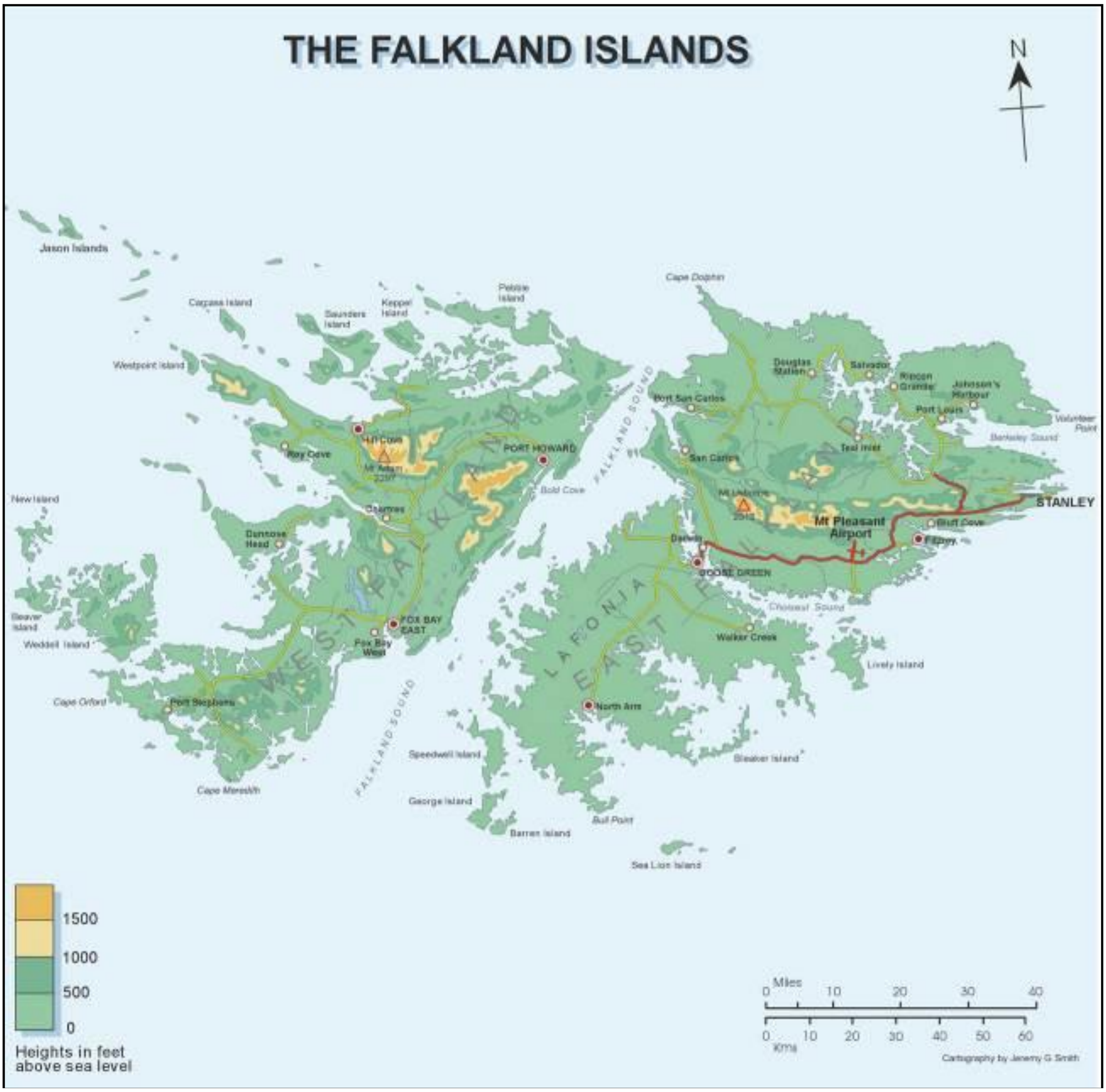
Outside Stanley, in what is referred to as Camp (the local term for the countryside derived from the Spanish word Campos), there are a number of smaller settlements. According to the 2012 Falkland Census, the total population of Camp stood at 351, representing 12.4% of the total resident population of the Falkland Islands. The economic pull of Stanley has led to depopulation in Camp settlements in recent decades. Although this trend has reduced over the last ten years, Camp depopulation remains a significant local concern (Regeneris, 2013).

There are three main Camp settlements on West Falkland (Fox Bay, Port Howard and Hill Cove) and three on East Falkland (Goose Green, North Arm, and Fitzroy). In total, there are 84 mostly family owned farms across the Islands, 38 of which on East Falkland, 35 on West Falkland and a further 11 on the outer islands (Figure 42) (Plexus Energy, 2012).

The Ministry of Defence base at MPC towards the centre of East Falkland is a largely self-contained community, but provides the main airport base for international flights (Regeneris, 2013). The remaining 12.9% of the population are civilian contractors working at the MPC (FIG Policy Unit, 2012).

The majority of the population is British by birth or descent, with many tracing their family origins in the Islands back to the early nineteenth century. In addition to the Falkland Islanders, there is a significant minority of resident Chileans and St. Helenians who work on the Islands. Most the remaining population comprises people from the UK and other countries working under contract or in certain government positions that require specialist skills (Plexus Energy, 2012, Falkland Census, 2012).

There are over 1,200 homes on the Islands, with around 1,000 of these in Stanley. On average only 20 new houses are being built each year, largely detached houses in their own plots. Around three quarters of homes are detached houses and development is fairly low density. There are currently very few empty homes (Regeneris, 2013). A new development in the west of the town, at Sapper Hill, and an extension to Murray Heights have helped to ease the pressure on housing recently.



Source: Plexus Energy, 2012.

Figure 42: Main Settlements and Roads within the Falkland Islands

5.5.1.3 The Falkland Islands Economy

Prior to the mid-1980s, the Falkland Islands economy was almost completely based on agriculture, mainly sheep farming and the export of wool for income. Following the establishment of the FICZ in 1986 for fishery purposes, and creation of a 200 nautical mile Exclusive Economic Zone (EEZ) in 1990, the bulk economic activity shifted to the sale of fishing licences to foreign trawlers operating within the Falkland Islands EEZ (Plexus Energy, 2012). The income from these licence fees fluctuates, but currently makes up 50-60% of the Government's revenue (FIG, 2014).

There are around 290 registered businesses on the Falkland Islands, of which it is estimated that around 130 are active. Analysis by GDP and employment highlights that public services, fisheries, agriculture, tourism and construction are all key sectors of the local economy. These five sectors account for around 85% of GDP and around two thirds of all jobs (Regeneris, 2013).

This contrasts markedly with the percentage breakdown of annual employment (Falkland Census, 2012). In particular, fisheries employment accounts for only 3% of total employment, compared with 50-60% of economic output. This is largely because fishing revenues are from the sale of fishing licences to foreign fishing fleets, not from the Falkland Islands-based fishing activities. In contrast, FIG accounted for 25.4% employment, compared with just 13% of economic output (Plexus Energy, 2012). Similarly, agriculture's 9.9% share of employment is much higher than its 2% share of economic output (Plexus Energy, 2012).

The employment rate for working age people (those aged 16-64) is 89.5%, with only 1.4% unemployed and seeking work. This is an exceptionally high level of employment by international standards, and means that there is virtually no spare capacity in the labour market (Regeneris, 2013).

- The majority of workers in the Falklands undertake a ~45 hour working week, and around half of Camp residents report working a 50+ hour week.
- The mean income level in Stanley is £23,300, making it around 10% lower than the mean level for the UK. Around a quarter of Falkland Islanders supplement the income from their primary job with a second job.

5.5.1.4 Agriculture

Agriculture was the main economic activity in the Falkland Islands for most of the 20th century and remains an important part of the Islands' economy and culture. Although its relative importance in terms of GDP has been lower than the fisheries sector in recent years, it remains one of the largest employers outside of the public sector (Plexus Energy, 2012).

Until recently the mainstay of the agricultural sector was wool production. A key constraint is the distance to markets, which makes Falklands' wool relatively expensive. The focus has therefore been on organic wool and the production of finer wool, which can hold a premium of up to 10%. In an effort to diversify the camp economy and to help to encourage people to stay in Camp, measures were taken in 2002 to generate additional income from meat export (lamb, mutton and beef), complemented by improved farming practices and pasture improvements (Plexus Energy, 2012).

Most farming activity takes place during the summer months (September to March) and as a result there is much seasonality associated with employment in Camp. This period is also the core tourist season and as such there is competition for labour during the summer months. Contract labour is often used for shearing, fencing or tractor work and is often difficult to source, particularly at peak times of the year (Plexus Energy, 2012).

5.5.1.5 Tourism

The role of tourism in the Islands' economy has increased in recent years (FIG, 2014). Tourist numbers continue to grow, with many attracted by the Islands' pristine environment and its diverse wildlife. According to the Falkland Islands Government (FIG, 2014), approximately 60,000 tourists visit the Islands by cruise ship each year, and a further 1,600 'land-based' tourists arrive by air annually to enjoy the Islands unique wildlife and unspoilt environment. The tourism sector is the second largest contributor to the Islands economy and contributes approximately £4m to annual GDP (FIG, 2014).

During the cruise ship season many people take time off from their regular work to drive tourists to see wildlife around the Islands. In Camp, tourism accounts for a greater share of income than in Stanley. According to FIG figures, tourism accounts for an estimated 17% of whole farm income, with the outer islands experiencing a greater share of tourism income at 41% of the total.

FIG aims to increase the economic benefits from tourism to the Falkland Islands. A key aspect of the Tourism Development Strategy (TDS) is sustainable development, preserving and protecting the Falkland Islands' character, building on the Islands' abundant wildlife, flora, clean air, open skies, space and remote location – as well as their friendly people and virtually crime-free environment (FIG, 2014).

5.5.1.6 Education

There are approximately 380 school children between the ages of 5 and 16 in the Falkland Islands. Their education, which follows the English system, is free and compulsory (Plexus Energy, 2012). Primary education is available at Stanley where there are boarding facilities; at RAF Mount Pleasant for children of service personnel; and at a number of rural settlements where remote learning is supported by the Stanley-based Camp Education Unit. The Government funds qualified students to study A-levels or vocational qualifications, and higher education within the UK.

5.5.1.7 Health

The Falkland Islands Government Health Service is responsible for the provision of all health care services in the Islands, including dental care, social and benefits services (Plexus Energy, 2012). Primary and secondary health care facilities are based at the King Edward VII Memorial Hospital (KEMH) in Stanley, the only hospital in the Islands. The hospital is run jointly by FIG and the UK MoD, specialist medical care is provided by visiting ophthalmologists, gynaecologists, ENT surgeons, orthopaedic surgeons, oral surgeons and psychiatrists from the United Kingdom. Patients requiring emergency treatment are airlifted to the United Kingdom or to Santiago, Chile.

Healthcare in remote Camp farm settlements is provided by the KEMH's GPs via telephone consultations and six weekly visits by doctors who will visit residents' homes as needed. In an emergency situation the patient can be evacuated to Stanley using the Falkland Islands Government Air Service (FIGAS).

5.5.1.8 Infrastructure

There is a network of roads linking the main settlements in the Falkland Islands (Figure 42). Outside of Stanley the road to MPC is partially tarred, but all other roads are gravel all-weather surfaced. The absence of capping on some of the roads leads to significant erosion, especially during the winter, making all types of road travel difficult and increases safety risk during those periods (Plexus Energy, 2012). The road between Stanley and MPC will be used on crew change days

The availability of accommodation in Stanley is limited and will be augmented with temporary accommodation (Section 10.8). This will be reliant on the existing power and water supply, although the temporary accommodation may be equipped with its own generators for emergency power.

Freshwater supply

The town of Stanley is currently reliant on one source of freshwater at Moody Brook. The availability of freshwater varies seasonally, according to rainfall, with supply lowest during the summer months. Reliance on a limited supply leaves the residents of Stanley vulnerable to periods of extreme dry weather and potential contamination. Currently, infrastructure for a second source of freshwater for the town (Murrell River) is being put in place. However, this will not be on line before the start of the 2015 Drilling Campaign but will cover all eventualities in the future.

Residents of Stanley and local businesses, such as the Falkland Islands Meat Company (FIMCO), rely on the Stanley freshwater supply. However, previous shortages have only occurred during unusually dry summers (November to January). The vast majority of drilling operations will be conducted outside of this period.

During a previous drilling campaign, in January 2011, demand did become stretched due to factors such as; lower than average rainfall in Nov/Dec 2010 and January 2011, higher demand by Stanley residents due to warm dry weather (i.e. watering gardens), FIMCO operations commencing and demand by the drilling campaign (C. Paice pers. comm.).

It is not possible to predict the quantity of freshwater that will be required during the drilling campaign. However, it is anticipated that it will not exceed that of previous campaigns.

Unlike previous campaigns, the TDF is fitted with a freshwater reservoir with a capacity of one million litres. This reservoir will be trickle fed to avoid excessive peaks in demand on the local supply.

5.6 Shipping

5.6.1 Falkland Islands Fisheries

Since the late 1970s, the seas around the Falkland Islands have been an important area for commercial fisheries, with multinational fleets operating in the waters around the Islands. The creation of the EEZ was critical in transforming the post-1982 Falklands economy, previously dependent on the production of wool, into one of the wealthiest communities per capita in the South American region. The fishing-licensing regime has generated millions of pounds in revenue and currently contributes between 50 and 60% of total GDP annually (FIG, 2014).

It is therefore important to understand current fishing activity within the area of the Drilling Campaign Area in order to determine to what extent the development and production of the Drilling Campaign Area might interfere with fishing activities. For example; as a result of exclusion of fishing vessels from around the field, and whether this could translate into loss of revenue for the fishing fleet or the FIG as a result of licence sales.

This section provides an understanding of the fishing activities and intensity in the Sea Lion area in order to evaluate the potential impacts associated with the proposed development. This area is known to support very low fishing activity. These low levels of fishing activity are likely for two reasons: the depth of the area is greater than the normal maximum depths at which the bottom trawlers fish, and; the area is denoted by rough fishing grounds and therefore there is a high risk of bottom trawlers losing fishing gear.

This review is based on the Summary Report of fishing activity over the Sea Lion development area, conducted by Pale Maiden Consultancy (April 2013), and FIG Fisheries Department Catch Report Database from 2008 to 2012. Some information is also taken from the Fishing and Trawling Risk Study conducted by Jee on behalf of Premier Oil (2013).
The Falkland Islands EEZ contains rich fishing grounds, particularly for the two important squid species, Argentine shortfin squid and Loligo (Patagonian squid). Table 25 presents total catch (tonnes) data for the main target species in the Falkland Islands fishery between 2008 and 2012 (FIGFD, 2008-2013). This illustrates that the Argentine shortfin squid, is consistently the most important (in terms of catch) fishery (with the exception of 2009 where the species was virtually absent from the EEZ), accounting for 53.8% catch by weight in 2013, followed by Loligo squid which accounted for 15.2% of the catch by weight in 2013.

Southern rock cod has increased in importance over recent years, experiencing 20-30 fold increase in catches (Laptikhovsky et al., 2013), and is currently the third most important fishery accounting for 12.3% of catch by weight in 2013 (Table 25). The rise in this fishery followed the decline in the blue whiting fishery in 2007 (Laptikhovsky et al., 2013).

Fisheries of considerably smaller magnitude also operate for the main finfish species, such as; whiptail hake (hoki) (6.4%), hake (4.6%), red cod (2.0%) kingclip (1.5%), blue whiting (1.0%) and Patagonian toothfish (0.5%). Additionally, skates and rays account for a small 2.2% of the catch (Table 25).

The Argentine shortfin squid is primarily fished by jiggers from the Far East, whereas the smaller inshore squid species Loligo, and other finfish species, particularly hake, have been the target of the European bottom trawling fleet. (FIG, Directorate of Natural Resources, Fisheries Department 2012).

Table 25: Annual Fishing Catch by Target Species in the FICZ/FOCZ

Target Species	Catch (Tonnes)					
	2009	2010	2011	2012	2013	% Catch (2013)
Argentine shortfin squid	43	12,110	79,389	86,981	142,405	53.82
Loligo squid	31,477	66,532	34,663	70,888	40,177	15.18
Southern rock cod	58,246	76,451	55,707	63,512	32,418	12.25
Hoki	23,396	19,226	22,980	15,866	16,845	6.37
Hake	13,056	13,604	9,903	10,477	12,284	4.64
Skates and Rays	5,880	5,894	6,975	6,650	5,910	2.23
Red cod	5,119	3,120	4,202	4,625	5,162	1.95
Kingclip	3,386	3,631	3,864	3,515	3,960	1.50
Southern blue whiting	10,395	6,469	3,944	1,596	2,697	1.02
Patagonian toothfish	1,408	1,396	1,550	1,309	1,420	0.54
Others	1,225	700	2,616	818	1,331	0.50

For fisheries licensing and management purposes, the Falkland Islands Conservation Zones, are divided into grid squares. Each grid square is 15' of Latitude by 30' of Longitude, or approximately 15 nautical miles by 17 nautical miles in size. These gird squares are the same as the ¼ ICES squares used for Seabird data (Section 3). Each square can be referred to by a four letter code (the first two letters denote Latitude and the second two Longitude). Falkland Islands Government Fisheries Department (FIGFD) fisheries statistics from 2008 to 2012 indicate that the most important fishing areas corresponding to the highest catch (tonnes) per grid square are concentrated around the 200 m depth contour surrounding the Falkland Islands. The Patagonian toothfish is fished in depths greater than 600 m with the best catch per unit effort achieved off Burdwood Bank to the south and on the Deep Slope area to the northeast (FIGFD, 2008-2013).

5.6.1.1 Fisheries Operating within the Sea Lion Area

The Sea Lion area is located in FIFD grid squares XFAK and XEAK, 20 to 30 miles north of the 200 m depth contour line, with depths of approximately 450 m. These grid squares have been fished by vessels with licences for fishing either for the Argentine shortfin squid, or for skates, or finfish. The licence types which are issued by FIFD for these grid squares are:

B: Argentine shortfin squid and sevenstar flying squid (*Martialia hyadesii*)

G: Argentine shortfin squid and restricted finfish

A: unrestricted finfish

F: skates and rays

S: blue whiting and hoki

W: restricted finfish

Data extracted from the Fisheries Department database by Pale Maiden (2013) (Table 26) indicated that both jiggers and trawlers spent just 14 days in the Sea Lion grid squares (XFAK and XEAK) over the five year period, 2008-2012, confirming that this is an area of very low fishing effort.

Analysis of fisheries statistics data, Volumes 13-17 2009-13, indicate that fishing activity in the Sea Lion area was consistently very low during the period 2008-2013 (Table 26). Sporadic catches of Argentine shortfin squid, hoki, skates and rays, kingclip, southern rock cod, common hake and Patagonian toothfish were made, predominantly during the 2nd season (July to December). All catchs within the Sea Lion area were very low in comparison to the total catch within the FICZ/FOCZ, accounting for < 1% of total catch in all cases.

Table 26: Total Annual Catch and Effort in Grid Squares XFAK and XEAK

Species	2008	2009	2010	2011	2012	
	Jigger	Trawler	Jigger	Jigger	Jigger	Trawler
Catch (tonnes)						
Argentine shortfin squid	84.2	0	6.95	53.9	9.4	0
Rock cod	0	0	0	0	0	0.24
Hoki	0	15.7	0	0	0	49.7
Common hake	0	0.04	0	0	0	0
Rays	0	1.5	0	0	0	1.7
Kingclip	0	0.09	0	0	0	0
Patagonian toothfish	0	0.09	0	0	0	0.2
Total	84.2	17.4	6.95	53.9	9.4	51.8
Effort (jigger night, trawler day)						
XFAK	1 night	1 day	3 nights	1 night	2 nights	2 days
XEAK	1 night	-	1 night	-	2 nights	-

The depth of the eight jigging events ranged between 160 - 195 m, and the depths of the three trawling events ranged between 318 - 427 m (Pale Maiden Consultancy, 2013). The catch that was landed by two trawlers in 2012 over two trawl days was 51.8 tonnes, which represents ~0.02 % of the total catch in 2012. There has been very little toothfish, rockcod and kingclip by-catch reported, to date. The data indicates that this area is rarely visited by fishing vessels and is not regarded as a regular fishing ground.

The vast majority (97.8 %) of all bottom trawl fishing for finfish and skates in the Falkland Islands was conducted in waters less than 350 m in depth (Pale Maiden, 2013).

Additional analysis of vessel tracks from Vessel Monitoring System (VMS) data (Pale Maiden, 2013) indicated that only one trawl vessel in 2012 was actually fishing within the Sea Lion gird squares (XFAK).

5.6.2 Marine Archaeology

The UK Hydrographic Office Wrecksite database indicates that there are 177 wrecks recorded within Falkland Islands waters, with records dating from the 1800's to present day. There are six recorded wrecks within 100 n miles radius of the Sea Lion Field; the closest of these wrecks is located approximately 50 n miles from the field (Table 27, Figure 43). There are no recorded wrecks within the vicinity of the Drilling Campaign Area.

Table 27: Recorded Wrecks within 100 miles of the Drilling Area**.**

Wreck	Vessel Type	Latitude	Longitude	Depth (m)	Date
ARA Comodoro Somellera	Argentine patrol boat	49°30'00.2"S	58°30'17.8"W	400	1982
MFV Chiann Der III	Small fishing boat	48°30'00.0"S	59°43'00.0"W	~480	1986
Ferralemes MFV	Falkland Islands trawler	50°15'30.4"S	58°13'23.4"W	135	2008
Wreck No 129700356	Unknown	49°55'06.1"S	58°02'47.8"W	300	unknown
Wreck No 140502865	Unknown	50°17'12.2"S	60°11'17.8"W	160	unknown
Wreck No 140503079	Unknown	50°57'21.0"S	58°52'36.0"W	140	unknown

Source: UK Hydrographic Office (2014).

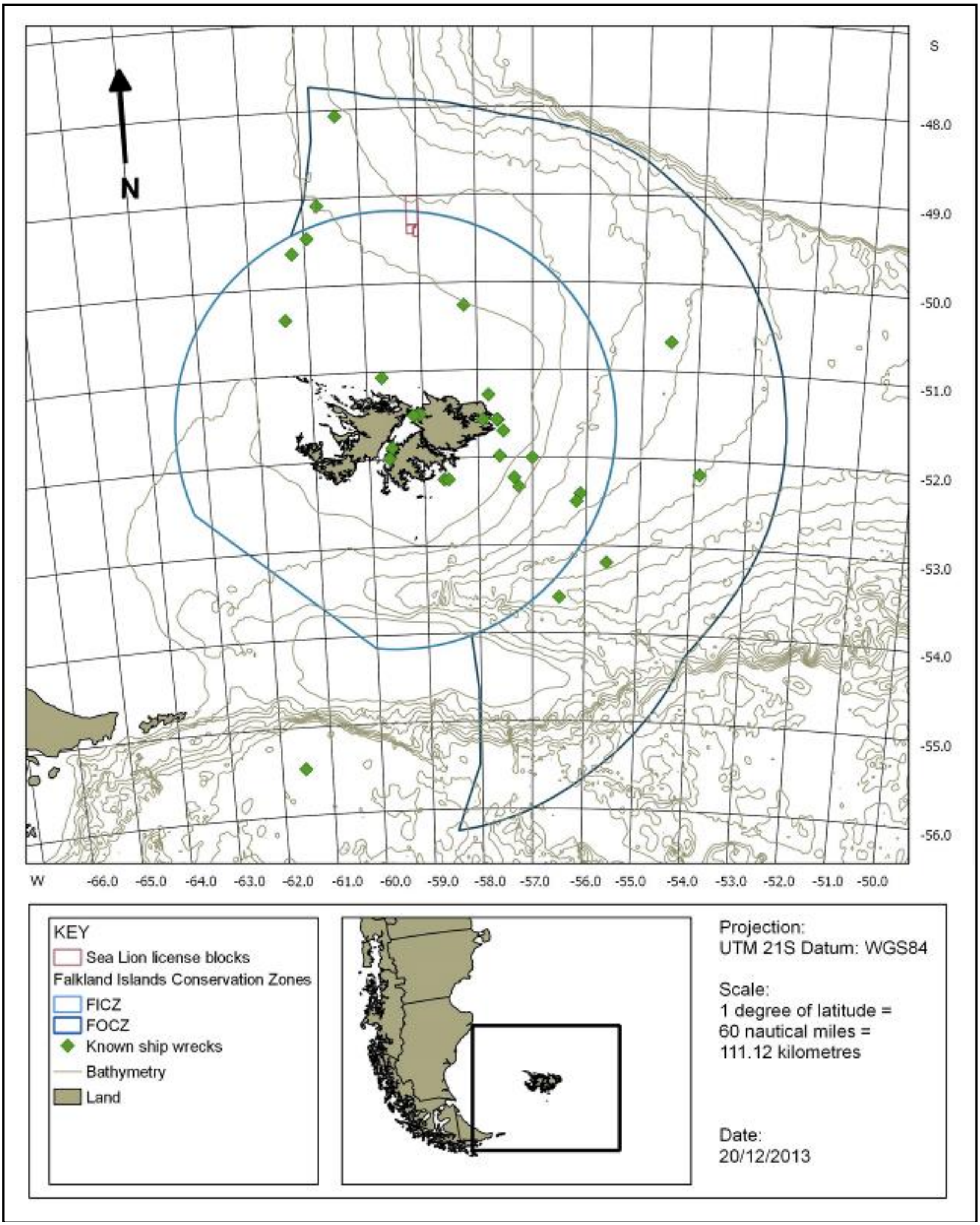
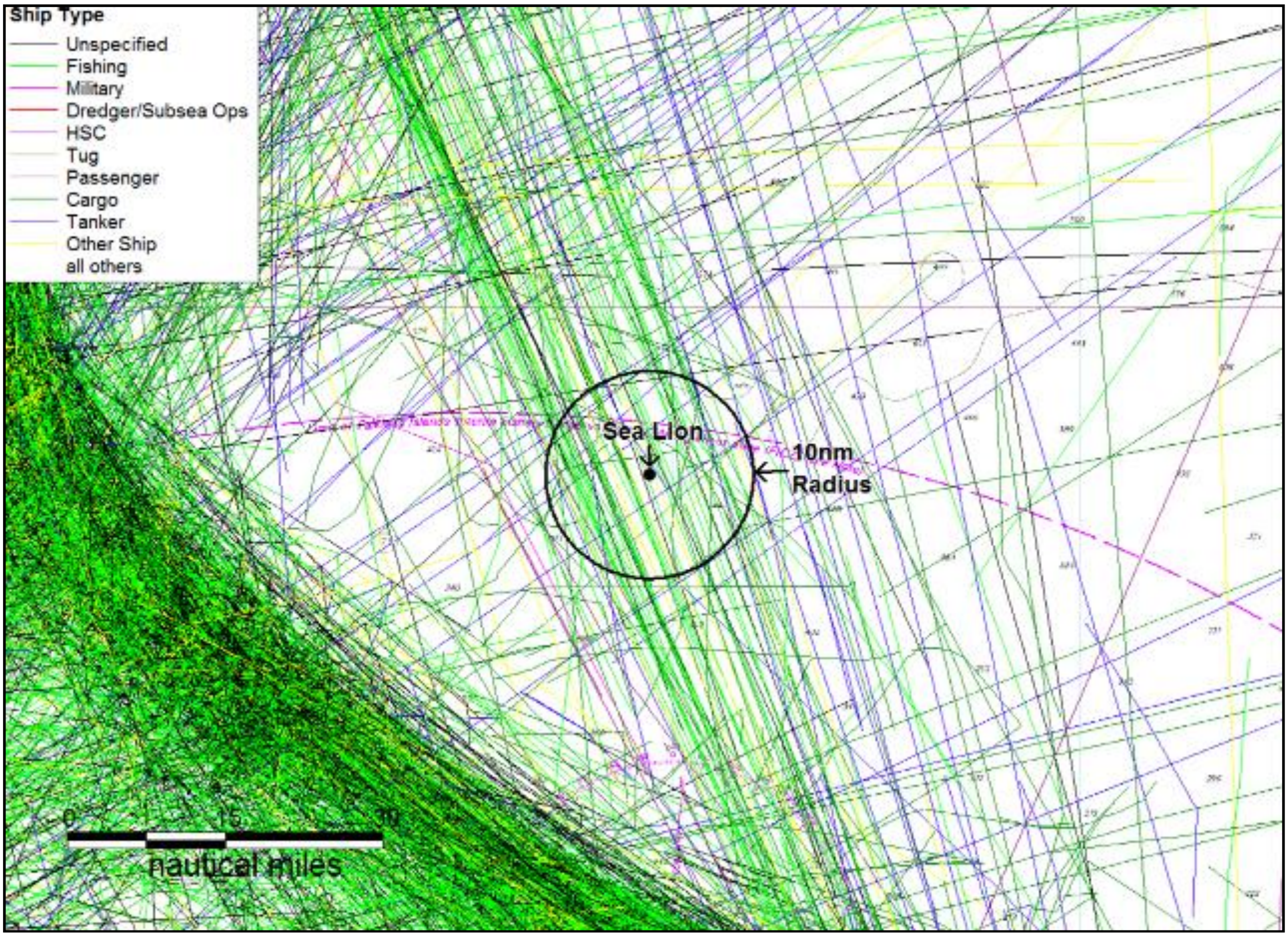


Figure 43: Known Ship Wrecks within the Falklands' Continental Shelf

5.6.3 Navigation and Maritime Transport

Premier Oil commissioned Anatec to identify the shipping routes passing the Sea Lion area in the NFB. Details of all of the shipping routes passing close to the Sea Lion area were identified using detailed analysis of Automatic Identification System (AIS) data (Anatec, 2013). AIS is an automated tracking system used on ships and by vessel traffic services for identifying and locating vessels by electronically exchanging data (such as unique identification, position, course and speed) with other nearby ships, AIS base stations and satellites. The International Maritime Organisation's International Convention for the Safety of Life at Sea requires AIS to be fitted onboard international voyaging vessels with gross tonnes of 300 or more. Figure 44 illustrates a composite of AIS tracking data in the vicinity of the Sea Lion area, indicating that it is located in an area of low shipping activity (Anatec, 2013). The nearest area of high-density shipping activity passes the Sea Lion area approximately 30 n miles to the southwest (Figure 44).



Source: Anatec, 2013.

Figure 44: Overview of AIS shipping data for the Sea Lion Location

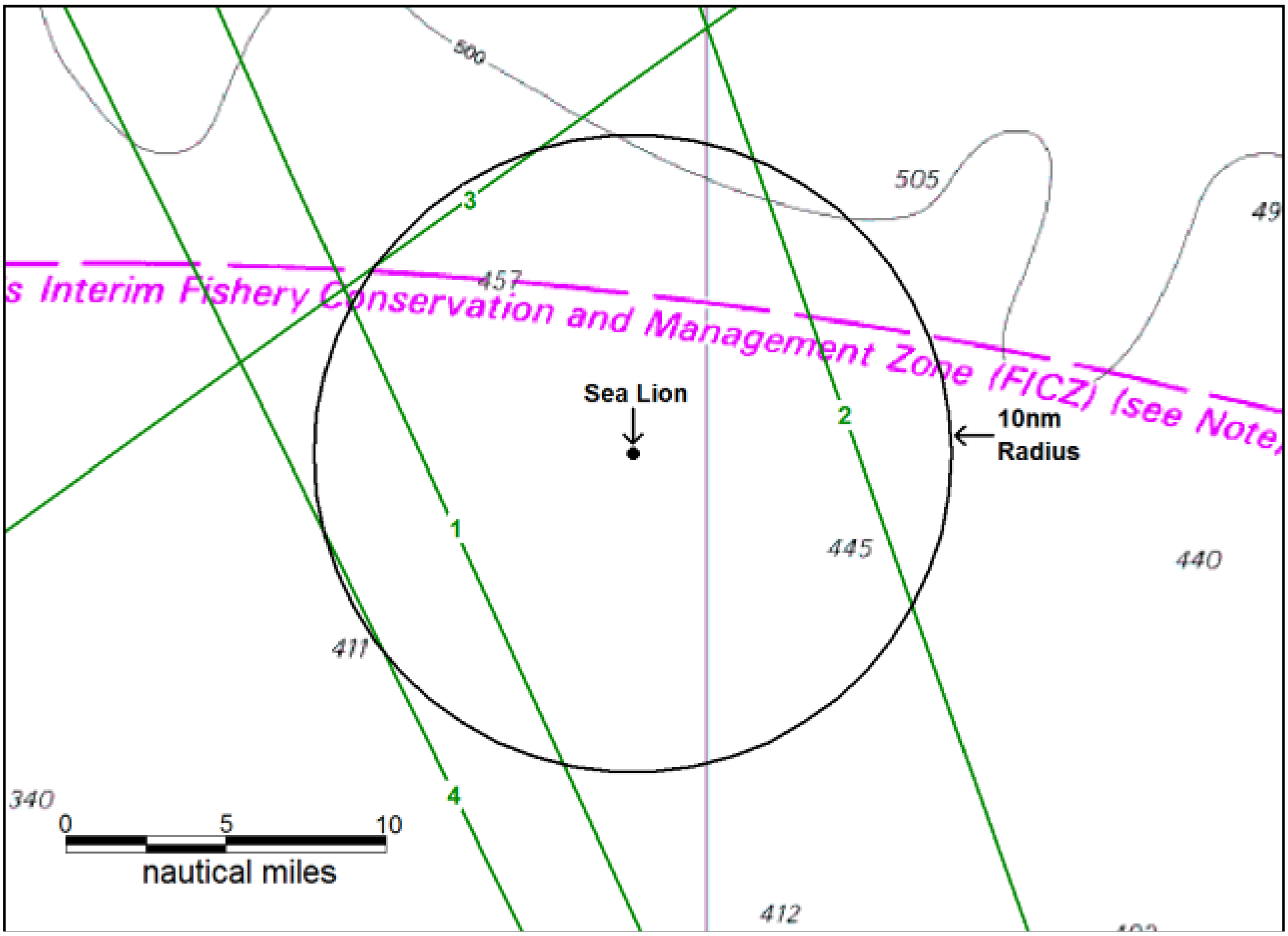
There are four shipping routes that pass within 10 n miles of the Sea Lion Field, with a total of 85 ships per year travelling through these shipping routes (Table 29, Figure 45), equating to one vessel passing every four days.

Table 28: Ship Routes Passing within 10 nautical miles of the Sea Lion Field

Route No.	Description	CPA (nm)*	Bearing (°)	Ships per year	% of Total
1	Berkeley Sound – fishing grounds (north)	6.0	245	40	47%
2	Berkeley Sound – Montevideo	6.7	70	30	35%
3	West Africa – N. America West Coast	9.5	324	5	6%
4	Berkeley Sound – Puerto Madryn	9.8	245	10	12%
TOTAL				**85**	**100%**

* Where two or more routes have identical Closest Point of Approach (CPA) and bearing they have been grouped together. In this case, the description lists the sub-route with the most ships per year.

Source: Anatec, 2013.



Source: Anatec, 2013.

Figure 45: Shipping Route Positions within 10 nautical miles of the Sea Lion area

Four shipping routes pass the Sea Lion location with mean positions within 10 nautical miles. Details of these routes are as follows:

Route No. 1 is used by an estimated 40 fishing vessels per year between Berkeley Sound and Fishing Grounds (north). This route passes the location to the southwest at a mean distance of 6.0 nautical miles.

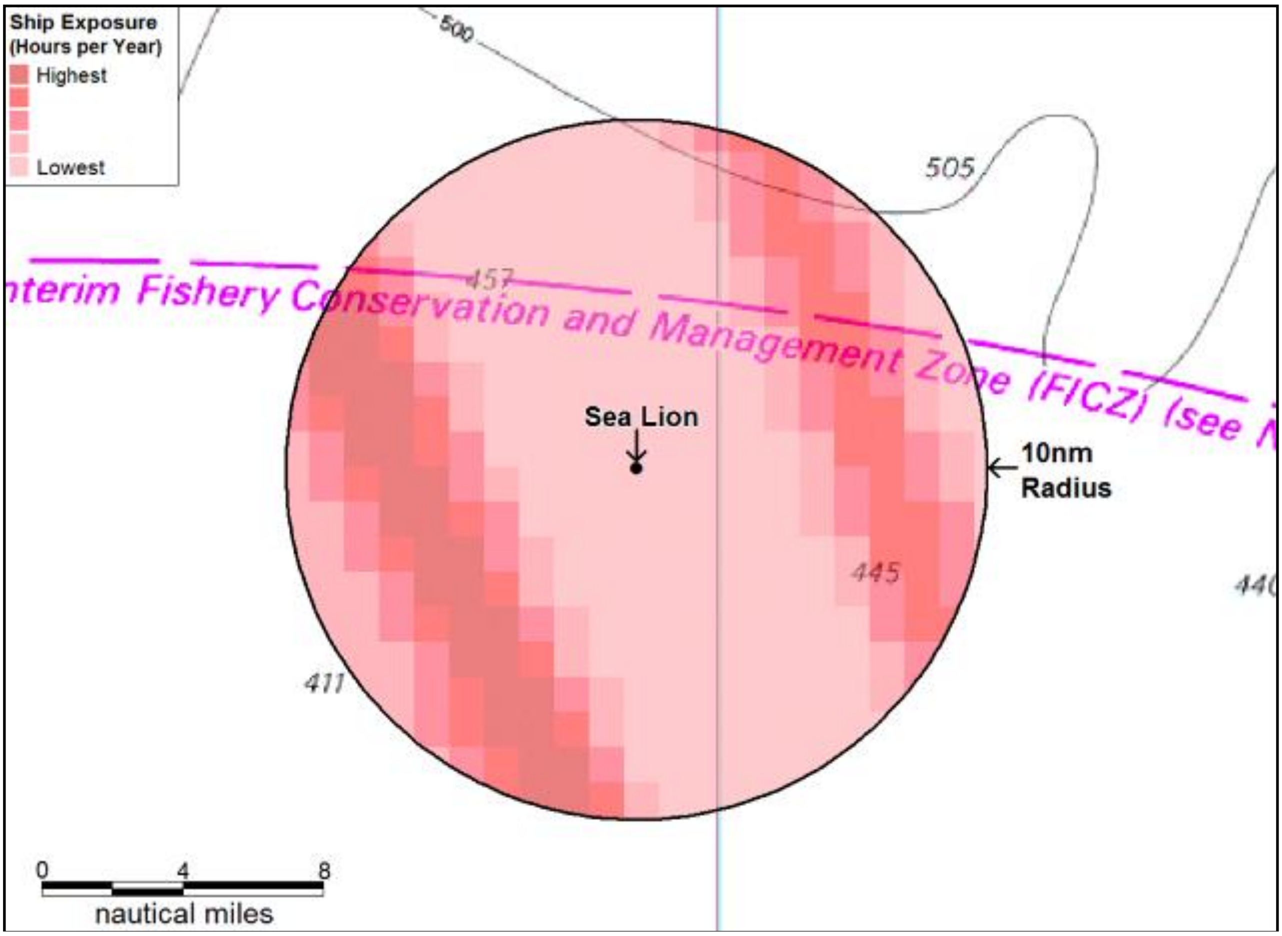
Route No. 2 is used by an estimated 30 reefers per year between Berkeley Sound and Montevideo. This route passes the location to the east at a mean distance of 6.7 nautical miles.

Route No. 3 is used by an estimated five tankers per year between West Africa and North America West Coast. This route passes the location to the northwest at a mean distance of 9.5 nautical miles.

Route No. 4 is used by an estimated 10 cruise ships per year between Berkeley Sound and Puerto Madryn. This route passes the location to the southwest at a mean distance of 9.8 nautical miles.

The majority of vessel traffic comprises fishing vessels travelling to and from fishing grounds and reefers operating between ports in the area. Over 90% of these vessels are below 5,000 tonnes dry weight, with the remaining 10% of vessel traffic exceeding 40,000 tonnes dry weight and accounting for the tankers operating on Route 3 to West Africa (Anatec, 2013).

Figure 46 illustrates the number of vessel-hours each square nautical mile surrounding the Sea Lion area is exposed to on an annual basis. These data are used to model the risk of passing ships losing power and drifting into the Sea Lion Field and takes into account vessels within a 10 nautical mile radius. The Sea Lion Field is located within an area of low exposure levels, with two bands of higher exposure passing from northwest to southeast approximately 4 nautical miles away on either side of the field.



Source: Anatec, 2013.

Figure 46: Passing Shipping Exposure Levels around the Sea Lion area

5.6.4 Military

It is important to be aware of the other users of the licence area and Sea Lion area, and whether the development and production of the field will have the potential to interact with areas used by the military for naval exercises.

There has been a substantial military presence in the Falkland Islands since 1982, which provides air, land, and sea coverage. In particular;

- A Castle Class offshore patrol vessel was based in the Falkland Islands on a full time basis (RPS Energy, 2009); however, this has recently been replaced with a River Class vessel (M. Jamieson, pers. comm.).
- A Royal Fleet Auxiliary tanker is also based permanently within the Falkland Islands (M. Jamieson, pers. comm. 2013).
- A destroyer or frigate Guardship also visits the Falkland Islands on a regular basis throughout each year.

It is possible that the military vessels residing in the Falkland Islands will enter into the Sea Lion area as there are no restrictions on their movements within the Falkland Islands waters, however it is understood that this does not happen with any frequency (M. Jamieson, pers. comm. 2013). It is also possible that the visiting Guardships may pass through or close to the Sea Lion area en route to/from the UK and the Falkland Islands (M. Jamieson, pers. comm. 2013).

The MoD has provided the military vessels, flights and helicopters that are in operation around the Falklands with maps of wildlife avoidance areas within the Falklands and the Falklands' waters. However, these areas of avoidance are all in more coastal or terrestrial areas and are primarily in place for helicopters and planes. The wildlife avoidance areas will also be in force for helicopters moving to and from oil and gas installations based further offshore.

5.6.5 Other sea users

Research vessels, such as the British Antarctic Survey (BAS) vessel the RRS *James Clark Ross* often transit through Falklands waters en route to South Georgia, Antarctica or other areas within the South Atlantic. It is possible that these vessels pass through, or close to, the Sea Lion area. Also, several yachts and pleasure craft may travel through or close to the Sea Lion area either en route to/from the Falkland Islands or other locations, such as South Georgia. However, this is difficult to ascertain given that VMS is only for Falklands registered vessels, and yachts do not have AIS (M. Jamieson, pers. comm. 2013).

6.0 Environmental Impact Assessment Methodology

6.1 Introduction

The EIA process provides a framework for assessing the environmental consequences of a project during the planning stages, such that favourable alternatives may be considered, and mitigation measures may be proposed to adjust impacts to acceptable levels prior to the decision for project sanction.

The purpose of this section is to describe the impact assessment methodology that has been used to identify potential impacts and risks resulting from the 2015 Exploration Drilling Campaign. The methodology has been prepared based on the Falkland Islands Government's Department of Mineral Resources (FIG DMR) *Field Developments Environmental Impact Statements Guidance Notes* (2012) and international best practice for EIA (IEEM 2010; Horvath (IAIA) 2013; Morris and Therivel, 2009; Glasson et al., 2013).

6.2 Environmental Impact Assessment Process

The activities associated with the proposed drilling campaign have the potential to affect the environment in a number of different ways.

Project activities can be categorised into a sequence of **planned activities** that must occur for the project to be successfully completed. During the course of any project execution there is a risk that, if project activities do not occur as planned, an **accidental event** may occur. Planned activities give rise to **environmental impacts,** and may pose a risk to the environment if unplanned or accidental events occur.

The impacts of unplanned or accidental events are evaluated by taking the likelihood of the event occurring into consideration in an **environmental risk assessment**.

The International Standard for Environmental Management (ISO 14001) defines an environmental impact as any change to the environment, whether adverse or beneficial, wholly or partially resulting from a project's environmental aspects. The project's environmental aspects are defined as project activities or outcomes that could present an environmental impact.

The evaluation of impacts follows a structured methodology (Figure 47) that systematically:

- Identifies and assesses the **environmental aspects**: planned project activities or outcomes that could present an **environmental impact**, unplanned or accidental events that could pose an **environmental risk**,
- Assesses the value or **sensitivity** (Section 6.2.1) of the environmental receptor,
- Assesses the **severity** (Section 6.2.1) of the environmental impact caused by the aspect prior to implementing mitigation measures,
- For planned activities the **significance of the impact** (Section 6.2.1) is evaluated based on the sensitivity of the receptor and the severity of the effect.
- For accidental or unplanned events the **significance of the risk** (Section 6.2.1) is evaluated based on the sensitivity of the receptor, the severity of effect and the likelihood of the unplanned or accidental event occurring,
- Assesses the degree of confidence (Section 6.2.2) in the impact or risk assessment based on the definition and certainty of project activities; understanding of the sensitivity of the receptor and nature of the impact; and the number and criticality of data gaps,
- Identifies any mitigation measures (Section 6.2.3) required to reduce the identified environmental impact,
- Evaluates the residual impact (Section 6.2.4) or risk once mitigation measures to reduce the impact have been accounted for,
- Evaluates the potential for **cumulative** or **in-combination impacts**,

- Describe the **environmental management plan** (Section 6.2.5) that will be used to systematically implement measures to manage the environmental impacts during project execution.

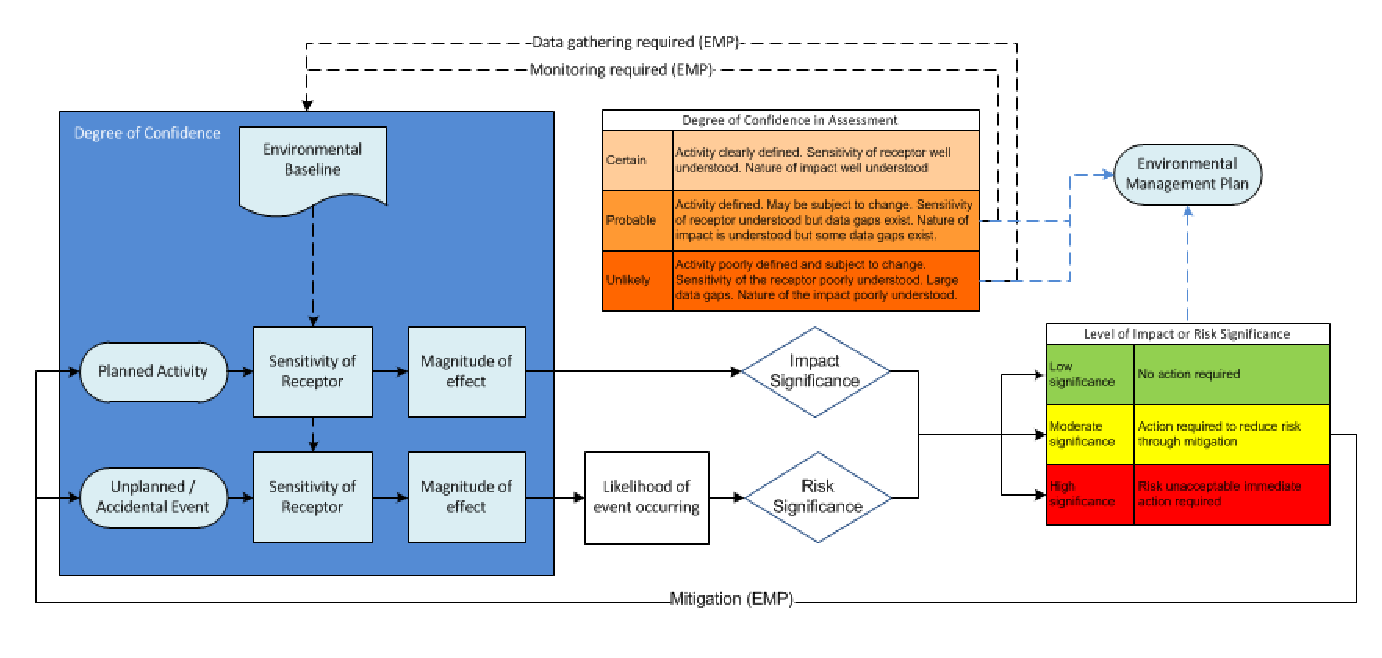


Figure 47: Overview of the Environmental Impact and Risk Evaluation Process

6.2.1 Impact and Risk Assessment Methodology

Environmental aspects were identified by systematically stepping through the different phases of the exploration drilling campaign to determine which project activities or outcomes could present an impact to the identified environmental components. The environmental components considered to be relevant to this project include:

- Air quality (local),
- Climatic factors,
- Soil (including the seabed),
- Water quality
- Benthic (animals living on or in the seabed), terrestrial ecology,
- Plankton (plant or animals which live in the water column and drift with the ocean currents),
- Fish ecology,
- Seabirds,
- Marine Mammals,
- Commercial fisheries,
- Human population,
- Landscape and seascape,
- Waste landfill resource,
- Architecture and archaeology,
- Designated sites,
- Transboundary impacts,
- In-combination and cumulative impacts,
- Stakeholder and or regulatory concern.

Planned events

The drivers for evaluating environmental or social impacts are the sensitivity of the receptor to the environmental or social impact and the severity of the effect (IEEM 2010; Morris & Therivel 2009). Sensitivity of the receptor has particular significance in the Falkland Islands, as the Falkland Islands and the surrounding waters support a diverse and important assemblage of species that live within or rely on the marine environment for survival.

The sensitivity of the receptor considers a number of factors including the relative importance of the local population size, the conservation status of the habitat or species, the seasonal migrations or abundance, and species sensitivities. Project specific definitions have been developed to describe the 'sensitivity of the receptor to the environmental aspect' (Table 29). The definitions were based on the criteria for assigning value to ecological features as described in IEEM (2010). Effects on the human population as a result of the identified environmental impacts were assessed using the descriptors in Table 30, which are based on types social impacts described in IAIA, 2003 and Morris & Therivel 2009.

The severity of the effect on the receptor considers whether the effect is positive or negative, the magnitude, spatial extent, duration, reversibility and the timing and frequency of the effect. The definitions for the 'severity of the effect on the receptor' are based on the PMO HSES Risk Management Standard and are presented in (Table 33).

The significance of an environmental impact can be assessed as:

The significance of the impact	=	The sensitivity of the receptor to the environmental aspect	x	The severity of the effect on the receptor

Each impact was evaluated and a measure of significance of the impact on the receptor determined using the impact assessment matrix in Table 33 (sensitivity vs severity). Impacts were categorised as low, medium and high significance as defined in Table 34.

Unplanned or Accidental Events

Should an unplanned or accidental event occur, it might result in unintended harm to the environment. Therefore, unplanned or accidental events that have the potential to arise from planned project activities pose a risk to the environment. A distinction is made between planned and unplanned events in the assessment methodology in recognition of the potentially high consequence but generally very low likelihood of these types of impact.

Environmental risks must be controlled throughout the project. An environmental risk assessment (ERA) process is used to identify potential unplanned or accidental events that could arise from project activities and to determine steps that could be implemented to prevent or reduce the risk of the event occurring. The environmental risk assessment (ERA) process takes into account the sensitivity of receptor (Table 29 and Table 30), severity of the effect (Table 31) and the likelihood of occurrence of an unplanned or accidental event occurring (Table 32) (Morris & Therivel 2009).

The significance of the environmental risk can be assessed as:

The significance of the risk	=	The sensitivity of the receptor to the environmental aspect	x	Severity of the effect on the receptor	x	The likelihood that an unplanned or accidental event will occur

Each risk was evaluated using the risk assessment matrix (Table 33) (sensitivity vs severity vs likelihood) to determine what level of risk the proposed activity could pose to receptors in the receiving environments. The overall significance for a particular risk was determined by taking the highest level of risk associated with the project activity against any one of the receptors/attributes. Risks were categorised as low, medium and high significance and are defined in Table 34.

Table 29: Project Specific Definitions for the Sensitivity of Environmental Receptors (adapted from IEEM, 2010)

Level	Category	Environmental Receptor Sensitivity Definition
5	Very High	Population size of international importance (1% of global population) during period of project activity. Habitat / site of international value - protected under international designation. Species IUCN status Critically Endangered. Endemic species. Large populations of animals considered under wider threat, present during period of project activity.
4	High	Population size of regional importance (1% of biogeographic population) during period of project activity. Habitat / site national value - protected under national designation. Species IUCN status Endangered. Locally distinct sub-populations of a species present during period of project activity.
3	Moderate	Population size of national importance (1% of Falkland Island population) during period of project activity. Habitat / site regional value - containing viable areas of threatened habitats. Species IUCN status Vulnerable.
2	Low	Population size of little geographical importance during period of project activity. Habitat / features which are undesignated but are considered to appreciably enrich the local habitat resource. Species IUCN status Near Threatened.
1	Very Low	Population size of no geographical importance during period of project activity. Habitat / site undesignated and of low grade and widespread nature. Species IUCN status Least Concern.

Table 30: Project Specific Definitions for the Sensitivity of Human / Social Receptors

Level	Category	Human / Social Receptor Sensitivity Definition
5	Very High	The receptor has little or no capacity to absorb change without fundamentally altering its present character. For example: • Population changes – population size, temporary and permanent; • Health and wellbeing (physical, mental, social, spiritual); • Local services - educational, health services, social support, recreation, transport, housing availability; • Lifestyles / quality of life, community stress and conflict, integration, community character, crime, culture, way of life; • Environment – air quality, water, noise, food availability etc.
4	High	The receptor has low capacity to absorb change without fundamentally altering its present character.
3	Moderate	The receptor has moderate capacity to absorb change without significantly altering its present character.
2	Low	The receptor is tolerant of change without detriment to its character.
1	Very Low	The receptor is resistant to change.

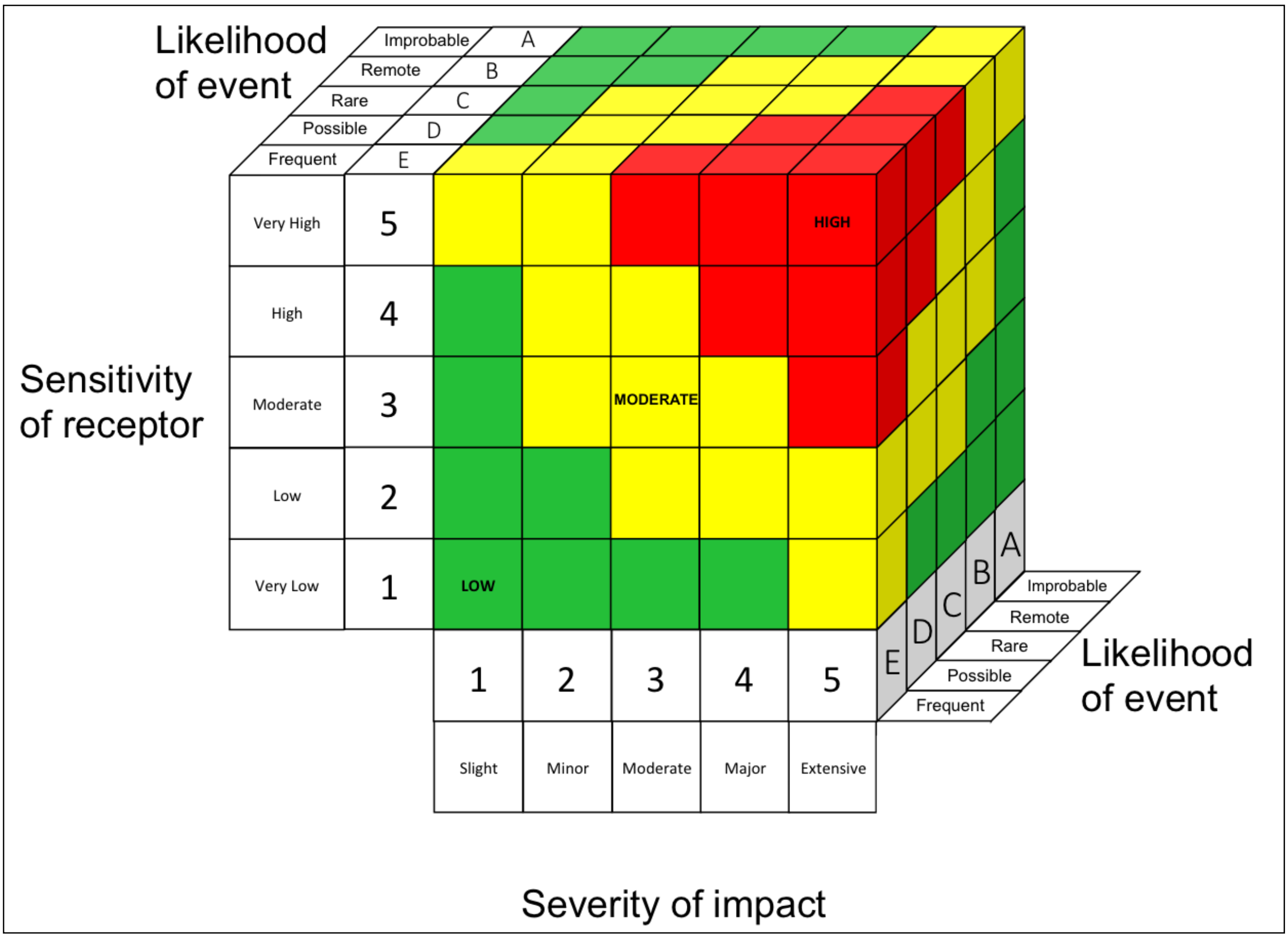
Table 31: Severity of impact (Premier Oil HSES Risk Management Standard FK-BU-HS-ST-006)

Level	Impact level	Description
1	Slight	Negligible environmental effect. No habitat / population effects. No breach of permit / non-regulatory reportable.
2	Minor	Minor, localised short-term, reversible environmental effect. Barely detectable impact on species / habitat / ecosystem. Rapid on site clean-up. Delayed regulatory notification for information.
3	Moderate	Moderate effect in small area e.g. small chronic / moderate short-term release. Temporary and rapidly reversible impact on species / habitat / ecosystem. Site / local response required. Immediate regulatory report required.
4	Major	Major effect away from facility e.g. uncontrolled spill, large gas release. Serious and long lasting (multi-year) but eventually reversible impact on species / habitat / ecosystem. Full Business Unit response required (with corporate support). Immediate and on-going regulatory reporting / interface required.
5	Extensive	Extensive effect over large (regional) area e.g. major well blow out. Permanent loss / irreversible damage to species / habitat / ecosystem. Full company corporate response. Immediate and on-going regulatory interface.

Table 32: Guidelines for assessing the likelihood of an impact event occurring (adapted from Premier Oil HSES Risk Management Standard FK-BU-HS-ST-006)

Level	Likelihood	Frequency of an unplanned or accidental event occurring and impacting receptors during the project lifetime
A	Improbable	Never heard of in the industry Virtually improbable and unrealistic
B	Remote	Heard of in the industry Not anticipated or expected, remote chance
C	Rare	Has happened in Premier Oil or >1yr in the industry Rare but may occur in the lifetime of a BU
D	Possible	Has happened >1yr in Premier Oil Occurs several times in BU lifetime – once every 10 yrs
E	Frequent	Has happened >1yr in BU Likely to occur at more than once per year

Table 33: Impact and Risk Significance matrix (adapted from Premier Oil HSES Risk Management Standard FK-BU-HS-ST-006)



* Impact is evaluated using sensitivity x severity. Risk is evaluated using sensitivity x severity x likelihood.

Table 34: Definition and Implication of Significance Categories to the Project

Significance Level	Impact Definition (planned events)	Risk Definition (accidental events)
High Significance	• Serious concerns from consultees which cannot be resolved • Non-compliance with environmental legislation and company policy ➢ Impact unacceptable: Immediate action required to reduce impact to an acceptable level.	• Substantial environmental or socio-economic risk which cannot be reduced with the resources available to the project. ➢ Risk unacceptable: Immediate action required to alter project design to reduce risk to an acceptable level.
Moderate Significance	• Concerns expressed by consultees which can be adequately resolved ➢ Impact acceptable: Identify opportunities for improvement through mitigation and controls.	• Risk-reduction measures available, which generally have a history of successful use and acceptance. • Evidence of adequate contingency planning and response capabilities for hydrocarbon spills or other emergencies. ➢ Risk should be reduced: Identify opportunities for improvement project controls.
Low Significance	• No concerns from consultees ➢ Impact acceptable: No additional actions required beyond industry standard measures and controls.	• No or negligible environmental, socio-economic or technical risks ➢ Risk acceptable: Risk-reduction measures not required, or are industry standard.
Beneficial	• Have a positive environmental or social impact. ➢ Impact acceptable	N/A

Where impacts or risks were identified as having a moderate level of significance or higher they are taken forward for a more detailed assessment, including identification of mitigation measures, evaluation of residual risk or impact, level of confidence in the assessment and potential cumulative impacts. In addition to the impact and risk assessment process, aspects were automatically taken forward for detailed assessment if they were identified as:

- being of concern by consultees,
- or identified in Falkland Islands Government *Field Development Environmental Impact Statement Guidelines* (DMR 2012).

6.2.2 Uncertainty and Confidence in Assessment

The level of confidence that can be placed on the impact significance predictions in EIA are highly dependent on the degree of uncertainty associated with the basis for the assessment, including the adequacy of available data, knowledge, and understanding about the environmental component being assessed, the proposed technology, the nature of the project-environment interaction, and the efficacy of proposed mitigation (IAIA, 2013). It is important to understand the level of confidence in the assessment so that where low to moderate levels of uncertainty exist appropriate monitoring may be determined, or in the case of significant levels of uncertainty, additional analysis may be undertaken to more fully characterize the potential risk.

The level of confidence in the impact and risk predictions (in terms of the nature of the impact and its level of significance) is evaluated in each of the following impact assessment chapters and takes into account key characteristics of the impact (e.g. magnitude, extent, reversibility, duration, frequency and sensitivity of the receptor) (IAIA, 2013). For the purposes of this EIA, the degree of confidence that the impact will occur as predicted by the assessment (e.g. project description, sensitivity of receptors and nature of the impact is well understood, without large data gaps) was evaluated using the qualitative scale: *Certain, Probable, Unlikely* (IEEM, 2010). Project specific definitions have been developed for the degree of confidence in the assessment as described inTable 35.

The limitations in the baseline data have been described in the environmental baseline description (Chapter 5.0) and the implications for the confidence in the impact predictions has been evaluated in each of the following impact assessment chapters

Table 35: Project Specific Definition of the Degree of Confidence in the Impact Assessment

Degree of Confidence	Project Specific Definition
Certain	The project activities are clearly defined and are not subject to change. The nature of the impact is well understood from previous projects in terms of the magnitude, extent, reversibility, duration and frequency of the impact. The sensitivity of the receptor is well understood and documented.
Probable	The project activities have been defined although they may be subject to change as the project progresses, a precautionary approach has been taken. The nature of the impact on the environmental receptor is understood, although data gaps exist in the monitoring data from previous projects. The status and sensitivity of the environmental receptor is largely understood although some data gaps exist. The data gaps are not considered to have the potential to significantly change the outcome of the assessment.
Unlikely	The project activities are poorly defined and are subject to change as the project progresses. The nature of the impact on the environmental receptor is poorly understood and little monitoring data exists from previous projects. The status and sensitivity of the environmental receptor is poorly understood and large data gaps exist.

6.2.3 Mitigation Measures and Monitoring

If the impacts and risks are deemed of moderate significance or above, they should be removed or reduced through design or the adoption of operational measures (mitigation). Following mitigation, there may be residual impacts that must be described. Where there are uncertainties concerning the significance of impacts or the effectiveness of proposed mitigation measures monitoring should be undertaken.

Mitigation

Mitigation measures aim to avoid, reduce, remedy or compensate for the predicted significant adverse impacts of the project (Morris & Therivel 2009, Glasson et al., 2013). These different mitigation outcomes are known as the mitigation hierarchy (Glasson et al., 2013), which focuses on the principal of prevention rather than cure and consequently options to avoid and reduce should be considered or implemented before those to remedy or compensate the impact. Mitigation measures can be classified by the level of mitigation e.g. project alternatives, physical design measures, management measures or deferred mitigation; by the mitigation hierarchy; and by different project phases. It is important that mitigation measures are designed with monitoring in mind to ensure that the effectiveness of the measures can be evaluated.

Monitoring

Opportunities for monitoring will be identified throughout the impact assessment process where measuring and recording physical variables and the occurrence and magnitude of impacts associated with the predicted exploration impacts, could improve impact understanding and / or mitigation measures. Monitoring the appropriate variables can provide an early warning system to identify harmful trends in the vicinity of the project activities before it is too late to take remedial action (Glasson et al., 2013). Additionally, where there are data gaps, monitoring could provide additional information relating to the nature of the impact. Monitoring activities will be focused on the environmental aspects that are considered to pose a moderately significant environmental impact, or those activities, which have been highlighted as a particular concern by stakeholders.

Monitoring is also essential for effective environmental impact auditing, which involves comparing the impacts predicted in the EIA with those that actually occur during the project execution phase.

6.2.4 Residual Impacts

Mitigation measures are proposed where environmental impacts and risks are assessed to pose an unacceptable risk or impact level to the receiving environment. The purpose of the measures is to reduce the impact to an acceptable level for the project to go ahead. It is therefore necessary to re-evaluate the environmental impact or risk following the application of the mitigation measure. The project activities that have been identified as posing a significant impact or risk to the environment are considered in detail in the following chapters. Where appropriate mitigation and monitoring measures are recommended an assessment of the residual environmental impact or risk following application of the mitigation measures (post-mitigation) are performed using the methodology and criteria described above. Effective mitigation measures should reduce the level of environmental impact or risk.

6.2.5 Project Environmental Management Plan

The monitoring and mitigation measures identified during the EIA process will form the basis of a Project Specific Environmental Management Plan (EMP) that will be implemented throughout the various phases of the project. The EMP sets out the actions that are needed to manage the environmental risks associated with the lifecycle of the project, identifies what is needed, when they should be implemented, the achievement criteria, and who is responsible for the delivery (IEMA, 2008).

The basis for the Premier Oil EMP is detailed in Section 14.2 and incorporates the actions identified in the preceding Sections.

6.3 Assessment of Potential Impacts

This section presents the results from the identification and scoping of environmental impacts from the proposed 2015 Exploratory Drilling Campaign. The identification of potential impacts and risks and the determination of their significance have been undertaken using the methodology outlined in Section 6.2.

An environmental impact identification workshop (ENVID) was undertaken involving specialists from a variety of disciplines. The objective of the ENVID was to identify the environmental aspects associated with the drilling campaign and their possible environmental impacts and risks, and to discuss control and mitigation measures. The activities associated with the 2015 Exploratory Drilling Campaign can be grouped into the following categories to summarise the main groups of activities:

- Rig and vessel operations (including logistical support vessels / standby tugs / supply vessel)
- Helicopter operations
- Shore based operations
- Drilling operations
- Accidental and emergency events

The project activities and unplanned or accidental events that were identified through the environmental impact and risk assessment process as requiring further consideration in the EIA are listed below:

- Generation of underwater noise (Chapter 6.0);

- Generation of atmospheric emissions (Chapter 8.0);
- Generation of light offshore, attracting seabirds and marine life (Chapter 9.0);
- Onshore and inshore impacts (Chapter 10.0);
  - Interference to other users of the sea from increased vessel traffic in Stanley Harbour;
  - Collisions between support or supply vessels and marine mammals;
  - Introduction of marine invasive species;
  - Disturbance to wildlife and local population onshore from helicopter noise;
  - Introduction of terrestrial invasive species with cargo imports;
  - Disturbance to wildlife and local residents from shore base light and noise;
  - Demands for accommodation in Stanley;
- Waste management (Chapter 11.0);
- Discharge of drilling mud and cuttings (Chapter 12.0); and
- Accidental events (Chapter 13.0)
  - Significant loss of containment from an uncontrolled release or from rig failure to maintain location on DP;
  - Loss of rig or vessel resulting from collision.

Section 14.0 provides a summary of the assessment justification for all aspects identified in the ENIVD, in particular this includes activities that were screened out from further assessment as they were determined to have low impact or risk.

Table 36: Summary of Pre-Mitigation Environmental Impact Evaluation of Activities Associated with 2015 Drilling Campaign

Lilac	Benefit
Green	Non-significant impact
Yellow	Moderate significant impact
Red	High significant impact
Blue	Subject of separate EIA

Environmental Aspect	Air quality (Local)	Climatic Factors (GHG's)	Soil (including the seabed)	Water quality	Benthic & terrestrial ecology	Plankton	Fish ecology	Seabirds	Marine mammals	Commercial fisheries	Human Population	Landscape and seascape	Waste landfill	Architecture and archaeology	Designated Sites	Transboundary impacts	Cumulative impacts	Stakeholders	Regulatory
Rig and vessel operations offshore																			
Underwater noise and vibration from DP thrusters during rig and vessel movements						Green	Green	Green	Yellow								Green		
Temporary placement of rig clump weight and transponders on the seabed			Green		Green														
Physical presence of the rig and vessels										Green								✓	
Generation of light on rig and support vessels offshore						Green	Green	Green	Green									✓	
Atmospheric emissions from power generation during rig and vessel movements	Green	Green									Green						Green		✓
Discharges of vessel drainage, firewater, sewage and galley waste from rig and vessels				Green		Green	Green	Green											
Discharge of closed drains following separation, and firewater foam to sea during system test				Green		Green	Green	Green											
Drilling Operations																			
Discharge of drill cuttings, WBM, cement and chemicals to marine environment			Green	Green	Green	Green	Green		Green										✓
Generation of atmospheric emissions during potential well test flaring	Green	Green															Green		✓
Generation of light during potential well test flaring						Green	Green	Green										✓	
Generation of non-hazardous and hazardous waste for disposal in UK/FI													Green						✓
Use of Stanley domestic water supply for preparation of drilling mud				Green														✓	
Intake of seawater to make potable water on the rig				Green		Green	Green												
Discharge of heated seawater from heating /cooling medium or Reverse Osmosis unit				Green		Green	Green												
Generation of noise and vibration during drilling, cutting casing and well plug & abandonment							Green	Green	Green										
Generation of noise and vibration during Vertical Seismic Profiling (VSP) operations						Green	Green	Green	Yellow										

Table 36 continued: Summary of Pre-Mitigation Environmental Impact Evaluation of Activities Associated with 2015 Drilling Campaign

Lilac	Benefit
Green	Non-significant impact
Yellow	Moderate significant impact
Red	High significant impact
Blue	Subject of separate EIA

Environmental Aspect	Air quality (Local)	Climatic Factors (GHG's)	Soil (including the seabed)	Water quality	Benthic & terrestrial ecology	Plankton	Fish ecology	Seabirds	Marine mammals	Commercial fisheries	Human Population	Landscape and seascape	Waste landfill	Architecture and archaeology	Designated Sites	Transboundary impacts	Cumulative impacts	Stakeholders	Regulatory
Activities Onshore and Inshore																			
Atmospheric emissions from power generation during vessel movements	Non-significant impact	Non-significant impact									Non-significant impact						Non-significant impact		✓
Physical presence of shore base and use of land resource			Non-significant impact		Non-significant impact						Non-significant impact			Non-significant impact	Non-significant impact				
Generation of light during 24hr operations								Non-significant impact			Moderate significant impact								
Generation of noise during 24hr operations								Non-significant impact			Non-significant impact								
Generation of waste for transportation to landfill in UK/FI													Non-significant impact						
Use of local electrical and water resources for operation of the shore base	Non-significant impact	Non-significant impact		Non-significant impact							Non-significant impact							✓	
Demands for temporary accommodation in Stanley											Subject of separate EIA							✓	
Physical presence of vessels interfering with other users of Stanley Harbour										Moderate significant impact	Non-significant impact							✓	
Introduction of marine invasive species from existing marine growth on rig and support vessel			Non-significant impact	Non-significant impact	Moderate significant impact														✓
Introduction of marine invasive species from rig and vessel ballast water (including Stanley Harbour)			Non-significant impact	Non-significant impact	Moderate significant impact														✓
Collision between support or supply vessel with marine mammals									Moderate significant impact										✓
Introduction of terrestrial alien species at shore base via equipment import from UK			Moderate significant impact		Moderate significant impact						Moderate significant impact								✓

Table 36 continued: Summary of Pre-Mitigation Environmental Impact Evaluation of Activities Associated with 2015 Drilling Campaign

B	Benefit
NS	Non-significant risk
M	Moderate significant risk
H	High significant
EIA	Subject of separate EIA

Environmental Aspect	Air quality (Local)	Climatic Factors (GHG's)	Soil (including the seabed)	Water quality	Benthic & terrestrial ecology	Plankton	Fish ecology	Seabirds	Marine mammals	Commercial fisheries	Human Population	Landscape and seascape	Waste landfill	Architecture and archaeology	Designated Sites	Transboundary impacts	Cumulative impacts	Stakeholders	Regulatory
Crew Presence and Transportation																			
Gaseous emissions from engine power generation for charter flight and minibus transfer	NS	NS									NS						NS		✓
Generation of noise, flight path over sensitive seabird colonies, livestock grazing areas and local communities								M			M								
Presence of oil industry workers in Stanley impacting availability of temporary/hotel accommodation											EIA								
Presence of oil industry workers in Stanley could result in antisocial behaviour by transitory workers											EIA								
Presence of oil industry could have adverse effect on Falkland Islands as a tourist destination											NS							✓	
Charter flights potentially supporting local freight options											B								
Unplanned event																			
Dropped objects			NS		NS														✓
Accidental minor spill of diesel/oil/ chemical during loading operations				NS		NS	NS	M										✓	✓
Storm water overwhelming rig deck drains resulting in discharge of contaminated water				NS		NS	NS	NS											✓
Unplanned discharge from rig open or closed drain system				NS		NS	NS	NS											✓
Accidental Events																			
Vessel collision in Stanley Harbour				NS	NS	NS	NS	NS	NS	NS								✓	✓
Emergency situation leading to significant loss of containment	NS		M	M	M	M	M	M	M	M			NS		NS	NS		✓	✓
Loss of containment of drilling mud from riser due to rig failing to maintain station			NS	NS	NS	NS	NS											✓	✓
Major rig incident resulting in loss of rig			NS	NS	NS	NS	NS	NS	NS	NS								✓	✓
Major vessel incident resulting in collision with rig or another vessel and loss of diesel inventory				NS	NS	NS	NS	M	M									✓	✓

7.0 Underwater noise

7.1 Introduction

The properties of sound in water (range and speed) are exploited by many marine animals; sound travels at approximately 1,500 m/s in water (about five times faster than in air) and low frequency sound can propagate over hundreds to thousands of kilometres. Marine animals have evolved to use sound as a means of communication, navigation and detecting prey or predators. Specifically, the toothed whales have developed sophisticated bio-sonar capabilities to feed and navigate; the large baleen whales have developed long-range communication systems using sound in reproductive and social interaction; and the pinnipeds (seals) make and listen to sounds for critical communicative functions (OSPAR, 2009a). Man-made noise in the marine environment can interfere with these processes and is recognised as having potentially serious consequences for marine animals. Despite growing awareness, this is still an area that has received little dedicated research, largely due to the difficulties of observing and measuring the impact on animals in the marine environment.

In recent years, there have been a number of comprehensive reviews written that investigate the sources of underwater noise generated by the oil and gas industry (Genesis, 2011) and the implications of anthropogenic noise on marine animals (OSPAR, 2009a; NOAA, 2013). These reviews provide much of the information that forms the basis of this impact assessment. It should be stated that currently this is an area that is poorly understood, however, it is clear that excessive exposure to anthropogenic underwater noise has the potential to cause harm to marine animals. In these cases, underwater noise should be regarded as a form of pollution. Very little is known about the long-term implications of anthropogenic noise in the marine environment and therefore a precautionary approach is required.

This chapter provides an assessment of the potential impacts of underwater noise generated during the Campaign. The assessment identifies and characterises the sources of underwater noise that will be generated during the exploratory drilling; identifies the sensitive environmental receptors within the zone of influence.

7.2 Sources of Underwater Sound during Premier Oil's 2015 Exploratory Campaign

7.2.1 Description of Sound Characteristics

The field of underwater acoustics is full of technical terminology;Table 37 provides definitions of the terms used in this Chapter.

7.2.2 Ambient Sound in the 2015 Exploratory Area

Between July 2012 and July 2013, an array of hydrophones was deployed within the region of the 2015 Campaign Area (see Hipsey et al., 2013 for full details). Along with the vocalisations of marine mammals, ambient noise both natural (for example, wind, waves and rain) and anthropogenic (shipping) were recorded. Ambient noise levels were generally consistent with a remote, deep continental shelf location in a temperate climate with occasional fishing activity but little or no regular mercantile shipping traffic.

Noise events assessed as being caused by vessel traffic were infrequent and sporadic, except during the second half of February. During this period an increased but still small number of detections were made. This corresponds broadly with the findings of the White et al. (2002), who only recorded fishing vessels in the area between February and June, and then in very small numbers.

In overall ambient noise terms, the Campaign Area was relatively quiet compared to five other locations where similar projects have been conducted elsewhere in the world (Hipsey et al., 2013).

Table 37: Definitions of terms found in the text

Term	Definition
Hz	Hertz; measurement of sound frequency (cycles per second).
TTS	Temporary Threshold Shift, A temporary, reversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range
PTS	Permanent Threshold Shift; a permanent, irreversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range
dB (re. 1µPa)	deciBel; An expression of sound pressure (Newtons m^{-2}) on a logarithmic scale, re. 1µPa indicates a reference pressure for underwater sound.
dB_{ht} (generic)	The generic (for all species) hearing threshold, the detectable sound intensity. These values are frequency specific and are expressed as an audiogram.
Source level	Refers to the level of sound measured at a nominal distance of one metre from the sound source, expressed as dB re. 1 µPa @ 1m in water.
Sound Pressure Level	Intensity of a sound at any given point, expressed in dB re. 1 µPa.
Transmission Loss	The change in signal strength as a sound wave spreads from a source. A combination of geometrical spreading and attenuation.
Perceived Sound	The sound level perceived by a receptor. Expressed as: Sound Pressure Level – dB_{ht} (generic)
Sound Exposure Level	A measure of the energy of a sound, and is therefore related to Sound Pressure Level and time (exposure)

7.2.3 Characterising the Sources of Anthropogenic Sound in the 2015 Campaign Area

The main sources of noise associated with the operations and activities during the 2015 exploration drilling campaign have been identified as:

- Coasters transiting from the UK to Stanley;
- Supply vessel transporting materials and equipment to and from the field;
- ERRV providing support to the drilling rig in the field throughout the campaign;
- Rig transit to the site and between well locations, and maintaining position during drilling operations;
- Drilling operations;
- Vertical Seismic Profiling.

Supply and Coaster vessels

Shipping is a widespread and common source of low frequency sound in the marine environment. The nature of the sounds produced depends on a vessel's; type, size, mode of propulsion, speed and a range of operational characteristics. It has been estimated that while steaming 85% of a vessel's noise is due to propeller cavitation (Barlow and Gentry, 2004). When alongside the rig, supply vessels will maintain their position with the aid of dynamic DP)thrusters. Vessels operating on DP, generate considerably more noise than when using conventional forms of propulsion (stern propellers).

Coaster vessels will transit from the UK to Stanley prior to the start of drilling operations. The rig will also be serviced by two supply vessels during the campaign, these vessels generally produce low frequency noise (<1 kHz) in the range of 136-190 dB (re. 1µPa) depending on the vessel's size and activity (Genesis, 2011). The range of frequencies produced overlap with those utilised by many marine animals, particularly baleen whales and pinnipeds (Figure 48) but also fish.

The vessels will run between Stanley and the rig on a rotational basis, on average a supply vessel will visit the rig every five-seven days.

Emergency Response and Rescue Vessel (ERRV)

An ERRV (standby or guard vessel) will be on station, in close proximity to the rig, at all times to be able to assist in the case of emergencies and maintain an exclusion zone around the rig. These vessels are often dedicated to the task and are relatively small and inactive compared with the rig supply vessels, therefore the level of sound produced is lower. However, the age and condition of a vessel will also influence frequency and intensity of sounds produced.

A ERRV will be on station, near the rig, at all times. Periodically (every 4-6 weeks), the ERRV will steam to Stanley to bunker fuel, take on stores and change crew members. At these times, one of the supply vessels will replace the ERRV on standby.

Rig positioning

The drilling operations will be conducted from the *Eirik Raude*, a semi-submersible drilling rig, which is supported by pontoons that are partially submerged in the water. The rig will be held on station by DP thrusters and will not be anchored to the seabed.

There are few published data to indicate the intensity of sound produced by semi-submersible rigs under varying conditions. One of the few documented examples is presented in Nedwell and Edwards (2004), who took measurements of the semi-submersible drilling rig, *Jack Bates*, in deep water northwest of the Shetland when the rig was drilling and on location. During both drilling and non-drilling periods there was a peak noise level at about 10 Hz with other low frequency tonal signals being detected in the range 10 - 600 Hz. It was found that the use of DP thrusters, and the associated cavitation noise, caused a significant elevation of the low frequency sounds from 3 - 30 Hz by about 30 dB (Table 38).

There was significant variation in the broadband noise during non-drilling periods this was attributed to the operation of specific types of machinery.

The drilling schedule is outlined in Chapter 3.0 In summary, each well will take approximately 30 days to complete, (20 drilling days). Throughout this time, the rig will be maintained on station by DP thrusters. Drilling of Premier Oil's four wells is currently expected to take place from March to June and during October and November (the rig will operate elsewhere between July and early October). The *Eirik Raude* is self-propelled and will transit between wells under its own power.

Drilling operations

Underwater sound is generated from drilling rigs through the transmission of vibrations from machinery and drilling equipment (such as; pumps, compressors and generators) that are operating on the rig. Additionally, the action of the drill on the substrate creates additional vibration and sound, which is dependent on the substrate type.

The few published examples indicate that drilling will increase the sound source pressure level. For example, sound from the semi-submersible rig *Ocean General* in the Timor Sea was measured during periods when the rig was drilling and not drilling (McCauley, 1998; reviewed in Genesis 2011). During non-drilling periods the typical broadband level encountered was ~113 dB re 1μPa@125m with various tones from the machinery observable in the noise spectra. During drilling periods the broadband noise level increased to the order of 117 dB re1μPa@125m. An approximate 4 dB increase at 125 m would equate to an approximate increase of 42 dB in Source Level. The frequency of sound generated by semi-submersible rigs is primarily in the range of 10 – 500 Hz.

Vertical Seismic Profile (VSP)

Underwater sound is generated during a VSP by the release of high-pressure air from devices called airguns. The air forms an expanding bubble, the rapid expansion of this bubble generates the seismic wavefront.

An array of 3-4 airguns (totalling less than 1,000 cubic inches in volume) will be used during VSP operations. The peak in sound pressure generated is likely to be in the region of 240 dB (re. 1μPa), focused between 10–150 Hz but also includes a higher frequency component. The survey consists of a number of shot points, approximately 15 m apart. At each point, a series of 3-5 shots are made before the geophones are relocated to the next spot point. It takes about 15 minutes to complete each shot point; take the shots, record the data and move onto the next point. It is estimated that this procedure will take 12-15 hours on each well. VSP airguns will only be in operation for a total period of 48-60 hours over all four wells (1.6-2.5% of the Campaign). This procedure is standard working practice within the oil and gas industry around the world.

Genesis (2011) present recorded sound pressure levels from a range of different sized airguns. The sound intensity is related to the volume of the airgun, array configuration and air pressure.

Well abandonment

Exploratory wells are usually abandoned once the quality and quantity of any hydrocarbons found has been evaluated, or drilling is complete. There is currently no intention to flow or suspend the wells for future use. At the end of the drilling operations, it is therefore intended that the wellhead will be severed and sealed. This will entail the cutting of the well casing approximately three metres below the seabed. The cutting process will introduce another source of anthropogenic sound into the marine environment, however, this is anticipated to be a low intensity sound source and the operation should only take 20 minutes for each well (for all four wells this will be equivalent to less than 0.05% of the total Campaign).

Table 38 gives representative examples of the sound sources generated by the type of activity proposed during the Campaign. Where appropriate, a range of values are given to reflect values cited in the literature, (see Genesis, (2011) and OSPAR, (2009a) for further examples).

Table 38: Characterisation of anthropogenic sounds associated with the 2015 Exploratory Campaign

Sound source	Source sound pressure level (dB re 1µPa)	Range of highest sound pressure (Hz)	Total Bandwidth of source sound (Hz)	Duration (ms)	Directionality	Source
Supply vessel steaming	164	<1,000	6->30,000	Continuous	Omnidirectional	Genesis 2011
Supply vessel on DP	184-190	<1,000	6->30,000	Continuous	Omnidirectional	Genesis 2011
ERRV	136-180	<1,000	6->30,000	Continuous	Omnidirectional	Genesis 2011
Rig on DP, not drilling	160	<100	10-10,000	Continuous	Omnidirectional	Nedwell and Edwards 2004
Rig on DP, drilling	188	<100	10-10,000	Continuous	Omnidirectional	Nedwell and Edwards 2004
VSP	230-240	10-120	10-100,000	30-60	Vertically focused	Genesis 2011

7.3 Environmental Receptors in the Exploration Campaign Area

Marine mammals (cetaceans and pinnipeds) are generally considered to be of the greatest conservation concern in relation to underwater noise pollution, as they are protected species that are known to use sound to communicate over large distances, navigate and detect potential prey or predators.

There has been some research into the impacts of noise directed at marine fish and cephalopods. Most of the fish species studied are able to emit and detect sounds that are less than 1 kHz. Some cephalopods are known to be sensitive to infrasound (<20 Hz) with an upper hearing limit of 200 Hz (OSPAR, 2009a). These ranges fall within the scope of anthropogenic sounds produced during oil and gas related activities. Several studies have been undertaken to consider any potential effects of seismic surveys on marine fish species, and the results show that harm to individual fish and increased mortality from firing airguns can occur at distances up to 5 m, with most frequent and serious damages up to 1.5 m. Fish in the early stages of life are most vulnerable (OSPAR, 2009a). However, so far only a few fish and cephalopod species (and sometimes only a few individuals of these species) have been investigated. Consequently, our knowledge in this field is still very limited. However, in comparision to the impact of fisheries on fish and cephalopod species in Falklands waters, the impact of sound during the 2015 drilling campaign is considered to be negligible.

Although there is also limited information regarding the effect of anthropogenic sound on marine mammals, their protected status and known presence in the Drilling Campaign Area mean that a thorough assessment of the potential impact on these animals is required. For these reasons, the following impact assessment will focus on marine mammal species.

7.3.1 Marine Mammals in the 2015 Exploratory Campaign Area

At least 14 species of cetacean and at least three species of pinniped were recorded by White et al. (2002) within Falkland Islands waters. An additional 12 species of cetacean (mostly species of beaked whale) are known from stranding's and rare sightings within Falklands waters (Otley et al., 2011, Falklands Conservation, 2013). Marine mammal observations from seismic vessels in early 2011 (Geomotive and MRAG, 2011; Polarcus, 2011) add to and confirm earlier at-sea observations. In order to improve the knowledge of cetacean distribution and abundance in the vicinity of Premier Oil's 2015 Campaign wells, an array of hydrophones were deployed in the area between July 2012 and July 2013 (Hipsey et al., 2013). Combined, these sources provide a good indication of the seasonal abundance of marine mammal species in the region (see Biological Description chapter).

In the Falkland Islands, all marine mammals are protected by law under the Marine Mammal Act 1992 and internationally under the Convention on Migratory Species. Fin and sei whales, two regularly observed species in the Drilling Campaign Area, are both classified as Endangered by the IUCN (Reilly et al., 2008; Reilly et al., 2013). Although much of the campaign will coincide with the period with lowest marine mammal abundance in Falklands waters (the austral winter), some species, particularly long-finned pilot whale and fur seals, are most numerous at this time. Additionally, the campaign will start in March, when sei and fin whales may still be present, and continue into the austral spring, when several species of cetacean return to Falkland Islands waters (Section 5.4.6).

7.3.2 The Hearing Thresholds of Marine Mammals

Cetaceans are known to emit sounds over a large range of frequencies from 10 Hz in the blue whale to 200 kHz in some dolphins (OSPAR, 2009a). However, the hearing range of species is likely to extend beyond the emitted sound range. Different species of marine mammal are sensitive to different ranges of frequencies (graphical descriptions of a species' range are shown in Figure 48). Therefore, the range of frequencies utilised by an assemblage of marine mammal species can be very extensive. The auditory range of species can only be determined through field observations, which are extremely difficult in the marine environment. Consequently, the full range of vocalisations used by many species encountered in the south west Atlantic are poorly understood (Hipsey et al., 2013).

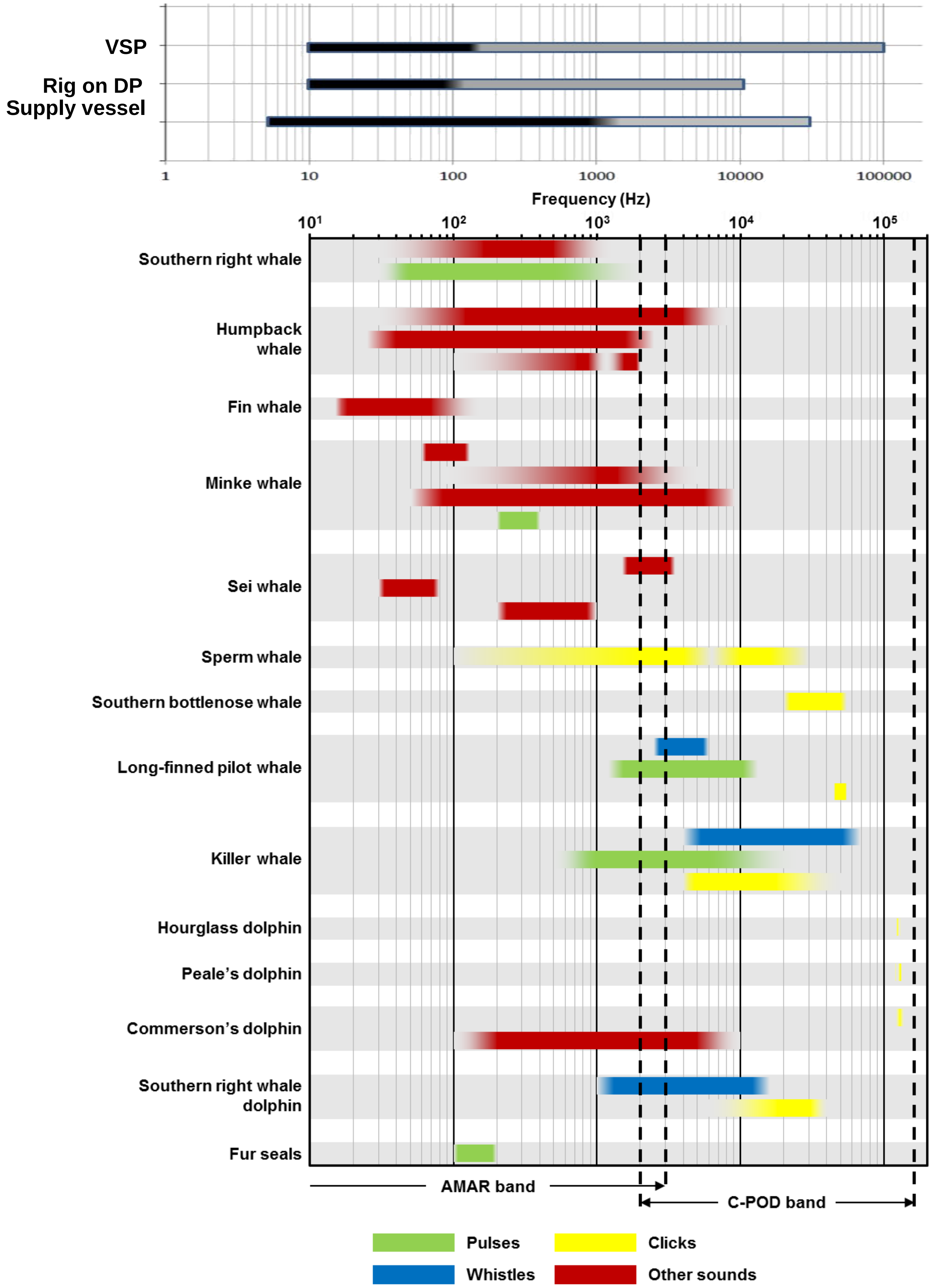


Figure 48: Frequency bands of species' vocalisations with AMARs and C-POD click operating bands (from Hipsey et al., 2013) and anthropogenic sounds associated with the 2015 Exploratory Campaign

Figure 48 also shows the range of frequencies emitted by anthropogenic activities. Although these sounds may cover a wide range of frequencies, peak sound pressure (loudness) occurs over specific parts of the frequency scale (usually in the region of 100 Hz). These sounds overlap with those utilised by baleen whales and pinnipeds, such as fur seals, and to a lesser extent with toothed whales, which use higher frequencies. In order to help classify marine mammals according to the frequency ranges that they employ, the National Oceanic and Atmospheric Administration (NOAA, 2013) have proposed five functional hearing groups (Table 39).

Table 39: Marine mammal functional hearing groups (from NOAA, 2013)

Functional Hearing Group	Functional Hearing Range*	Range of highest sensitivity
Low-frequency cetaceans (baleen whales)	7 Hz to 30 kHz	500 Hz to 1 kHz
Mid-frequency cetaceans (dolphins, toothed, beaked and bottlenose whales)	150 Hz to 160 kHz	20 kHz to 40 kHz
High-frequency cetaceans (true porpoise, Commerson's, hourglass and Peale's dolphin)	200 Hz to 180 kHz	30 kHz to 40 kHz
Phocid pinnipeds (true seals)	75 Hz to 100 kHz	500 Hz to 20 kHz
Otariid pinnipeds (sea lions and fur seals)	100 Hz to 40 kHz	500 Hz to 6 kHz

*Represents frequency band of hearing for entire group as a composite, individual hearing ranges are typically not as broad.

7.3.3 Sensitivity of Marine Mammals to Anthropogenic Sounds

There are a number of potential effects of underwater noise on marine mammals, they can broadly be classified as; masking, behavioural disturbance, hearing loss, discomfort/stress, tissue trauma and, in extreme cases, death. The strength of the effect depends on the intensity of the sound experienced by the receptor, which is related to the sound source intensity, distance of the receptor from the sound source, sound frequency and length of exposure. If a sound source is sufficiently powerful to impact on marine mammals the distance between the source and the receptor is a key factor.

Masking

Masking occurs when anthropogenic sounds impair the ability of marine mammals to detect biologically significant sounds, such as communication calls, echo-location clicks or passive environmental sounds used in navigation or prey detection.

Behavioural disturbance

Behavioural disturbance is usually detected by changes in activity due to sound, these can range from strong avoidance behaviour to subtle changes in vocalisations. The degree of behavioural change is very difficult to measure in the field and is likely to differ between and within individuals, depending on motivational state. For example, animals that are engaged in feeding may be more reluctant to change behaviour, move away from a food source, when subjected to noise.

Hearing loss

In more extreme cases, underwater noise may result in hearing loss, which could have severe consequences for animals, through impaired communication, navigation and abilities to detect prey and predators. Hearing loss is likely to be over a specific range of frequencies and can be classified as either; TTS (Temporary Threshold Shift) or PTS (Permanent Threshold Shift). Recovery from TTS can occur over a relatively short period, hours or days, PTS results in tissue or structural damage and is permanent. Attempts have been made to set threshold values for TTS and PTS in different species (see below). It is likely that behavioural changes will occur at thresholds below the TTS.

Discomfort / stress

There is limited information regarding stress in marine mammals, it is very difficult to measure. However, Rosalind et al. (2012) have recently published results that correlate changes in stress related hormones with changes in the density of shipping traffic. The long-term impacts of noise induced stress are unknown.

Tissue damage

Like many areas of marine mammal science, research on the non-auditory effects of sound on marine mammals is in its infancy (OSPAR, 2012). However, there is evidence of damage to non-auditory swim-bladder and muscle tissue in fish and enhanced gas bubble growth and traumatic brain injury in fish and marine mammals (see Richardson et al., 1995; Hastings and Popper, 2005 for review). It has been proposed that avoidance behaviour, induced by anthropogenic sound, may cause some deep diving species (such as beaked whales) to surface rapidly or remain on the surface for extended periods. This can induce a condition similar to the decompression sickness and has been proposed as a potential cause of stranding in these animals (Crum & Mao, 1996 in OSPAR, 2009a).

7.4 Characterising and Quantifying the impact of underwater sound on marine animals

By comparing the auditory range of each species with the range of anthropogenic sounds generated during the exploratory campaign (Table 38), it is possible to identify the species that are potentially at risk of disturbance (see Table 39 and Figure 48). The anthropogenic sounds that will be generated during the campaign are of low frequency (most anthropogenic sounds in the marine environment peak at around 100 Hz; OSPAR, 2009a; Hipsey et al., 2013) and overlap with the auditory range of low-frequency cetaceans (baleen whales) and pinnipeds, therefore these species are most likely to be impacted.

Impact assessments are generally concerned with those man-made activities that overlap in frequencies with the hearing range of marine organisms in question. An exception has to be made for very loud sounds. In these cases, the peak sound pressure is decisive and the frequency becomes less relevant. The source sound pressure level of a VSP airgun falls into this category.

Using a precautionary approach, worst-case scenario, with the data available, it is possible to broadly assess whether an impact is likely to occur from the proposed activities.

Within their auditory range, each species of marine animal shows different sensitivity to different sound frequencies. A species' sensitivity to each sound frequency can be determined through experimentation and plotted as an audiogram. The hearing sensitivity of very few individuals of few species, of marine animals, has been measured and therefore it is not possible to assign an audiogram to any of the species that are likely to be present in the NFB. For instance, to date there are no audiograms for baleen whales. Comparative studies on humans indicate that there is considerable variation in the hearing sensitivity of individuals and it is likely that the same applies to marine animals (David, 2011). With these considerations in mind and taking a precautionary approach, it is possible to take all of the available data to produce a generic audiogram (as described by David (2011)). This approach uses the minimum hearing sensitivities of a range of marine species and also takes into account ambient environmental noise levels (Figure 49).

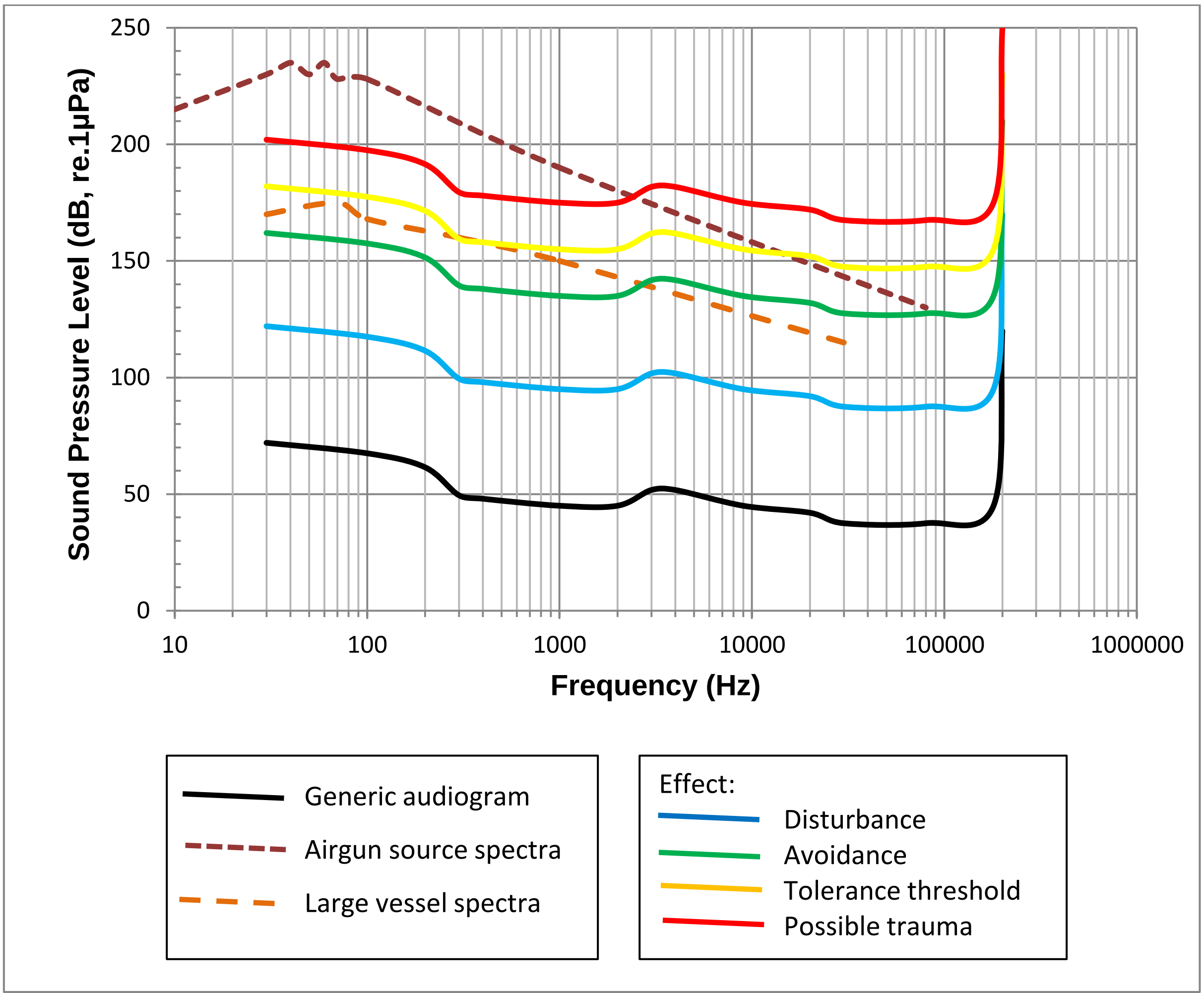


Figure 49: A generic audiogram for marine animals (adapted from David 2011) indicating increasing sound effect levels (from Nedwell et al., 2007), and anthropogenic sound pressure levels at source.

The intensity of a perceived sound by a particular species (known as dB_{ht}(*Species*)) is a function of the emitted sound level (dB, re.1µPa) and the species' hearing threshold at that particular frequency (perceived sound is the intensity above the hearing threshold). For example, in Figure 49 the generic hearing threshold at 100 Hz is approximately 70 dB, therefore an animal exposed to a sound with frequency of 100 Hz and intensity of 120 dB, re.1µPa will effectively be exposed to a perceived sound intensity of 50 dB_{ht} (*generic*). Any sound that falls below the dB_{ht}(*generic*) line on the generic audiogram will not be heard, sounds above the line will be perceived as increasingly louder noise.

Nedwell et al. (2007) reviewed the available literature and defined broad categories describing the response of individuals to different sound levels, which are described in Table 40 and illustrated on Figure 49. The recorded source sound profiles for airguns, used in VSP operations, and large vessels are also illustrated on Figure 49 to give an indication whether the sound levels associated with the 2015 Exploratory Campaign will elicit behavioural responses or exceed the limits of tolerance and possible trauma for the animals present.

The generic audiogram and source sound pressure levels indicate that if a marine mammal were adjacent to the airgun when it was fired it would be likely to experience traumatic hearing damage, as the peak sound pressure level for the airgun exceeds the 'Trauma' threshold. Similarly the presence of vessel sound is also likely to result in avoidance behaviour. However, these examples illustrated in Figure 49 do not account for the distance that a marine mammal may be from the source sound, the attenuation of sound with distance from source is described in Section 7.4.

Table 40: Behavioural and Physiological Response by Marine Mammals to Increasing Perceived Sound Levels, suggested by Nedwell et al. (2007)

Perceived Sound Level (dB_{ht} (*Species*))	Behavioural and Physiological Effect
Less than 0	None; sound imperceptible
0 to 50	Mild reaction in minority of individuals, probably not sustained
50 to 90	Stronger reaction by majority of individuals, but habituation may limit effect
90 and above	Strong avoidance reaction by virtually all individuals
Above 110	Tolerance limit of sound; unbearably loud
Above 130	Possibility of traumatic hearing damage from single event

7.4.1 Methodology to Estimate the Perceived Sound Level with Distance from Source

In order to provide an objective and high-level quantitative assessment of the degree of environmental effect, it is necessary to estimate the sound level as a function of distance. The propagation of sound in water is complicated by a number of factors. The sound from a source can travel through the water both directly and by means of multiple bounces between the surface and seabed. Sound may also travel sideways through the rocks of the seabed, re-emerging back into the water at a distance. Refraction and absorption (influenced by salinity, temperature and pressure) further distort the impulse, leading to a complex sound wave arriving at a distant point, which may bear little resemblance to the sound wave in the vicinity of the source.

Accurately predicting the level of sound at a point away from a source is therefore extremely difficult, and use is generally made of simple models or empirical data, based on measurements, for its estimation. Here we follow the procedure outlined in OSPAR (2009a) for calculating transmission loss and therefore Sound Pressure Level at the receptor:

Sound Pressure Level at receptor = Source pressure Level – Transmission Loss

Where:

- the Source Level, is the pressure level of sound generated by the source, and
- the Transmission Loss, is the rate at which sound from the source is attenuated as it propagates.

Transmission Loss is estimated by the equation:

$$\text{Transmission Loss} = N_{log}(r) - \alpha r$$

Where:

N = a coefficient relating to geometrical spreading (20 assuming spherical spreading OSPAR, 2009a)
r = range in metres
α = absorption coefficient, which is frequency dependant.

For low frequency sounds (<1,000Hz), such as those predicted during the exploration drilling campaign, the absorption coefficient is negligible at ranges less than 10 km and will be therefore treated as 0 here (OSPAR, 2009a).

Obtaining accurate measures of the anthropogenic sound sources under investigation is not straight forward. There are relatively few published records of the sounds generated by semi-submersible rigs and supply vessels in different operational modes (see Genesis, 2011 for review).

The data presented here was selected to be generally representative of the types of vessel and rig operating during the campaign (Table 38).

There is a little more information available regarding the source pressure levels of airguns, where the size (ranging between 20 - 800 cubic inches for single airguns) and air pressure (generally 2,000 - 2,500 psi) influences the source sound. Additionally, airguns are directional, most of the energy is focused vertically downwards, although there is also some horizontal spreading of higher frequencies. Therefore, it is very difficult to model the potential impact with a high degree of certainty. To reflect this, this assessment uses the precautionary principle throughout, which should result in a degree of built in safety.

It should be noted that, due to the logarithmic decibel scale the cumulative sound pressure level of more than one source at the same location is not simply the sum of the two sources (for example, two vessels emitting sound at the same sound pressure level will result in a combined sound level that is 6 dB above the individual sources). If the difference between two sound sources is more than 20 dB, the stronger source dominates and the weaker source does not increase the overall sound pressure (Erbe, 2011).

Exposure Duration

The categories of behavioural and physiological responses developed by Nedwell et al. (2007) for marine mammal exposure to increasing sound pressure level must also be considered in relation to the duration of time that the animal is exposed to such sound levels. Nedwell et al. (2007) suggests marine mammals have a maximum tolerable exposure time to sounds exceeding 90 dB_{ht}(*Species*), beyond this time duration the animal is likely to experience hearing loss. Sound exposure over time follows the 'equal energy rule', whereby an increase in sound level leads to a decrease in the tolerable exposure time. Nedwell et al. (2007) suggest that hearing loss may occur when animals are exposed to sounds greater than 90 dB_{ht} (*Species*) for a period of eight hours, above 130 dB_{ht} (*Species*) traumatic injury could occur regardless of exposure time. Figure 50 indicates the exposure time at different sound exposure levels (above dB_{ht}(*Species*)) that would induce TTS (from Nedwell et al., 2007).

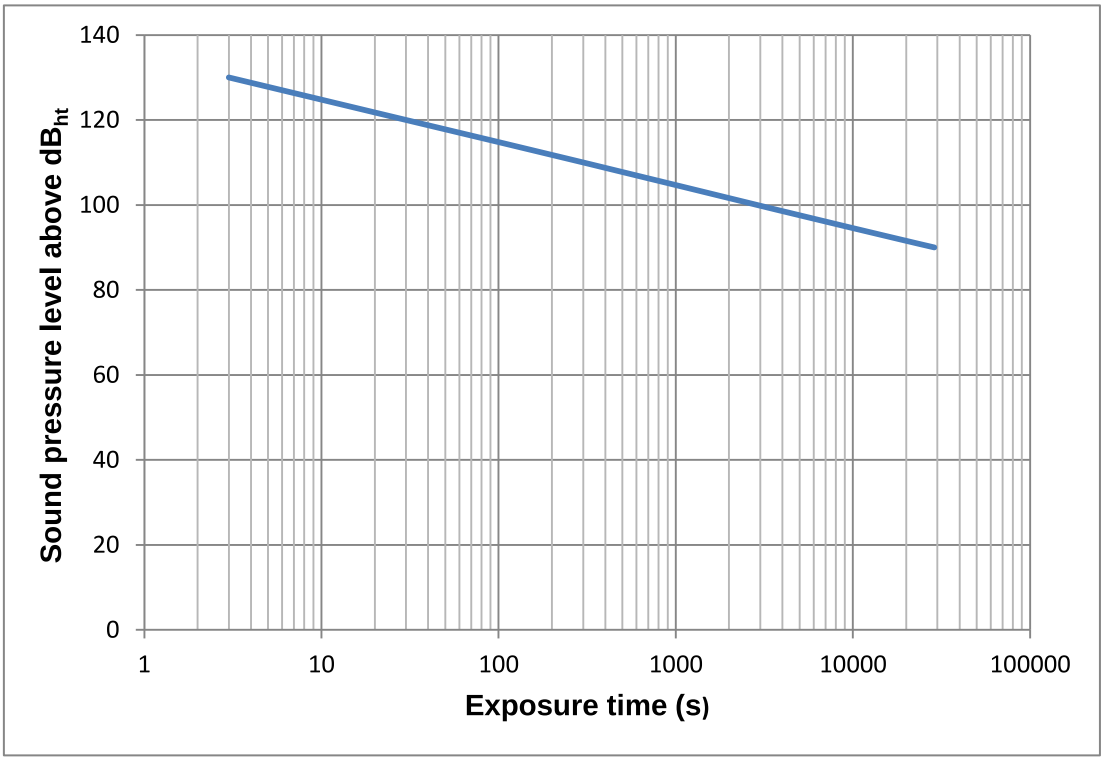


Figure 50: Comparison of sound pressure level and duration for the same cumulative noise dose (from Nedwell et al., 2007)

It is assumed that marine mammals exposed to sound levels that elicit an avoidance response will move away from the sound source, effectively reducing the sound level experienced by the receptor. At times, the response of the receptor may also be influenced by other factors such as feeding or social behaviour and may be more reluctant to change behaviour, for example move away from a food source, when subjected to noise. In some cases, an individual subjected to high sound pressure levels may not be able to move to an area of lower sound pressure quickly enough to avoid a high sound exposure.

7.4.2 Predicted Impacts of Anthropogenic Sounds Generated during the 2015 Exploration Campaign

The perceived sound pressure levels for the activities identified as generating underwater noise during the 2015 Exploration Drilling Campaign have been calculated using the methodology described in Section 7.4. The calculated perceived sound pressure levels at various distances, ranging from 1 to 5,000 m, from the source are shown in Table 41.

The calculations of perceived sound levels in Table 41 are based on the peak source sound pressure level for each activity, as the worst-case.

Where the perceived sound levels exceed the thresholds for disturbance, avoidance behaviour, tolerance limit of sound and the threshold for hearing damage (based on the generic audiogram for marine animals (David, 2011; Figure 49, indicating a dB_{ht} of 67.5 dB re.1μPa at 100 Hz)), cells have been highlighted blue, green, yellow or red respectively. It is clear that most sources of sound will stimulate a reaction at close range but it is only the VSP that has the potential to induce threshold shifts and potentially auditory damage.

Note that the VSP is directed vertically downwards and therefore distances of 500 m and above are not applicable as maximum water depth in the area is 450 m. The degree of horizontal transmission from the VSP is not known but animals in the immediate vicinity of the airgun are probably at risk.

Here we assume that the prolonged exposure to sound levels greater than 90 dB_{ht}(*Species*) could result in auditory damage. The results presented in Table 41 indicate that a marine mammal would need to spend a period of eight hours within 50 m of the loudest source of continuous noise (Supply vessel on DP) before exceeding the cumulative noise dose described by Figure 50. Although the noise generated by the VSP is louder the sound is delivered in pulses lasting 30-60 ms. Therefore, a marine mammal, exposed to perceived sound levels less than 130 dB_{ht}(*Species*), would have to experience multiple exposures to surpass the cumulative noise dose indicated in Figure 50.

Table 41: The sound pressure levels (dB re.1μPa) at a range of distances from the source and the perceived sound pressure (assuming a dB_{ht} (generic) at 100 Hz of 67.5 dB re.1μPa).

	Sound Pressure Level (dB re.1μPa) at increasing distance from source (m)											
Activity	**Source**	**10 m**	**20 m**	**30 m**	**40 m**	**50 m**	**100 m**	**200 m**	**300 m**	**500 m**	**1000 m**	**5000 m**
Supply vessel steaming	164	144	138	134.5	132	130	124	118	114.5	110	104	90
Supply vessel on DP (low)	184	164	158	154.5	152	150	144	138	134.5	130	124	110
Supply vessel on DP (high)	190	170	164	160.5	158	156	150	144	140.5	136	130	116
ERRV (low)	136	116	110	106.5	104	102	96	90	86.5	82	76	62
ERRV (high)	180	160	154	150.5	148	146	140	134	130.5	126	120	106
Rig, not drilling no DP	160	140	134	130.5	128	126	120	114	110.5	106	100	86
Rig, drilling on DP	188	168	162	158.5	156	154	148	142	138.5	134	128	114
VSP (low)	230	210	204	200.5	198	196	190	184	180.5	N/A	N/A	N/A
VSP (high)	240	220	214	210.5	208	206	200	194	190.5	N/A	N/A	N/A

Disturbance
Avoidance behaviour
Above tolerance threshold
Potential hearing damage

Although the methodology used here is precautionary and relies on many assumptions, the predicted impacts broadly agree with assessments made by other authors, as summarised in Table 42 (Southall et al., 2007; OSPAR, 2009a). Southall et al. (2007) suggest a peak pressure of 230 dB (0-peak, re: 1 μPa) for cetaceans and 235 dB (0-peak, re: 1 μPa) for pinnipeds would be required to cause TTS, which is higher than the precautionary limit used here.

Table 42: The potential for oil and gas activity to have adverse impacts on marine mammals

	Activity	Southall Exposure Criteria (2007)				EU Task Group indicator thresholds (OSPAR, 2009a)
		Injury PTS cetaceans	Injury PTS pinnipeds	TTS cetaceans	TTS pinnipeds	
Airguns (single shot)	Single airgun 40 cubic inches	N	N	N	N	N
	Single airgun 100 cubic inches	N	Y	Y	Y	Y
	Array 280 cubic inches and above	Y	Y	Y	Y	Y
Drilling and production	Semi-submersible	N	N	N	N	N
	Platforms	N	N	N	N	N
	Drillships	N	N	N	N	N
Shipping	Cargo ship 25,550 tonnes (on passage)	N	N	N	N	N/A
	Tug (on passage)	N	N	N	N	
	Anchor handling vessel	N	N	N	N	

N = No adverse impact

Y = Potential for adverse impact

7.5 Impact Assessment Summary

Premier Oil's 2015 Exploratory Campaign will introduce a number of sources of underwater sound into the marine environment. A summary of the impact assessment of underwater sound on marine animals is shown in Table 43, page 209.

7.5.1 Severity and Receptor Sensitivity

Rig and vessel engine noise

Operations during the 2015 Campaign will add considerably to the ambient noise levels in an area that normally experiences little anthropogenic sound. These activities produce predominantly low frequency (<1,000 Hz) continuous sounds that are less than 190 dB re.1μPa at source. Sound of this intensity could induce avoidance behaviour of marine animals at close range (<50 m), and disturbance over several hundred metres range, hence impacts would be predominantly localised in their effects and this impact would be extremely short-lived, as the distance between the source and animal will increase rapidly. A small increase in vessel noise to animals that are already subject to, and possibly accustomed to, vessel noise may disrupt feeding and cause short-term stress, however, these impacts are very hard to measure. It is expected that any negative impact would be readily reversible once the campaign has been completed (as found by Rosalind et al., 2012), therefore, it is considered unlikely that this would have any long-term negative impact. The Campaign will be conducted over a short period of time (approximately 120 days in total) during the months when the densities of potential receptors are relatively low. Therefore, the severity of this impact has been assessed as **'Minor'**.

Within the Falklands, all marine mammals are protected under the Marine Mammals Ordinance 1992. Additionally, some of the species at potential risk are classified as Endangered under IUCN guidelines. Therefore, under the definition outlined in Chapter 6.0, the sensitivity of the receptors is assessed to be **'High'**.

VSP airguns

The sound source of greatest concern during the Campaign is the impact of high intensity, low frequency (10-150 Hz) pulsed sounds of VSP airguns. The source pressure of these devices is in the region of 230-240 dB re.1µPa, which is above the limit of tolerance and possible trauma used in this analysis. The results of this analysis indicate that marine mammals within 100 m of the airgun could experience hearing loss. Although in terms of the NFB this is an extremely localised area and the time when potential impact from VSP can occur will be short-lived, as the airguns will only be in operation for 12-15 hours on each well, the severity of the impact has been assessed as **'Moderate'**.

A large number of marine mammal species are at potential risk, particularly at the start and end of the Campaign, when numbers of low frequency cetacean species such as fin, sei and southern right whales are still relatively high. Hipsey et al. (2013) recorded seven times lower fin whale activity in the area between April and July than during the summer months (December to March). Approximately half of the Campaign coincides with the period of lowest marine mammal abundance in the area. However, there are some exceptions, Hipsey et al. (2013) frequently recorded sperm whales throughout the year and long-finned pilot whales were most numerous between April and August. Visual surveys have encountered more fur seals in the exploratory area during the winter months than at other times of the year (White et al., 2002). Despite the potential for presence of sensitive receptors in close proximity to the rig, previous surveys have only recorded low numbers of marine mammals in the austral winter months. As a worse-case scenario, it is assumed that the Endangered fin whale, known to be in the area year-round (Hipsey et al., 2013), and sei whales, known to be seasonally abundant (Geomotive and MRAG, 2011; Polarcus, 2011), are the receptor species. Therefore the sensitivity of the receptors is assessed as **'High'**.

7.5.2 Significance

The significance of the disturbance created by the loudest mechanical sounds (engine and DP noise), produced by the rig and vessels has been assessed as **'Moderate'**. However, the static nature of the rig and relatively slow movement of the vessels means that animals are not subjected to sudden bursts of noise. As the vessels or animals move through the water the sound intensity will increase, or decrease, gradually. The behaviour of the animals is a form or self-regulation. Nonetheless, animals will alter their behaviour to avoid vessels and the long-term implications of stress due to underwater noise are not known, it is currently not possible to mitigate further.

The most significant source of potential impact from underwater noise is VSP, which is assessed as **'Moderate'**. The pulsed nature of airguns means that animals can be suddenly exposed to high sound levels that could result in TTS or PTS. Therefore, mitigation measures will be put in place to reduce the significance of the impact of VSP airguns on marine mammals.

7.5.3 Degree of Confidence

The model used here relies on many assumptions regarding the sound source levels of oil and gas related activity and auditory sensitivity of receptors. Previous observational and acoustic surveys give a reasonable indication of the species present but further surveys would help to determine the inter-annual variation in marine mammal abundance in the area and help to resolve the status of rare species. Further acoustic surveys would help to evaluate the vocal range of the species encountered within Falklands waters. The forthcoming Exploratory Campaign provides an opportunity to quantify the intensity of sound produced by the rig and associated vessels under a range of operational conditions using acoustic recording devices. During VSP activities a hydrophone will be deployed, which will record the sound level of the airguns and background rig and vessel sounds. The deployment of a marine mammal observer (MMO) will provide an opportunity to investigate the interactions between oil and gas related activity and marine animals. This information would help to better inform future Exploratory and Development Phases.

With the available data, the level of confidence in the impact predictions (in terms of the nature of the impact and its level of significance) is considered to be '**Probable**' and the data gaps are not considered to have the potential to significantly change the outcome of the assessment.

7.5.4 Cumulative Impacts

Acoustic recordings indicate that the campaign drilling area is subject to low ambient anthropogenic noise and therefore there will be little cumulative impact near the well sites. Vessels travelling to and from Stanley will add to the existing vessel noise in the area.

7.6 Mitigation Measures

It is generally regarded that a single exposure to vessel noise is unlikely to cause any physical damage. The most likely impacts resulting from low frequency sounds produced by vessels are masking and disturbance, though the long-term implications of this are unknown (OSPAR, 2009a). The species most at risk are baleen whales, seals, sea lions and fish, although the lowest social sounds of toothed whales are also in the spectrum of sounds generated by medium sized vessels (50-100 m in length).

An increase in vessel/rig noise within the area covered by the 2015 Campaign is inevitable, although this is likely to be of '**Minor**' severity. There are currently no guidelines governing anthropogenic noise that does not exceed the TTS. These include vessel/rig noise and sound generated from drilling operations. No specific mitigation measures are proposed for these activities.

The significance of underwater noise resulting from VSP activity on marine mammals has been assessed here as '**Moderate**' and therefore measures must be taken to reduce the risk to these animals. In line with JNCC guidance, a MMO will be deployed to search for marine mammals within a mitigation zone (500 m radius, standard for UK operations) for a period of 60 minutes prior to firing of airguns, soft-start procedures will be followed and VSP activity will commence during daylight hours. These measures will further reduce the risk of marine mammals being exposed to intense low frequency pulses.

JNCC guidelines, Section 3.3.1 (JNCC, 2010)

The operator should whenever possible implement the following best practice measures:

- If marine mammals are likely to be in the area, only commence seismic activities during the hours of daylight when visual mitigation using Marine Mammal Observers (MMOs) is possible.
- Only commence seismic activities during the hours of darkness, or low visibility, or during periods when the sea state is not conducive to visual mitigation, if a Passive Acoustic Monitoring (PAM) system is in use to detect marine mammals likely to be in the area, noting the limitations of available PAM technology (seismic surveys that commence during periods of darkness, or low visibility, or during periods when the observation conditions are not conducive to visual mitigation, could pose a risk of committing an injury offence).

- Provide trained MMO to implement the JNCC guidelines.
- Use the lowest practicable power levels to achieve the geophysical objectives of the survey.
- Seek methods to reduce and/or baffle unnecessary high frequency noise produced by the airguns (this would also be relevant for other acoustic energy sources).

Soft-start

There are three means of performing a soft start:

- The standard method, where power is built up slowly from a low energy start-up (e.g. starting with the smallest airgun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the vicinity.
- As the relationship between acoustic output and pressure of the air contained in the airgun is close to linear and most site surveys / VSP operations use only a small number of airguns a soft start can be achieved by slowly increasing the air pressure in 500 psi steps. From our understanding the minimum air pressure which the airgun array can be set to will vary, as this is dependent on the make and model of the airgun being used. The time from initial airgun start up to full power should be at least 20 minutes.
- If neither of the above techniques can be used, over a minimum time period of 20 minutes the airguns should be fired with an increasing frequency until the desired firing frequency is reached.

7.6.1 Residual Impact

The activity of vessels and the rig during the drilling campaign will cause localised disturbance to marine mammals, this is unavoidable and therefore there will be some residual impact.

The deployment of a dedicated MMO to conduct 60 minute observations prior to the commencement of soft-start procedures will lead to greater detection and tracking of marine mammals, especially deep diving species. With these measures in place, the likelihood of marine mammals being within 500 m of airguns discharging at full power is greatly reduced and therefore the severity of the impact is also reduced. With mitigation measures in place the significance of the impact of VSP noise on marine mammals is **'Low'**.

Table 43: Summary of the impacts of underwater noise on marine animals

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance		Certainty	Mitigation / Prevention / Control
							Pre-mitigation	Post-mitigation		
Supply vessels	Engine/thruster noise	Disturbance to marine life	Planned	Daily	High	Minor	Moderate		Probable	None proposed
Rig presence	Maintaining station	Disturbance to marine life	Planned	Daily	High	Minor	Moderate		Probable	None proposed
Drilling Operations	Mechanical boring and machinery noise	Disturbance to marine life	Planned	Daily	High	Slight	Low		Probable	None proposed
Vertical Seismic Profile (VSP)	Airgun discharge	Disturbance - physical injury to marine life	Planned	Once every 3-5 mins for about 12-15 hours on each well	High	Moderate	Moderate	Low	Probable	Following JNCC Guidelines (MMO, mitigation zone and soft-start). Start operation in daylight hours.
Plug and abandonment	Noise and vibration from cutting casing	Disturbance to marine life	Planned	c. 20 minutes per well	High	Slight	Low		Probable	None proposed

** See Section 6.0 for definitions of severity and significance.*

8.0 Generation of Atmospheric Emissions

8.1 Introduction

Activities associated with the exploration drilling campaign will generate atmospheric emissions as a result of power generation, vessel transportation for equipment and supplies, crew transportation to and within the Falkland Islands and potentially flaring during well testing.

At the local, regional and transboundary levels, gaseous emissions may impact air quality. At the global level, it is generally accepted that anthropogenic gaseous emissions are amplifying the natural atmospheric greenhouse effect, leading to global warming and climate change (Cubasch et al., 2013). Some gases have a direct effect by radiative warming, whilst other gases have an indirect impact on the abundance of greenhouse gases through chemical reactions in the atmosphere (Cubasch et al., 2013).

In addition, research suggests that the absorption of anthropogenic CO_2 is causing acidification of seawater, with potential impact on the shells and skeletons of marine organisms (Doney et al., 2005).

This chapter provides an assessment of the potential impacts of atmospheric emissions generated during the Campaign. The assessment identifies and characterises the sources of emissions that will be generated during the exploratory drilling and identifies the sensitive environmental receptors within the zone of influence.

8.2 Sources of Atmospheric Emissions

The main sources of emissions generated by the operations and activities during the exploration drilling campaign will be:

- Drilling rig transit to the Falkland Islands and between well locations, maintaining position during drilling operations, and transit back to West Africa;
- Drilling operations;
- Supply vessel transporting materials and equipment to and from the field;
- ERRV providing support to the drilling rig in the field throughout the campaign;
- Coaster vessels delivering cargo to and from the UK;
- Potential flaring of hydrocarbons during the well test operations;
- Transportation associated with crew change, including fortnightly charter flights to and from the UK, minibus transfer from MPC to Stanley, helicopter flights between Stanley and the rig;
- Operation of the onshore supply base; and

The emissions associated with transportation and vessel operations have been summarised in terms of the duration and frequency of each activity in Table 44. Helicopters are planned to operate to and from the rig on a daily basis with an additional four to eight journeys every two weeks to accommodate crew change requirements, over the 120 day drilling period there are expected to be approximately 165 flights.

Although not currently part of the campaign base case flaring operations associated with well testing will (if they are conducted) could occur for a maximum of two days per well (over a continuous 48 hour period), therefore the total quantity of crude flared would be 1,445 tonnes based on a flow rate of 5,000 bbls/day (specific gravity of 0.8828).

The onshore supply base will be connected to the existing Stanley power supply and will require electricity for lighting and domestic use, whilst any plant operations will use diesel fuel. Power generation in Stanley is derived from both non-renewable and renewable sources; the Stanley diesel run power station accounts for the majority of the energy supply, whilst a small wind development at Sand Bay Farm contributes 35-40% of Stanley's energy demand (FIG, 2014). At the time of writing this EIS, no estimates of electricity use for the shore base were available and hence predicted emission cannot be included here. The onshore base will be operational for a period of a year to 18 months.

Table 44: Summary of Activities that will Generate Atmospheric Emissions during the Campaign

Source of Emissions	Frequency	Duration (days / hours)	Fuel Consumption (tonnes/day)
Drilling rig (transit from western Africa to the Falkland Islands)	1	38 days	120
Drilling rig (in transit between each well location)	4	24 hrs	120
Drilling rig (operational)	4	30 days each well	50
Platform Supply Vessel (in transit from West Africa with the Rig)	2	38 days one way	15
Coaster supply vessel from UK (24 hrs one-way)	6	30 days on way	15
Return charter flight from LGW UK to MPC for crew change (9 crew changes, 36 hrs return)	9	36 hrs round trip	5.3 (t/hr)
Helicopter - crew change from rig to Stanley (3 hrs one-way) (daily flights plus 5 on crew change days)	165	3 hrs round trip	0.510 (t/hr)
Helicopter – emergency response test flight	20	3 hrs round trip	0.510 (t/hr)
Platform Supply vessel – from Stanley to rig	96	30 hrs round trip	15
ERRV alongside rig (15-19 hrs)	1	120 days	0.8
Onshore minibus transport – return from MPC to Stanley (10 minibuses x 9 crew changes)[3]	90	-	15 (litres / round trip)
Electricity demand for onshore supply base	-	120	Unknown

[1] Charter flight duration is based on current return flight duration between Brize Norton and MPC. Fuel consumption based on the current Airbridge Aircraft Airbus A330-200 operating between Brize Norton and MPC (Airberlin 2014). [2] Aviation diesel factors from Institute of Petroleum, 2000. [3]Falkland Islands Tours and Travel pers com.

8.3 Potential Environmental Receptors

Global Warming Potential

The Earth's long-term, globally-averaged equilibrium temperature depends on the balance between the level of incoming solar energy (from the sun) and the outgoing radiated heat which has been reflected or emitted from the earth's atmosphere and the surface of the Earth.

The two main components of the Earth's atmosphere are nitrogen (78%) and oxygen (20%); both of these gases have poor thermal absorption properties. Consequently, the gases that make up the remaining 2% of air have sufficient thermal absorption to capture energy from the sun and make the Earth habitable.

These gases are referred to as greenhouse gases because they absorb and effectively trap heat within the Earth's atmosphere. The presence of greenhouse gases is one of the key factors that govern the temperature of the Earth's atmosphere, and therefore as greater quantities of greenhouse gases are generated by human activities the more the planet warms.

Certain greenhouse gases are more effective at warming than others. The two most important characteristics of a greenhouse gas, in terms of climate impact, are how well the gas absorbs energy (preventing it from immediately escaping to space), and how long the gas stays in the atmosphere. The combination of these two factors is known as the Global Warming Potential (GWP), and it is a relative measure of the total energy that a gas absorbs over a particular period of time (usually 100 years) when compared to carbon dioxide. The larger the GWP, the more warming the gas causes. For example, methane's 100-year GWP is 21, which means that methane will result in 21 times as much warming as an equivalent mass of carbon dioxide over a 100-year time period. As the GWP is a ratio of the warming potential of a gas relative to that of carbon dioxide, when it is applied to the estimated emissions for different gases it returns a value of carbon dioxide equivalent (CO_2E) i.e. how much CO_2 would have to be produced to give the same warming potential for a given gas emission.

Four primary greenhouse gases are considered to have the greatest potential to contribution to global climate change, they are:

- Carbon dioxide (CO_2) - has a GWP of 1 and serves as a baseline for other GWP values. CO_2 remains in the atmosphere for a very long time and changes in atmospheric CO_2 concentrations persist for thousands of years. Typically emitted through fuel combustion during oil and gas exploration and production activities.
- Methane (CH_4) - has a GWP more than 21 times that of CO_2 for a 100-year time scale. CH_4 emitted today lasts for only about a decade in the atmosphere, on average. However, CH_4 absorbs more energy than CO_2, making its GWP higher. Typically emitted through fuel combustion during oil and gas exploration and production activities.
- Nitrous oxide (N_2O) - has a GWP 300 times that of CO_2 for a 100-year timescale. N_2O emitted today remains in the atmosphere for more than 100 years, on average. Typically emitted through fuel combustion during oil and gas exploration and production activities.
- Fluorinated gases, particularly hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). These gases are relatively rare in the atmosphere but have very high GWP. The 100-year GWP for fluorinated gases have the following ranges: HFCs: 140-11,700, PFCs 800-50,000, and SF_6 23,900. These gases are emitted from a variety of industrial processes and typical sources associated with oil and gas exploration and production include: compounds within refrigerants, solvents, foam blowing agents and firefighting fluids.

Greenhouse gas emissions are governed by the legally binding international treaty known as the Kyoto Protocol, which came into force in 2005. The Protocol is an agreement under which industrialised countries will reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990. The goal is to lower the overall emissions from the six main greenhouse gases CO_2, CH_4, N_2O, SF_6, HFCs and PFCs.

Additionally, there are four gases that have an indirect 'greenhouse gas' effect by producing increased ozone (O_3) concentrations in the lower atmosphere (tropospheric - lower 5-10 miles of the atmosphere). Ozone gas is produced when nitrogen oxides (N_XO), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2), react with sunlight. In the lower atmosphere, ozone gas contributes to the greenhouse gas effect by its thermal absorption properties. Table 45 summarises the GWP of the main greenhouse gases.

Table 45: Summary of Global Warming Potential (GWP) Factors

	Ratio of Gas_X Required to Create the Equivalent Warming to 1 Tonne of CO_2						
	CO_2	CH_4	N_2O	NO_x	SO_2	CO	VOC
GWP Factor	1	21	310	40	0	2	11

Ozone depleting substances (ODS)

Ozone is present throughout the Earth's atmosphere and whilst it comprises only a small fraction of the upper atmosphere (stratosphere – 15 - 25 miles above the Earth's surface) it intercepts much of the harmful ultraviolet (UV) light produced by the sun. Ozone depleting substances (ODS) contribute to the breakdown of ozone into oxygen in the upper atmosphere, and consequently allow these harmful rays to pass through the Earth's atmosphere. It is suspected that a variety of biological consequences such as increases in skin cancer, cataracts, damage to plants, and reduction of plankton populations in the ocean's photic zone may result from the increased UV exposure due to ozone depletion.

Common examples of ODS potentially used in oil and gas exploration and production activities include refrigerants, solvents, foam blowing agents and firefighting fluids, such as the fluorinated gases chlorofluorocarbons, hydrochlorofluorocarbons and Halon.

Ozone depleting substances (ODS) are subject to the Montreal Protocol, an international agreement, which introduced control measures to eliminate the production and use of ODS. In alignment with the Montreal Protocol MARPOL 73/78 Annex VI Regulations for the Prevention of Air Pollution from ships was amended to the control of emissions of ozone depleting substances and prohibits the deliberate emission of such substances. The Protocol requires ships (including drilling rigs) to be surveyed and issued with an International Air Pollution Prevention (IAPP) Certificate to ensure that Annex VI is complied with.

Regional air quality

At the local, regional and transboundary levels, gaseous emissions may impact air quality. Key issues include the formation of acid rain from oxides of sulphur (SO_X) and nitrogen (NO_X) and, direct impacts on human health from particulate matter (formed by chemical reactions involving pre-cursor gases NO_X, SO_X, and volatile organic compounds (VOCs)) (EEA, 2012).

Particulate Matter (PM) comprises small particles that are suspended in the atmosphere which are small enough to be inhaled and have the potential to cause health effects. Some PM is generated naturally from forest or grassland fires, sea spray etc, whilst human activities such as burning fossil fuels or releasing aerosols may also generate significant quantities of particulates. Of particular concern is the class of particles known as fine particulate matter or PM2.5 (< 2.5µm in diameter) that can penetrate deep into the lungs, whilst larger particles, PM10 (<10µm in diameter) and ultrafine particles PM0.1 (<0.1µm in diameter) may also be inhaled and are of concern.

Ocean Acidification

Carbon dioxide is highly soluble in water and consequently the oceans absorb carbon dioxide from the atmosphere by direct air-sea exchange; the exchange process equilibrates surface water CO_2 to atmospheric levels with a timescale of approximately one year (Doney et al., 2005). However, there is a cost; when carbon dioxide dissolves in seawater it forms carbonic acid (H_2CO_3) and as more carbon dioxide is taken up by the oceans' surface, the pH decreases, moving towards a less alkaline and therefore more acidic state. One well-known effect of ocean acidification is the lowering of calcium carbonate saturation states, which impacts shell-forming marine organisms from plankton to benthic molluscs, echinoderms, and corals (Doney et al., 2009). Many calcifying species exhibit reduced calcification and growth rates in laboratory experiments under high-CO_2 conditions.

8.4 Characterising and Quantifying the Impact

Quantification of atmospheric emissions can be estimated on the basis of total fuel consumption and published conversion factors for the unit amounts of various gases emitted when fuel is burnt, as described below.

Emissions (gas_x) (tonnes) = Emissions factor (tonne gas_x / tonne fuel) x Fuel consumption (tonnes)

In this assessment, emissions factors have primarily been sourced from the UKOOA (now Oil and Gas UK) Environmental Emissions Monitoring System (EEMS) Atmospheric Emissions Calculations, the National Atmospheric Emissions Inventory and the Exploration and Production Forum (1994). These emissions factors have been summarised in Table 46. The total fuel consumption for transportation (rig, vessels, charter flight, minibus etc) was calculated based on the number and type of vessels or vehicle, the duration and type of operations and the average daily consumption of fuel based on vessel or vehicle type, as described in Table 44. The total fuel consumption estimates are multiplied by the appropriate emissions factor from Table 46 to estimate the total atmospheric emissions, as summarised in Table 47.
Emissions from well testing (Table 48) can be estimated on the basis of the total mass of gas and oil burnt and published emissions factors from EEMS Atmospheric Emissions Calculations for the combustion of those fluids.

Table 46: Summary of Emissions Factors

	Tonne Gas_x / Tonne Fuel Consumed						
	CO_2	CH_4	N_2O	NO_x	SO_2	CO	VOC
Flaring (oil)[1]	3.2	0.025	8.1×10^{-5}	0.0037	1.28×10^{-5}	0.018	0.025
Diesel consumption (Engines)[1]	3.2	0.00018	0.00055	0.0594	0.004	0.0157	0.002
Diesel consumption Helicopter[2]	3.2	8.7×10^{-5}	0.00022	0.0125	0.008	0.0052	0.0008
Charter flight aviation fuel[3]	3.15	3×10^{-5}	0.018	0.0001	0.0013	0.0056	0.0003
Diesel consumption [3] (Onshore coach)	3.16	1.1×10^{-5}	0.012	8.8×10^{-5}	1.5×10^{-5}	0.0032	0.0005
Incineration of waste [3]	0.34	0.0029	0.0009	3.8×10^{-5}	2.2×10^{-5}	9.0×10^{-5}	7.3×10^{-6}
Burning waste cooking oil [3]	3.15	0.00046	3×10^{-5}	0.0032	0.00067	0.0018	5×10^{-5}

[1] Data from OGUK, 2008, unless otherwise stated. [2] E&P Forum, 1994. [3] NAEI, 2012.

To account for the varying efficiency of different greenhouse gases in warming the Earth, the Global Warming Potential (GWP) is also applied to the atmospheric emissions to calculate the CO_2 equivalent.

The emissions released during the exploration drilling campaign resulting from the rig operations, associated vessels and crew transportation are presented in Table 47, and the estimated emissions associated with well test flaring are presented in Table 47. The total estimated atmospheric emissions from the drilling campaign are summarised in Table 50.

Table 47: Summary of Atmospheric Emissions from Vessels and Transportation

	Emissions (Tonnes)						
	CO_2	CH_4	N_2O	NO_x	SO_2	CO	VOC
Drilling rig (return transit from South Africa to the Falkland Islands)	29,184	1.64	5.02	541.73	36.48	143.18	18.24
Drilling rig (in transit between each well location)	1,536	0.09	0.26	28.51	1.92	7.54	0.96
Drilling rig (operational)	19,200	1.08	3.30	356.40	24.00	94.20	12.00
Platform Supply Vessel (in transit from South Africa with the Rig)	3,648	0.21	0.63	67.72	4.56	17.90	2.28
Coaster supply vessel from UK	17,280	0.97	2.97	320.76	21.60	84.78	10.80
Charter flight from LGW UK to MPC	5,409	0.05	30.91	0.17	2.23	9.62	0.52
Helicopter - crew change from rig to Stanley	808	0.02	0.06	3.16	2.02	1.31	0.20
Helicopter – emergency response test flight	98	<0.01	0.01	0.38	0.24	0.16	0.02
Platform Supply vessel – from Stanley to rig	5,760	0.32	0.99	106.92	7.20	28.26	3.60
ERRV alongside rig	307	0.02	0.05	5.70	0.38	1.51	0.19
Onshore coach transport – return from MPC to Stanley	4	0.00	0.01	<0.01	<0.01	<0.01	<0.01
Electricity use shore base	Unknown						
Total Emissions	**83,234**	**4.40**	**44**	**1,431**	**101**	**388**	**49**

Table 48: Summary of Atmospheric Emissions from Well Test Flaring

	Emissions (Tonnes)						
	CO_2	CH_4	N_2O	NO_x	SO_2	CO	VOC
Emissions per well	4,623	36	0.12	5.35	0.02	26	36
Total emissions for 4 wells	18,493	144	0.47	21.38	0.07	104	144

Table 49: Total Estimated Atmospheric Emissions Generated during the Drilling Campaign

	Emissions (Tonnes)						
	CO_2	CH_4	N_2O	NO_x	SO_2	CO	VOC
Total Campaign emissions	101,727	149	45	1,453	101	492	193
GWP (CO_2E)	101,727	3,126	13,849	58,113	-	985	2,126
GWP Total (CO_2E)	**179,926**						

8.5 Impact Assessment Summary

The main environmental effects as a result of the emissions of gases to the atmosphere are:

- Contribution to greenhouse gases (direct CO_2, CH_4, N_2O, indirect NO_x, SO_2, CO, VOCs)
- Contribution to local air quality (via photochemical pollution formation (NO_x, SO_2, VOCs))
- Contribution to ocean acidification (CO_2)

A summary of the impact assessment of atmospheric emissions is shown in Table 51, page 220.

8.5.1 Severity and Receptor Sensitivity

Global Warming Potential

Atmospheric emissions statistics for the Falkland Islands (provided by the EPRD 2014) indicate that total FI emissions of CO_2e in 2012 were 0.16 million tonnes CO_2e, approximately 78% of emissions generated as a result of agricultural farming, with domestic combustion (10.6%), power generation (4.8%) and road transport (4.2%) accounting for the majority of remaining emissions. Emissions statistics for 2012 did not account for air or shipping transport from the UK to the FI, which has been included in some previous years statistics, where on average air transport from the UK to the Falkland Islands accounted for less than 8% emissions and shipping less than 1% between 1990 and 2010. Emission statistics for the period 1990-2012 do not account for emissions arising from previous oil and gas exploration campaigns. It should also be noted that the emissions statistics for the Falkland Islands are not directly comparable to those calculated for the campaign, as they do not include emissions of NO_x, SO_2, CO, VOC.

In the context of annual Falkland Islands emissions, the total emissions generated from the 2015 drilling campaign would exceed the Falklands Islands 2012 annual emissions by approximately 18,000 tonnes CO_2e, and would more than double the Islands' annual emissions in 2015. To consider the emissions on a comparable basis, 2012 Falkland Islands emissions can be compared to 2015 drilling campaign emissions excluding NO_x, SO_2, CO, VOC. Based on a comparison of CO_2e calculated from CO_2, CH_4 and N_2O, the 2015 drilling campaign emissions would account for 75% of Falkland Islands 2012 annual emissions. In either case, the emissions generated from the 2015 drilling campaign result in a very significant increase in annual emissions in Falkland Islands waters.

It is also necessary to compare the emissions in the context of the oil and gas industry as the Falkland Islands currently does not have any on-going oil and gas operations. Additionally, as the Falkland Islands emissions are incorporated under the United Kingdom's emissions inventory for reporting under the Kyoto Agreement, the impact on UK emissions must also be considered. UK national statistics of estimated greenhouse gas emissions indicate that total UK emission of CO_2 in 2012 were 474.1 million tonnes CO_2 (581.1 million tonnes CO_2e) (DECC, 2014). Energy supply from power stations accounted for the greatest proportion of 2012 emissions, one third of UK emissions at 158.2 million tonnes CO_2 (159.52 million tonnes CO_2e), whilst exploration and production of oil and gas accounted for 0.03 million tonnes CO_2 (0.2 million tonnes CO_2e) and flaring of oil and gas for 3.3 million tonnes CO_2 (3.58 million tonnes CO_2e).

In this context the total emissions generated from the 2015 drilling campaign would represent 0.03% of total UK emissions, and flaring emissions from the campaign would represent 0.7% of UK offshore flaring. In isolation this project would have a negligible effect on the global concentrations of greenhouse gases and subsequent climatic impacts, at a UK national level the campaign will also have negligible impact on emissions targets, whilst in the Falkland Islands the campaign will have a very high impact on annual emissions.

Under the Kyoto Agreement, the Falkland Islands is not required to reduce its emissions or place a ceiling on emissions in the first commitment period of 2008-2012, and the same situation is likely for the following periods, however, it is expected to introduce policies in line with objectives of the UK Climate Change Programme in driving energy efficiencies. Emissions arising from the 2015 drilling campaign would not compromise Falkland Islands commitments under the Kyoto Agreement, as due to their relatively very small level of greenhouse gas emissions the Islands are not required to cap emissions. With relation to the UK Kyoto commitments and Climate Change Programme, emissions from the 2015 drilling campaign would contribute a small amount to the UK emissions total, and require that Premier Oil consider equipment and technologies that improve the energy efficiency of all aspects of the operation.

Following consideration of the estimated campaign emissions in the context of annual Falkland Islands and UK emissions and both countries commitments to the Kyoto Agreement, the overall severity and sensitivity of this impact has been assessed as '**Low**'.

To further put the campaign emissions into context of activity in the regional area, there are areas of high-density shipping approximately 30 nautical miles to the west of the exploration area (Section 5.6.3), which primarily result from fishing, tanker and other non-specified vessels. The severity of the effect is therefore considered to be '**Slight**' resulting in a negligible environmental effect, whilst the sensitivity of the receptor is considered to be '**Low**'.

Regional air quality

The primary contributions to the atmospheric PM generated from the drilling campaign would result from the transit and operation of the drilling rig, well test flaring operations and the return charter flight from the UK to the Falkland Islands.

These activities will either take place in the offshore environment over 200 km from the nearest land or along the flight path from the UK to the Falkland Islands. The offshore conditions in the NFB would rapidly dissipate any effects on air quality, which would therefore be relatively temporary and localised in nature. The drilling operations are scheduled to be conducted over a 120 day period and are therefore of a relatively short-term duration, with the local air quality being expected to rapidly return to background conditions.

The main sources of PM arising from the drilling campaign that could be detrimental to human health would be road transportation from the airport at MPC to Stanley during crew change and the crew transfer flight as it comes into land. It is expected that there will be one flight every two weeks with a requirement for ten minibuses to transport offshore workers to and from Stanley to MPC. Currently there are three flights per week landing in Stanley and due to the exposed nature of the airport at MPC and road to Stanley, and the relatively low traffic levels (compared to many global towns and cities) the particulate matter is rapidly dispersed by local winds and changes in air quality rapidly return to background conditions. It is expected that emission of particulate matter arising from the additional charter flight and crew transfer to Stanley for the drilling operations would result in comparable levels of pollution to the existing flight activities and would therefore be within acceptable levels.

Any impacts to the local air quality from offshore and onshore operations are considered to be minimal, and would only have a very low level and short-term effect on local air and marine life (severity '**Slight'**), with no expected effects on Falkland Islands' communities (sensitivity '**Very Low**').

Ocean Acidification

The principal combustion product of the proposed 2015 drilling campaign activities is CO_2, which is directly related to the rate of ocean acidification. The amount CO_2 generated as a result of the proposed drilling campaign is finite and very low in relation to overall UK emissions and would therefore have a negligible effect on the oceans' pH. For example, in 2012 UK net emissions of CO_2 were estimated to be 464.3 million tonnes, the emissions generated by the drilling campaign would account for 0.014% of UK emissions. The severity of the impact is considered to be '**Slight**' and the sensitivity of the receptor is '**Very Low**'.

Ozone Depleting Substances

Premier Oil will audit the *Eirik Raude* prior to accepting the rig on hire to ensure that all of the appropriate certificates are in place and that international standards are being met.

No ozone depleting substances will be used except hermetically sealed domestic-type appliances (e.g. refrigerators) with an inventory <3 kg. Premier Oil is investigating whether the *Eirik Raude* has CFC or HCFC's on onboard.

8.5.2 Significance

Assessment of the significance of greenhouse gases and carbon dioxide generated as a result of the drilling campaign is considered on a global scale, as appropriate for impacts that contribute to global processes such as global warming and ocean acidification. The quantity of greenhouse gases resulting from the campaign is relatively low in comparison to similar exploration and oil and gas activity in the rest of the world; the campaign is of a moderate to short duration (<1 year) and the emissions in isolation would have a barely detectable effect. Generated emissions released into the atmosphere will behave in different ways; some gases persist in the atmosphere for only short periods before decaying and would therefore have only a short-lived effect, whilst some gases such as carbon dioxide persist for centuries and have a long-lived effect. The scale of emissions generated during the drilling campaign would have a negligible effect on both global warming and ocean acidification and hence have been assessed of '**Low**' significance.

Impacts associated with regional air quality are considered to be of '**Low**' significance due to the remote location and dispersive effects of the offshore environment, and due to the relatively low level of emissions generated from waste incineration in Stanley. There will be no emissions of ozone depleting substances during the drilling campaign and therefore this aspect is also considered to be of '**Low**' significance.

8.5.3 Degree of Confidence

The duration of the drilling campaign is known and the associated transport for equipment, supplies and crew have been estimated on a conservative basis. However, the energy requirements for the operation of the shore base are currently unknown. Power requirements would primarily be for domestic use such as lighting and heating and would be supplied from Stanley Power station, which currently receives 30% of its power from renewable sources. It is not expected that the addition of emissions for the onshore supply base would appreciably alter the impact assessment conclusions reached in this report. Where possible, up-to-date emissions factors and data have been used to calculate the emissions arising from the project activities. The relationship between the generation of greenhouse gases and the subsequent global warming and ocean acidification potential are both well researched and documented.

The level of confidence in the impact predictions (in terms of the nature of the impact and its level of significance) for atmospheric emissions is considered to be '**Certain**' as the activity is clearly defined, the sensitivity of the receptor and the nature of the impacts are well understood.

8.5.4 Cumulative Effects

Premier Oil and Noble Energy will both be conducting exploration-drilling campaigns in Falkland Island waters during 2015, sharing both the drilling rig and the onshore base. The Noble drilling campaign will involve drilling two potential wells in the Falkland Plateau Basin. Noble have calculated their estimated atmospheric emissions from the campaign, based on power generation by the drilling rig, Offshore Supply Vessels (OSVs) and helicopters, summarised in Table 50. Noble do not plan to conduct any well tests, therefore, there would be no emissions resulting from flaring.

Table 50: Estimated total atmospheric emissions resulting from Noble exploration drilling activities (Noble Energy, 2014).

	Emissions (Tonnes)						
	CO_2	CH_4	N_2O	NO_x	SO_2	CO	VOC
Total Campaign emissions	67,653	3.73	4.65	1,213.99	84.57	322.57	41.21

Both the Premier Oil and Noble Energy drilling campaigns will produce similar quantities of atmospheric emissions, resulting in total emissions of carbon dioxide equivalents of 298,757 tonnes CO_2E, which is approximately 7.1% of UK oil and gas exploration and production. Whilst these emissions are relatively small compared to those currently generated in similar activities in the UK, they nevertheless contribute to a small global additive affect on global warming.

The exploration project has the potential to contribute to the future development and production of the Sea Lion Field, should the drilling prove successful, and therefore the subsequent generation of atmospheric emissions associated with it. The emissions arising from any future development and production from the Sea Lion Field will be accounted for in detail in a separate environmental impact assessment, however, the link between the two should be acknowledged here.

Overall the cumulative impact associated with the drilling campaign is considered to be of '**Low**' significance due to the very small incremental effect and the relatively short duration of the drilling campaign.

The potential for the exploration drilling campaign to contribute to cumulative regional air quality impacts is negligible. The drilling activities will be located over 200 km from the nearest land and whilst there will be other vessels, such as fishing vessels, in the area the weather conditions in the offshore NFB would rapidly dissipate the emissions.

8.6 Mitigation Measures

Whilst atmospheric emissions associated with the drilling campaign are considered to have a low environmental significance, they contribute to a global cumulative effect and as such are governed by International Treaties, such as the Kyoto Protocol for greenhouse gases, and consequently a number of industry standard mitigation measures will be implemented. These include:

- All vessels employed during drilling and installation activities will comply with the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008, which controls the levels of pollutants entering the atmosphere. All combustion equipment will be subject to regular monitoring and inspections and an effective maintenance regime will be in place, ensuring all combustion equipment runs as efficiently as possible.
- Vessels will be audited as part of selection and pre-mobilisation.
- The time spent drilling the well is the predominant factor in overall emissions and this is minimised through the careful planning of the well and by executing the well with a robust drilling platform, using state of the art combustion plant.

- MARPOL controls on the quality of diesel limit the sulphur content of fuel to low levels, thereby controlling acid gas emissions in the form of sulphur dioxide. Certain areas have been identified as Emissions Control Areas (ECA) where sulphur emissions are limited more stringently, the Falkland Islands does not fall within an ECA. Marine diesel available to the Falklands region can vary in sulphur content from 0.008%-0.20% (Stanley Services pers com.), which is well within the current limit for sulphur content both within (1.00%) and outside (3.5%) ECA. The sulphur limit inside ECA is due to change in January 2015 to 0.1%, whilst outside ECA it will remain 3.5% until January 2020, when it will reduced to 0.5%.

8.6.1 Residual Impacts

The impacts associated with atmospheric emissions are considered to be of low significance prior to mitigation measures. It is acknowledged that generation of emissions contribute to a cumulative global effect, albeit on a very small scale, and consequently emissions are subject to International Treaties that provide a framework to reduce global emissions. To this end standard industry and international recommended mitigation measures will be employed during the campaign, but as the pre-mitigation impacts were assessed to be of '**Low**' significance, there will be no change in assessment of the residual impacts, which are also of low significance.

Table 51: Summary of the impacts of atmospheric emissions arising from the 2015 Campaign

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance		Confidence	Mitigation / Prevention / Control
							Pre-mitigation	Post-mitigation		
Power generation associated with rig and vessel movements, possible flaring, crew change transportation, onshore supply base	Generation of atmospheric emissions (CO_2, CH_4, N_2O, indirect NOx, SO_2, CO, VOCs)	Global warming	Planned	Daily	Low	Slight	Low		Certain	All vessels will comply with the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 Vessels will be audited as part of selection and pre-mobilisation Optimisation of drilling schedule and efficient execution to minimise time spend on operations. Apply MARPOL controls on sulphur content of fuel
	Generation of atmospheric emissions (via photochemical pollution formation (NOx, SO_2, VOCs))	Contribution to local air quality	Planned	Daily	Very Low	Slight	Low		Certain	
	Generation of atmospheric emissions (CO_2)	Contribution to ocean acidification	Planned	Daily	Very Low	Slight	Low		Certain	

** See Section 6.0 for definitions of severity and significance.*

9.0 Generation of Artificial Light Offshore

9.1 Introduction

The level of anthropogenic light in the night-time sky has increased dramatically in recent decades. Where this has an adverse effect on humans or other animals, this is referred to as light pollution (see Davies et al., 2014 for review). Most ecological studies take place during day-light hours and therefore the ecological consequences of light pollution are only just beginning to be appreciated.

Artificial light can affect the natural behaviour of animals in several ways; for instance, disturbance to activity patterns and hormone-regulated processes, such as the internal clock. A more obvious affect is attraction and disorientation of animals to man-made light sources; this is known as positive phototaxis.

This behaviour has been exploited to catch species of squid (FAO, 2014), with approximately 63-89% of the global catch being made by light-fishing vessels (jiggers).

It has long been known that seabirds are attracted to lights at-sea (Murphy, 1936), which has been exploited as a technique for capturing seabirds. There is a growing awareness of the impact that anthropogenic sources of light are having on seabirds (Montivecchi, 2006), although quantitative studies are few in number.

This chapter assesses the potential impacts from anthropogenic light arising from the Drilling Campaign which include:

- Attraction of marine life, e.g. plankton, fish and squid
- Attraction of seabirds and subsequent collision risk with the rig or vessels

9.2 Artificial Light Sources

Offshore operations associated with the Campaign will introduce several sources of artificial light into the offshore waters of the NFB, including supply vessels, the ERRV and the drilling rig. Drilling, and other rig activities, will operate for 24 hours a day and to do this safely, all working areas will have to be well illuminated. Sources of light on the vessels will include navigational lights, illuminated living spaces within the ships and rig, floodlighting to provide a safe working environment on the decks of ships and rig and any gas or oil brought to the surface will be flared (burnt) off.

Navigational Lights

Vessels are required to display navigational lights when at-sea. These are relatively small coloured lights (white, red and green) that are of low intensity to avoid glare. Alone, these lights don't appear to pose a great risk (see Poot et al., 2008).

Living Spaces

Light can be emitted from living spaces (accommodation, mess rooms etc.) through uncovered portholes and windows on the rig and other vessels.

Deck Lights

Deck lighting is required to provide a safe working environment. These lights are usually very bright flood lights, designed to illuminate a wide area.

Flaring

Excess gas and hydrocarbons are usually burned off by flaring during Exploratory Campaigns. Flaring will only occur if it is deemed necessary to test any hydrocarbons found during the drilling Campaign, if so, this will occur for a maximum of two days per well (a continuous 48 hour period). At present, it is not anticipated that flaring will be employed during the Drilling Campaign but it is clearly the most lethal form of artificial light at-sea.

Ambient Light Levels

Under natural conditions, the only sources of light at-sea are moonlight, starlight and bioluminescence. Currently, there are several other sources of anthropogenic light in the wider area of the NFB. The finfish trawl fleet operate along the edge of the continental slope (200 m depth contour) to the south west of the Campaign Area. These vessels often stop fishing at night but are an additional source of light. A limited number of cargo vessels pass within a few kilometres of the well sites (see Section 5.6.3). However, the most significant source of artificial light in the south west Atlantic is the *Illex* jigging fleet. These vessels use powerful arrays of lights (up to 150 bulbs totalling 300 kW per vessel) to attract squid to jigging lures. Jiggers fish in fleets, squid abundance varies from year to year and fleet size and fishing effort tend to be related to squid abundance. Over recent years, the number of jiggers fishing within the Falklands EEZ has peaked at about 100 vessels (FIG FIFD, 2013 and 2014). The distribution of these vessels can be followed via satellite images (Rodhouse et al., 2001; Waluda et al., 2008), which have been used to quantify fishing effort. The presence of these animals, and the vessels that fish for them, within Falklands waters is seasonal; the licence period extends from February to June (FIG FIFD, 2014).

9.3 Potential Environmental Receptors

9.3.1 Zooplankton and Fish

It is well known that marine zooplankton is attracted to artificial light (Davies et al., 2014), which attract small fish, which in turn attract larger predatory fish. The affect appears to be more pronounced with static light sources. Experimental trials to investigate the abundance and behaviour of fish in response to artificial light indicate that, artificial nocturnal lighting created conditions that potentially benefitted larger, piscivorous (primarily fish diet) fish through both the concentration of prey and an enhanced foraging environment for visual predators (Becker et al., 2013). There are relatively few pelagic fish species in the deeper waters of the NFB, catch statistics indicate that hoki is the most abundant species in the area (FIG FIFD, 2014). Hoki are known to feed on plankton (Brickle et al., 2009).

9.3.2 Squid

It is well known that pelagic squid are attracted to light; this behaviour is exploited to catch Argentine shortfin squid in the Falklands' jig fishery. The fishery generally starts in the extreme north of the Falklands EEZ and moves southwards as the season progresses (for example see FIG FIFD 2013 and 2014). The spread of catches indicates that there is considerable inter-annual variation in the distribution of this species (Waluda et al., 2008). It is possible that there will be *Illex* squid in the vicinity of the *Eirik Raude* from March to June, the deck lighting may be sufficiently powerful to attract some of these animals to the rig.

9.3.3 Seabirds

Seabirds have evolved to live in an environment that is essentially dark at night, except for moonlight and sources of bio-luminescence. Seabirds take advantage of natural sources of light to find prey and navigate. Light generated by the oil and gas industry, and other marine users, has the potential to negatively impact seabirds in a number of ways, these include: direct mortality from the impact of a collision, resulting loss of feather condition and hypothermia (due to contact with the rig deck) or incineration in rig flares.

Not all species of seabird are equally vulnerable to light induced effects, diurnal albatrosses and petrels seem less likely to be involved in bird strikes than smaller petrels (Wiese et al., 2001; Black, 2005). Attraction to artificial lights is particularly strong in small, planktivorous procellariiform seabirds (petrels, shearwaters and storm-petrels) that remain active at night. It is unclear what exactly attracts the birds but there are several theories; these species feed on bioluminescent planktonic organisms that migrate close to the surface at night, and are therefore attracted to light sources (Imber, 1975). Light from the moon may also be a navigational cue for some species of seabird (Montivecchi, 2006). In the absence of celestial light, on overcast nights, Poot et al. (2008) postulate that artificial lights interfere with a bird's magnetic compass. Whatever the reason, it is clear that many small petrels collide with anthropogenic structures at-sea and die as a consequence (for examples see, Wiese et al., 2001; Black, 2005; Merkel, 2010).

In the South Atlantic there are a few documented accounts of bird strikes on vessels at-sea, although it is known to be a common event in the Falkland Islands waters, South Georgia and elsewhere in the world (A. Black pers. obs.; Wiese et al., 2001; Merkel, 2010). Generally, the scale of these events is small but occasionally a far larger incident (bird-strike) is recorded, involving hundreds of birds on a single night (for example Ryan, 1991; Black, 2005).

During the 2011 exploratory campaign, observations from a standby vessel recorded birds associating with the rig but did not record any negative interactions (Munro, 2011). However, most observations were made at a distance of 500 m from the rig. In order to be able to detect small petrels at night, observations would ideally be carried out from on board the rig. Statistically, significantly more birds were recorded during the morning than the afternoon, it was suggested that this was due to attraction to lights during the night (Munro, 2011).

9.3.4 Marine Mammals

Literature reviews for this assessment have found no evidence that marine mammals would be attracted to artificial light directly. Munro (2011) did not observe any marine mammals in the vicinity of the rig drilling in the Sea Lion field during 14 days of observations in June 2011.

9.4 Characterising and Quantifying the Impact of Artificial Light

The episodic nature of light induced effects is linked to light use, seabird abundance and weather conditions on any given night and is therefore difficult to quantify. It can be safely assumed that lights will be used and vulnerable species of seabird will be present (if only in low numbers). Therefore, poor visibility due to (snow or fog in particular) is likely to be a key variable.

9.4.1 Quantifying sources of artificial light

Measuring Light Intensity

Until recently, light bulbs were classified in terms of Watts (or kiloWatts = 1,000 Watts), which is the unit of electrical input power required to light a bulb. However, the intensity of light output from a bulb is measured in lumens. Different light sources could have the same power requirements, but vastly different light output, as not all the energy is converted to light (for example, some energy will be lost as heat). Luminous intensity is the amount of light emitted in a given direction and is the most useful measure of 'brightness' with regards to environmental impact. There is a positive relationship between the power consumption of a light source and the amount of light emitted, which is known as 'luminous efficacy' and has units of lumens per watt (lm/W). Luminous efficacy varies between light sources, although it is still common to refer to light intensity in terms of Watts (see examples below).

The potential impact of offshore light on marine life is related to the length of the drilling campaign, the intensity of light sources, wavelength of light and orientation of light sources.

Duration of Light Exposure

The drilling Campaign will last a total of 130 days, over two periods (March to June and October and November). The rig will operate 24 hours a day and will be permanently lit.

If flaring operations are undertaken during the drilling campaign they will be limited to a maximum of two days per well (48 hours) for each of the four wells.

Intensity of Light

Marguenie and van de Laar (2004) experimented with the lighting of a gas-production platform (gas production platform L5) in the North Sea to investigate the relationship between light intensity and bird attraction (reported in Poot et al., 2008). By disconnecting different sources of light, they were able to show that bird attraction was influenced by light intensity, although they were more concerned with migratory landbirds than seabirds. For illustrative purposes Table 52 shows the power consumption of different lights on the gas production platform L5, this can provide a rough guide for light intensity as an increase in power consumption results in an increase in light intensity. It was thought that, at full intensity (30 kW) the lights influence extended 3-5 km from the rig. By way of comparison, each jigger is equipped with lights totalling 300 kW and the fleet may contain up to 100 vessels within Falklands waters, with more fishing in Argentine waters.

The lights used on the *Eirik Raude* are likely to differ from those on the L5, however as specific information for the *Eirik Raude*, or any other semi-submersible rig, was not available at the time of writing this has been used as an example.

Table 52: Examples of the power required by different light sources on gas production platform L5

Source	Source power consumption (kW)
Navigational lights (red and green)	3.0
Sodium floodlights of crane	1.5
Helicopter platform	0.16
Landing lights	0.148
Platform total	30.0

The Wavelength of Light

There are several sources of light on the vessels and rig, which are usually white light sources. Although this is very much an under-studied subject, there has been some experimentation with different wavelengths of light, which have shown potential to reduce the incidence of bird strike. Poote et al. (2008) found that the use of green lights, instead of the usual white lights, reduced the number of birds that were disorientated. Figure 51 shows the 'experimental' rig following the replacement of most white light sources with green. However, there may be restrictions, in terms of lighting configuration, in certain areas, such as the helideck.

Figure 51: The gas production platform L15, fitted with green lights

Orientation of Lights

Some lights, such as navigation lights, are designed to be seen by other vessels and therefore are orientated to face out-board. However, these are usually low intensity lights (Table 52). Helicopter platform and landing lights also face outwards, or upwards, to guide incoming aircraft. These are usually of relatively low intensity (Table 52).

The highest intensity lights are the deck or crane floodlights, which are generally orientated to illuminate any operational activity being undertaken on the deck of rig and can vary in orientation if following a load suspended on the crane.

Should flaring be undertaken the flame would be emitted from the highest point on the rig (away from any other infrastructure) and would be vertically orientated, with a possible flame height of five metres.

Location of Light Sources

The rig will be permanently based offshore within the Drilling Campaign Area (see Section 3.1 for well locations). Flaring would only be undertaken whilst the rig is stationed at each of the well locations.

The two rig supply vessels will travel between Stanley and the rig on a five-seven day rotation. While working cargo, the supply vessels will have to use deck lighting, however, when steaming light should be limited to navigation lights.

9.4.2 Weather Conditions and Moon Phase

Virtually every reported bird strike associated with artificial light at-sea is linked to weather conditions (for instance; Ryan, 1991; Black, 2005; Merkel, 2010). When visibility is reduced due to snow or fog, bird strikes are far more likely and events tend to affect greater numbers of individuals. The probability that snow will fall on any given day is presumed to be higher during the winter than the summer months, which coincides with the proposed drilling campaign. Fog is generally related to wind direction and is more frequently observed during periods of north or north easterly winds, which can be experienced at any time. The influence of artificial light appears to be greatest on moonless nights when there is limited ambient natural light (Montivecchi 2006). The longer nights and poorer weather experienced during the winter months are conducive for bird strikes.

9.5 Impact Assessment Summary

A summary of the impact assessment of artificial lights to wildlife offshore is shown in Table 53, page 230.

9.5.1 Severity and Receptor Sensitivity

***Attraction of Marine Life* (plankton, fish and squid)**

Any impact of the Drilling Campaign on zooplankton, fish and squid is expected to be very small and localised. These animals may be attracted to the lights of the rig but there is nothing to suggest that this should be regarded as a significant risk to these species, however, there could be some indirect impacts on these animals. Squid and fish may be attracted to the rig to feed on zooplankton and may in turn be an easier target for larger squid, fish, seabirds or marine mammals. Attraction of these animals to the rig will also make them more vulnerable to other impacts, such as; underwater noise or accidental spills (discussed in Sections 6.0 and 13.0).

Vessels in transit should only be displaying navigation lights, therefore, the low light intensity. The relatively slow moving plankton, fish and squid would be unable to maintain position alongside a moving vessel.

Given the relatively modest intensity and power of lights used on the rig (30 kW), compared with squid jigging vessels (300 kW per vessel), the severity of the impact from the rig is considered to be relatively small, short-term (120 days spread over two drilling periods), extremely localised and fully reversible once the rig has been removed and is therefore assessed as '**Minor**' severity. The sensitivity of these receptors is considered to be '**Very Low**' as the population under the influence of the rig will be of no geographic importance.

Seabird Strikes / Collision with the Rig or Vessels

Bird strikes tend to be episodic events that are related to a number of factors. Along with excessive light use; reduced visibility due to mist, fog or snow, the presence of a large number of birds (for instance, close to a breeding site) are important factors. When all of these factors align, hundreds of birds could collide with a vessel on a single night.

Bird strikes reported by Black (2005), Ryan (1991) and observations on vessels in Falklands waters (A. Black pers. obs.) indicate that the most vulnerable species groups in the South Atlantic are; prions, blue petrel, storm-petrels, diving-petrels, gadfly (*Pterodroma*) petrels and shearwaters. Most of these birds are migratory or widely dispersed during the non-breeding season, which coincides with the Drilling Campaign. These species generally have very large population sizes, are found over extensive ranges and are mostly regarded as Least Concern by IUCN, however, some of the gadfly petrels (such as Atlantic petrel) are regarded as Endangered, due to a restricted breeding distribution and land-based threats.

All of these species show seasonal patterns of distribution and abundance within Falkland Islands waters and, more generally, within the Campaign Area (see Section 5.4.7). Some species (such as sooty shearwater) may be more numerous in coastal waters at the beginning and end of the Campaign (White et al., 2002) and thus vulnerable to bird strike as vessels transit through coastal waters (Geomotive and MRAG, 2011). Juvenile birds appear to be particularly vulnerable to the disorientating effects of artificial light (Montevicchi, 2006) and as many vulnerable species will fledge chicks near the start of the Campaign (March and April) the risk of bird strikes would increase at this time.

It is not possible to quantify the number of birds at risk from bird strikes, caused by artificial lighting, during the 2015 Campaign. However, from experience gained on vessels that operate in Falkland Islands waters and on oil and gas platforms elsewhere (Hope-Jones, 1980; Tasker et al., 1986; Wiese et al., 2001), it is considered likely that bird strikes will happen. Although the species concerned have large population sizes, a collision with a vessel, the rig or flare is likely to result in injury and death of the individual. However, it is considered that the impact would be barely detectable on the size of any species' population, as the impact is localised and short-term. Therefore the severity of offshore light has been assessed as '**Minor'**. The proportion of the local populations that are at risk is considered to be of little geographical importance, (less than 1% of the local population). Consequently the sensitivity of seabird species involved has been assessed as '**Low**'.

Indirect Effects on Diurnal Species of Seabird

Other species of seabird and land birds will be attracted to the rig but this is not necessarily due to excessive light. Some of these species may exploit feeding opportunities associated with the rig, however, there is also a risk of these birds colliding with the structure and close association increases the risk of contamination from any minor oil spills (see Section 13.3 for further discussion).

Several land birds migrate between South America and the Falkland Islands and these may be attracted to the rig (for example, snowy sheathbill *Chionis albus*). Of particular note, every autumn a large number of cattle egrets (*Bubulcus ibis*) arrive in the Falklands, and further south, however, these birds are essentially lost and die soon after arriving due to starvation. It is likely that groups of birds will arrive on the rig during the austral autumn in poor condition and die of starvation but this should not be regarded as an impact caused by the rig.

9.5.2 Significance

Overall, the significance of the impact of offshore artificial light on plankton, fish, squid and seabirds is considered to be '**Low'**, as it poses a negligible risk to the populations of receptor species. However, concerns have been raised by stakeholders regarding artificial light at-sea, and good housekeeping measures would help to further reduce the impact.

9.5.3 Degree of Confidence

Whilst the duration of the drilling campaign is known and the locations of the light source during the campaign have been confirmed, the intensity and orientation of lights on the rig are unknown, and an example has been used in this assessment. Flaring activities have not been confirmed at this stage of the project and consequently have been included to account for the worst-case scenario in the assessment. The nature of the impact on the environmental receptor is understood, however, the scale of the potential impact is difficult to predict due to its episodic nature. A little monitoring data exists from previous Falklands campaigns, although short-term this did not directly record an issue with bird strikes. Whilst some specific survey data exists for seabirds in the NFB and the Drilling Campaign Area, these data are limited to very short time points and lack good spatial coverage over several years that would take into account the temporal and spatial variability of such mobile species.

The use of deck lighting, occurrence of potentially vulnerable species (albeit in low numbers) and the likelihood of poor weather conditions (reduced visibility) combined suggest that some incidents of bird strike are likely to occur during the 2015 Campaign.

On the available data the level of confidence in the impact predictions (in terms of the nature of the impact and its level of significance) is considered to be '**Probable**'. Additionally, the data gaps are not considered to have the potential to significantly change the outcome of the assessment.

In the unlikely event that flaring occurs, the deployment of a seabird observer will provide an opportunity to investigate the interactions between artificial light produced by oil and gas related activity and marine animals. This information would help to better inform future Exploratory and Development Phases.

9.5.4 Cumulative Effects

Several of the species of fish and squid that may be attracted to the rig are subject to fisheries in the Falklands EEZ (light fisheries in the case of Argentine shortfin squid), by comparison to the fishing fleet the influence of the rig on these species is insignificant.

There are already numerous trawler vessels and a fleet of jiggers operating on the edge of the continental shelf to the south and west of the Drilling Campaign Area. The distribution of the south west Atlantic jigging fleet in April 2012 is shown in Figure 52.

The additional light of the drilling rig and supporting vessels is considered to be insignificant compared with the jigging fleet and is therefore not expected to result in a significant cumulative effect.

*The lights at-sea are from the squid jigging fleet, Comodoro Rivadavia is the largest settlement on the South American mainland, (Image April 2012, NASA Earth Observatory)

Figure 52: The distribution of artificial light in the south west Atlantic.

There are occasional bird strikes on trawlers (A. Black pers. obs.) but these go largely unreported. An assessment of the extent and nature of the incidental catch of seabirds on squid jiggers operating in Falklands waters was undertaken in 2006 (reported in Wolfaardt et al., 2010). Estimates confirmed earlier fisheries observations that incidental mortality associated with this fishery was minimal. However, the focus of these investigations was the incidental capture of ACAP species in fishing gear not mortality due to attraction by lights.

9.6 Mitigation Measures

Although the significance of the impact of artificial light has been assessed as Low, this is in part due to the season and location of the Drilling Campaign. Good working practice will help to limit the amount of light pollution and further reduce the risk of bird strikes.

Season and Location

The vulnerable seabird receptor species all show seasonal patterns of abundance and distribution within Falklands waters. Although potentially vulnerable birds are present in all months, the timing of the Campaign generally coincides with the period of lowest abundance for these species. The period of greatest concern will be early in the Drilling Campaign (March and April) when young birds will be departing from breeding colonies. The number of birds will increase towards the end of the Campaign as adults return to breed.

Reducing Light Pollution

Heli-deck landing lights will be switched off when not in use (if not required to be left on for safety reasons) to reduce potential impacts of these skyward facing lights on any bird species that may be present. In addition, the ERRV and supply vessel deck lighting will be switched off when not in use (if not required to be left on for safety reasons).

For safe working practices, all working areas will have to be well illuminated. Additionally, the risks of explosion and corrosion mean that it is not always possible to switch lights on and off on drilling rigs. However, there are means of limiting the horizontal and vertical spread of light, which will help to reduce the risk of light induced bird strikes.

Some of the guidelines that are applied to ships operating in the region would be appropriate for use on supply vessels and the rig, these include;

- The use of blackout blinds/curtains will eliminate light from living spaces,
- The majority of lights on the rig will be directed inwards to allow safe working conditions however, outward facing lights are necessary for navigation and safety, so cannot be reduced.

9.6.1 Residual Impact

The impacts associated with artificial light offshore are considered to be of low significance prior to mitigation measures. It is best practice to minimise any impacts to the marine environment and the amount of light spilling horizontally into the environment will be minimised where practical and possible. However, as the pre-mitigation impacts were assessed to be of '**Low**' significance, there will be no change in assessment of the residual impacts, which are also of '**Low**' significance.

Table 53: Summary of the impact of offshore light generated during the Campaign on marine life

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance		Certainty	Mitigation / Prevention / Control
							Pre-mitigation	Post-mitigation		
Supply/ERRV vessels	Vessel, navigation lights	Seabird strikes	Planned	Daily	Low	Minor	Low		Probable	Heli-deck landing lights will be switched off when not in use (if not required to be left on for safety reasons) to reduce potential impacts of these skyward facing lights on any bird species that may be present. In addition, the ERRV and supply vessel deck lighting will be switched off when not in use (if not required to be left on for safety reasons). Minimise light emission from accommodation with blackout blinds. Direct deck lighting inboard and shade/deflect horizontal spreading where practical and possible, If flaring occurs, deploy a dedicated observer to quantify impact
Supply/ERRV vessels	Vessel, accommodation	Seabird strikes	Planned	Daily	Low	Minor	Low		Probable	
Supply/ERRV vessels	Vessel, deck lights	Seabird strikes and attraction of other marine life	Planned	Daily	Low	Minor	Low		Probable	
Drilling operations	Rig, accommodation	Seabird strikes	Planned	Daily	Low	Minor	Low		Probable	
Drilling operations	Rig, deck lighting	Seabird strikes and attraction of other marine life	Planned	Daily	Low	Minor	Low		Probable	
Drilling operations	Rig, flaring	Seabird strikes	Planned	Max. 2 days per well	Low	Minor	Low		Probable	

** See Section 6.0 for definitions of severity and significance.*

10.0 Inshore and Onshore Impact

10.1 Introduction

Logistical support for the 2015 drilling campaign will be based in Stanley. Cargo will be delivered and stored in lay-down yards at the shore base before being transported to the rig, by supply vessels. At times, this activity will potentially have an impact on the local environment and community. Inshore and onshore impacts cover a range of activities associated with the operation of vessels, on the TDF and at the shore base. These include:

- Interference to other sea users due to increased vessel traffic in Stanley Harbour;
- Collisions between support or supply vessels and marine mammals;
- Introduction of marine invasive species by support or supply vessels;
- Disturbance to wildlife and the human population onshore from helicopter noise;
- Introduction of terrestrial invasive species with cargo;
- Disturbance to Stanley residents and wildlife from inshore and onshore light and noise sources; and
- Demands for accommodation in Stanley.

The range of activity is so varied that each of these subjects will be treated separately below.

10.2 Interference to Other Sea Users due to Increased Vessel Traffic in Stanley Harbour

10.2.1 Introduction

Stanley Harbour and Port William are utilised by a wide range of vessels; including fishing vessels, reefers, cruise ships and cargo vessels. Peaks in usage are associated with the timing of fishing seasons (particularly at the start when vessels licences are issued and at the end, when catch may be offloaded) and the summer cruise ship season. Space for vessel manoeuvres in Stanley Harbour and through the passage into Port William (The Narrows) can be tight (see Figure 12: Location of the Temporary Dock Facility, Section 3.5.9) and there is history of vessel collisions and groundings within these areas (A. Black pers. obs.). The Harbour Master is accustomed to different types of vessels and crews from a range of nationalities entering and exiting Stanley Harbour and vessels are required to report intended movements within the Harbour. A system is in place to record the entry and exit of vessels into Port William and Berkeley Sound.

Interference with other sea users due to increased traffic in Stanley Harbour has already been covered under the TDF specific ESHIA (Noble Energy/RPS, 2013) and a harbour management plan for the TDF will be in place for the duration of the operations. This section describes the potential impacts that are specific to the 2015 drilling campaign.

10.2.2 Sources of Interference to Users of Stanley Harbour

A number of different vessels associated with the 2015 drilling campaign will be using Stanley Harbour. These include;

- Six coaster cargo vessels will travel between Aberdeen (Scotland) and Stanley to deliver all the equipment required for the drilling campaign. On arrival, coasters will moor alongside the TDF to facilitate the transfer of cargo.
- The two rig supply vessels will travel between the drilling rig and Stanley on a five to seven day rotation throughout the drilling campaign. On arrival in Stanley Harbour, these vessels will moor alongside the TDF to facilitate the transfer of cargo.

- The rig ERRV will spend the majority of the time offshore, close to the position of the rig, however, it will return to Stanley occasionally (on a 4-6 week basis) to refuel and change crew.

These vessels will be passing through Port William and The Narrows before docking at the TDF. The TDF is not equipped with fuel bunkering facilities and it is intended that vessels will move to FIPASS for refuelling during each visit to Stanley Harbour.

10.2.3 Environmental Receptors within Stanley Harbour

Any disruption to third-party vessels has the potential to impact fishing and cargo operations, which could result in a loss of business revenue, due to the additional time and fuel needed to complete their activities.

There is a system of reporting for vessels entering/leaving Stanley Harbour and Port William, which enables information regarding ship movements to be passed to arriving/departing vessels. However, additional traffic in a confined space will increase the risk of collisions between vessels.

The key area restricting shipping activity in Stanley Harbour is the lack of berth space at FIPASS. At times, demand outstrips available space and vessels may have to leave FIPASS and anchor to create space for other vessels, or wait for a berth to become available. Due to the necessity to transfer cargo to and from lay-down yards onshore, the oil and gas industry have been heavy users of FIPASS in previous campaigns. However, not all vessels use FIPASS as licensing inspections, passenger transfers, fuel bunkering and transhipment of fish to reefers can all be achieved at anchor.

Other users of the Harbour include:

Fishing vessels

At the start and end of fishing seasons (see Section 5.4.5), fishing vessels tend to arrive in Stanley Harbour for licensing. Not all these vessels go alongside FIPASS, instead many will anchor in Port William or Stanley Harbour.

Fishery Patrol Vessels

The Falkland Islands and South Georgia and the South Sandwich Islands Government's Fishery Patrol Vessels are regular visitors to Stanley Harbour throughout the year and will go alongside FIPASS if space is available.

Cargo vessels

Cargo vessels visit Stanley on a regular basis and require a berth at FIPASS to transfer cargo onshore.

Cruise ships

All but the smallest cruise ships anchor in Port William, from where they ferry passengers onshore (to the Public Jetty) in tenders. Some of the smaller cruise vessels will go alongside FIPASS. The vast majority of cruise ship visits occur between October and April.

Reefers

Reefers are refrigerated vessels that transport catch from fishing vessels and deliver it to market. Most of these vessels anchor in Port William or Berkeley Sound and rarely enter Stanley Harbour. The activity of reefers reflects the timing of the fishing seasons and catch rates in any given year.

Tankers

Tankers will visit FIPASS occasionally to transfer fuel (less than 20 visits per year, Harbour Master pers. comm.). At other times, tankers may be anchored in Berkeley Sound to bunker fishing vessels.

Yachts and pleasure craft

A number of locally owned yachts are moored at The Canache, the inlet to the east of the TDF. Most visiting yachts moor at jetties in the town or anchor in front of the town.

10.2.4 Characterising and Quantifying the Impact of Increased Traffic in Stanley Harbour

The TDF could potentially be operational 24 hours a day seven days a week, and therefore, vessels could arrive or depart at any time.

The Number of Vessels Visiting FIPASS

Statistics regarding the number of vessels visiting FIPASS are only available on an annual basis (Harbour Master pers. comm.). Figure 53. Shows the number of visits by vessel type over the period 2008 to 2013.

The number of visits for ‘fishing’ and ‘all other vessels’ was reasonably consistent between 2008 and 2013, however, supply vessel visits varied considerably, reflecting oil and gas exploration activity. Exploration campaigns were ongoing throughout most of 2010, 2011 and into 2012. The necessity to move cargo through FIPASS resulted in a considerable increase in demand for this facility. For instance; during 2011, supply vessels accounted for over 39 % of all vessel visits to FIPASS.

During the 2015 campaign each supply vessel is expected to refuel once a week, the ERRV will refuel every 4-6 weeks and coasters will refuel prior to departure, therefore over a 120 day campaign there will be approximately 53 refuelling visits to FIPASS.

In addition to their own requirements, supply vessels will be transporting fuel to the drilling rig. Refuelling is achieved at a rate of 35-40 m^3/hr and the maximum capacity of the supply vessels is believed to be in the order of 800 m^3. From empty, refuelling could take approximately 20 hours.

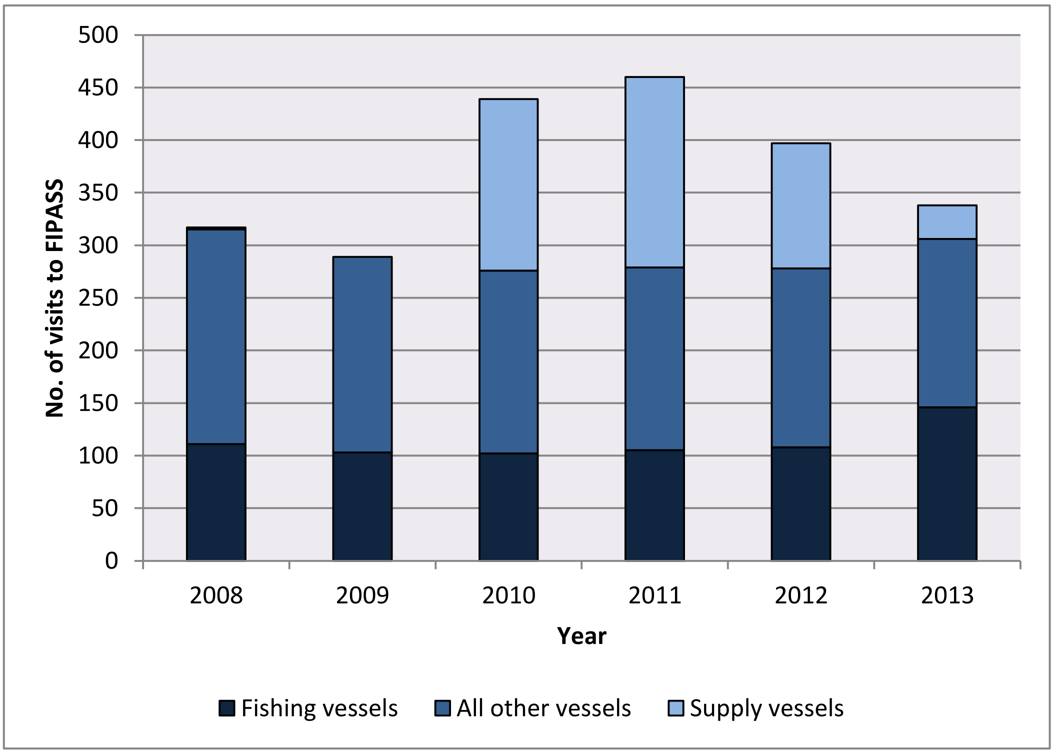


Figure 53: The recorded number of vessel visits to FIPASS between 2008 and 2013 (Data from Harbour Master)

10.2.5 Impact Assessment Summary

A summary of the impact assessment is shown in Table 56, page 265.

10.2.5.1 Severity and Receptor Sensitivity

Disruption to Other Users of Stanley Harbour

Facilities and space within Stanley Harbour are limited, which means that during busy periods, vessels may not be able to obtain a berth at FIPASS when required. This can lead to delays and additional costs, in fuel and launches. Any additional pressure from the oil and gas industry will exacerbate the issue. However, the construction of the TDF will alleviate much of the pressure placed on facilities by the drilling campaign, although refuelling will still take place at FIPASS.

The TDF is situated in an area that is not usually used as an anchorage so the disruption to other users of Stanley Harbour, who wish to anchor, will be minimal. Along with the localised and short-term nature of the impact the severity of disruption to other user of Stanley Harbour is assessed as ‘**Minor’**.

With the TDF in place, there is moderate capacity to absorb the added pressure from the oil and gas industry without significant alterations to present working practices. There will however be some disruption to other users of Stanley Harbour, which may have economic implications. Therefore the sensitivity of the receptors involved has been assessed as ‘**Moderate’**.

10.2.5.2 Significance

Disruption to Users of Stanley Harbour

There is the potential for economic impact on other users of Stanley Harbour, through competition for berths at FIPASS. The construction of the TDF should reduce the amount of time that supply vessels are alongside FIPASS and help to allay any concerns of other users of the Harbour. However, the significance of disruption to other users of the Harbour has been assessed as ‘**Moderate’**. Measures will be put in place to help to reduce the significance. The risk is believed to be acceptable but the situation will be continually reviewed.

10.2.5.3 Degree of Confidence

There have been three previous exploratory drilling campaigns in the Falklands (since 1998) and therefore the nature of the potential impact of increased vessel traffic is well understood. This drilling campaign will run for a fixed, relatively short period and the number and frequency of ship visits are understood. Therefore confidence in the assessment is ‘**Certain’**.

10.2.5.4 Cumulative Impacts

There are peaks and troughs in the number of vessels using the Stanley harbour throughout the year. Most of these fluctuations are associated with the start or end of fishing seasons when demand for berths at FIPASS are at its highest. During previous campaigns, offshore supply vessels contributed considerably to the amount of traffic within Stanley Harbour, resulting in a large cumulative impact.

10.2.6 Mitigation measures

As part of standard working procedures, measures will be in place to limit the level of disruption to other users of Stanley Harbour. These measures include:

- The appointment of a Marine Superintendent to liaise with the Harbour Master, FIPASS management, Stanley Services and other users will help to keep everyone well informed and promote good working relationships;
- Notes to Mariners will be issued to inform all masters of vessels of the presence of a new shoreline facility;
- A navigational risk assessment will be completed to inform the preparation of a Stanley Harbour Management Plan. This Plan will be prepared in close collaboration with the

Harbour Master and cover the following as a minimum: pre-notification protocols associated with the entry of vessels in Stanley Harbour; pre-defined passage routes within Stanley Harbour; procedures associated with vessel collision and emergency response;

- Marine night-time lighting will be required and procedures will be put in place for periods of poor weather.

Alternatives

Critical to the disruption to other users of Stanley Harbour is the need to use FIPASS for refuelling. There are alternative means of vessel bunkering from tankers at anchor in Berkeley Sound and whilst this has been considered, it is safer and more efficient to use the facilities at FIPASS.

10.2.6.1 Residual Impact

The employment of a Marine Superintendent and the development of a Stanley Harbour Management Plan will help to coordinate activities thus reducing the severity of the impact. With severity reduced to '**Slight**', the significance of interference with other sea users becomes '**Low**'.

10.3 Collisions Between Support or Supply Vessels and Marine Mammals

10.3.1 Introduction

It is believed that collisions between cetaceans and vessels are more frequent than previously suspected (WDCS, 2006). An increase in the risk of collisions is linked to a general increase in the density of shipping traffic and in particular the number of large fast moving vessels (Silber et al., 2009). Globally, this has become an increasingly important issue (WDCS, 2006). In particular, the threat to northern right whales has received attention, as the impact of collisions with vessels is threatening the survival of this Critically Endangered species (NMFS, 2005). Off the east coast of the US and Canada, several mitigation measures have been put in place, including closed areas and speed limits, to reduce the risk of collisions (NMFS, 2005). Interactions between fin whales and ships in the Mediterranean Sea are also causing concern (Vaes and Druon, 2013).

Small cetaceans (dolphins) are fast moving and agile enough to avoid vessels travelling at moderate speed and are not considered further. In recent years, seal carcasses have been recovered from beaches in the UK with characteristic 'corkscrew' injuries. The available evidence suggests that these injuries are caused by contact with ducted propellers, such as Kort nozzles or ducted azimuth thrusters (Thompson et al. 2010).

In the following section, the risk of collisions between cetaceans and vessels associated with the 2015 drilling campaign is assessed and the potential for corkscrew injury is discussed.

10.3.2 Sources of Shipping Traffic

Like any area where cetaceans and shipping coexist, there is the potential for whales and vessels to collide in Falkland Islands waters. Coaster and supply vessels will be steaming through Falkland Islands waters on a regular basis throughout the drilling campaign. It is anticipated that the two supply vessels will travel from Stanley to the drilling rig and back on a five-seven day rotation. Coasters will arrive in the Islands at intervals of 10-14 days in the early part of the Campaign and the ERRV will visit Stanley on a monthly basis.

10.3.3 Environmental Receptors in the Exploration Campaign Area

There are a wide range of cetaceans found within Falklands waters, most of these have clear spatial and temporal patterns of distribution (see Section 5.4.6).

Sensitivity of Environmental Receptors

The available evidence suggests that, the risk of collisions is highest in waters where high densities of cetaceans and shipping are found, in the Falklands these are coastal waters, particularly near Berkeley Sound and Port William.

A range of factors relating to cetacean behaviour are thought to influence the likelihood of a collision, these include:

- ***Age and condition*** - A high proportion of the recorded incidents relate to young animals or females with calves.
- ***Swimming speed*** - Each species will display characteristic behaviour in terms of swimming speed and time spent on the surface.
- ***Congregation*** - At certain times, animals may congregate in areas to feed or breed. The risk of colliding with an animal where high densities occur is increased.
- ***Feeding / Mating Behaviour*** - Animals engaged in feeding or mating behaviour are less likely to respond to an approaching vessel. Also, many large whales feed on planktonic organisms in the surface layers of the water; therefore, feeding animals may spend longer on or near the surface than those that are travelling. Most planktonic organisms perform a daily vertical migration, being closer to the surface at night. Therefore, cetaceans may be more vulnerable at night when feeding near the surface and undetectable by watch keepers on vessels.
- ***Vessel habituation*** - Animals that are constantly subjected to vessel noise may become habituated and not respond to an approaching vessel.

Two species that are encountered in the coastal waters of the Falklands are likely to be the most vulnerable due to their behaviour (southern right whale) or abundance (sei whale).

Right whales

Globally the distribution and behaviour of right whales appears to make them particularly vulnerable; they have a coastal distribution, spend prolonged periods near the surface and are slow moving. In the Falklands, southern right whales are occasionally seen in inshore waters; including Stanley Harbour (A. Black pers. obs.).

Sei whales

Sei whale is by far the most numerous species of large whale in coastal waters near Stanley (White et al., 2002,) but are also found throughout the inshore waters of the entire archipelago (Thomsen and Munro, 2014). Anecdotally, there is evidence that the number of sei whales within Falklands waters, and more generally within the south west Atlantic (Iñíguez et al., 2010), is increasing, although the occurrence of this species has been erratic in the past. However, sufficient survey data to determine a population estimate is currently unavailable.

Sei whales appear to respond to approaching vessels and are relatively fast swimmers, however, they tend to swim just below the surface leaving a clear trail of ‘fluke prints’ in their wake (Sea Watch Foundation, 2012). There are many records from around the world of collisions between sei whales and vessels (IWC database, 2014).

10.3.4 Characterising and Quantifying the Impact of Vessel Collisions with Cetaceans

This is a global issue that requires further research in order to better understand and model the potential impact on cetacean species (IWC/ACCOBAMS, 2011). The International Whaling Commission (IWC) encourages mariners to report collisions with cetaceans, although many collisions go unobserved or unreported. The objectives of collecting this information are; to lead to more accurate estimates of the incidence of mortality and injuries, to help detect trends over time, to allow better modelling of risk factors (for example, vessel type, speed and size), and to identify high risk or unsuspected problem areas.

- Any incidents of collisions with marine mammals should be reported to the International Whaling Commission (www.iwc.int\ship-strikes or shipstrikes@iwc.int) and FIG

The probability of a collision between a cetacean and a vessel is related to the density of shipping traffic and cetacean density in the same area (see Vaes and Druon 2013). The outcome of the collision is related to the size and speed of a vessel.

Vessel traffic

The penultimate round of exploratory drilling in the Falklands was underway throughout 2011. During this year, there were 1,515 vessel movements reported in Berkeley Sound, Port William and Stanley Harbour (Harbour Master pers. comm.). Of these, 314 (20%) were supply vessels for the exploration campaign.

Vessel size and speed

The size and speed of a vessel clearly influences the force and outcome of any collision between a cetacean and a ship. The length of the coaster vessels used during the drilling campaign is currently unknown, however, most supply vessels that have been involved with previous campaigns are approximately 80 m in length and 3,000 GRT (Mærsk, 2014).

The available evidence suggests that collisions occur between cetaceans and vessels of all sizes but most fatal collisions are on vessels greater than 80 m in length (Laist et al., 2001). Larger vessels clearly have more momentum than smaller vessels travelling at the same speed. Additionally, they are less able to manoeuvre to avoid a collision and visibility of animals near the bow may be restricted.

The outcome of a collision is related to speed, whales struck at speeds greater than 14 knots are more likely to die whereas whales struck at speeds lower than 14 knots are more likely to survive (Laist et al., 2001). The faster a vessel is travelling the less likely it is that a cetacean will be observed, ahead of a collision. The transit speed for a supply vessel is likely to be approximately 12 knots, as this is the most economical speed for vessels of this type (Mærsk, 2014).

Cetacean detectability is a function of vessel speed and breathing rate, although a range of environmental factors and observer experience are also important. The faster a vessel is travelling, the less likely it is that a cetacean will be observed ahead of the ship.

10.3.5 Impact Assessment Summary

A summary of the impact assessment is shown in Table 56, page 259.

10.3.5.1 Severity

Wherever high densities of cetaceans and shipping coexist there is the potential for collisions between the two. There are anecdotal reports of collisions or near misses between vessels and cetaceans in the south west Atlantic but little information that can be used to give a quantitative assessment of the issue. However, there are many examples of collisions between a wide range of cetacean species and vessels from elsewhere in the world, many of these species are also found within Falklands waters (IWC database, 2014).

Between March and May, which covers the currently anticipated start time of the campaign, it is likely that a large number of sei whales, and possibly other species, will be encountered while on passage through inshore waters of the Falkland Islands. Large cetaceans, albeit at lower densities, can be encountered anywhere within Falklands waters (see Section 5.4.6 and White et al., 2002). The number of cetaceans encountered within Falklands waters declines over the winter but will increase towards the end of the campaign, in November. The number of large cetaceans within Falklands waters remains relatively high throughout the summer, peaking in late summer. The 2015 campaign is currently anticipated to run from March to November. Therefore, given that a large number of whales are present in inshore waters during this period, it is assumed that there is a risk of collisions between cetaceans and vessels associated with the 2015 campaign.

The available evidence suggests that the size and speed of a vessel are key factors determining the outcome of a collision. The supply and support vessels used during the campaign are likely to be about 80 m long and are likely to steam at about 12 knots. The likelihood of survival following a collision is directly relative to the size and speed of the vessel concerned. Also, cetaceans are better able to avoid vessels travelling at low speed and mariners will be better able to detect and avoid cetaceans.

The conservation status and life history of large cetaceans (sei whales are Endangered) mean that any collision that could result in mortality would have a moderate short-term impact on the species. For these reasons the severity of collisions between ships and cetaceans has been assessed as '**Moderate**'.

10.3.5.2 Likelihood

Currently, much of the shipping activity is focused on the east coast of the Islands, near Stanley. Although the drilling campaign will increase shipping by about 25%, the annual number of ship movements is relatively low (the total number of vessel visits to Berkeley Sound and Port William is about 1,500 per year). Collisions between cetaceans and shipping are often unreported or unobserved. Post-mortem examinations of carcasses found elsewhere in the world indicate that the number of reported incidents under-estimates the scale of the issue. However, there are no known records of collisions or beached carcasses, with signs of ship-strike injury, from the Falkland Islands. Additionally, the density of shipping around the Falklands is relatively low, compared with elsewhere in the world, and there is no indication that there is currently an issue around the Falklands. The likelihood of a collision has been assessed as '**Remote**'.

10.3.5.3 Significance

The risk of collisions between shipping and cetaceans is of great concern in specific locations around the world where high densities of cetaceans and shipping coexist. Although it is not thought that a significant problem exists in the Falklands at present, further investigation to establish the causes, consequences and provisions for risk management are required. The overall significance of the risk has been assessed as '**Moderate**' and therefore opportunities to reduce the risk are proposed.

10.3.5.4 Degree of Confidence

Data gaps exist regarding the inter-annual variation in density of the environmental receptors. Sei whales are a common sight throughout the inshore waters of the Falklands but a complete survey is yet to be undertaken. It is clear that not all incidents of collisions between marine mammals and vessels are reported or even evident to the crew of the vessel. For these reasons, confidence in the assessment is '**Probable**'.

10.3.5.5 Cumulative impact

There is already a reasonable amount of fishing and cargo vessel traffic using Berkeley Sound, Port William and Stanley Harbour. The 2015 campaign will increase the amount of vessel traffic in and out of Stanley by about 25%. As a worst-case it has been assumed that this could translate to a similar relative increase in the risk of cetacean strike.

10.3.6 Mitigation Measures

Cetaceans could be encountered during any month throughout Falklands waters. A number of common sense precautions should be taken to reduce the likeliness of collisions with cetaceans:

- Mariners should be made aware of the issue and how it relates to the Falkland Islands (see IFAW (2013) leaflet).
- Along with the usual duties of a watch keeper, additional vigilance is required to detect cetaceans in inshore waters.

10.3.6.1 Residual Impact

Increased awareness and vigilance should reduce the risk of collisions between vessels and marine mammals, leading to a barely detectable impact on these species. With mitigation in place the likelihood of the impact will be reduced to '**Improbable**' and therefore the overall significance will be '**Low**'. Vessels will be requested to report any incidents, which will help to quantify the scale of the impact and better inform future impact assessments.

10.3.7 Corkscrew injury

In recent years, the discovery of seal carcasses in the UK with characteristic 'corkscrew' lacerations on their bodies has prompted researchers to investigate the cause (Thompson et al. 2010). In all likelihood the injuries were caused by ducted propellers, such as Kort nozzles or ducted azimuth thrusters. Observations in flow tanks indicate that these thrusters do not strongly draw a current of water towards the propeller and therefore animals would have to consciously approach close to a propeller (within the diameter of the blades) to be injured (SMRU 2014).

The extent to which this is an issue is unknown in the UK, research is ongoing. To date, research indicates that there is a seasonal component to these incidents in UK waters, which mainly affect female common seals (*Phoca vitulina*). Female common seals are known to respond to territorial calls made by breeding males and it is thought that the animals impacted are attracted to the sound generated by the propeller. Juvenile grey seals (*Halichoerus grypus*), which are the main victims during winter months in Norfolk and Scotland, have also been shown to be attracted by conspecific calls with a pulsing rhythmic pattern. The other possibility that has been considered is that animals are attracted to concentrations of food associated with the vessel.

In the Falklands this is an unknown phenomenon, although it may have gone unobserved. While on station the rig and supply vessels will maintain position with DP thrusters. The Eirik Raude's position is controlled by 6 x fixed pitch variable speed thrusters and the PSVs' positions are controlled by 2 x 2500 kW Azimuth thursters and 3 x 965 kW (3 x 1294 bhp) electric motor driven tunnel type bow thrusters. Several species of seal are likely to be present in the vicinity of the well sites in low numbers (White et al. 2002; Hipsey et al. 2012). However, observations over a two week period during drilling operations in June 2011 did not record any marine mammals in the vicinity of the rig (Munro 2011).

At present, investigations are ongoing in the UK and the true scale of the issue is unknown, to date, no mitigation measures have been proposed. At this time, the certainty of any assessment of the impact of corkscrew injury on marine mammals in Falklands waters would be '**Unlikely**' and therefore of little value. However, any interactions between marine mammals and vessels used during the 2015 Drilling Campaign will be reported. This will help to determine whether there are any adverse interactions between these animals and vessels operating under DP in Falklands waters.

10.4 Introduction of Marine Invasive Species by Support Vessels and the Drilling Rig

10.4.1 Introduction

The IUCN has identified the introduction of non-native species as one of the major threats to native biological diversity. Not all non-native species that arrive in the Falklands are able to survive, reproduce and spread, to the point that they become invasive. However, the impact of species that do become invasive can be immense and often irreversible (Otley et al., 2008). The impact of invasive species on island ecosystems like the Falklands, where native species have evolved in biological isolation, can be particularly harsh. Over the last two hundred years, or so, human trade and travel has introduced alien species to areas like the Falklands were the native species are not adapted to the new threat.

Around the world, there are many documented cases of invasive species and their impact on native biodiversity, along with associated economic impacts in many cases (Lowe et al., 2004). In particular, OGP/IPIECA (2010) provides an excellent review of the risks that the oil and gas industry pose regarding the introduction of non-native species.

On the central Patagonian coast, most ecosystems have been modified by invasive species (Orensanz et al., 2002). In the Falklands, until recently there was no baseline, so determining those species that are native and those that are invasive is not always straight forward. However, it is clear that there are several invasive species already established within Stanley Harbour and Mare Harbour, such as, the tunicate (*Ciona intestinalis*) and the parchment worm (*Chaetopterus variopedatus*) (SMSG, 2011). Both species have the potential to out compete and smother native species.

In this Section, an assessment is made of the potential for the 2015 drilling campaign to introduce non-native species to the Falklands' marine environment that, in time, could become invasive.

10.4.2 Sources of Non-native Species Introductions to the Falklands

Globally, shipping routes cross many biogeographical boundaries and vessels have the potential to transport 'hitch-hiking' organisms from one region to another. All vessels, including the rig *Eirik Raude*, that travel to the Falklands for the purpose of the drilling campaign have the potential to introduce non-native species to the Islands.

- The *Eirik Raude* has been operating in southern and western Africa. A recent (September 2013) ROV hull marine growth survey found the degree of biofouling was between 5-60%, depending on area of hull, mostly composed of acorn barnacles, algae and slime. Around 95% of this growth was removed during the survey, where possible.
- Supply vessels and coasters will travel between either Aberdeen, Scotland, or West Africa, and the Falklands, passing through various international waters on route.

10.4.3 Sensitivity of Environmental Receptors to Invasive Species

The marine ecosystem of the Falklands has evolved in isolation and the introduction of alien species is likely to have serious impact on biodiversity, through competition or predation on native species. There are many examples from around the world where this not only impacts on biodiversity but also has serious economic impact (OGP/IPIECA, 2010). However, at present there is no discernible economic impact from marine invasive species in the Falkland Islands. Once established, marine invasive species are extremely difficult to remove.

10.4.4 Characterising and Quantifying the Impact of Marine Invasive Species

There are two main pathways by which non-native marine species are transported; through ballast water and biofouling on the hulls of vessels. Both routes are recognised as serious issues by the International Maritime Organisation (IMO), who have developed guidelines to guard against such introductions.

Ballast water

Planktonic organisms, larval stages, eggs and micro-organisms can all be transported from one location to another in ballast water, and associated sediments. Ballast is taken onboard to trim and stabilise a vessel, ballast exchange practices are specific to each vessel.

There is an international convention governing the exchange of ballast water, however, the UK is not a signatory. The Falklands may well adopt the legislation without adopting the Convention but have not done so yet (M. Jamieson pers. comm.). However, all international shipping is obliged to follow the Convention's guidelines under International Law.

IMO guidelines for ballast water exchange

Key to the safe and effective exchange of ballast water is a Ballast Water Management Plan. The Plan is specific to each ship and includes a detailed description of the actions to be taken to implement the Ballast Water Management requirements and supplemental Ballast Water Management practices. The Plan includes;

- The duties of key shipboard control personnel undertaking ballast water exchange at sea. Such personnel should be fully conversant with the safety aspects of ballast water exchange and in particular the method of exchange used onboard their ship, and the particular safety aspects associated with the method used;
- Ships must have a Ballast Water Record Book to record when ballast water is taken on board; circulated or treated for Ballast Water Management purposes; and discharged into the sea. It should also record when Ballast Water is discharged to a reception facility and accidental or other exceptional discharges of Ballast Water.

In terms of environmental effectiveness, ballast water exchange should take place in offshore oceanic waters, which will minimise the probability that harmful aquatic organisms and pathogens be transferred in ships' ballast water. The exact specifications vary between countries and regions, however, a general standard is for ballast water exchanges to take place at least 200 nautical miles from the nearest land in waters over 200 m deep (IMO, 2004).

The rig, *Eirik Raude*, will travel from western Africa under its own steam, while in transit the ballast tanks will be empty of seawater (fuel and freshwater will act as ballast) and therefore the risk of transporting marine organisms in ballast water is low. Ballast water will be taken onboard as fuel is burnt, which will be managed in line with IMO guidelines. The ballast requirements of the other vessels involved in the campaign are unknown at present.

Biofouling

Biofouling is the growth of marine organisms on man-made structures. Once established, biofouling species can be transported to colonise environments that they would not be able to reach through natural dispersal. Figure 54 outlines the stages that lead to the introduction of invasive species from one location to another via biofouling.

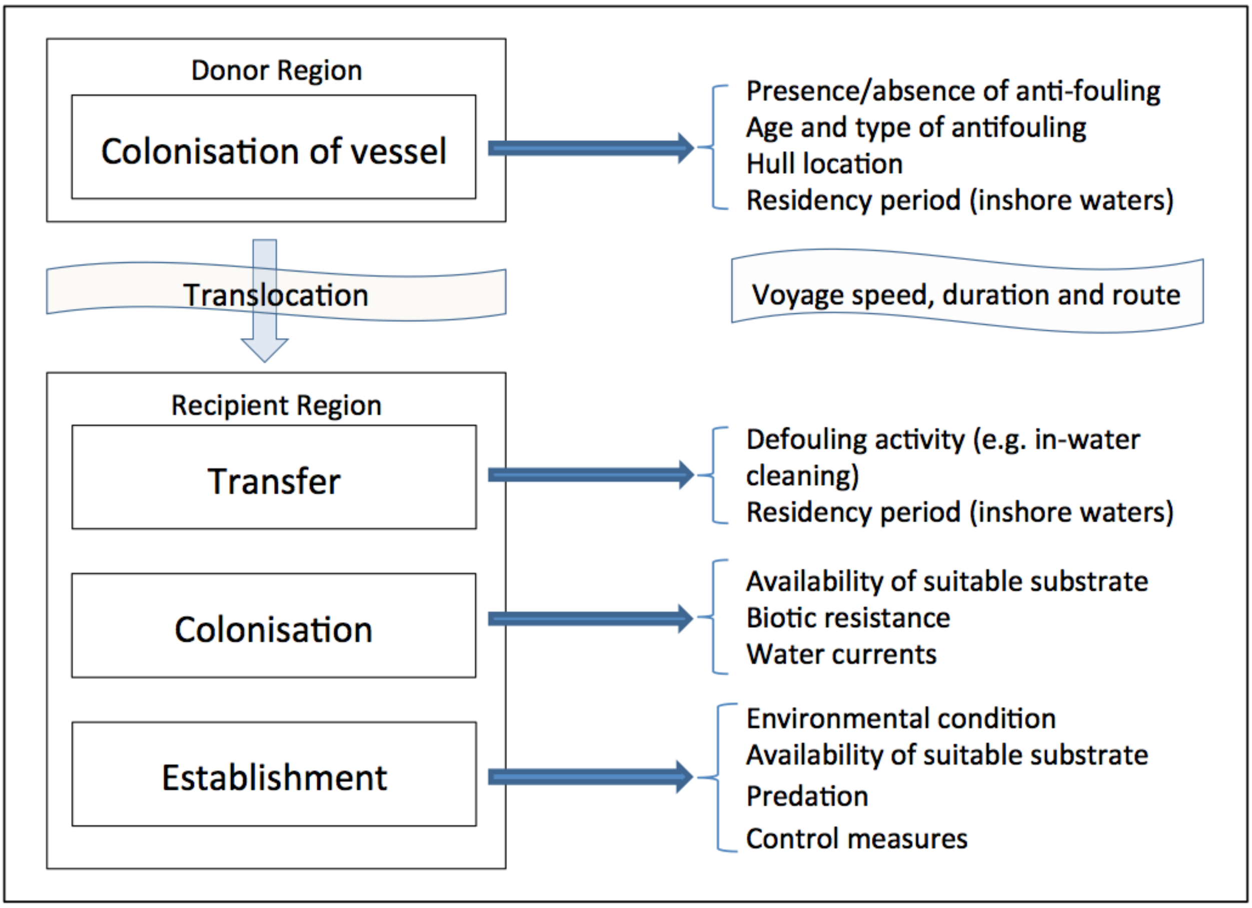


Figure 54: The process of invasive species introduction (from Lewis and Coutts 2010)

- ***Colonisation*** - Whether biofouling organisms become established on the hull of a vessel, or not, largely depends on the condition of anti-fouling treatment and the residence period in inshore waters, where biofouling organisms are most abundant.
- ***Translocation*** - Once established, particularly in niches in the hull like sea chests, organisms can be transported across oceans and biogeographic boundaries. The movement of the vessel through the water, changes in temperature and salinity may help to remove some organisms. However, this is no guarantee that biofouling organisms will be killed or removed from a vessel's hull. For instance, Lee and Chown (2007) found that biofouling organisms can survive multiple voyages between South Africa and Antarctica.
- ***Transfer*** - Once in the recipient region, biofouling organisms still have to transfer to the marine environment to become invasive. This can happen naturally over time or due to mechanical processes such as hull cleaning.
- ***Colonisation and Establishment*** - Once released into the marine environment of the recipient region, a potentially invasive species must become established and reproduce, which will require suitable conditions. This is more likely if the donor and recipient regions are ecologically similar. If an introduced non-native species becomes established it can be regarded as invasive and will impact the native biodiversity and may also result in long-term economic impact.

IMO guidelines to control and manage biofouling

There is an International Convention governing anti-fouling on ships, and the *Eirik Raude* rig will adhere to the requirements of the Convention.

In 2011, the Marine Environment Protection Committee of the IMO introduced guidelines for the control and management of ship biofouling to minimise the transfer of invasive aquatic species (MEPC, 2011). The guidelines recommend the use of a vessel specific Biofouling Management Plan and the maintenance of a Biofouling Record Book. The purpose of the Plan is to outline measures used to control and manage a vessel's biofouling to minimise the transfer of invasive aquatic species. Such a Plan should address the following;

- Details of the anti-fouling systems and operational practices or treatments used, including those for niche areas and sea chests;
- Hull locations susceptible to biofouling, schedule of planned inspections, repairs, maintenance and renewal of anti-fouling systems;
- Details of the recommended operating conditions suitable for the chosen anti-fouling systems and operational practices;
- Details relevant for the safety of the crew, including details on the anti-fouling system(s) used; and
- Details of the documentation required to verify any treatments recorded in a Biofouling Record Book (see MEPC, 2011 - Appendix 2).

Vessels employed during the Drilling Campaign

The specific support and supply vessels have not yet been selected for the campaign but they are likely to be travelling from Aberdeen or West Africa. Northern Scotland and the Falklands are both temperate regions and species from one of these regions are likely to survive in the other. It is less likely that species from tropical West Africa would thrive in the Falklands. Vessels travelling from Aberdeen to the Falklands will pass through the Tropics, which will help to remove most biofouling organisms although there is no guarantee of removing all of them (Minchin and Gollasch, 2003).

It is not anticipated that Premier Oil will take the rig into inshore waters, and it is understood that Noble Energy will also maintain the rig offshore (Noble Energy/RPS, 2014). The risk of biofouling organisms transferring to and becoming established in the Falklands is greatly increased when vessels are inshore, as most species require hard substrates to attach to. Therefore, coaster and supply vessels that will travel to and from Stanley Harbour pose the greatest risk. However, there is still a small risk that organisms growing on the rig could be transferred to supply vessels and then transported to inshore waters.

10.4.5 Impact Assessment Summary

A summary of the impact assessment is shown in Table 56, page 259.

10.4.5.1 Severity

Most marine invasive species impact inshore benthic communities of native species, which is difficult to detect and monitor. If invasive species were introduced during the drilling campaign the impact on the benthic ecology of the Islands may not be evident for a number of years. However, the long-term implications for the Islands ecology could be severe and irreversible. Currently, the number of invasive species in the Harbour is apparently small but the species present are able to out-compete native species (SMSG, 2011). Elsewhere in the world, the impact of invasive species can be far more dramatic. For instance, the European shore crab (*Carcinus meanus*) has been transported all over the world. Once established, they displace native species of crab and depredate native invertebrates resulting in loss of native biodiversity, and can greatly impact crab and shellfish industries (CABI, 2014). At present, there is limited exploitation of inshore resources and aquaculture in the Falklands but this could develop in the future. The introduction of parasites, disease, competitors or predators could impact these industries. The severity of the impact will be species specific but following the precautionary principle (worst-case scenario) the severity has been assessed as '**Major**'.

10.4.5.2 Likelihood

Vessels will be visiting Stanley Harbour on a regular basis throughout the drilling campaign. The vessels and therefore their operational history are unknown at the time of writing. There are International conventions regarding the ballast water and biofouling management but the Falklands are currently not signatories. However, vessels registered in the UK (and elsewhere) or operating in International waters will be following the requirements of the ballast water and biofouling conventions. The guidelines produced by the IMO are widely accepted within the shipping industry. When followed, the IMO's guidelines on exchanging ballast water and managing biofouling organisms, will greatly reduce the likelihood of introducing non-native species. Given the number of vessels that visit Stanley and the apparently few invasive species in the harbour (SMSG, 2011), the introduction of invasive species appears to be an uncommon event. However, introduction of invasive species has happened in the Falklands, and by the industry elsewhere, and therefore the likelihood of invasive species becoming established as a result of the drilling campaign has been assessed as '**Remote**'.

10.4.5.3 Significance

The environmental and economic impacts posed by the introduction of non-native marine species are well documented. However, many of the factors that lead to this are vessel specific; such as, anti-biofouling maintenance, previous location and activity. There are risk-reduction measures available that are widely used and accepted by the shipping industry. Although vessels will be following these measures to reduce the likelihood of an introduction, the precautionary approach used throughout this assessment assumes the worst-case scenario, in terms of severity. Therefore, overall significance of the risk of introducing non-native marine species has been assessed as '**Moderate**'. Additional mitigation measures are required to reduce the significance.

10.4.5.4 Degree of Confidence

The nature of the impact of invasive species on the marine environment will depend on the species involved but it is understood that the introduction of any non-native species is detrimental to the environment. The likelihood of vessels to be harbouring potentially invasive species is vessel specific and depends on a number of factors; including, anti-fouling maintenance and location prior to travelling to the Falklands. Data gaps currently exist regarding the identity and location of vessels that will be employed during the drilling campaign. However, the practices proposed here are used internationally and all vessels involved in the campaign will be well maintained and vetted before contracts are awarded. Confidence in the assessment is therefore '**Probable**'.

10.4.5.5 Cumulative Impacts

Numerous vessels arrive in Stanley Harbour from all over the world. There is the potential for any of these vessels to be harbouring non-native species. Vessels associated with the 2015 drilling will add slightly to the potential for the introduction of non-native species.

10.4.6 Mitigation Measures

Ballast water

At present, the FIG regard ballast water management as an issue but there is no policy or legislation in place. The industry standard mitigation measures for ballast water defined by IMO guidelines (described in Section 10.4.4 above) will be followed by all vessels during the campaign. Additionally the rig will depart from West Africa with empty ballast tanks, although ballast will be taken on during the passage as fuel is burnt. Ballast exchanges will be undertaken as the rig approaches the Falklands EEZ, in accordancy with the IMO guidelines. Once the rig is on station within Falklands waters any ballast water onboard will have originated from the south west Atlantic and can be exchanged without the risk of introducing non-native species. No further mitigation measures are proposed.

Biofouling

Biofouling is harder to mitigate than introduction through ballast water, and consequently the risk of each vessel introducing invasive species to Falkland Islands waters should be assessed on a case by case basis.

- Prior to arrival in the Falkland Islands the *Eirik Raude* has been operating in southern and western Africa. Regular ROV surveys are conducted on the *Eirik Raude* and survey results may give an overall indication of bio-fouling on the hull, however, removal of marine growth is not always practicable or standard practice due to the safety risks of undertaking this activity outside of dry dock. There are currently no plans to dry dock the *Eirik Raude* prior to the drilling campaign.
- The *Eirik Raude* will comply with the IMO Guidelines on Marine Biofouling.
- The coaster and supply vessels employed during the drilling campaign will also follow IMO guidelines on marine biofouling.

10.4.6.1 Residual Impact

Following the rig audit and standard application of the IMO guidelines, the risk of introducing non-native marine species should be reduced but not eliminated entirely, as such the likelihood of the impact will still be '**Remote**' and therefore the overall significance will remain '**Moderate**'. However, the identity and condition of the supply and coaster vessels is unknown. Each vessel needs to be assessed on a case-by-case basis. To ensure that bio-foulling management measures are up-to-date.

The IMO guidelines should minimise the risk of the introduction of non-native marine species. However, if non-native species were introduced their detection would be difficult without monitoring in place. In order to provide an early warning system, settlement plates will be attached to the TDF and checked regularly.

10.5 Disturbance to Wildlife and the Human Population Onshore from Helicopter Noise

10.5.1 Introduction

There has been considerable concern regarding the impact that aircraft noise can have on colonies of penguins and seals on Antarctica and on sub-Antarctic islands (for example, Hughes et al., 2008), and consequently this issue was also raised by stakeholders in relation to the 2015 drilling campaign. There have been few scientific studies that have examined such effects, however, evidence from these studies has suggested behavioural and physiological changes in penguins and seals resulting from low flying aircraft (discussed in Hughes et al., 2008).

Low flying aircraft invoke particularly strong responses in penguins, which can lead to trampling of adults, chicks and eggs, and the loss of exposed eggs and chicks to predators. There have been several studies to investigate the short-term behavioural response of penguins to overflying helicopters on South Georgia (Hughes et al., 2008; Lee and Black, 2013). In both studies, the behaviour of penguins changed significantly at a range of over flight heights (230 – 1,768 m) but the lower the flight the greater the observed changes in behaviour. It is usually the non-incubating / non-brooding birds that react most and will often leave the colony. Mortality of chicks or loss of eggs as a result of helicopter disturbance was not recorded in either study. To date, no studies have measured the physiological stress on penguins that is associated with this type of disturbance.

This section investigates the potential for disturbance caused by low flying helicopters on penguins and other wildlife, as well as the local community.

10.5.2 Sources of Helicopter Noise during Premier Oil's 2015 Drilling Campaign

Ambient Aircraft Noise in the Falkland Islands

There are a number of helicopters based at MPC that are used for Search and Rescue (SAR) and transporting military personnel and cargo around the Islands. Additionally helicopters fly visitors to some of the offshore islands that support concentrations of wildlife and occasionally overfly Stanley. SAR helicopters occasionally undertake exercises in Stanley Harbour and deliver patients to the KEMH, landing on the school's football pitch.

Additionally, there are a number of military fixed-wing aircraft (from Typhoon jets to C130 Hercules) that regularly practice low-level flying around the Islands. In recognition of the threat posed by low-flying aircraft to wildlife, and also the risk of bird strikes and damage to aircraft, the Ministry of Defence (MoD) has developed a flight avoidance map to protect areas of sensitive wildlife in the Falklands from disturbance (MoD, 2014).

Helicopter Noise Generated during Premier Oil's Campaign

Three Sikorsky S92 helicopters will be used to transport crew members to and from the drilling rig. Helicopter operations will be mostly run from Stanley but some flights may also use Mount Pleasant Airfield. The site used in previous drilling campaigns at Cape Dolphin will not be used during the 2015 drilling campaign.

It is anticipated that helicopter flights would occur on a daily basis, with at least one flight per day, as a worst-case. Additionally, every two weeks, half the rig crew will change and it is anticipated that this will require 4-8 flights to and from the rig.

10.5.3 Environmental Receptors Onshore

In the Falklands, the most vulnerable receptors are breeding and moulting penguins; a number of species will be present on land throughout the year.

The unusual breeding strategy of king penguins means that birds will be breeding at the Volunteer Point colony starting between September and November and running through to January. This colony supports virtually the entire Falklands breeding population.

Although they do not breed year-round, Gentoo penguins return to shore to rest throughout the winter months and may congregate away from breeding colonies. The number of breeding birds on the coasts of northern East Falkland is approximately 23% of the Islands' population (Baylis, 2012).

Rockhopper and Magellanic penguins depart from the Islands shortly after moulting and do not return until the spring (September). When breeding, Magellanic penguins are dispersed around much of the coastline but there are no population estimates. Rockhopper penguins are relatively uncommon in the north of East Falkland, which supports approximately 2.3% of the Islands' population.

Most penguins will be moulting during March and April. At this time, penguins lose all of their feathers and are unable to enter the water, and therefore feed, for a period of approximately one month. The moult is energetically extremely expensive and disturbance should be minimised to avoid unnecessary use of energy reserves.

It is also possible that helicopter noise could impact on livestock in the Islands. Following the austral winter local farmers are concerned about the weakness of their sheep flocks and the likelihood of a poor lambing season (mid Sep - end Oct). The farmers are equally concerned about the shearing season that runs from Nov - Feb. The danger is one of mass panic by a corralled flock, which has been startled by aircraft noise (FILFH, 2014).

It is likely that other species of seabird and seals would also be disturbed by helicopter over flights. In the Falkland Islands, areas with notably high wildlife significance are designated as NNRs, Ramsar sites or IBAs. Additionally, Eddystone Rock is used by South American fur seals, these animals favour the seclusion of isolated offshore rocks/small islands to avoid human disturbance (Campagna, 2008). Figure 55 highlights the distribution of sensitive environmental receptors and community settlements in the north of East Falkland. Direct flight lines between the two main heliports and drilling locations are indicated by arrows.

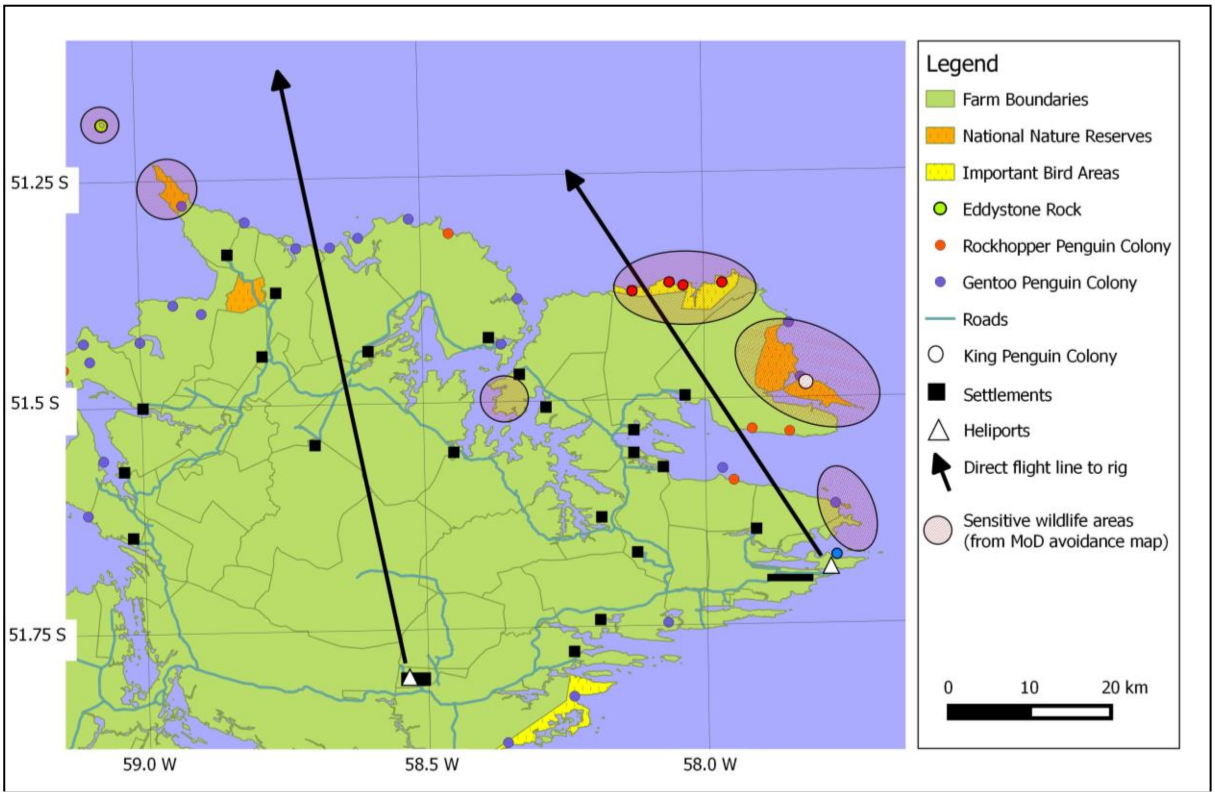


Figure 55: The distribution of sensitive wildlife receptors and settlements in the north of East Falkland.

Helicopters flying directly between Stanley and the drilling rig will pass nearly 10 km to the west of the king penguin colony at Volunteer Point. However, they will pass directly over the Seal Bay IBA, on the north coast of East Falkland. This area is designated an IBA due to the populations of breeding rockhopper, gentoo and Magellanic penguins and sooty shearwaters (see Section 5.4.7). The flights could also pass over a number of farms.

Disturbance to the Residents of Stanley and Other Settlements

The heliport in Stanley is approximately 3.5 km from the nearest housing. The north of East Falkland is dotted with small settlements and farms (Figure 3).

10.5.4 Characterising and Quantifying the Impact of Helicopter Noise on Wildlife and Human Settlements Onshore

Helicopter transfers of crew are an essential component of the campaign and will happen on a daily basis, they are planned events. Every two weeks, there will be up to five flights, to and from the rig, to change crew.

There are several sources of helicopter noise, which can be broadly split into three types; main rotor, tail rotor and engine noise. The Sikorsky S92 is fitted with tapered rotor blades that are swept back and downwards to increase lift but this also reduces noise.

These aircraft are widely used in the oil and gas industry but there is little data available regarding the sound level generated in flight. One study, looking at the impact on human health, reported sound levels of 110-115 dB as passengers boarded an idling aircraft (Klovning, 2012). It can be assumed that the same helicopter in flight would be considerably louder (assumed to be approximately 125 dB here). The noise experienced on the ground will be directly related to the distance between the helicopter and the listener. It is possible to calculate the sound level at various distances from the source (Table 54) by applying the following equation:

Noise difference = 20 x $\log_{10} (r_2/r_1)$: where r_1 and r_2 are distances in metres.

In the above equation, r_1 is a reference point with known sound levels (r_1 m from the source), r_2 is the location under investigation (r_2 m from the source).

Table 54: Sound Level from Helicopter Activity Experienced at Ground Level (BMT, 2005)

	Maximum sound level at distance from helicopter (dB)		
Activity	**1 m**	**600 m**	**3,500 m**
Idling	115	58	44
Hovering	125	68	54

In terms of human disturbance, for comparison Table 55 gives representative values of the sound experienced in everyday situations. Wildlife is likely to be far more sensitive and react not only to the sound of a helicopter but also to the visual disturbance (A. Black pers. obs.).

Table 55: Typical Sound Levels in Relation to a Hovering Helicopter at 600m Distance

Sound Level (dB)	Typical Everyday Activities Characteristic of Each Sound Level	Sound Level Relative to Idling Helicopter at 600m Distance
80	Diesel truck at 40 mph at 50 ft	Twice the 70 dB reference
70	Vacuum cleaner	1, 70 dB reference
60	Conversation in a busy restaurant	$^1/_2$, as loud as 80 dB
50	Conversation at home	$^1/_4$, as loud as 80 dB
40	Urban ambient (library)	$^1/_8$, as loud as 80 dB

Environmental factors, especially wind, will also influence the propagation of sound and far more sophisticated models are required to accurately predict the noise level experienced by a receptor at any given point under a range of environmental conditions. Therefore the values given here should be regarded as a rough guide to sound perceived under still wind conditions.

10.5.5 Impact Assessment summary

A summary of the impact assessment is shown in Table 56, page 259.

10.5.5.1 Severity and Receptor Sensitivity

Disturbance to Wildlife

The sensitive wildlife receptors that are most vulnerable to helicopter noise are mostly coastal in distribution, with a potential for some livestock to be present in-land. The impact of a single helicopter over-flight is likely to be short-term and rapidly reversible. However, the combined impact of numerous (daily) disturbances could have serious implications for the survival of moulting birds or chicks. The species of greatest concern is king penguin as these birds breed year-round and virtually the entire Falklands population is in one location, Volunteer Point. Under normal circumstances, the helicopters should have no need to overfly this area, which is designated as a NNR and should be avoided. Gentoo penguins return to shore throughout the winter. Nearly a quarter of the Falklands population breed in the north of East Falkland. Outside the breeding and moulting periods, these birds are less vulnerable to disturbance but over-flights should be avoided to minimise the impact of human activities on these species. Magellanic and rockhopper penguins will be on land between September and April but are at-sea between May and August. Due to the potential for chronic effects in small areas over the course of the campaign (currently March-November), the severity of helicopter over-flights has been assessed as '**Moderate**'.

There are areas that are designated as NNRs close to the direct flight paths between the rig and Stanley or MPC; Kidney and Cochon Islands, Volunteer Point and Cow Bay, Cape Dolphin and Moss Side (see Section 5.4.8). Additionally, the north coast of East Falkland, known as Seal Bay, and Bertha's Beach, near MPC, are designated IBAs for their colonies of penguins. The national importance of these areas means that the sensitivity of the receptors is assessed as '**High**'.

Disturbance to Human Settlements

Stanley airport is sufficiently far from the nearest housing to negate the effect of helicopter noise. At times it may be possible to hear the helicopters but the sound level experienced will be comparable with background noise. There should be no need for helicopters to overfly Stanley during normal operations, although this may happen in the case of a medivac situation.

The distribution of settlements in the north camp is well known. The impact of helicopter noise will be localised and short-term resulting in a barely detectable impact on the local population. The severity of the impact on Falklands' residents is **'Minor'**.

The use of aircraft to transport passengers is an everyday occurrence in the Falklands so there is a degree of tolerance. Direct flight lines between the heliports and the drilling rig locations do not pass directly over settlements. The sensitivity of the local population to helicopter disturbance is assessed as '**Low**'.

Disturbance to livestock

Generally livestock is widely spread at low densities and therefore a small proportion of animals would be subject to disturbance from helicopters at any one time. However, if animals were gathered in a confined space the impact would be more severe. Following the precautionary approach, the severity of helicopter disturbance on livestock is assessed as '**Moderate**', due to the small area that will be affected and short-term nature of the impact. Due to the relatively low proportion of the livestock impacted the sensitivity of receptors has been assessed as '**Low**'.

10.5.5.2 Significance

The overall significance of helicopter noise on wildlife and livestock onshore has been assessed as '**Moderate**' and therefore mitigation measures to reduce the significance will be developed and implemented.

The significance of helicopter noise on Falklands' residents is '**Low**'. This is largely due to the tolerance of people to aircraft and the fact that people subjected to mild noise disturbance do not come to any physical harm. Nonetheless, every effort will be made to ensure that helicopters do not fly unnecessarily close to settlements.

10.5.5.3 Degree of Confidence

The project activities are clearly defined in terms of the start and end points of flights, the frequency of flights and the locations of vulnerable receptors. The precise flight paths are yet to be determined but avoiding sensitive areas should be easily achievable. The long-term consequences of the impact to wildlife are not fully understood but means of completely negating the impact can easily be implemented. Confidence in the assessment is '**Certain**'.

10.5.5.4 Cumulative impact

Military helicopters generally fly under wildlife avoidance guidelines and in line with the Falkland Islands Low Flying Handbook, which should negate any wildlife and livestock disturbance. However, other MoD aircraft operate under the proviso that they follow the rules unless operationally necessary. In the past this has resulted in a degree of wildlife disturbance (Reid and Huin 2005). Under normal operating conditions helicopter activity during the drilling campaign will follow planned routes and have no need to land anywhere other than Stanley airport or MPC.

Therefore, the drilling campaign should not result in any additional impact on wildlife or livestock disturbance.

10.5.6 Mitigation Measures

The simplest and most effective way to mitigate the effects of noise from helicopter over-flights is to route helicopters away from colonies of penguins, other seabirds, seals, farms and human settlements. Following the example set by the MoD and on other islands; such as South Georgia, risk reduction methods (flight avoidance maps) are available, which generally have a history of successful use and acceptance. The development of a project specific flight plan should be sufficient to mitigate against the impact of helicopter noise to wildlife and people in the Falklands and allay the concerns expressed by stakeholders during consultations. Premier Oil will use the flight avoidance map as the basis for flight planning, follow the FI Low Flying Handbook Guidance, and brief helicopter pilots in flight avoidance protocols. The areas of greatest concern on the direct route between Stanley and the well sites are Volunteer Point and the IBA at Seal Bay. Where it is not possible to avoid areas of high wildlife sensitivity, minimum flight heights will be specified (>900 m, >3,000 ft). In addition to the restricted areas identified on the MoD map, the following recommendations follow those of the Government of South Georgia and the South Sandwich Islands:

- When following the coastline, maintain a vertical separation distance of 600 m (2,000 ft) and a horizontal separation of ¼ nautical mile (c.500 m) from the coastline where possible;
- Cross coasts at right angles and above an altitude of 600 m (2,000 ft) where possible;
- Never hover or make repeated passes over wildlife concentrations or fly lower than necessary; and,
- Avoid unnecessary over flight of livestock or known livestock grazing areas.

10.5.6.1 Residual Impact

With a flight plan in place that avoids areas containing sensitive wildlife the severity of the impact will be reduced to '**Minor**'. Avoidance of the high densities of receptors will also reduce the sensitivity of receptors to Low. With mitigation, the significance of disturbance caused by helicopter noise on wildlife and livestock will be reduced to '**Low**'.

10.6 Introduction of Terrestrial Invasive Species with Cargo Imports

10.6.1 Introduction

Many species have been introduced to the terrestrial environment of the Falklands, some intentionally and some unintentionally. In recent years, there has been a concerted effort by FIG to reduce the risk of visitors to the Islands unintentionally introducing more non-native species and biosecurity procedures have been improved.

There are numerous examples in the Islands where invasive species have had socio-economic impacts and almost certainly impact on the biodiversity of the Islands. For example, the invasion by the European earwig (*Forficula auricularia*) of Stanley is a timely reminder of the risks posed by non-native species. European earwigs were first accidentally introduced to Stanley in the early 2000s. Since then, they have spread throughout the town and to outlying settlements and increased hugely in number. These pests have had a number of consequences for the residents of Stanley, such as a direct nuisance from home invasions, and the long-term in-direct impact from the use of chemical pesticide treatments on native species and loss of fruit and vegetable crops. The implications for the Islands should earwigs spread beyond settlements are unknown. To date the Falklands Islands Government has expended much time and resource to combat the spread of earwigs with limited success. Currently a proposal to conduct biological control, with a parasitic fly, has been given consent. It has been assessed that this method has the potential to control earwigs without impacts on other environmental receptors (CABI, 2013).

The following section assesses the risk of introducing non-native species with cargo associated with the 2015 drilling campaign.

10.6.2 Sources of Non-native Species Introduction during the 2015 Drilling Campaign

Any cargo arriving from outside the Islands during the 2015 Exploratory Campaign poses a risk of unintentionally introducing non-native species. In this regard, the highest risks are invertebrates, seeds and soil (containing micro-organisms) that can adhere to the outside of containers or be hidden within cargo. Ecologically, the terrestrial habitat of the Falklands is comparable with that of the UK. Species that may be transported from the UK are very likely to survive and potentially become established in the Falklands (*c.f.* European earwig).

Coaster vessels are schedule to arrive in Stanley, from the UK, every 10-14 days during the early stages of the campaign. Each vessel will be carrying a range of cargo to facilitate all aspects of the 2015 drilling campaign.

Importing Fruit and Vegetables

During the previous round of exploratory drilling in 2011, fresh fruit and vegetables were imported into the Falkland Islands on the campaign charter flight. Whilst this was welcomed by local residents, it also represents one of the greatest risks of introducing non-native species; within the produce, adhering soil or packaging. Additionally, it may be necessary to air freight other cargo from the UK to MPC via the charter flight. This is not the preferred method for importing materials to the Islands but may be used if urgent drilling supplies are required.

10.6.3 Environmental Receptors Affected by the Introduction of Non-native Species

The greatest environmental impact associated with the introduction of non-native species would be on the biodiversity of the Falklands. When non-native species thrive to the point of becoming invasive, they tend to outcompete or predate native species. The precise receptor species would depend on the species introduced.

10.6.4 Characterising and Quantifying the Impact of Non-native Species

A cargo laden coaster will arrive in the Falklands every 10-14 days over a period of 5-6 months. The precise nature or origin of the cargo is not known at the time of writing but will include drill pipe and bulk chemicals.

It is clear that many species have been introduced in the past; however, quantifying the risk is not straight forward. It is likely that many cargos arriving in the Falklands are harbouring some non-native species, whether these are able to survive, breed to become invasive depends on the species concerned and whether they find a niche to exploit in the Falklands. Therefore, the impact of any introduction should be assessed on a case-by-case basis.

10.6.5 Impact Assessment Summary

A summary of the impact assessment is shown in Table 56, page 259.

10.6.5.1 Severity

If invasive species were introduced during the drilling campaign the impact on the ecology of the Islands through parasites, disease, competitors or predators may not be immediately evident. If found, potentially invasive species, particularly plants, can be removed and disposed of before becoming established. However, detecting microscopic or small mobile organisms (such as invertebrates) is very difficult once onshore. However, the long-term implications for the Islands could be severe and difficult to reverse. In the terrestrial environment the possibility of detecting potential invasive species and eradication, thereby reversing the effect, is easier than in the marine environment, on this basis the severity has been assessed as ‘**Moderate**’.

10.6.5.2 Likelihood

Coaster vessels will be arriving in Stanley throughout the drilling campaign and a large amount of cargo will be taken onshore. The transportation of invasive species to the Falklands has happened in recent years. The introduction of invasive species has happened in the industry elsewhere in the world and therefore the likelihood of invasive species becoming established as a result of the drilling campaign has been assessed as '**Possible**'.

10.6.5.3 Significance

The movement of large quantities of cargo has discernible environmental and social risks in terms of the potential to introduce non-native species. There are means of reducing the risk, which are becoming widely used and accepted. Overall the significance of the risk of introducing non-native terrestrial species has been assessed as '**Moderate**'.

10.6.5.4 Degree of Confidence

The nature of the impact of currently established invasive species on the terrestrial environment of the Falklands is understood. It is difficult to predict the impact of the arrival of additional non-native species, as it will depend on the species involved. Therefore there is a degree of uncertainty regarding the sensitivity of environment receptors.

Confidence in the assessment is therefore assessed as '**Probable**'.

10.6.5.5 Cumulative Impacts

Any cargo coming into the Falklands has the potential to transport non-native species into the Islands. The 2015 drilling campaign will add considerably to the existing risk of introducing invasive species to the Falkland Islands.

10.6.6 Mitigation measures

The best means of reducing the likelihood of introducing non-native species is to ensure that all materials are clean when packed or loaded in the port of origin, particularly items of fresh fruit and vegetables.

- All Premier Oil personnel should be briefed on the significance of non-native species and instructed to capture/kill any invertebrates that are found while unloading/unpacking cargo.
- Cargo should be clean when packed and sealed in appropriate packaging.
- Falkland Islands Biosecurity Guidelines will be adhered to for any freight imported via the charter flight.
- On arrival in the Falkland Islands, cargo will be inspected for biosecurity breaches. Any breaches should be reported to the FIG Biosecurity Officer.

FIG Biosecurity guidelines

Any person, vehicle or cargo travelling to the Falklands has the potential to introduce non-native species. The Government's guidance to visitors states:

The Falkland Islands are extremely fortunate in that they are free from most of the serious animal and plant pests and diseases that affect many other parts of the world.

The Government and people of the Falkland Islands would like this favourable situation to continue into the future. Your assistance is requested in ensuring that unwanted diseases and pests of either plants or animals are not inadvertently introduced into the Islands by the illegal importation of any biological material. The list is endless but includes the following:

- *Animals (Alive or dead).*
- *Unprocessed plant material to include everything in the nature of a plant and the flowers. To include fruits, vegetables, plants, shrubs, tubers, bulbs, nuts, seeds, leaves, cuttings, sprigs, bark and cut flowers.*

- *Uncooked foods of animal origin. To include meats of any kind such as Beef, Lamb, Pork, & Venison; Poultry such as Chicken &Turkey; Meat & Poultry products such as bacon, hams, sausages, burgers, pates, salamis & chorizos; Dairy foods such as milk, butter, cheese, yoghurts & milk puddings; Eggs, including eggshells.*
- *Any other unprocessed items of animal origin such as wood, feathers, hides, leather, wool, bone or any other biological product.*
- *Soil or any articles containing soil.*
- *Compost particularly if untreated.*
- *Any veterinary products or medicines.*
- *Any animal foodstuffs such as Oats/Barley/Hay/Straw/Animal Concentrate.*
- *Packaging that has contained any of the above products.*

10.6.6.1 Residual Impact

An increase in awareness regarding the risks associated with the import of non-native species, added vigilance when packing and unloading cargo and fumigation/trapping, where appropriate, should remove potential invasive species at source or enable the detection/capture of non-native species before they escape into the environment. The capacity for rapid on-site cleaning will reduce the severity to '**Minor**' and increased vigilance will reduce the likelihood to '**Remote**', resulting in '**Low**' post mitigation significance. Monitoring of incoming cargo will help to evaluate the effectiveness of the biosecurity protocols and indicate if revision is needed.

10.7 Disturbance to Wildlife and Local Residents from Shore Based Light and Noise Sources

10.7.1 Introduction

The impact of the operation of the TDF and the laydown yards has already been covered in a separate EIA (see Noble Energy/RPS 2013). For completeness, the impacts associated with shore based light and noise are summarised here.

As with lights at-sea, lights onshore can attract and disorientate wildlife, particularly nocturnal seabirds. Where endangered species of petrel nest near urban areas this has proved to be a major problem (Reed et al., 1985; Le Corre et al., 2002). Birds are vulnerable throughout the breeding season but fledgling birds are particularly vulnerable.

Light pollution and excessive noise can become a nuisance to local residents resulting in a reduced quality of life.

In the following section, the impact of artificial light and noise from inshore and onshore activities are assessed.

10.7.2 Sources of Onshore Light and Noise

Ambient Sources of Light

The area of the shore base is already an industrialised area, approximately 1.5 km to the east of Stanley. Additionally, vessels anchored in Stanley Harbour and Port William can at times add considerably to terrestrial sources of ambient light.

Ambient Sources of Noise

Although situated in an industrialised area, there is no heavy industry in the vicinity of the shore base. The Falklands Interim Port and Storage System (FIPASS) is the most industrialised area in Stanley, which sits between the TDF/shore base and the town. It is rare that vessels work cargo at FIPASS outside core working hours (8am to 8pm), however, there is no perception that these activities cause undue noise.

At times, vessels anchor in the Harbour adjacent to Stanley. Noise from these vessels, particularly if they have large generators, can be heard by local residents on calm nights.

Sources of Inshore and Onshore Light during the 2015 Drilling Campaign

It is anticipated that at times the TDF, shore base and laydown yards will be floodlit to enable safe working of cargo. Activity on the TDF and laydown yards could occur 24 hours a day, seven days a week, therefore, there could be a visual impact during night time hours. Night time lighting on the TDF may be visible from long distances and has the potential to cause a nuisance to residents.

Presently, there is a considerable background level of artificial light in Stanley. The town of Stanley is currently illuminated by street lights and industrialised areas (such as FIPASS) are equipped with floodlights similar to those on the TDF.

Sources of Inshore and Onshore Noise during the 2015 Drilling Campaign

The TDF and shore base could operate 24 hours a day seven days a week. The most significant noise generating sources and activities during operations are considered to be:

- Vessel arrival / departure during drilling programme Supply Vessels, typically 5,000 to 10,000 brake horsepower; and
- Vessel loading / unloading using a 250-tonne crane, a 30-tonne crane; and a 15-tonne forklift.

10.7.3 Environmental Receptors Impacted by Inshore on Onshore Light and Noise

The environment receptors to light and noise can be broadly classified as; the residents of Stanley (including Stanley Airport) and local wildlife.

Residents of Stanley and Stanley Airport

The receptors that are most likely to be affected by the light and noise emitted by the TDF and shore base during the drilling campaign are the residents of Stanley and Stanley Airport. The location of the TDF and shore base is within the existing industrial area of Stanley, to the east of FIPASS, and is more than a kilometre away from the nearest residential receptor.

An additional issue raised by stakeholders is the potential for east-facing lighting from the TDF and the use of bright lighting on vessels at the dock to affect night-time flying operations at Stanley Airport. It is anticipated that supply vessels will moor facing into the prevailing wind (westerly) and therefore the main deck lighting will face east. These lights have the potential to affect the night vision of pilots approaching the main runway at Stanley Airport. Night flying at Stanley is not a regular occurrence and is mainly limited to occasional medical emergencies and training flights in the winter months. However, the potential for lighting from the TDF to affect night-time flights remains.

Local Wildlife

The species most vulnerable to artificial light are small petrels and shearwaters (see Section 5.4.7). The closest breeding colonies of nocturnal petrels to Stanley are found near Hadassa Bay, on Top and Bottom Islands in Port William and Kidney Island near Mengeary Point. These are approximately two, five and eight and a half kilometres away respectively from the TDF and laydown yards and are not in direct line of sight. Breeding birds are present on these Islands during the summer months (September to May), fledging dates range from early April to early May (Woods and Woods, 1988). Wrecked birds (incidences of numerous dead seabirds), presumed to be juveniles, are occasionally found in Stanley after autumn storms. Outside the breeding season these birds remain at-sea.

10.7.4 Characterising and Quantifying the Impact of Inshore Sources of Light and Noise

Light

The preliminary lighting design for the TDF consists of 400 Watt high pressure sodium (HPS) lamps, located 3 m above the deck, tilted at 60 degrees and facing in-board. On the causeway, HPS flood-lamp will be placed every 18 m. This is similar to street lighting as it is only required for traffic travelling to and from the barge and therefore does not require intense lighting. Light towers fitted with 1,000 Watt flood-lamps will also be installed on both the bow and the stern of the barge facing in-board. In addition, it is planned to have 400 Watt flood-lamps installed in the boom of the crane to further aid visibility during lifting operations.

In addition, the majority of lights (other than on the causeway) will be directed away from Stanley towards the loading face of the barge during operation. The lighting and will be of a similar nature and intensity to that already emitted by FIPASS.

The shore base laydown yards are equipped with floodlights. These lights are generally directed inland and downwards, away from residential areas and the sea.

Noise

The EIA for the construction and operation of the TDF included a noise modelling study to assess the potential for noise generation and the potential impacts. Details of the modelling can be found in the TDF EIA (Noble Energy/RPS, 2013).

The supply vessels, which will be moored alongside the TDF or at anchor in the harbour, are equipped with very powerful engines. Engine noise from similar vessels currently using the harbour can be heard by Stanley residents on a calm night.

Forklift trucks at the TDF and the shore base will require safety reversing (a repetitive beeping sound), which may be audible outside the nearest houses in Stanley (Ross Road East and Rowlands Rise) during calm (i.e. quiet) weather.

Noise levels received by outside receptors at the eastern end of Stanley are predicted to be less than 15 and 25 dB $L_{Aeq,5\text{-}min}$ during night-time unloading at the TDF with average (westerly) and worst–case (easterly) wind respectively. Following consultation with local residents, the predictions of the model used appear to have been overly optimistic. Activity during the construction of the TDF is audible, not only during piling, as is activity on FIPASS. Whether this is at a level that causes undue disturbance is uncertain and is likely to depend on the time of day that noise is heard.

10.7.5 Impact Assessment Summary

A summary of the impact assessment is shown in Table 56, page 259.

10.7.5.1 Severity and Sensitivity of Receptors

Light and Stanley Residents

Light spillage towards Stanley will be minimised, given the orientation of the lights and attenuation with distance. In addition, the lighting is unlikely to add significantly to the light emitted by FIPASS and will be of a similar nature to that already employed there. The impact will be localised and short-term and therefore the severity is assessed as '**Minor**'. The sensitivity of Stanley residents is assessed as '**Low**' as they are already subjected to artificial light from FIPASS and from within the town.

The main deck lights of vessels alongside the TDF will face east, towards Stanley airport. Although they point downwards this has the potential to temporarily interfere with the night vision of pilots and the severity is assessed as '**Moderate**'. The potential for disruption of night flights from Stanley Airport is clearly of concern to stakeholders. Therefore, without mitigation the sensitivity of Stanley Airport is assessed as '**Moderate**'.

Light and Wildlife

The TDF and shore base will add to the existing sources of artificial light in the Stanley area and there is some potential for the additional lights to attract small petrels and shearwaters, which could collide with the TDF structure as a result. Currently, there is little evidence that the existing lights in Stanley have resulted in any displacement or collision impacts for petrels or shearwaters. The impact resulting from the drilling campaign will be localised and short-term and in the context of current ambient light levels will have negligible impact on the species concerned, therefore the severity of the impact has been assessed as **'Minor**'.

The nearest breeding colonies of such species are not in direct line of sight of the TDF and birds will migrate away from the Falklands during most of the drilling campaign. The sensitivity of receptors (sooty shearwaters) has been assessed as '**Low**'.

Noise and Stanley Residents

Significant adverse effects to the population of Stanley as a whole are unlikely due to the separation distance between the site of the TDF, the shore base and most homes. However, there are indications that noise can be heard by the residents closest to the TDF (approximately 1 km from the TDF). The results of the noise modelling assessment undertaken for the TDF indicate that the magnitude of operational noise would be below any thresholds at which noise is considered to cause an impact (Noble Energy/RPS, 2013). The modelling assessment also indicated that, during concurrent daytime operations at the TDF and FIPASS, cumulative noise will be dominated by existing operations at FIPASS and consequently the daytime noise environment will be unchanged due to the operation of the proposed TDF. Consultations indicate that this was overly optimistic.

The magnitude of noise impact during loading and unloading at the TDF and shore base during a calm and dry night for which there is a light easterly wind (worst-case scenario) is considered to be negligible and unlikely to cause any potential impact to local residents (Noble Energy/RPS, 2013). The predominant wind direction is westerly so these conditions occur for a minority of the time. In view of comments during the consultation it is likely that there will be some localised disturbance to residents in the east end of Stanley. The severity of the impact is assessed as '**Minor**' and the sensitivity of receptors is '**Low**'.

Noise and Wildlife

The noise generated during the operational phase of the TDF and the shore base is believed to be lower than during the construction phase of the TDF. Modelling suggests that the level of noise will be similar to that already generated by FIPASS and is not thought to be sufficient to impact on local wildlife (Noble Energy/RPS, 2013). The severity of the impact is assessed as '**Minor**' and the sensitivity of receptors is '**Low**'.

10.7.5.2 Significance

Light and Stanley Residents

The significance of the impact of light on the residents of Stanley has been assessed as **'Low'** and no further measures are proposed.

Light and FIGAS pilots

The orientation of deck lighting from vessels alongside the TDF (facing east) has raised concerns over night flying from Stanley Airport. The significance of the impact is assessed as **'Moderate'** and mitigation measures will be implemented to reduce the significance.

Light and Wildlife

The significance of artificial light from the TDF and shore base on inshore wildlife has been assessed as **'Low**', lights will be directed inboard to minimise the impact but no further mitigation measures are proposed.

Noise and Stanley Residents and Wildlife

The significance of noise on the residents of Stanley and local wildlife has been assessed as '**Low**' as it will not exceed levels generated by existing activities in the area.

10.7.5.3 Degree of Confidence

This assessment relies largely on the EIA, and associated modelling, that was presented prior to the construction of the TDF (Noble Energy/RPS, 2013). The TDF and shore base adds to existing sources of light and noise in the industrialised area to the east of Stanley and therefore the nature of the impact is well understood. However, a degree of monitoring is required to ensure that artificial lights do not interfere with FIGAS flights or local wildlife. Therefore the confidence in the assessment is '**Probable**'.

10.7.5.4 Cumulative Impacts

The drilling campaign operations at the TDF will add slightly to the noise generated in what is already an industrialise zone. Modelling indicates that the addition of noise generated at the TDF and shore base will be unnoticeable to the residents of Stanley.

10.7.6 Mitigation Measures

Although the significance of artificial light during the operational phase of the TDF is Moderate, several measures will be used to reduce the impact of the drilling campaign on the residents of Stanley.

Light

All lamp units, save those required for safety and navigation aids, will be pointed in-board towards the causeway and barge, to reduce potential light pollution to local residents in Stanley;

- The TDF and shore base permanent lighting will be designed and implemented in accordance with the Health and Safety in Ports (SIP009) Guidance on Lighting. This is a document jointly prepared by Port Skills and Safety with assistance from the UK Health & Safety Executive (HSE). This will ensure that the artificial lighting used does not generate light spill or reflection that could be a possible nuisance to local residents or attract wildlife; and
- Premier Oil will continue consultation with FIGAS to ensure that the lighting design minimises any potential issues related to the operations of flights in and out of Stanley Airport;

Noise

The significance of noise has been assessed as Low, however, the following measures will further reduce the impact on Stanley residents and wildlife.

- Vessel movements will be reduced where possible through optimised planning, making efficient use of vessel loads;
- All vessel engines shall be switched off whilst not in use and not left to idle, where possible; and
- Loading or unloading operations at night shall not normally occur and if necessary will be minimised where practicable.

10.7.6.1 Residual Impact

The correct orientation of lighting should allow for safe working practices and reduce the amount of light escaping into the surrounding environment. This should minimise the number of potential wildlife receptors (seabirds) that are disorientated and therefore reduce the sensitivity of these receptors to '**Low**'. Liaison with FIGAS to coordinate their requirements for night flying with cargo movements (and therefore the requirement for floodlighting) will help to minimise the sensitivity of this receptor to '**Low**', thus reducing the overall significance to '**Low**'.

10.8 Demands for Accommodation in Stanley

Throughout the drilling campaign, it is anticipated that approximately 85 additional personnel (representing Premier Oil, Noble Energy, third parties and stand-by crew) will be based in Stanley. The majority of personnel with be based offshore but will pass through Stanley during crew changes. During previous exploration campaigns, personnel have been accommodated in local hotels, guesthouses or rental property. However, there is a limit to the number of available beds and properties in Stanley and therefore a different strategy to accommodate personnel during the 2015 campaign is needed.

Having explored a number of potential options, a contract has now been awarded to construct a temporary accommodation block on a brown field site to the south of Stanley (near Stanley Services). It is anticipated that this option will satisfy the bulk of the campaign's accommodation needs. It is envisioned that this facility will also be able to cope with the eventuality of delayed flights, for instance due to bad weather, when 'emergency' accommodation may be required. The construction of the accommodation block will place some additional demands on the power and water supplies in Stanley, although these are on a domestic scale. As a back-up to local power supplies, the unit will be equipped with generators.

It is likely that some individuals involved in the campaign will be accommodated in local hotels and guesthouses, providing a boost to business. However, it is anticipated that the majority of these workers will be housed in the purpose built temporary accommodation unit.

Permanent Stanley based personnel

It is anticipated that the number of additional permanently shore based Premier Oil personnel working in Stanley during the course of the 2015 exploratory campaign will be low (five individuals). Although this is a small number of people they will put extra pressure on the local housing market. Although the recent development of the Sapper's Hill site and extension to Murray Heights have helped to reduce the demands for rented accommodation, rented accommodation in Stanley is in short supply.

Crew change

The majority of personnel will be working offshore. The rig, *Eirik Raude* can take a maximum of 120 workers, with half the rig personnel exchanged every two weeks. Workers may well require accommodation for a night as they arrive in or depart from Stanley or they may be taken by bus straight to MPC. The logistical arrangements will become clearer once a schedule has been confirmed with the MoD regarding the arrival and departure times of the charter flight.

Environmental Impact of the Temporary Accommodation Unit

At the time of writing, planning permission for the temporary accommodation unit has been approved and is in the process of being implemented.

Table 56: Summary of the assessment of inshore and onshore impacts associated with the 2015 drilling campaign

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance		Certainty	Mitigation / Prevention / Control
							Pre-mitigation	Post-mitigation		
Support/supply vessels	Physical presence in Stanley Harbour	Interference with other sea users	Planned	Daily	Moderate	Minor	Moderate	Low	Certain	TDF Manager to liaise with Harbour Master
Support/supply vessels	Collision with other vessels in Stanley Harbour	Release of pollution, injury to personnel	Unplanned	Remote	High	Moderate	Moderate	Low	Certain	Development of a Harbour Management Plan
Support/supply vessels	Collision with marine mammals	Injury to marine mammals	Unplanned	Remote	High	Major	Moderate	Low	Probable	Awareness and increased vigilance in inshore waters
Support/supply vessels	Marine biosecurity	Introduction of invasive species	Unplanned	Remote	High	Major	Moderate		Probable	Follow IMO guidelines on ballast water exchange and bio-foulling management. Hull inspections, monitoring in Stanley Harbour
Heli-ops	Noise disturbance to wildlife	Disturbance to seabirds onshore	Planned	Daily	High	Minor	Moderate	Low	Certain	Identify flight avoidance areas
Heli-ops	Noise disturbance Falklands population	Disturbance	Planned	Daily	Low	Minor	Low		Certain	Identify flight avoidance areas

** See Section 6.0 for definitions of severity and significance.*

Table 56 continued: A summary of the assessment of inshore and onshore impacts associated with the 2015 drilling campaign

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance		Certainty	Mitigation / Prevention / Control
							Pre-mitigation	Post-mitigation		
Shore base, marine and air freight	Terrestrial biosecurity	Introduction of invasive species	Unplanned	Possible	Moderate	Moderate	Moderate	Low	Probable	Educational awareness, ensuring that cargo is clean and checking cargo on arrival in the Falklands. Report any breaches in biosecurity to the FIG Biosecurity Officer
Shore base/TDF	Light	Disturbance to Stanley Residents	Planned	Daily	Low	Minor	Low		Probable	Orientate light away from Stanley
Shore base/TDF	Light	Disturbance to FIGAS pilots	Planned	Daily	Moderate	Moderate	Moderate	Low	Probable	Liaise with FIGAS
Shore base/TDF	Light	Disturbance to local wildlife	Planned	Daily	Low	Minor	Low		Probable	Orientate lights in board
Shore base/TDF	Noise	Disturbance to local residents and wildlife	Planned	Daily	Low	Minor	Low		Probable	None Required

** See Section 6.0 for definitions of severity and significance*.

11.0 Waste Management

11.1 Introduction

Any industrial process will produce waste products, some waste is inherently hazardous to the environment but only if it is improperly managed. Modern disposal and recycling techniques can be employed to minimise the impact on the environment, however, waste disposal options in the Falkland Islands are limited.

The accepted approach to waste management involves the application of a prioritised of management practises, referred to as the Waste Hierarchy (Figure 56: Waste HierarchyFigure 56).

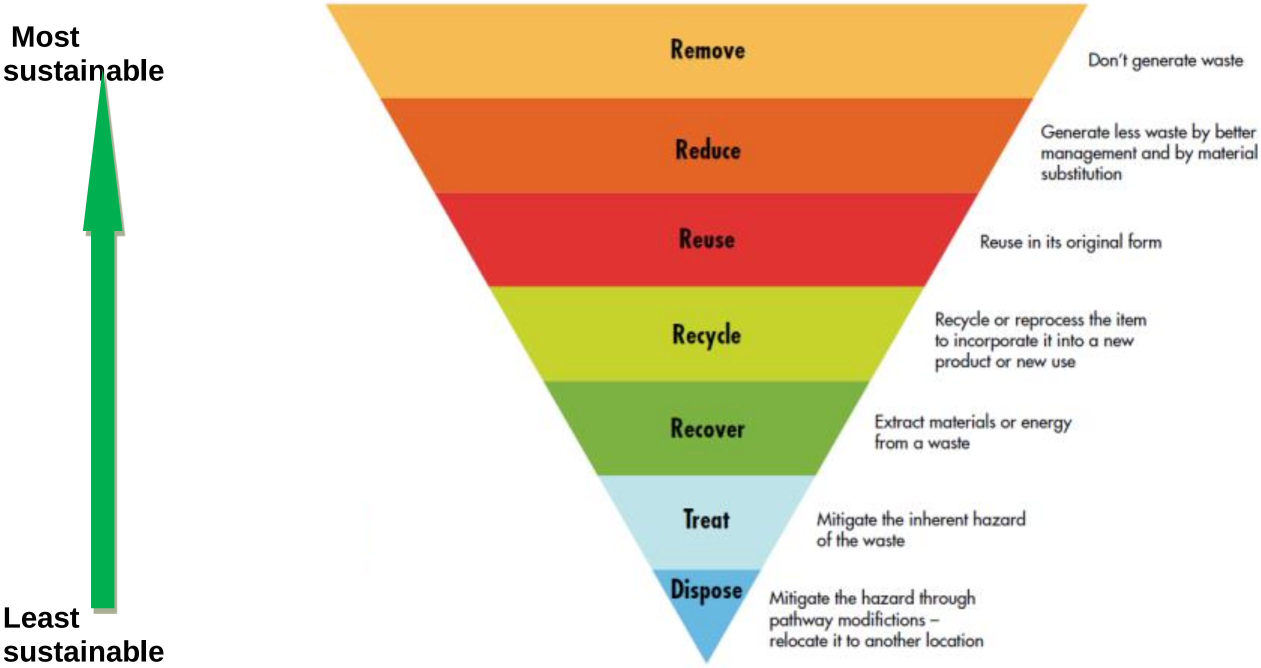


Figure 56: Waste Hierarchy

A range of hazardous and non-hazardous waste will be produced during the Campaign. Premier Oil's Falkland Islands Business Unit (FIBU) have developed a waste management strategy (WMS) to ensure that all waste is processed, stored, transported and disposed of responsibly.

This chapter describes the types of waste that are likely to be generated during the 2015 Drilling Campaign, potential risks to the environment of that waste, and disposal routes for that waste. A combination of this risk assessment and the WMS will be used to develop a Waste Management Plan (WMP) for the 2015 Campaign.

The discharge of Water Based Mud during drilling operations is covered in Chapter 12.0.

International Legislation Regarding Waste Management

There are numerous International and National laws and regulations that govern and control disposal of waste generated in the marine environment. Key pieces of legislation are listed below:

- The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008, implement Annex V of MARPOL 73/78, and provide a general prohibition against the overboard disposal of all types of garbage waste from vessels and offshore installations.

- The 'Duty of Care' was introduced under the UK's Environmental Protection Act 1990. Anyone who imports, produces, carries, keeps, treats or disposes of waste is subject to a duty of care whereby they must take all reasonable and applicable measures:
  - To ensure that waste is stored and transported appropriately and securely so it does not escape;
  - To check that waste transferred to people or businesses for disposal are authorised to do so;
  - To complete Waste Transfer Notes (WTNs) to document transfers.
- The shipment of waste from the Falklands for onward processing in the UK will follow the protocols outlined by the Basel Convention.

11.2 Sources and Types of Waste Generated during Premier Oil's 2015 Drilling Campaign

Virtually every aspect of the drilling Campaign will produce waste in some form, including: corporate operations (offices), drilling, construction, installation and commissioning, utilities, well services and well abandonment. The wastes will typically comprise:

- Galley and domestic waste
- General waste (paper, packaging, scrap metal)
- Hazardous waste (empty chemical drums, oily rags, medical waste etc.)

One of the guiding principles of waste management is the categorisation of waste products, which separates waste of different types and ensures efficient disposal. From the perspective of environmental risk, the key distinction to make is the difference between non-hazardous and hazardous waste.

11.2.1 Definitions of Waste Types

Non-Hazardous Waste*:* will typically include scrap metals, cement, plastics, wood and grey water and sewage from accommodation areas that are not cross-contaminated with hazardous waste and can therefore be removed and recovered for reuse or recycling.

Hazardous Waste: Shares the properties of a hazardous material (e.g. ignitability, corrosivity, reactivity, or toxicity), such as Waste Electrical and Electronic Equipment (WEEE), oil contaminated materials, asbestos, batteries, chemicals and radioactive material, and may pose a potential risk to human health or the environment, if not properly managed.

11.2.2 Waste Disposal in the Marine Environment

Few waste streams generated during the drilling campaign will be eligible for discharge at sea, these include domestic waste, certain drainage water that will be routed to sea following treatment and macerated food waste.

Domestic waste including blackwater (sewage) and grey water (domestic water used in bathrooms, kitchens and laundry) are generated and discharged in the course of normal ship operations. These discharges are regulated internationally through Annex IV of the International Convention for the Prevention of Pollution from Ships (MARPOL) and The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008.

Sewage will be treated prior to disposal at sea and under MARPOL may be discharged in waters greater than 12 nautical miles from the nearest land. Discharge of waste food from the galley is permitted if it is passed through a macerator to ensure that the size of solid particles is less than 25 mm before being discharged, this will aid its dispersal and decomposition in the water column.

Seawater used in fire pumps to wash-down the deck and precipitation will also be discharged at-sea. There is the potential for water on the deck to become contaminated before being discharged into the sea. Bilge water from supporting vessels will also be discharged at-sea.

- The firewater system on the rig relies on sea water mixed with foam. The system is tested every week with sea water alone to ensure that the system is working. The foam system is tested on an annual basis, which is not planned to occur during the 2015 Campaign. A test with foam, or a real incident, would result in foam being discharged into the sea.
- Drainage water is passed through a separator to remove any oil that is picked up from the deck, in accordance to MARPOL 73/78 Annex I requirements the maximum concentration of oil at discharge is 15 parts per million (ppm). Oily water may contain emulsified oil and grease, diesel, hydraulic oil, lube oil, and a full range of marine fuel oils.
- Bilge water from supporting vessels is also covered by MARPOL 73/78 Annex I and will pass through an oil separator before being discharged with a maximum oil content of 15ppm.

11.2.3 Waste Generation and Handling in the Falkland Islands

The majority of waste streams generated by the drilling rig and its supporting vessels will be shipped back to Stanley, where it will be stored along with waste generated in the shore base on a short-term basis in a suitably controlled environment, before being shipped back to the UK for disposal. These waste streams will include general waste (packaging, scrap metal) and hazardous waste (empty chemical drums, oily rags, medical waste etc.). The only potential exceptions will be any waste streams that can be disposed of acceptably in the Islands. Waste oil, as well as select non-hazardous combustibles will be dealt with in the Islands. No waste will go directly to landfill but ash from the combustion processes in the Islands will be landfilled by Premier Oil’s contractors, though it should be noted that none of Premier Oil’s waste will be directly disposed of by landfill at Eliza Cove or Mary Hill Quarry.

There is the potential for loss of containment of waste while in transit or storage. This can lead to wind-blown debris or leachate of liquid waste into the environment. The WMP will ensure that waste is collected, handled, stored and transported in a manner that reduces the risk of escape to the environment and minimises the risks to human health. As part of the WMP the following measures will negate the risk of waste products escaping into the environment;

- Fit for purpose waste containers shall be clearly labelled stating the material that is stored inside. As appropriate, containers shall be covered to prevent ingress of rain water or the generation of windblown wastes,

- Liquid wastes (e.g. waste oils/chemicals) shall be stored in water tight containers, of sufficient strength and structural integrity. Hazardous liquid wastes shall be stored on an impervious base within a suitably bunded, contained area. Hazardous waste liquids must be stored in bunded areas to contain potential releases. Any oil or chemical spills to land or sea should be reported to the appropriate person within Premier Oil, and the relevant authorities should be notified immediately.

11.3 Potential Receptors

11.3.1 Potential Receptors in the Marine Environment

With WMP in place, the only waste that will be disposed of at-sea on a routine basis will be grey water, black water and galley food waste. This will potentially have some minor localised impact, due to nutrient enrichment. As with any vessel at-sea, the rig and associated vessels are likely to attract a mixed flock of seabirds, including albatross and petrel species listed under ACAP (see Section 5.4.7). These species rely on scavenging for much of their food and are attracted to anthropogenic activity, which often generates sources of food.

11.3.2 Potential Receptors on the Falkland Islands

If any waste is to be disposed of in the Islands it will be incinerated. Premier Oil have committed not to add directly to the landfilled waste at Eliza Cove or Mary Hill Quarry.

Waste that is not handled correctly could be targeted by scavengers, leach into the ground or become wind-blown, resulting in contamination of the environment with potential human health implications.

11.4 Characterising and Quantifying the Impact of Waste Generated during the Campaign

Solid waste (sewage and food) will be macerated before being discharged, to achieve no floating solids and no discolouration of surrounding water as per MARPOL 73/78 Annex IV requirements. The discharge point is 12.5 m below the surface of the water. The discharge point and maceration should ensure that waste is dispersed rapidly by the natural water movement around the rig. The dynamic environment will quickly disperse and dilute waste. Additionally, the activity of bacteria and other marine organisms will rapidly break down organic waste. The volume of waste water produced depends on the system used, conventional verses vacuum. Most vessels use vacuum systems, which make more efficient use of water. Assuming the rig and vessels use a vacuum system, an average daily volume of grey and black water per person (0.185 m^3 and 0.025 m^3 respectively (Huhta et al., 2007)) it is possible to estimate the total volume produced during the Campaign (Table 57).

Table 57: Estimated Grey and Black Water Production during Premier Oil 2015 Drilling Campaign (four wells)

Source	Number of men	Number of days	Grey water (m^3)	Black water (m^3)
Rig *Eirik Raude*	120	120	2,664	360
2 Supply vessels	30	120	666	90
ERRV	15	120	333	45

* Grey water produced at 0.185 m^3/man/day, Black water produced at 0.025 m^3/man/day (Huhta et al., 2007)

Deck drain water and bilge water will pass through an oil separator before being discharged, at a maximum oil concentration of 15 ppm. Separated oil will be collected and stored in drums / transit tanks for shipping back to the shore for disposal. The amount of water passing through the drains will depend on the amount of precipitation received and cleaning activities on the rig. At present, it is not possible to estimate the quantity of water that will pass through the deck drainage system.

At a concentration of 15 ppm, oil does not create a sheen on the water surface and hence birds do not become oiled (Wiese, 2002). Whether oil at this concentration still has the potential to damage other marine organisms is not known. Wave action will help to dilute and disperse any oil entering the sea.

Disposal of all Other Waste Products

The quantity and type of waste produced during a previous exploratory campaign was recorded. It is anticipated that the quantities of waste produced during the 2015 drilling campaign will be of a similar magnitude to previous rounds of exploratory drilling. It is therefore possible to estimate the quantities of each type of waste that will be produced and plan to dispose of it in a responsible manner. The estimated quantities described here are the average values from eight wells drilled during the 2011 exploration campaign.

Table 58 identifies the waste types and estimated quantities.

Table 58: Estimated Total Waste Generated during Premier Oil 2015 Drilling Campaign (four wells)

Hazardous Waste	Quantity (kg)
Aerosol Cans, Empty	100
Batteries	12
Chemical Sacks, Empty	4,275
Fluorescent Light Tubes	25
Grease / Oil Tins	275
Oil Filters	1,050
Oily Rags	3,150
Paint Cont. Rags & Brushes	100
Paint Scales / Chippings	237
Paint Tins, Empty	529
Thinner	50
Waste Oil	21,800
Other (mostly oily water)	850
Hazardous Waste Total	**32,454**

Non-hazardous Waste	Quantity (kg)
Cardboard	2,900
Electronic Equipment, Waste	385
Glass	175
General Waste	12,125
Plastic Cans / Containers, Empty	337
Plastic Drum, 210 L, Empty	11,782
Plastic Waste	1,125
Rubber Waste	825
Scrap steel	15,500
Steel Cans / Tins	47
Steel Drum, 210 L, Empty	540
Wood Pallets	6,000
Wood Waste	5,800
Other - unsegregated non-hazardous waste	3,612
Non-hazardous Waste Total	**61,155**

Impacts on Human Health and Wellbeing

In order to guard against loss of containment to the environment and the potential for associated impact on human health and wellbeing, any temporary or permanent dedicated waste storage area, as part of FIBU onshore facilities, shall comply with the following:

- Be located on a flat segregated area;
- Be located close to or within the boundary of the FIBU onshore facility to assist in security and access control;
- If located outside the main FIBU onshore facility, access to the waste handling and storage area shall be restricted with a level of security appropriate to the operation. Fencing shall be designed to prevent access by unauthorised people and by wild or domesticated animals;
- The waste handling and storage area shall also be located close to the main access road to the FIBU onshore facility and/or port to allow easy vehicle/vessel access for delivery and collection of waste for onward treatment;
- Signboards shall be posted at the entrance to the waste handling and storage area indicating the hazards;
- Waste storage areas shall not be in close proximity to habitations (> 250m from the perimeter) due to potential health hazards;
- Segregated wastes shall be stored in suitable containers with appropriate spacing around each site to allow safe vehicle access and turning;
- Adequate bunding and overhead protection shall be provided for waste streams, if applicable, to ensure migration of waste to the environment is not possible;
- Fit for purpose waste containers shall be clearly labelled stating the material that is stored inside. As appropriate, containers shall be covered to prevent ingress of rain water or the generation of windblown wastes;
- Segregated non-hazardous and hazardous waste streams (e.g. scrap metal, plastics, used batteries, light bulbs, oily wastes, tyres etc) shall be stored at the waste handling and storage area until an appropriate volume of waste is available to justify collection and transport for final treatment or disposal.

11.5 Impact Assessment Summary

A summary of the impact assessment is shown in Table 60, page 271.

11.5.1 Severity and Receptor Sensitivity

Scheduled Discharges into the Marine Environment

The discharge of grey and black water and food waste at-sea may cause slight eutrophication (nutrient enrichment) of the surrounding waters, however, wave action will rapidly disperse and dilute effluent and the action of micro-organisms will breakdown additional nutrients. The impact on the marine environment will be negligible and the severity of the impact has been assessed as '**Slight**'.

The offshore habitat of the Falklands is undesignated and widespread in nature, the influence of eutrophication from the rig is comparatively very small. For grey and black water and food waste, the sensitivity of receptors has been assessed as '**Very Low**'.

In accordance with MARPOL, storm water drains and bilges will be fitted with oil separators and the discharge will be monitored to ensure a maximum oil content of 15 ppm. At this concentration, these events would have a localised, short-term and reversible effect on the environment. The severity of minor oil or chemical contaminated water passing via the oil separator has been assessed as '**Minor'**. At a concentration of 15ppm, oil does not form a sheen on the surface and birds do not become oiled (Wiese, 2002), it is not known whether there is an impact on other marine organisms. However, wave action will rapidly dilute any oil remaining in the drain water and further reduce the risk to marine organisms. The sensitivity of the environmental receptors to this level of oil contamination is assessed as '**Low**'.

Disposal of Waste on the Falkland Islands

There is the potential for small quantities of waste to be disposed of in the Falklands, via incineration of non-hazardous burnable waste and the burning of waste oil for energy. This will only be done where the waste can be dealt with to Premier Oil's WMP, and will not include direct disposal of wastes to Eliza Cove or Mary Hill Quarry landfill. This will have negligible environmental impact and the severity is assessed as '**Slight**'. As Premier Oil will not be landfilling waste at Eliza Cove or Mary Hill Quarry, the waste management practices that would be considered on Islands, for selected and small waste streams, are expected to have a limited effect on the environment and the sensitivity of receptors in the terrestrial environment has been assessed as '**Very Low**'.

Transport and Storage of Hazardous Waste Onshore prior to onward Treatment or Disposal

With the appropriate waste handling and storage protocols in place the risk of the accidental release of hazardous waste into the environment is assessed as '**Remote**'. The provision of hard-standing and bunding within waste storage areas will contain hazardous materials in the event of an accidental release. This would enable a rapid on site clean-up resulting in a barely detectable impact on the environment or human health. In the event of an accidental release, the severity is assessed as '**Minor**'.

11.5.2 Significance

The discharge of waste water and food at-sea will be achieved in a manner that conforms to MARPOL regulations, to minimise the impact on the marine environment. All other waste streams will be handled to conform to MARPOL and the WMS, which should result in no or negligible environmental impact, this will also negate the risk of accidental loss of waste products. The WMS indicates that risk reduction measures are standard practice in the oil and gas industry and will be rigorously followed, therefore, the environmental risk is negligible. The significance of environmental risk associated with waste disposal is assessed as '**Low**'.

11.5.3 Confidence

The WMP that will be developed for the 2015 Drilling Campaign will follow best practice in the oil and gas industry. The nature of the impact is well understood from previous projects, in terms of; the magnitude, extent, reversibility, duration and frequency of the impact. The confidence in the assessment is assessed as '**Certain**'.

11.5.4 Cumulative Impact

At-sea, the disposal of grey and black water and food waste will add to that produced by existing users of the marine environment. All vessels discharge grey and black water and food waste at-sea, in line with MARPOL regulations. There could be in excess of 100 fishing vessels operating within Falklands waters during the Drilling Campaign (FIG 2014). The number of crew on each varies but is likely to exceed 4,000 men in total. The addition of 120 men on the rig and 45 on the support vessels represents a small increase (<5 %) in the number of people, which is directly related to waste production. Additionally, the Campaign will be short-lived and these waste streams are not regarded as an environmental threat.

The loss of oil in drain and bilge water at a maximum concentration of 15 ppm is not believed to pose a risk to seabirds, the impact on other marine organisms is unknown but is likely to represent a small risk to marine organisms.

There is the potential for certain waste streams generated during the Campaign to be disposed of on the Falklands, but this will not include disposal of waste to Eliza Cove or Mary Hill Quarry landfill, and as such is not expected to add to the cumulative impact of the current waste disposal practices in use.

11.5.5 Indirect Effects

Seabirds are known to congregate around offshore installations. In the North Sea, Tasker et al. (1986) reported seabird densities seven times higher within 500 m of an oil rig than the surrounding waters. In the north-west Atlantic, seabird concentrations were 19-38 times higher around rigs than adjacent waters, on the approach to the rig (reported in Wiese et al., 2001). Munro (2011) also recorded birds in close attendance of the rig during the previous exploratory campaign in the NFB. The exact reason for this is unclear, however, it is likely that birds view offshore installations as feeding opportunities, whether on discharged waste (food and/or sewage) or on aggregated prey species. The structure itself will be visible from many miles and is likely to attract seabirds out of curiosity. In the south-west Atlantic, many of these species are large diurnal scavengers; such as albatrosses, giant petrels, Cape petrel and Antarctic fulmar. All albatross species and seven species of petrel are covered by the Agreement for the Conservation of Albatrosses and Petrels (ACAP) and are the focus of international concern (see Section 5.4.7 for a description of these species abundance and distribution). Some of these species may exploit feeding opportunities associated with the rig, however, there is also a risk of these birds colliding with the structure and close association increases the risk of contamination from any minor oil spills.

11.6 Premier Oil Waste Management

Premier Oil will employ efficient working practices to minimise the amount of waste generated. Waste streams will be identified and waste products will be packaged according to type (to minimise cross contamination) to ensure safe storage, transportation and ultimately disposal. Waste consignment notes will be used to trace waste from source to disposal.

Alternatives - Waste Disposal on the Falkland Islands

During the planning phase of the project, Premier Oil investigated the possibilities for waste disposal in the Falkland Islands. It was found that there was very little capacity to deal with waste in the Islands and therefore the decision was made to ship the majority of waste back to the UK for disposal via suitably qualified operatives at regulated sites. A WMP will be written that states how each waste stream will be segregated, collected, stored, transported, monitored and finally disposed of. Initially, all waste will return to Stanley, where it will be consolidated and stored before being shipped to the UK for disposal, or disposed of in the Islands.

Disposal of all Other Waste Products

The majority of waste products will be shipped back to the UK in returning coasters and will therefore not result in any additional shipping or emissions. Waste will be handled in accordance with the Premier Oil WMP.

Waste Management Plan

Premier Oil will follow the Duty of Care principle, which is designed to be an essentially self-regulating system that is based on good practice. To ensure that waste is handled correctly, is traceable and the risk of cross contamination is minimised, Premier Oil guiding principles are:

- wastes are accurately described/characterised and consigned when they leave the Premier Oil site where the waste was generated;
- wastes are securely packed to ensure they do not escape in transit;
- all handlers of waste on behalf of the company are competent and authorised to do so;
- wastes are disposed of in an appropriate way, at a site that is authorised to accept them.

An example of the potential waste recycling, treatment and final disposal options along with best practice recommendations, where possible, is given in Table 59. This will form the basis of the 2015 Exploration Drilling Project WMP.

Effluent discharge parameters will follow UK or IFC legislation and guidelines in the absence of any national regulations.

Implementation of the Project Waste Management Plan

The project WMP shall clearly define the responsibilities of project personnel required to implement the agreed waste management strategy.

Prior to start up of operations Premier Oil shall ensure that project staff are aware of their roles and responsibilities in implementing the WMP and key staff shall be trained to ensure they are competent to perform their roles.

Housekeeping and waste management shall form a key part of the induction for all members of the project team.

Premier Oil shall ensure that the on-going requirement for good housekeeping and the implementation of the WMP are routinely raised through Project HSE meetings and on-going waste awareness programmes/campaigns as required.

Monitoring and Reporting

Effective application of the project WMP and applicable legislation shall be monitored by the relevant Premier Oil FIBU personnel through a programme of routine inspections and audits. These shall include inspections of operational sites and facilities, project waste storage facilities and audits of waste transportation contractors and third party waste facilities.

Any deficiencies noted in the WMP or non-conformances with legislative or procedural requirements shall be recorded via the appropriate action tracking process for the project, and closed out in a timely manner. Non-conformances with the WMP should be reported to DMR and EPD, in addition to any inspection, audit and/or investigation reports.

The total quantity of waste generated along with the quantities reused/recycled/disposed shall be recorded and reported at regular intervals identified in the WMP. As required, waste reports will be made available to the appropriate regulatory bodies.

Table 59: Example of Premier Oil WMP format illustrating potential waste streams and disposal routes

Waste Stream	Offshore Storage	Transport offshore to onshore	Onshore storage	Transport from onshore FI to final disposal	Final Disposal
Waste Generated Offshore					
Chemicals - used WBM and cements	To sea with cuttings/ downhole	N/A	N/A	N/A	Seabed/ downhole
Containers (contaminated)	Hazardous waste skip	PSV	Laydown yard	Coaster	All hazardous waste returned to UK waste company for disposal
Waste oil	Sealed containers	PSV	Laydown yard	Road transport	TBC
Cuttings (water-based mud)	to Seabed	N/A	N/A	N/A	Seabed
Medical waste	Containers for incineration	PSV	Laydown yard	TBC	TBC
Mercury-containing waste (incl. fluorescent tubes)	Haz waste skip	PSV	Laydown yard	Coaster	All hazardous waste returned to UK waste company for disposal
NORM contaminated waste	Secure containers	PSV	Laydown yard	Coaster	All hazardous waste returned to UK waste company for disposal
Oily sludge/ sand/ soil	Sealed containers	PSV	Laydown yard	Coaster	All hazardous waste returned to UK waste company for disposal
Oily rags	Hazardous waste skip	PSV	Laydown yard	Coaster	All hazardous waste returned to UK waste company for disposal
Wood and pallets	Wood pile	PSV	Laydown yard	Road transport	TBC
Plastic packaging	Waste skip	PSV	Laydown yard	Coaster	Returned to UK to waste company
Waste Generated Onshore					
General waste from onshore base	N/A	N/A	Laydown yard	Road transport / Coaster	All hazardous waste returned to UK waste company for disposal, non-haz waste TBC
Sewage and grey water from onshore	N/A	N/A	N/A	Local sewage system	Local sewage disposal (Rookery Bay)

11.7 Future Waste Management Solutions

Waste management in the Falklands relies on unregulated landfill, which is unsustainable. The development of the oil industry in the Islands is likely to result in the development of waste management infrastructure in the Islands. This will not only be of benefit to the oil and gas industry but will also greatly improve waste management and recycling in the Islands generally. During this exploratory stage of oil and gas development in the Falklands, exporting waste to the UK for disposal is a more economically viable option but the potential for developing waste management strategies in the Falklands for future campaigns and developments is under review.

11.7.1 Residual Risks

The impacts associated with waste management are considered to be of low significance prior to mitigation measures. It is best practice to minimise any impacts to the marine environment where possible. With a WMP will be in place to guard against accidental release of waste into the environment, any residual impact will be of '**Low**' significance.

Table 60: Summary of the impact assessment for waste generated during the 2015 Campaign

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance		Certainty	Mitigation / Prevention / Control
							Pre-mitigation	Post-mitigation		
Campaign operations	Grey water	Eutrophication	Planned	N/A	Very Low	Slight	Low		Certain	Discharged at-sea
Campaign operations	Black water	Eutrophication	Planned	N/A	Very Low	Slight	Low		Certain	Macerated and discharged at-sea
Campaign operations	Food waste	Eutrophication	Planned	N/A	Very Low	Slight	Low		Certain	Macerated and discharged at-sea
Campaign operations	Storm drain run-off and bilge water	Minor oil and chemical spills	Planned	N/A	Low	Minor	Low		Certain	Good housekeeping, Oil separator
Campaign operations	All non-hazardous waste	Emissions from transportation	Planned	N/A	N/A	Minor	Low		Certain	Application of a WMP, majority of waste returned to UK for management
Campaign operations	All hazardous waste	Emissions from transportation	Planned	N/A	N/A	Minor	Low		Certain	Application of a WMP, majority of waste returned to UK for management
Drilling operations	Indirect effects	Attraction of ACAP species	Unplanned	Remote	Very High	Minor	Low		Certain	Follow best practice to limit the risk of accidental spills

** See Section 6.0 for definitions of severity and significance.*

12.0 Discharge of Drilling Mud and Cuttings

12.1 Introduction

Drilling muds, also known as drilling fluids, are an essential component of any drilling operation. The mud or fluid consists of a liquid phase to which various chemical and solids have been added to modify the operational properties of the drilling system. The primary function of the drilling mud is to suspend the drill cuttings and return them to the surface, however, muds are designed to fulfil a number of additional functions such as; cool and lubricate the drill bit; increase the density (weight) of the mud to balance formation pressure and prevent any uncontrolled releases (i.e. blowouts) from the well; plug leaks in the wellbore wall to prevent loss of drilling mud to the formation.

Drilling mud is pumped from the platform down the wellbore hole through the drill string, where it exits the through nozzles in the drill bit. As the drill bit grinds rock into drill cuttings, the cuttings become trapped within the mudflow and are carried to the surface through the annular space between the drill string and the walls of the hole. As the initial, top-hole, wellbore sections are drilled the mud and cuttings are discharged directly onto the seabed. Once the top-hole sections have reached a set depth a steel pipe, known as a casing, is lowered into the wellbore and cemented in place to prevent the wall from caving into the wellbore. A blowout preventer (BOP) is secured to the top of casing, and then a riser pipe to the drilling rig is secured to the BOP which allows mud and cuttings to be returned to the rig where they are separated so the drilling mud can be re-used in the wellbore.

A number of different types of drilling muds have been developed over the history of oil and gas exploration, including water based mud (WBM), diesel based mud, oil based mud (OBM), synthetic oil based mud (SOBM) and low-toxicity oil based mud (LTOBM). Diesel and oil based muds were introduced to overcome instability issues associated with WBM, however, the discharge of oil based muds was subsequently banned due to the environmental impact of hydrocarbon discharge.

Drilling activities during the Premier Oil exploration drilling campaign will use seawater for the top-hole sections and WBM for the lower section, both of which will contain a number of additives to control the downhole conditions. WBM is an aqueous suspension of clay or other viscosifiers such as bentonite, using either freshwater or seawater as the carrier fluid. By its nature WBM has a lower toxicity and environmental impact than diesel or oil based muds, however, some of the fluid additives may pose other impacts to local marine life, such as damage to the gills of filter feeding organisms.

This chapter draws on modelling studies to assess the expected environmental impact arising from the discharge of drilling mud and cuttings during the Premier Oil 2015 exploration drilling campaign.

12.2 Sources of Discharge Associated with Drilling Exploration Wells

Drilling the four exploration wells will result in the discharge of drilling muds and rock cuttings at each of the well locations. Each of the four exploration wells will follow the same well design comprising three main sections (42”, 17.5” and 12.25”), and a fourth contingency section (8.5”) in the event that the third section is unsuccessful (Table 61). If required the 8.5” contingency section would be drilled to the same total depth as the 12.25” section and as this would be a narrower diameter hole it would generate a smaller amount of mud and cuttings than the 12.25” section, therefore only the impacts of the 12.25” section are considered as this presents the worst-case.

The top-hole sections of each well will be drilled with seawater with bentonite sweeps, and bentonite displacement mud, with all mud and cuttings being discharged directly to the seabed. The final section of the well will be drilled with a WBM, with mud and cuttings being returned to the rig and separated so that the mud can be reused. The cuttings will be discharged near the sea surface, and mud will also be discharged once drilling activities have been completed or when the mud can no longer be reused. Oil based mud will not be used during the drilling campaign.

Table 61: Exploration Campaign Typical Well Design and Discharge Quantities per Well

Well Section	Section Length (m)	Drilling Mud Type	Release Depth and Location
42” (1,067 mm)	75	Seawater with bentonite sweeps, and bentonite displacement mud	Seabed (460m)
17.5” (445 mm)	715		Seabed (460m)
12.25” (311 mm)	1736	Water Based Mud (WBM)	Near Surface (23m)
8.5” (216mm) Contingency*	1736	Water Based Mud (WBM)	Near Surface (23m)

** The contingency section will only be drilled if problems are encountered in the 12.25” section, and would be drilled to the same total depth.*

12.3 Potential Environmental Receptors

There are a wide range of environmental receptors to the discharge of drill cuttings and mud during the exploration campaign. These include:

- Seabed sediment – discharge direct to the seabed and settlement of particles through the water column will impact sediment chemistry and particle size over the affected area.
- Water quality – suspension of mud and cuttings in the water column as well as discharge to surface waters will impact water chemistry and turbidity.
- Phytoplankton and Zooplankton – organisms with limited mobility will be impacted by changes in local water quality.
- Benthic organisms – discharge of drill cuttings and mud affects benthic organisms through direct burial, habitat change and sediment suspension at the seabed.
- Fish – mobile species such as fish may be affected if drilling coincides with certain life history stages such as spawning periods and juvenile stages when they inhabit particular spawning or nursery grounds, or if it coincides with productive feeding season and feeding grounds.

Chapter 5.0 describes the range of species recorded within the vicinity of the drilling campaign and the sensitivity of different aspects of their lifecycle.

12.4 Characterising and Quantifying the Impact

The drilling discharges were modelled using the ‘DREAM’ (Dose-related Risk and Effect Assessment Model) published by the Foundation for Scientific and Industrial Research (SINTEF) (v6.5.1), which incorporates the ‘ParTrack’ sub-model used for modelling the dispersion and settlement of solids.

The modelling studies were specifically designed to estimate:

- Drill cuttings and mud depositional thickness on the seabed;
- Environmental risk to the seabed resulting from burial thickness, particle size change, toxicity and pore water oxygen depletion;
- Environmental risk in the water column resulting from toxicity and particle stresses; and,
- Recovery of the sediments over time.

The methods and outputs of the modelling studies have been summarised in this chapter, and the full details are available in the following report:

- Genesis, 2014. Drill cuttings modelling for Sea Lion Exploration Wells. Document number: J72925D-Y-TN-24000/B2. Prepared for Premier Oil.

12.4.1 Exploration Drilling Model Input Parameters

The well top-hole, 42" and 17.5", sections will be drilled with seawater and bentonite sweeps which contain barite, bentonite as well as caustic soda, soda ash and lime. The latter three components are categorised as PLONOR, which means that they have been assessed to 'pose little or no risk' to the environment, consequently they were not included as a mud component in the cuttings discharge model. Both barite and bentonite are known to be toxic to marine life and contribute to the environmental risk from drilling discharges and consequently their physical and toxicological characteristics were modelled in the release from these two sections (Table 62).

The discharge from the 12.25" section comprises WBM, which also contains barite as well as several chemicals, six of which are PLONOR and were therefore not specified as mud components in the model. Two of the WBM chemical additives are non-PLONOR, PERFORMATROL and GEM GP, and consequently they are included in the model input parameters (Table 62).

Table 62: Drilling Mud Components and Estimated Discharge Quantities per Well

Well Section	Quantity of Drilling Mud Discharged (tonnes)	Quantity of Drill Cuttings Discharged (tonnes)	Barite (tonnes)	Bentonite (tonnes)	Chemicals (tonnes)
42"	41.4	197.65	31	10	0
17.5"	95.6	327.45	59	35	0
12.25"	204.7	389.40XX	80	0	Performatrol: 29 Gem GP: 28

Details of the specific drilling mud type have not yet been finalised, consequently characteristics of 'MI-high' (a type of barite used in WBM) were used as a conservative estimate of heavy metal content within UK-market sourced drilling mud barite (Neff, 2005). Background concentrations of heavy metals recorded in sediments close to the previously drilled Sea Lion exploration wells (Section 5.3) are compared with MI-high concentrations in Table 63.

Table 63: Metals in Typical Barite Water Based Drilling Mud Compared to Background Sea Lion Values in Sediment

Heavy Metal	Barite WBM (µg/g)	Sea Lion Background Concentrations (µg/g)
Cadmium (Cd)	0.77	0.3
Chromium (Cr)	6.5	46
Copper (Cu)	88	22
Iron (Fe)	9,270	-
Mercury (Hg)	5.9	0.03
Lead (Pb)	243	7.5
Zinc (Zn)	167	71
Nickel (Ni)	-	18

The concentration of chromium in barite mud is lower than the average concentrations recorded in Sea Lion sediments and consequently would not pose any additional risk and are therefore not included in the model parameters (Table 63).

Concentrations of cadmium, copper, mercury, lead and zinc in the barite mud were found to exceed those recorded from Sea Lion area sediments (Table 63). However, these metals are present in barite primarily as insoluble mineralised sulphide salts with limited environmental mobility and low toxicity (Neff, 2005) and consequently these components are not considered to pose a specific risk to the environment and they were not included in the modelling (Genesis, 2014).

Current data used in the model utilises site-specific data collected from a single acoustic doppler current profiler (ADCP) deployed 7km north of the Chatham well (49° 12.909' S, 59° 7.395' W). The ADCP took measurements across 46 depths between 6m and 453m (Fugro, 2012). The 46 measurements were made every 10 minutes between 7th November 2011 and 16th November 2012 and therefore represent approximately one year of measured data. From the surface to approximately 200m the predominant currents are towards the west and northwest. From 200m to the seafloor, the predominant currents are towards the southwest and west. The current speed decreases with depth from approximately 0.2 m/s in the surface waters to 0.1 m/s near the seafloor (Genesis 2014).

12.4.2 DREAM/ParTrack model (SINTEF)

The DREAM/ParTrack model calculates the dispersion and deposition of drilling muds and cuttings on the seabed and the dispersion of chemicals and particles in the water column (Genesis, 2014). The model calculates the time required for concentrations of contaminants in water column or sediment to return to previous levels once the discharges have ceased. Within the water column, the solids settle out relatively quickly, but recovery of the sediment on the seabed takes substantially longer.

The rates of ecosystem recovery are variable depending on the particular location, and the model predicts the subsequent physio-chemical composition over time by taking into account processes such as mixing, re-suspension and dilution due to currents, and sediment re-colonisation rates leading to bioturbation and biodegradation of the sediments. Additionally, expected recovery times from burial and grain size change, and changes in chemical toxicity over time (generally around 5-10 years after cessation of the drilling programme) are included in the forecast of the reduction in environmental risk to the sediments over time. Figure 57 illustrates the processes computed by the model.

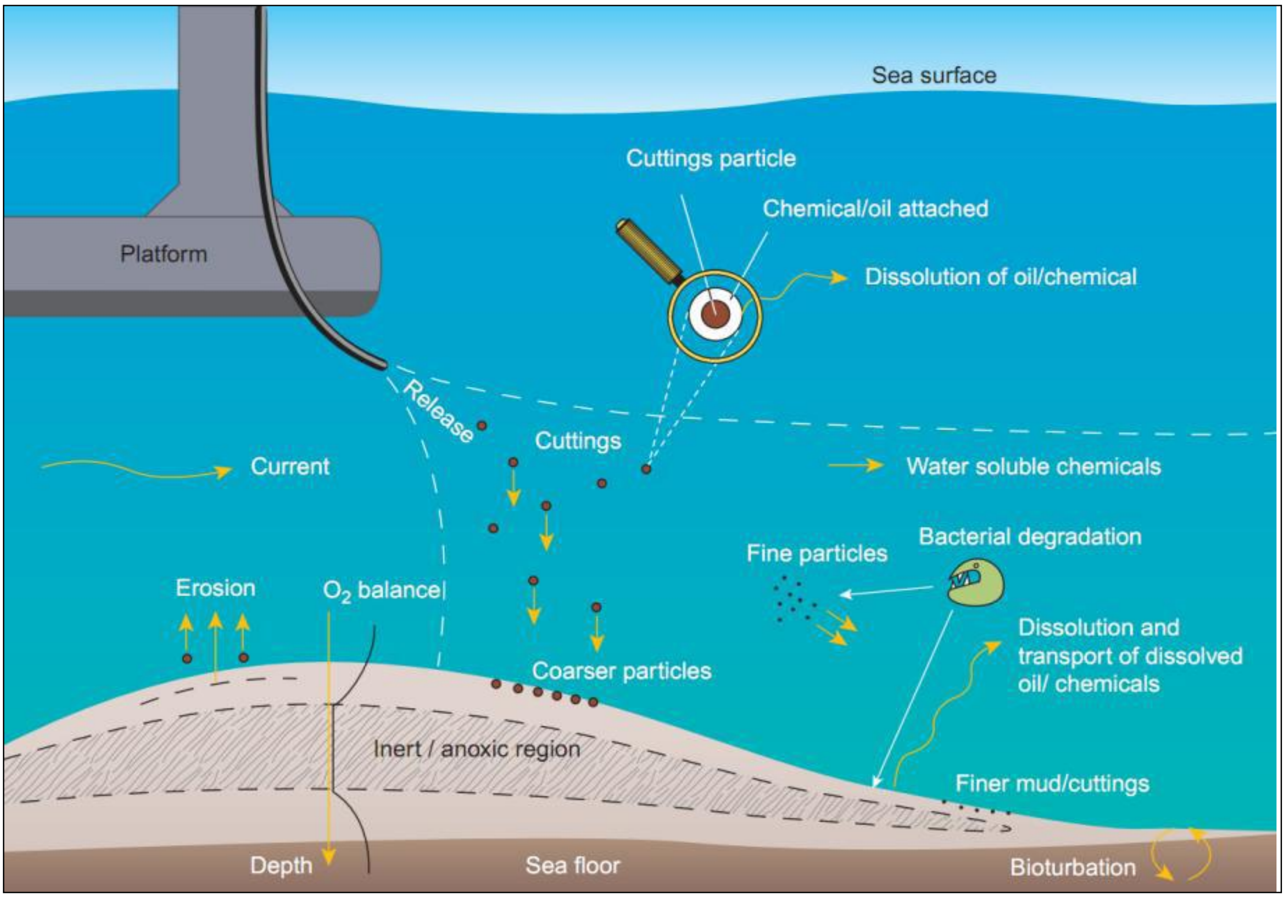


Figure 57: Processes involved in DREAM/ParTrack model (Genesis, 2014)

12.4.3 Calculation of environmental risk

The model output also calculates an estimate of risk to the environment using a metric known as the Environmental Impact Factor (EIF), which is based on the PEC:PNEC ratios used to estimate environmental risks for chemicals in different marine environmental compartments. The PEC (Predicted Environmental Concentration) is an estimate of the concentration of a chemical to which the biota would be exposed during and after the discharge of the chemical. The PNEC (Predicted No Effect Concentration) is the concentration of the chemical in the environment below which it is unlikely that adverse effects on the biota inhabiting a particular environmental compartment would occur. The ratio of the PEC to the PNEC indicates the likelihood of the occurrence of adverse effects from drilling discharge chemicals in the water column and sediments.

The EIF for drill cuttings is based on the following identified stressors relating to drill cuttings and the PNEC values for each of the stressors, which were determined from scientific literature:

- Water Column: Toxicity of chemicals and oil, physical effects of suspended matter;
- Sediments: Toxicity of chemicals and oil, burial of organisms, change in sediment structure, oxygen depletion.

The model calculates an individual PEC:PNEC ratio for each of the stressors and applies a species sensitivity distribution to each stressor, which allows the model to combine and compare the contribution of different stressors to the overall risk, known as the potentially affected fraction (PAF) of species. The level of 5% PAF (corresponding to a PEC/PNEC ratio of 1) is a generally accepted risk level representing the concentration below which unacceptable effects on organisms will most likely not occur (EC, 2003). As such the value of EIF is taken as the spatial extent over which the multi-stressor PAF exceeds 5%. An EIF of 1 in sediment occurs when an area of 100 m x 100 m is predicted to exceed a 5% risk. This is referred to as “risk > 5%” throughout the remainder of this Section.

Model predictions were recently validated through field measurements at the Trolla Field in 265 m water depth in the Norwegian Sea, where reasonably good correspondence was obtained between measured and simulated deposition of the cuttings on the sea floor (Rye, 2010; Jødestøl & Furuholt, 2010). The observed deposition thickness was lower than was predicted by the ParTrack model, which suggests that the modelling results are conservative (Genesis, 2014).

12.4.4 DREAM/ParTrack Model Uncertainties

There are a number of uncertainties associated with this modelling technique (Genesis, 2014). The main uncertainties identified in the model are:

Release volumes and geometry

The release geometry is constrained by operational equipment and typical drilling rig design and is unlikely to significantly change. The downhole conditions are potentially quite variable in terms of volumes of mud required but this is allowed for in the inputs provided to the model, which are based on conservative assumptions.

Discharge characterisation

The properties of the mud components are well understood and produced to industry standard specifications. The size distribution of the cuttings particles themselves is based on an average of data from a drilling programme in the Norwegian Sea. Some regional variation is possible relating to the rock types being drilled and it would be beneficial to report on cuttings particle size distribution from ongoing drilling campaigns in this region to inform future modelling. It is unlikely that new data would alter the overall conclusions, however.

Metocean data

The metocean dataset covers 12 months of direct observations covering the full depth of the water column. This provides a full annual cycle and a wide range of weather conditions, although a statistical analysis of all potential outcomes throughout this period has not been undertaken.

Instead, discharges have been timed approximately to coincide with the most likely scheduling of the wells. The overall programme of four wells covers approximately six months, and each well shows similar deposition characteristics over this time period.

The modelling results are relatively conclusive in showing a tendency for deposition and water column dispersion to the west of the site. It should be noted, however, that the currents do move in all directions at different times and due to the short nature of each release. While it is most likely that effects are concentrated to the west of the location, they could occur at other points depending on the precise conditions at time of discharge. Overall distances of effect and deposition rates would, however, be similar.

Environmental sensitivities

Grain size change is an important parameter and it should be noted that the thresholds for this parameter within the risk assessment are based on the analysis of environmental monitoring data from the Norwegian Continental Shelf covering 246 species. Burial thickness is based on data from Europe and the United States. There may be regional differences in prevailing fauna that would give different thresholds for the Sea Lion location. The basis of the thresholds is felt, nevertheless, to represent the best available data and covers a wide range of normal benthic fauna.

12.4.5 Modelling Results: Prediction of Impacts to Sediments and the Water Column

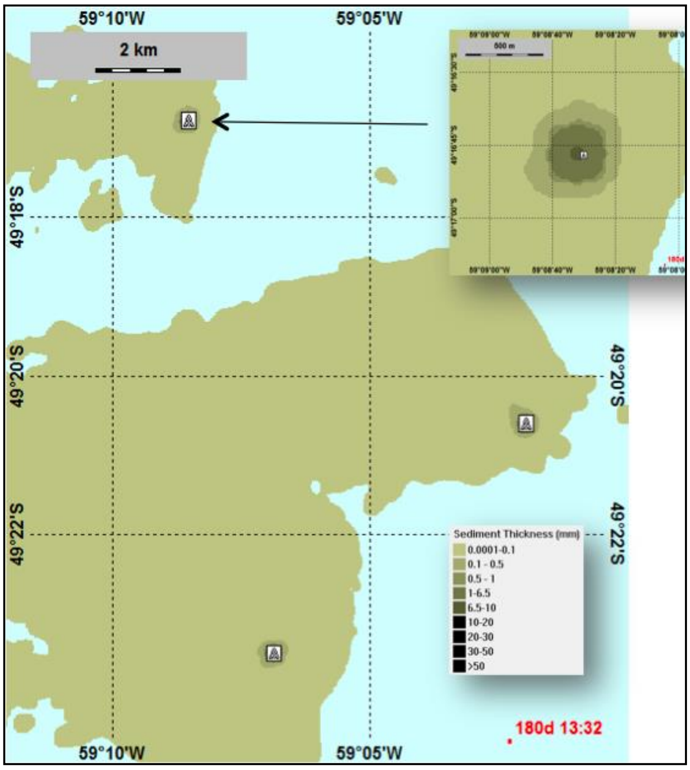
Sediment Impacts

Discharges of drill cuttings and mud directly to the seabed from the top-hole sections (42” and 17.5”) result in deposition of the majority of relatively dense cutting material immediately around the well location with peaks in sedimentation thickness of 600mm.

Sediment thickness rapidly diminishes to below 6.5mm within the first 45 m distance from the well. Kjeilen-Eilertsen (2004) reported that, in general, a thickness of 6.5 mm represented the threshold at which 5% of the most sensitive species would be affected by smothering, in the absence of other risk stressors. This threshold has been adopted in the modelling approach and hence this assessment. The area of seabed where cuttings deposition >6.5mm corresponds to 6.3 km^2 per well, and a total of 25.2 km^2 for all four wells.

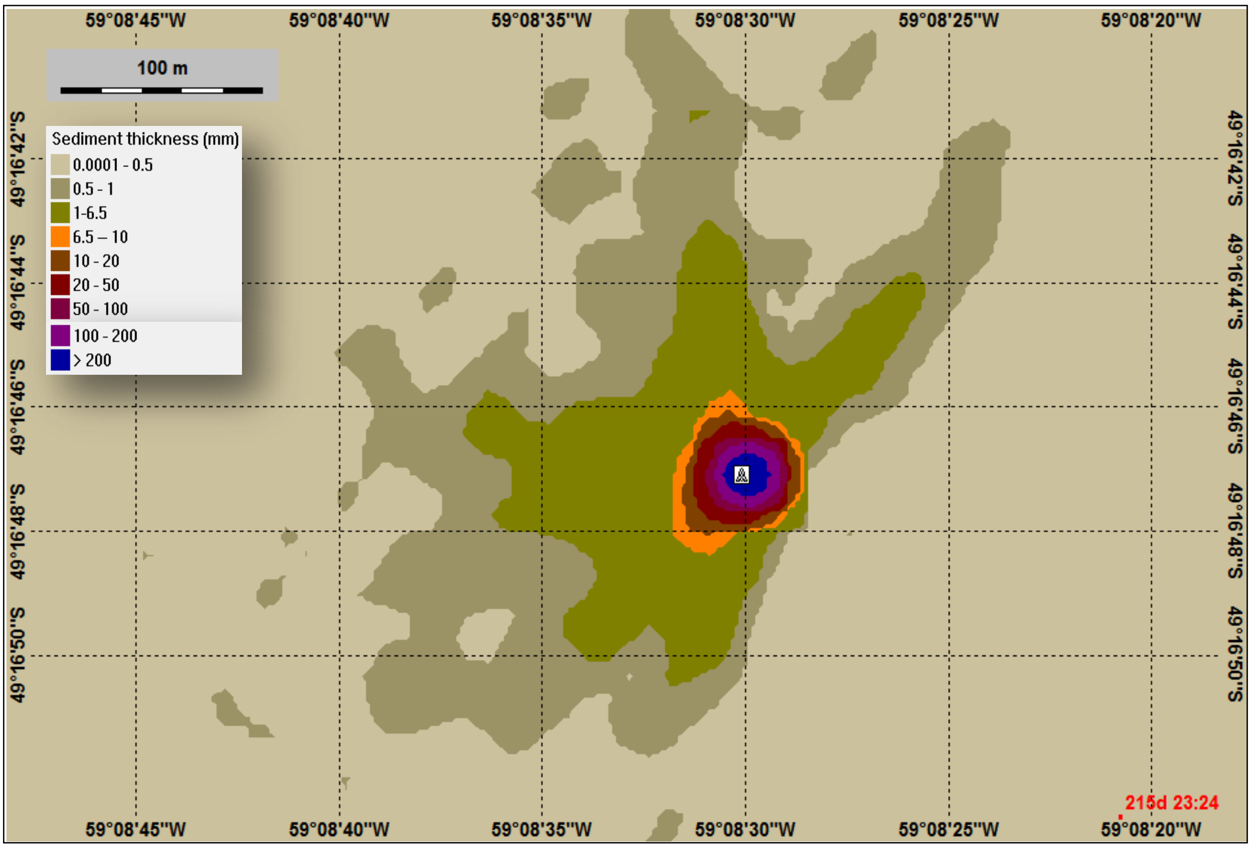
Drill cuttings and mud discharged at the sea surface from the bottom-hole section (12.25”) would remain suspended and be transported by local currents, gradually settling out onto the seabed along the direction of the prevailing current (Figure 59). The model results indicate that a thin layer of sediment (<0.1mm) is deposited over a larger area, extending away from each well to a distance of 2.4 km from the discharge point.

Whilst the predominant current flows in a westerly direction, current direction is variable and may change over a period of several hours. A close up view of the area of thickest deposition around the Chatham well (modelled with a higher resolution grid) (Figure 58) indicates that the resulting deposition pattern reflects the variability in current direction.



* Low resolution 27 km x 28 km grid with a cell size of 100 m (i.e. calculations averaged over 100 m).

Figure 58: Immediately Post Drilling – Overview of the Distribution of Drill Cuttings and Mud Depositional Thickness around the three northerly Wells from the Discharge of all Well Sections.



** High resolution 2.4 km x 2.3 km grid with a cell size of 10 m (i.e. calculations averaged over 10 m)*

Figure 59: Immediately Post Drilling - Drill Cuttings and Mud Depositional Thickness around the Chatham Well Post Drilling resulting from Discharge of the all Well Sections

Discharges of drill cuttings and mud modify the natural sediment particle size distribution across the area where they are deposited. The average particle size in background sediments from the exploration area was measured to be 27 µm in the environmental baseline surveys (Section 5.3). Modelling results predict that particle size following drilling operations would range from a peak of 5,000 µm 55 m east of each well location (from discharge of the 42" and 17.5" sections direct to the seabed), to median particle size greater than 2,000 µm (200 mm) extending 7 km along the direction of prevailing current to the west of each drilling location (Figure 60). These grain size changes will persist for at least 10 years.

Figure 61 presents a close up contour plot of median particle size for the Chatham well, showing that deposited grain sizes above 3,000 µm are deposited up to 2.4 km to the west of the well in line with the prevailing current direction.

The majority of the cuttings from all well bore sections are deposited near to the discharge point, particularly during slack currents. In periods of strong currents at certain states of the tide, the cuttings from the surface discharge of the 12.25" section are carried west for a period before this current wanes and this results in a secondary area of deposition from particles in surface waters. The cuttings travel this distance given the combination of water depth in this area and current strength. This is illustrated further in Figure 62, which represents an instantaneous pattern of particle motion influenced by the particular current conditions at the time.

It should be noted that although the plots show the size of the particles deposited, they are complementary to the mass deposited; the vast majority of the mass of cuttings is deposited within 100 m of the discharge point, and only a very small fraction is deposited at distances of several kilometres. The deposited grain size is important, however, as it can be a relatively significant stressor compared with burial thickness.

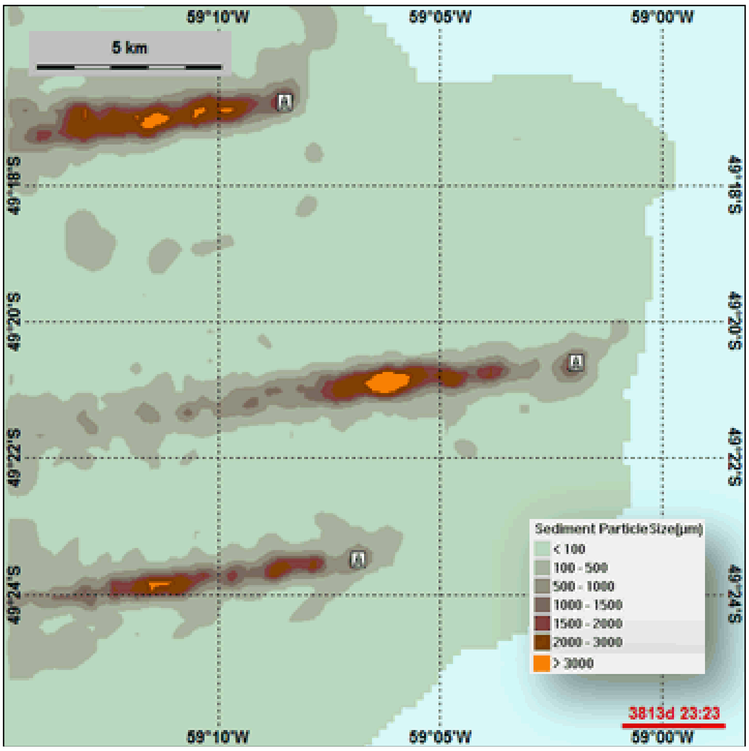


Figure 60: 10 Years Post-Drilling - Median Particle Size Distribution resulting from Discharge of Mud and Cuttings from all the Well Sections of the Chatham, Jayne East and Zebedee Wells

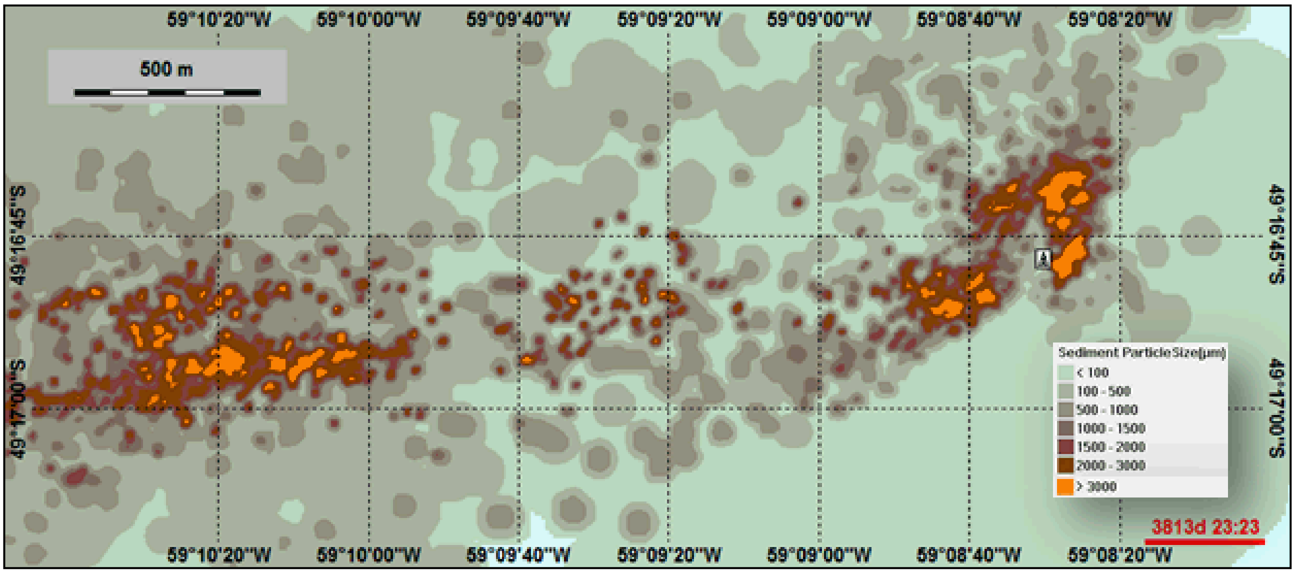


Figure 61: 10 Years Post-Drilling - Median Particle Size Distribution resulting from Discharge of Mud and Cuttings from the all Well Sections of the Chatham Well

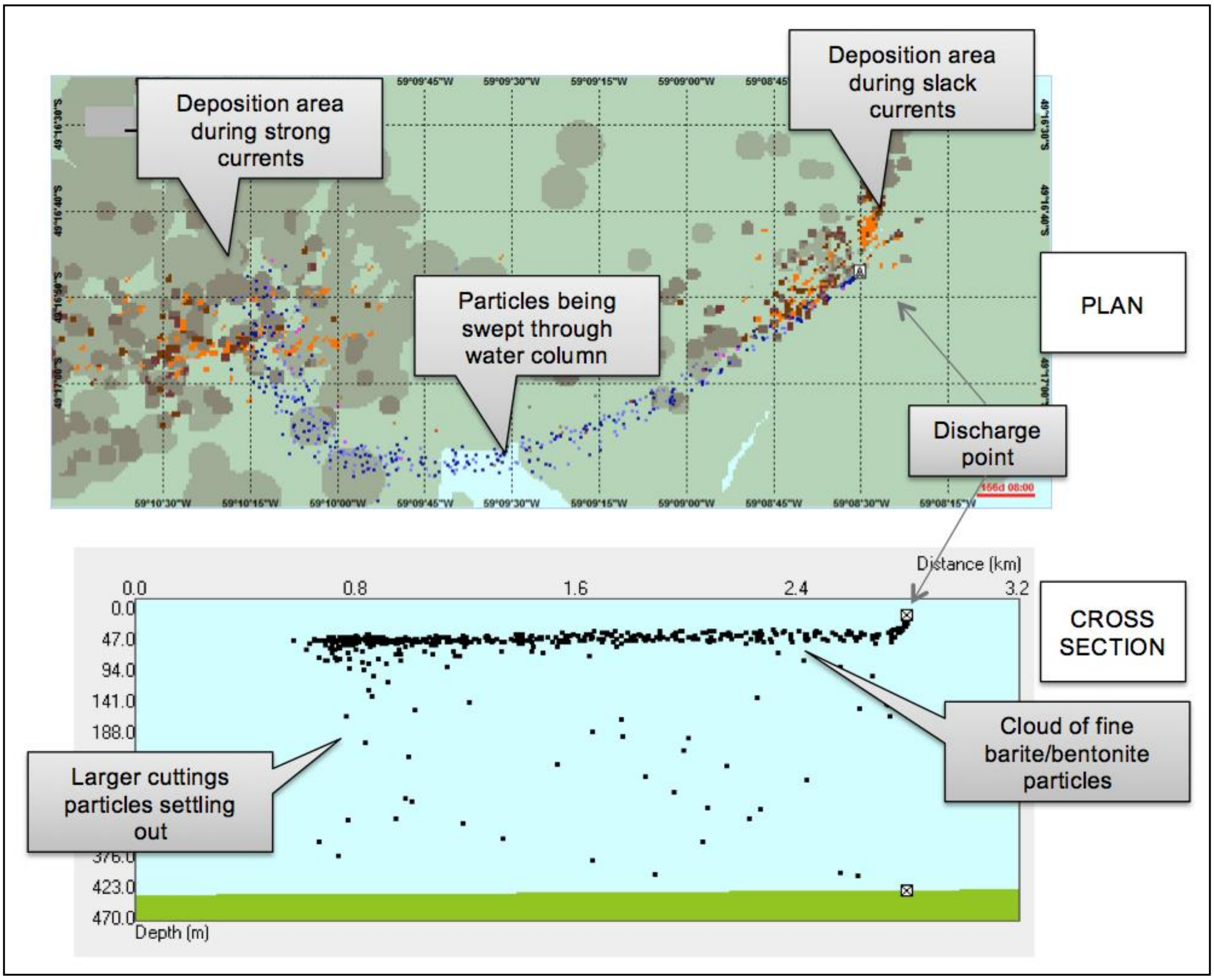


Figure 62: During Discharge – Instantaneous Snapshot of the Dispersion Pattern of Mud and Cuttings Particles in the Water Column from Near Surface Discharge

Total environmental risk to the seabed sediment was calculated from the Environmental Impact Factor (EIF), which describes the area within which the predicted environmental concentration (PEC) exceeds the predicted no effect concentration (PNEC), i.e. there is a risk to at least 5% of the most sensitive species ("risk > 5%"). The EIF is based on a combination of factors such as, grain size change, burial thickness and pore-water oxygen depletion.

Modelling results indicate that a maximum EIF of 1.5 would be generated in the seabed sediments, which corresponds to an area of seabed at >5% risk of approximately 0.015 km^2 per well. Analysis of the EIF indicated that the primary contributing factor, accounting for ~80% of the risk, was the change in grain size resulting from deposition of cuttings particles; whilst the sediment deposition thickness leading to smothering accounted for the remaining ~20% risk (Genesis, 2014).

Figure 63 indicates that the risk to the sediments intermittently exceeds 5% up to 200 m from the Chatham well at the end of the drilling period. The environmental risk to seabed sediments from the discharge of drilling mud and cuttings falls below 5% approximately five years post-drilling.

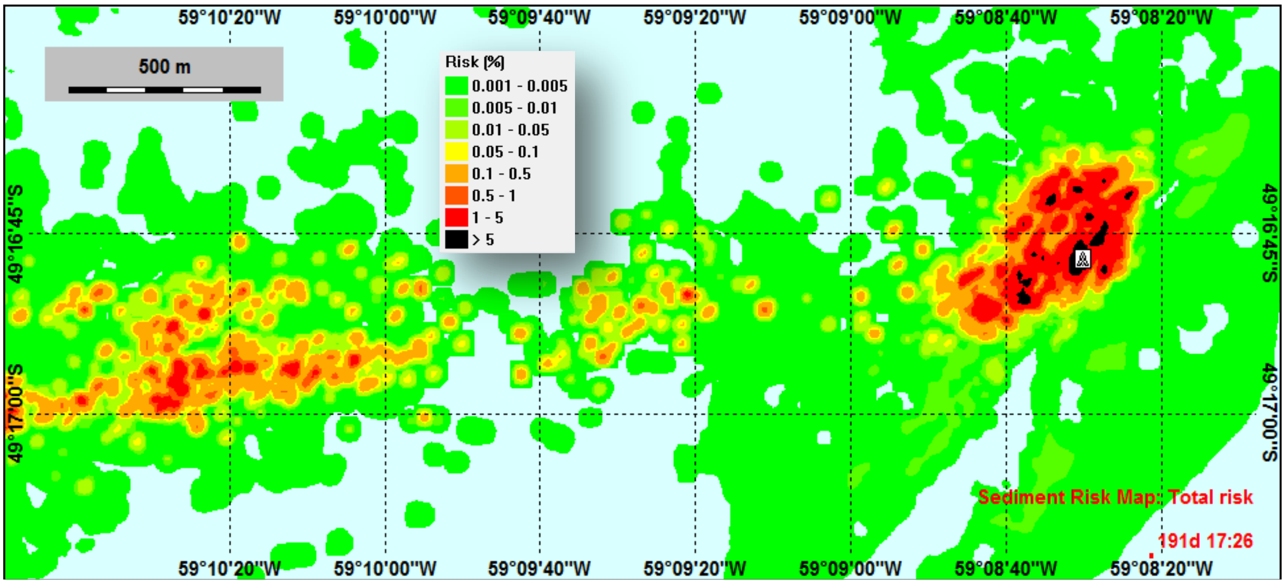


Figure 63: End of Drilling Operations - Total Environmental Risk (EIF) to the Sediment from the discharge of all Well Sections from the Chatham Well Drilling

Water Column Impacts

Water depths in the region of the drilling campaign range between ~450 m at the three most northerly wells and 360 m at the southerly Isobel Deep well. Currents in the area were found to vary with depth, with predominant currents from the surface to approximately 200 m depth flowing towards west and north-west; whilst from 200m to the seabed predominant currents flow towards the south-west and west (Genesis, 2014).

Drill cuttings and mud from the upper sections (42" and 17.5") will be discharged directly to the seabed, whilst mud and cuttings from the lower section (12.25") will be discharged near the surface, hence modelling results indicate very different zones of impact for surface and seabed discharges.

Discharge at the Seabed

A snapshot of the instantaneous risk to the water column resulting from the discharge of seawater and bentonite sweeps at the seabed from the longer 17.5" top-hole section of Chatham well is shown in Figure 64. The discharge only contains seawater, cuttings, bentonite and barite (no added chemicals).

The plume is dispersed away from the drilling location along the direction of prevailing currents to the west. The contour plot indicates water affected at greater than 5% risk (black contour) from the cuttings discharge, which extends at least 2.8 km from the well and remains in the lower 100 m of the water column. Modelling results indicate that the environmental risk falls below 5% within 25 hours on completion of the discharge.

A maximum water column EIF of 427, corresponding to a volume of 0.0427 km^3 of water where the risk is >5%, is predicted from the discharge of seawater and bentonite sweeps from the 17.5" top-hole section.

Analysis of the EIF indicate that the primary contributors to the risk were suspended bentonite and barite particles, accounting for 57% and 43% of the cumulative risk respectively. The stresses incorporated into the model include the physical effect of the barite particles on zooplankton and filter feeders.

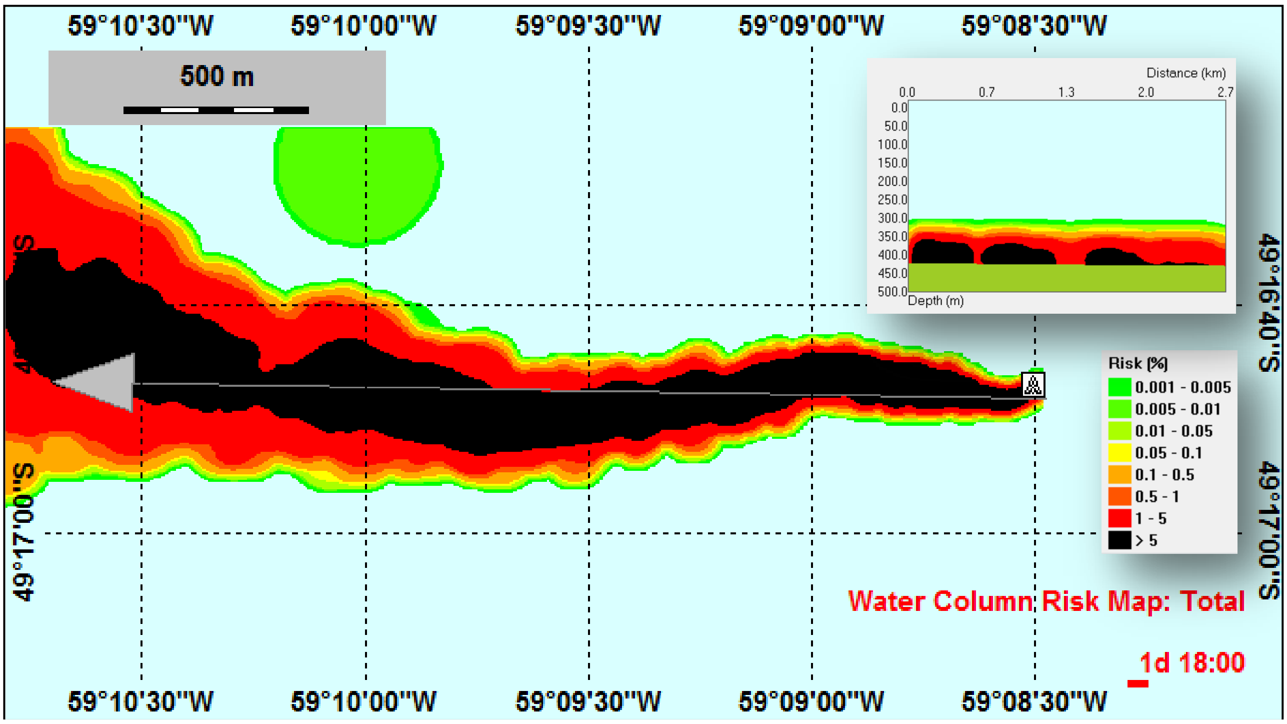


Figure 64: During Discharge – Instantaneous Environmental Risk (EIF) to the Water Column from the Discharge of the 17.5" Section at the Seabed

Discharge at the Surface

A snapshot of the instantaneous risk to the water column resulting from the near-surface discharge of WBM from the 12.25" section of Chatham well is shown in Figure 65. The discharge only contains WBM, cuttings, bentonite, barite and the shale stabilising chemicals PERFORMATROL and GEM GP.

The plume is dispersed away from the drilling location along the direction of prevailing currents to the west. The contour plot indicates water affected at greater than 5 % risk (black contour) from the cuttings discharge, which extends at least 1 km from the well and remains in the upper 100 m of the water column. Modelling results indicate that the environmental risk falls below 5% within 7 hours on completion of the discharge.

A maximum instantaneous water column EIF of 251, corresponding to a volume of 0.025 km^3 of water where the risk is >5%, is predicted from the discharge of WBM from the 12.25" section. This volume reflects the maximum volume of water experiencing an EIF >5% at any one point in time and does not reflect the total volume of water at risk over the duration of the discharge.

Analysis of the EIF indicates that suspended barite particles are the primary contributors to the risk, accounting for 90% of the cumulative risk. The stresses incorporated into the model include the physical effect of the barite particles on zooplankton and filter feeders. The discharge of the drilling chemical PERFORMATROL contributes 7% of the remaining risk, with GEM GP and cuttings particles accounting for the final 2%.

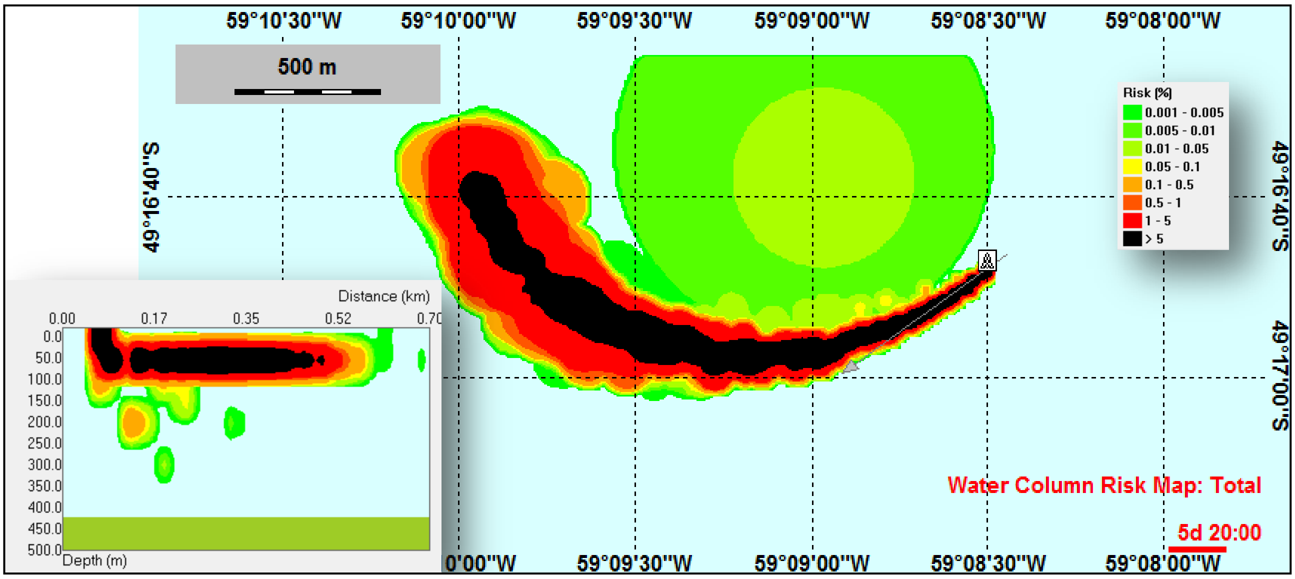


Figure 65: During Discharge – Instantaneous Environmental Risk (EIF) to the Water Column from the Discharge of the 12.25” Section near the Sea Surface

Overall time development of water column risk

Figure 66 illustrates the development of environmental risk over time during the course of drilling one of the wells. The water column EIF represents the volume of water above a risk of 5% with one EIF equal to 100,000 m^3 (0.00001 km^3) volume of water. The maximum risk to the water column is caused by the release of bentonite particles during the discharge of top-hole cuttings near the seabed. Discharges from the bottom hole section, at the sea surface are dominated by the presence of barite in the drilling mud. The fluctuations in risk are largely caused by variations in metocean conditions, which influence the plume size before it is deposited on the seabed or disperses to an insignificant concentration.

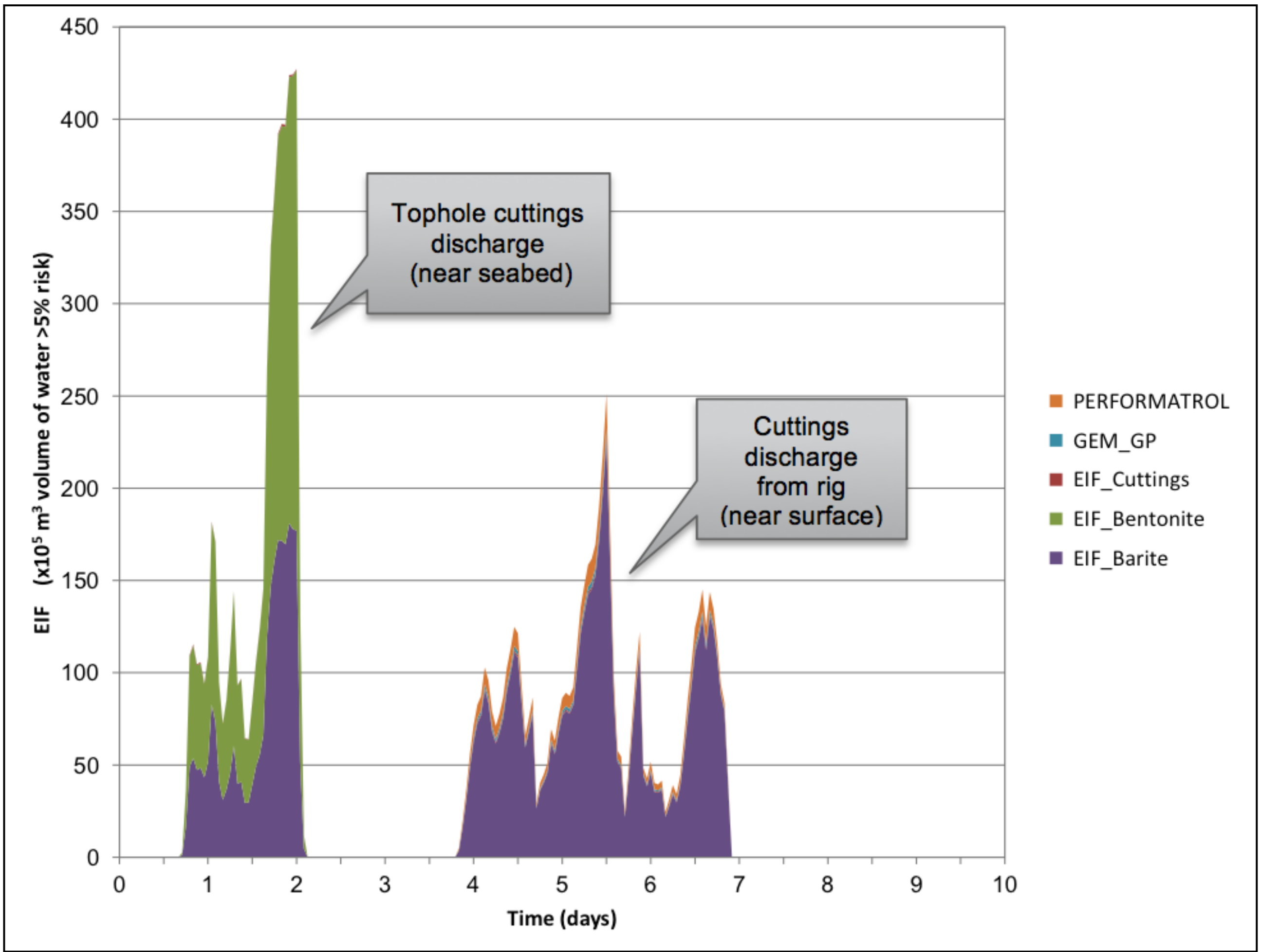


Figure 66: Instantaneous Environmental Risk (EIF) to the Water Column Throughout Time During the Discharge of Mud and Cuttings of all Well Sections from a Single Well

12.5 Impact Assessment Summary

12.5.1 Severity and Receptor Sensitivity

Seabed Sediment

Sediment quality will primarily be affected by the discharge of drill cuttings direct to the seabed from the two top-hole sections (42” and 17.5”), which will result in an increase in average sediment grain size in the close vicinity of the well. These sections will also be circulated with bentonite sweeps, which contains barite, bentonite, caustic soda, soda ash and lime; however, these components are virtually toxicologically inert (Neff, 2005) and will therefore have little impact on the sediment quality aside for their contribution to the sediment particle size modification.

Modelling indicates that coarser drill cuttings (5000 µm) will be deposited within 50 m of each well location, and that a median particle size nearly three orders of magnitude greater than typical background sediments, will extend to a distance of 7 km along the prevailing current. This will result in a highly modified sediment structure along the direction of prevailing current from each of the well locations. It is expected that these changes to local sediment grain size will persist for at least 10 years (Genesis, 2014).

Concentrations of a number of heavy metal components within the drilling mud will exceed the natural background sediment concentrations within the exploration area, including cadmium, copper, mercury, lead and zinc. However, these metals are present in barite primarily as insoluble mineralised sulphide salts which will therefore have limited environmental mobility and a low toxicity (Neff, 2005).

The severity of the impact to sediment quality is assessed as '**Moderate**' having an effect over a relatively small area, from a short-term release that will have a temporary but reversible impact on the habitat.

The sensitivity of the receptor is assessed as '**Very Low**' as the habitat is undesignated and has no geographical importance owing to it being widespread in nature.

Water Quality

The discharge of drill cuttings is expected to result in a local reduction in water quality both in surface waters and in the lower part of the water column, due to an increase in turbidity. Modelling results indicate that a plume of affected seawater would extend over 2.8 km kilometres down-current from each well location. Turbidity in the water column is not expected to extend more than a 100 m above the seabed whilst drilling the top-hole sections (42" and 17.5") and within approximately 100 m of the sea surface whilst drilling the bottom hole section (12.25") (Genesis, 2014).

Drilling operations for the entire campaign are scheduled to occur between March and October 2015, with each well taking approximately 30 days to drill and abandon and resulting in a total of 120 drilling days spread throughout the campaign with approximately 120 days gap between the second and third well, whilst the rig is on hire to Noble. On completion of drilling operations for each well the oceanic currents would rapidly dilute the suspended particles and drill cuttings would re-settle onto the seabed, with water quality largely recovering within approximately 25 hours (Genesis, 2014).

It is therefore concluded that there would be a '**Minor**' impact to the water quality based on a relatively small volume of water being affected, short duration of the operations and the rapid recovery period (Table 4).

The sensitivity of the receptor is assessed as '**Very Low**' as the area of affected water column is located in an area within the Falkland Islands continental shelf that is not very productive in the austral winter (Section 5.4), and is directly influenced by both Patagonian Shelf waters and superficial sub-Antarctic waters which spread over wide areas of the continental shelf.

Phytoplankton and Zooplankton

Increased turbidity leading to reduced light penetration in surface waters can affect primary production, and could lead to a shorter or shifted phytoplankton bloom period or shifts in species composition. Experiments assessing the impact of WBM concentrations on survivorship of the marine diatom (*Thalassiosira pseudonana*), did not show any significant changes in algae biomass or physiological condition that could be attributed to WBM following exposure to 50 mg/l for a period of 10 days (Cranford et al., 1998).

High concentrations of suspended particulates may cause responses in zooplankton, such as physical interaction with the gills, gastrointestinal tract and feeding behaviour, as opposed to chemical toxicity (Smit et al., 2006).

The increase in water column turbidity resulting from suspended fine particulates is expected to be localised to within a distance of approximately 1 km to the west of each well location, continuously affecting a volume of approximately 0.025 km^3 in the upper water column. The drilling operations and hence cuttings discharge are scheduled to take 30 days per well and the upper water column is predicted to recover within seven hours of drilling completion.

The severity of the impact to plankton is therefore considered to be '**Minor**' impact as there will be a short-term release at each well location, the environmental risk is predicted to be localised and the impact will be minor in nature.

Both phytoplankton and zooplankton have a '**Low**' sensitivity as they are widely distributed throughout the water column and over the Falklands Continental Shelf and do not represent any rare or vulnerable species (Section 5.4).

Benthic Fauna

Discharge of drill cuttings at the seabed and from the surface will physically disturb benthic fauna in the area around the discharge location and will bury sedentary benthic fauna in the immediate discharge area. In the short-term, this would lead to the mortality of some benthic organisms in the area of the cuttings discharge and create a collective area of disturbed habitat <1 km^2 in the vicinity of the four well locations. Modelling indicates that the modification of sediment grain size drives the environmental risk factor, with sediment thickness accounting for a much smaller proportion of risk. It is feasible that changes in sediment particle size characteristics could affect the suitability of the seabed for re-colonisation by species normally characteristic of the area for a number of years; whilst sediment deposition may have a lethal short-term effect from burial these sediments will have a negligible toxicity in the long term.

Modelling outputs indicate that the environmental risk will fall below 5% within five years after the end of drilling activities (Genesis, 2014). Studies have shown that re-colonisation of cuttings pile sediments may commence 1-2 years after the cessation of cuttings discharges (UKOOA, 1999; Neff 2005).

Predictions of rapid recolonisation are supported by results from environmental surveys conducted in the exploration area during 2012. These studies compared baseline surveys where no drilling had previously taken place, with post-drilling surveys around areas of historical drilling activity (Section 5.3, Gardline 2013a and b). These surveys indicated that there was no evidence of anthropogenic disturbance as a result of historical drilling activities and that species diversity, community assemblage and abundance were typical of those found in background/undisturbed areas (Section 5.4, Gardline 2013a). Additionally, environmental surveys conducted in the North Falklands Basin during the FOSA drilling campaign in 1998 included a pre- and post-drilling survey around the 'Little Blue A' well (Section 5.3) (also drilled with WBM). Survey results indicated no change in the composition of dominant species and similar levels of abundance and species diversity in both pre- and post-drilling surveys. Therefore, drilling activities did not appear to appreciably disturb the benthic community in the area.

Benthic filter feeding organisms, such as bivalve molluscs, are known to experience toxic effects of suspended particulate matter causing clogging in the gills (Cranford et al., 1998). Laboratory studies have shown that elevated concentrations of bentonite and barite, the two major constituents of WBMs, can affect the growth of suspension feeding organisms (Cranford & Gordon, 1992; Cranford et al., 1999; Barlow & Kingston, 2001), with some species more sensitive than others. However, particles such as barite settle out rapidly from the WBM and the cuttings plume resulting in declining concentrations of barite in the water column, and even in the benthic boundary layer where most bivalves feed, therefore it is probable that barite has limited toxic effect to these organisms (Neff, 2010).

The severity of the impact to the benthic fauna is considered to be '**Moderate**' affecting a relatively small area, the impact will be temporary and with environmental risk to benthic fauna falling below 5% within five years after completion of drilling.

The environmental receptor is considered to be of '**Very Low**' sensitivity, there are no vulnerable species recorded within the benthos and the community structure is widespread and typical of the area.

Fish and Shellfish

Fish are highly mobile organisms and are likely to avoid the areas of re-suspended sediments and turbulence during the drilling operations; consequently, larvae and eggs of fish are more sensitive to an increased concentration of suspended sediment than adult life stages. Experiments assessing the impact of turbidity on survivorship on fish embryos and larvae, showed a significant decrease in survivorship in late-stage haddock embryos (8-12 days old) and yolk sac larvae (3-7 day post-hatch) at the highest WBM concentrations tested (100 mg/l); whilst early stage embryos (1-4 days old) and feeding larvae (13-17 days post-hatch) showed no significant response to any of the WBM concentrations (Cranford et al., 1998). Other studies suggest that concentrations of suspended particulate matter of approximately 200 mg/l may damage the gills of fish; whilst higher concentrations are may inhibit feeding activity (Kinne, 1971 – referenced in Smit et al., 2006).

The proposed well locations are situated within the Falkland Islands Northern Slope habitat zone (Section 5.4.5), which has been identified as an important feeding area for a number of fish species, whose abundance varies with season. The drilling operations at each well site are scheduled to occur between March 2015 and August 2015, and would therefore coincide within recorded high abundances of the following fish species in the Northern Slope: hoki, Patagonian toothfish, loligo squid, common hake, kingclip, yellownose skate and slender tuna; and lower abundances of southern blue whiting, greater hooked squid, southern rock cod and Argentine shortfin squid. Many of these species, with the exception of the Patagonian toothfish, primarily inhabit the shallower areas of the NS habitat than the area where the exploration drilling will take place. Additionally, most species have relatively wide distributions being present in several habitat areas within each season, which suggests that no species is solely reliant on the NS area as a feeding ground. However, during the austral autumn and spring more than 50% of the Falkland Islands hoki population inhabit the NS over other areas, similarly southern blue whiting predominantly inhabit the NS during summer, slender tuna during autumn and the yellow nosed skate during winter. Whilst Falkland Islands waters support diverse and productive feeding grounds, the majority of higher trophic fish species migrate outside of Falkland Islands waters to spawn elsewhere. Of the few commercial finfish species that remain in Falkland Islands waters to spawn, to our knowledge none spawn in within the Northern Slope habitat zone (Section 5.4.5). However, some non-commercial species are likely to spawn in this area including the psychrolutids *Psychrolutes marmoratus* and *Cottunculus granulosus*, small morid cods like *Notophycis marginata* (P Brickle pers obs.). Other species in the area include mytophids and bathylargids with the former in significant quantities (P Brickle per obs). The former species were observed in a high proportion of the down camera surveys during the Sea Lion Field survey in 2013 (Gardline 2013). It is also likely that a number of skate species will breed in this area due to their known distributions (e.g. Arkhipkin et al., 2008; Arkhipkin et al., 2012); egg cases from a number of species have been encountered in this area (P Brickle per obs.).

During the drilling programme discharges of drilling mud and cuttings will be made both to the surface waters and to the seabed, resulting in high levels of suspended particulate matter concentrated within the upper and lower 100 m of the water column, settlement of particles will also occur throughout the water column. Of the fish species that migrate to the Northern Slope habitat to feed during the autumn and winter months, five are pelagic feeders primarily consuming zooplankton, small fish and squid, and the remaining species are near bottom predators feeding primarily on southern rock cod and other small fish.

The Northern Slope habitat covers an area of 50,686 km^2, with an average depth of greater than 400 m. Modelling indicates that a maximum instantaneous volume of water of 0.0427 km^3, would be at >5% environmental risk at any one time during the drilling operations. The spatial extent (volume) of the habitat predicted to be affected by the total drilling discharges is therefore of little to no geographical importance (<0.001% of available habitat) to the fish populations migrating to the area to feed.

The severity of the impact to fish species in the exploration area is expected to be '**Minor**' in nature owing to the absence of spawning commercial fish species on the Northern Slope which are the most sensitive life stage; the relatively localised area of effect; short-term impact and reversibility of the effect (less than 14 days per well including recovery of the water column to <5% risk).

Whilst there are nationally important numbers of hoki (50% of Falkland Islands population) present on the Northern Slope during the drilling period, only a very small proportion of fish would be exposed to the drilling discharges, owing to the very small impact volume. Of the fish species known to be present in the exploration area, the yellow nosed skate and grey tailed skate have been assessed as Vulnerable and Endangered respectively on the IUCN Red List. These species are primarily found on the north-west outer shelf habitat area during the austral autumn and winter period, where they are most abundant between 100 and 300 m water depths, they also known to occur on the southern slope habitat area during this period (Section 5.4.5).

As adult fish are highly mobile species, capable of migrating outside of Falkland Islands water to spawn and are likely to avoid areas of high turbidity, and once drilling commences any individuals within the area are likely to move into adjacent areas of the Slope that are unaffected by the discharge. Overall the sensitivity of the receptor is considered to be ‘**Low**’, due to the very small proportion of key species that would be affected.

12.5.2 Significance

Seabed Sediment

The severity of the impact to seabed sediments was assessed as ‘**Moderate**’ and the sensitivity of the receptor was assessed as ‘**Very Low**’, hence the overall significance is considered to be ‘**Low**’ and of an acceptable level of risk.

Water Quality

The severity of the impact to water quality was assessed as ‘**Minor**’ and the sensitivity of the receptor was assessed as ‘**Very Low**’, hence the overall significance is considered to be ‘**Low**’ and of an acceptable level of risk.

Phytoplankton and Zooplankton

The severity of the impact to phytoplankton and zooplankton was assessed as ‘**Minor**’ and the sensitivity of the receptor was assessed as ‘**Very Low**’, hence the overall significance is considered to be ‘**Low**’ and of an acceptable level of risk.

Benthic Fauna

The severity of the impact to benthic fauna was assessed as ‘**Moderate**’ and the sensitivity of the receptor was assessed as ‘**Very Low**’, hence the overall significance is considered to be ‘**Low**’ and of an acceptable level of risk.

Fish and Shellfish

The severity of the impact to fish species was assessed as ‘**Minor**’ and the sensitivity of the receptor was assessed as ‘**Low**’, hence the overall significance is considered to be ‘**Low**’ and of an acceptable level of risk.

12.5.3 Degree of Confidence

The duration of the drilling campaign is known and the quantities of drilling mud and cuttings have been estimated on a conservative basis. Modelling uncertainties have been identified and their potential to materially alter the outcome of the modelling has been considered. The environmental receptors are well known from site-specific survey data and extensive fisheries research in the area. The nature of the impact from water based drilling discharges is relatively well known from several decades of research and also from model validation studies conducted by SINTEF.

The level of confidence in the impact predictions (in terms of the nature of the impact and its level of significance) for drilling discharges is considered to be ‘**Certain**’ as the activity is clearly defined, the sensitivity of the receptor and the nature of the impacts are well understood. Although, it is acknowledged that improvements in the modelling design could increase accuracy of quantification of the impact.

12.5.4 Cumulative Impact

During the 2015 Premier Oil drilling campaign there will be no other oil and gas activities occurring in the NFB. Noble Energy will also be conducting an exploration drilling campaign in 2015, however, their operations will be located in the SFB and drilling discharges from their campaign will be so remote that there is not considered to be an in-combination or cumulative impact to those organisms and species in the NFB.

The interactions with other pressures acting on the environment must also be considered for their potential in-combination effects. The Falkland Islands support rich fishing areas within the Falkland Islands Conservation and Management Zones (FICZ/FOCZ), which are sustainably managed by the Directorate of Natural Resources, Fisheries Department. Any significant detrimental interactions or cumulative effects could impact the current running of the fishery within the area. Analysis of fisheries statistics data between 2008 and 2012 indicated that fishing activity within the exploration area was consistently very low during this period, with catch for all species accounting for <1% of total catch within the FICZ/FOCZ in all cases (Section 5.6.1.1). The fishing effort within the exploration area is by jig and trawl vessels targeting primarily Argentine shortfin squid, skates or finfish. Fisheries Department data indicate that both jig and trawl vessels spent only 14 days in the exploration area between 2008 and 2012, and further detailed analysis of vessel tracks indicated that only one vessel was actually fishing in the exploration area (Section 5.6.3). Impacts resulting from drilling discharges are expected to have an environmental impact within <2.5 km from well location, and as the exploration area is of very low importance to the Falkland Islands fishing industry any in-combination or cumulative effects are considered to be negligible.

Following the exploration drilling campaign in 2015, Premier Oil are planning to further develop the field into a hydrocarbon production facility. The exact date of installation and production drilling is currently not confirmed, however, Premier Oil are working towards starting development construction activities around 2017. Drilling approximately a further 32 wells within the field could lead to additional and cumulative impacts in the area associated with long-term habitat modification due to increased particle sizes from drill cuttings discharges.

12.6 Mitigation measures

Whilst the impact significance is considered to be low for all environmental receptors, good practice measures will be followed during drilling operations to ensure that the risk to the environment is maintained as low as possible:

- Drilling fluids will be re-circulated with cuttings being separated from the muds and the mud being re-used to minimise discharges as far as possible.
- The majority of WBM chemicals planned for use are considered to Pose Little or No Risk, known as PLONOR chemicals. Where non-PLONOR chemicals are required for operational or safety reasons, their use and discharge will be strictly monitored and minimised as far as possible.

During stakeholder scoping consultations, fitting a diffuser on the drill cuttings discharge in surface waters was suggested as a means to increase dispersion of the cuttings. Premier Oil have considered the use of a diffuser device on the cuttings discharge caisson, however, as no examples of this specific use (diffusers are commonly used on heated seawater discharges) were found it is considered unproven technology, and due to the particle load in the discharge could present a risk of clogging the discharge. Given the predicted low and short-lived environmental impact from the discharge of cuttings at the surface, and the remote drilling location (the Falkland Islands are remote from provision of spares if required) any additional environmental benefit was not considered to outweigh the risk of using an unproven device.

12.6.1 Residual Risk

The impacts associated with drilling discharges are considered to be of low significance prior to mitigation measures. It is best practice to minimise any impacts to the marine environment where possible and on this basis standard industry mitigation measures will be employed during the campaign. However, as the pre-mitigation impacts were assessed to be of '**Low**' significance, there will be no change in assessment of the residual impacts, which are also of '**Low**' significance.

Table 64: Summary of the impact assessment for discharge of WBM and drill cuttings during the 2015 Campaign

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance Pre-mitigation	Significance Post-mitigation	Certainty	Mitigation / Prevention / Control
Drilling operations	Discharge of seawater and bentonite sweeps, WBM and drill cuttings	Deposition of drill cuttings modifying sediment particle size	Planned	At each well	Very Low	Moderate	Low		Certain	Drilling fluids will be re-circulated with cuttings being separated from the muds and the mud being re-used to minimise discharges as far as possible. The majority of WBM chemicals planned for use are considered to Pose Little or No Risk, known as PLONOR chemicals. Where non-PLONOR chemicals are required for operational or safety reasons, their use and discharge will be strictly monitored and minimised as far as possible.
		Suspension of particles leading to increased turbidity			Low	Minor	Low		Certain	
		Reduction the ambient light, barite particles may affect zooplankton			Very Low	Minor	Low		Certain	
		Burial of benthic fauna and modification of habitat			Very Low	Moderate	Low		Certain	
		Suspended barite particle may affect gill structures			Low	Minor	Low		Certain	

** See Section 6.0 for definitions of severity and significance.*

13.0 Accidental Events leading to oil and chemical spills

13.1 Introduction

Along with the potential environmental impacts from planned exploration activities, impacts may arise from unplanned/accidental events. Chemical spills, fuel spills and oil spills are unplanned events that would result in potential impacts, the significance of which will depend on the conditions of the event; for example, the properties of the oil/chemical spilt and the size of spills. These accidental events would have varying impacts on the offshore, onshore environments and on the socio-economics of the Falkland Islands.

The following accidental events were identified during the Environmental Risk Identification (ENVID) process:

- Emergency situation leading to a significant loss of containment or an uncontrolled release;
- Accidental loss of containment during operations leading to small diesel or chemical spills;
- Major rig incident resulting in loss of rig;
- Major vessel incident resulting in a collision with rig or another vessel; and,
- Loss of containment of drilling mud from riser due to rig failing to maintain station.

The most significant spills that could occur are associated with an uncontrolled release during drilling or loss of containment of diesel fuel inventory from the drilling rig.

The sources of smaller spills can include; bunkering of diesel and drilling muds from supply vessels to the drilling rig and loss of containment of drilling mud due to the rig failing to maintain station.

In this chapter, the environmental risk of these events occurring during the 2015 Drilling Campaign is assessed.

13.2 Emergency situation leading to an uncontrolled release

13.2.1 Sources of Major Oil Loss of Containment into the Environment

Uncontrolled Releases

There are two main control measures that prevent the uncontrolled release of hydrocarbons during drilling, primary and secondary:

- Primary well control is achieved by maintaining a hydrostatic pressure in the wellbore greater than the pressure of the fluids in the formation being drilled, but less than the formation fracture pressure – this is done using drilling mud. If the formation pressure exceeds the wellbore pressure reservoir fluids will flow into the wellbore,
- A blow-out-preventer (BOP) is installed onto the wellhead at the seabed once the top-hole section has been drilled, to function as a secondary control measure. In the event that the primary control fails and the formation pressure exceeds the wellbore pressure, the BOP will be activated from the rig to positively close the wellbore.

In the unlikely event that both primary and secondary well controls fail, an uncontrolled release can occur.

13.2.2 Potential Environmental Receptors

The impacts of oil spills on marine organisms are well documented. Moore and Dwyer (1974), Burger (1993) and Kingston (2002) provide comprehensive reviews of the impact on marine life.

Oil does not affect all components of marine ecosystems equally; some are more vulnerable to physical impacts, others to chemical toxicity and some are relatively resilient to both. The key effects of oil include the following:

Plankton

Plankton plays a key role in marine food web dynamics, biogeochemical cycling and fisheries recruitment. However, despite the importance in the marine environment our knowledge of the interactions between plankton and anthropogenic pollutants is not well known. Although low concentrations of hydrocarbons (<0.05 mg/l) may stimulate phytoplankton growth, higher concentrations are likely to inhibit growth or kill phytoplankton.

Eggs and larvae in the zooplankton appear seasonally and many have been shown to be vulnerable to oil during laboratory experiments (Almeda et al. 2013). Any changes in the distribution and abundance of plankton communities could result in secondary effects. Plankton form the base of the food chain and therefore sub-lethal contamination of plankton could result in significant toxic effects in higher predators.

There are three main types of interactions between zooplankton and pollutants.

- pollutants can have direct toxic effects on zooplankton, including lethal or sub-lethal effects (Walsh, 1978).
- zooplankton may influence the physicochemical characteristics of the pollutants in the water column by absorption, transformation and elimination (Walsh, 1978; Fisk et al., 2001; Muschenheim et al., 2002).
- zooplankton may play an important role in the bioaccumulation of pollutants up food webs. Therefore, understanding the interactions between pollutants and zooplankton is crucial for our understanding of the fate of pollution in the pelagic zone and their impact on marine environments.

The oceanography and topography of the southern Patagonian Shelf, with the strong Falkland Current deriving from the ACC moving northwards both west and east of the Falkland Islands, creates an area of very high zooplankton productivity immediately to the north of the Islands (Tarling et al., 1995; Agnew, 2002). The distribution and abundance of plankton in Falkland Islands waters varies on a seasonal basis.

Benthic communities

Invertebrates vary greatly in their sensitivity to oil. Corals are among the most sensitive, whereas some barnacles and limpets may withstand a degree of oiling. Shellfish may accumulate oil residues with attendant secondary effects, particularly relating to health (OSPAR, 2009b).

To date benthic surveys have indicated that the seabed in the exploratory area is uniform (see Section 5.3 for further details). The results of the latest surveys, in the vicinity of the Isobel Deep well, are yet to be published but preliminary results indicate that this area is slightly more diverse than the Sea Lion area. This difference is largely due to erratic rocks, which provide habitat for corals.

Fish and Fisheries

Fish eggs and larvae are more susceptible to toxic effects of oil than are adults, due to the ability of adult fish to avoid contaminated water. However, adult fish may accumulate hydrocarbons in their tissues that may affect their health and also taint their flesh (OSPAR, 2009b). Toxic components in crude oil include Polycyclic Aromatic Hydrocarbons (PAHs), phenols, naphthalene, phenanthrene and pyrenes. PAHs can also be mutagenic and carcinogenic.

Although there is little fishing effort in the immediate vicinity of the wells sites, the Sea Lion and Isobel Deep wells sit on the Northern Slope, which supports a number of commercial species. The most abundant fisheries resources here include southern blue whiting (Summer); hoki (spring, summer, autumn); Patagonian toothfish (Summer and Autumn); Loligo squid (winter); common hake (Autumn, Winter); kingclip (Winter); southern rock cod (Summer); Argentine shortfin squid (Summer, Autumn); skate (see Section 5.4.5 for more detail). Perhaps of greatest significant is the Argentine shortfin squid, which migrates into deeper water (in May and June) to access the

Falkland Islands current to aid their northerly spawning migrations, a significant proportion of the South Patagonian Stock passes through the North Slope.

The most significant fishing ground in the vicinity of the exploration area is in the deeper waters to the north and northeast. These areas are targeted by longliners fishing for Patagonian toothfish (Section 5.4.5 and Section 5.6.1).

The area is also used by species of little or no commercial value, such as *Onykia ingens* squid, myctophids and Falkland sprat. These species are important food sources for predatory fish, seabirds and marine mammals. Grenadiers also occur in this area, particularly *Macrourus carinatus* and this is potentially a new fishery for the Falkland Islands (Payá, 2009)

Seabirds

The affinity between oil and plumage makes seabirds particularly vulnerable to accidental hydrocarbon releases. Worldwide, millions of seabirds have been killed by oil pollution (e.g. Goldsworthy et al., 2000; García Borboroglu et al., 2006 and 2010; Wolfaardt et al., 2009) and seabirds tend to be the most conspicuous group at oil spill events. Oil pollution can impact birds directly through contamination, or indirectly through consumption of contaminated prey (Committee on Oil in the Sea, 2003).

Most birds have a poorly developed sense of smell; however, procellariiforms (albatrosses and petrels) are unusual in having a well-developed sense of smell. The enhanced sense of smell in these scavenging species enables them to find food and it is likely that these birds would be able to detect oil from a considerable distance. It is unclear whether this makes these birds more vulnerable due to attraction to surface oil or whether it enables them to avoid noxious smelling slicks.

Although ingested oil during plumage cleaning may be lethal, the most common cause of death is due to the loss of feather condition, which leads to hypothermia. Plumage is essential to flight, heat insulation and waterproofing, and even small effects on any of these functions can result in mortality.

Seabird species differ in their susceptibility to contamination from oil pollution due to differences in foraging ecology, geographical distribution, breeding phenology (timing) and life history strategies (White et al., 2001). Although a wide variety of seabirds may be affected, the greatest impact is generally on those species that spend a large amount of time at the sea surface, such as diving species. For this reason, the birds most affected directly by oil pollution in the southern hemisphere have been penguins and shags (García Borboroglu et al., 2006 and 2008; Altwegg et al., 2008; Wolfaardt et al., 2009).

Oil can also indirectly influence the survival or reproductive success of seabirds by affecting the distribution, abundance or availability of prey, but this is much more difficult to assess.

The seasonal vulnerability of seabirds within Falkland Islands waters is presented in White et al., (2001) and Figure 30 to Figure 35 (Section 5.4.7). The most sensitive time of year for seabirds around the exploratory well sites are January, February, May, June and August, when vulnerability to surface oil pollution was considered to be ‘high’ in some proportion of the area.

Vulnerability was generally ‘moderate’ for the remainder of the year, and ‘moderate’ to ‘low’ during December, when relatively few seabird species were present in low densities.

The area around the exploratory well sites was not considered to be of ‘very high’ vulnerability during any period of the year, although an adjacent area to the south was of ‘very high’ vulnerability during January.

Marine Mammals

Like seabirds, pinnipeds (seals) may be directly impacted through contact with hydrocarbon pollution, or indirectly through impacts to lower trophic level prey that may change foraging patterns or lead to bioaccumulation of contaminants.

The pelage (fur) of pinnipeds can be fouled by coming into contact with oil at sea or when crossing an oil contaminated shore. It is generally accepted that phocid (true seals) are less sensitive to the effects of direct hydrocarbon fouling than otariids (eared seals - fur seals and sea lions) and seabirds. Whilst for phocids the pelage can be coated/fouled with oil it is the sub-dermal fat layer that provides most insulation. Only in the fur seals and sea lions that rely on the insulation provided by the animal's coat, is oiling likely to result in hypothermia (Atlantic OCS, 1988). The location and severity of an oil spill will obviously influence the level of impact and contamination of coastal breeding sites, near-shore transit routes and restricted foraging areas. Besides hypothermia, there are a number of other potential impacts. Exposure may cause severe eye watering (lacrimation), conjunctivitis, and corneal abrasions and ulcers if debris becomes mixed with encrusted oil. This may subside if exposure is short but it might be assumed that prolonged exposure could result in permanent damage (Atlantic OCS, 1988; Salaza, 2003). Severe fouling of pelage may lead to an inflammatory response in the dermis and to skin ulcers following contamination but with subsequent recovery if contamination is of short duration (Atlantic OCS, 1988; Salazar, 2003).

The greatest risk of mortality may result from inhalation of toxic volatile compounds from the surface of oil spills and this may be exacerbated if the animal is already stressed from the secondary effects of spill and disturbance (Atlantic OCS, 1988; Jenssen, 1996).

Cetaceans (whales, dolphins and porpoise) are believed to be less vulnerable to oil pollution than pinnipeds or seabirds. Cetaceans generally spend a longer period submerged that seabirds and pinnipeds rather than on the surface of the water where contaminants are likely to occur. However, they do need to surface to breathe and rest and it is here that they can be fouled or inhale volatile components of hydrocarbons. In cetaceans, the respiration of volatile chemicals at the surface of a slick or the ingestion of oil may be lethal or chronic affecting longer term foraging performance. Polyaromatic Hydrocarbons tend not to be accumulated in marine mammals but certain metallic trace elements present in oil can be transferred and bioaccumulate.

A description of the spatial and temporal distribution of marine mammals in the NFB can be found in Section 5.4.6.

Potential Coastal Impacts

Premier Oil have recently conducted an environmental sensitivity assessment of the North Falklands coastline to the potential impacts from an oil spill (Premier Oil, 2014c). This study is based on oil spill modelling to ascertain the potential distribution of oil in the unlikely event of a worst-case oil spill from the proposed Sea Lion Field Development and therefore the scale of the event is different to this exploratory phase. The North Falklands Coastline Environmental Sensitivity study is also relevant to the exploration campaign as it highlights the most sensitive sites along the north Falklands coastline in the event that a shoreline oil spill response operation needs to be initiated, these sites have been summarised in Section 5.4.8.6).

Throughout the year, inshore and coastal waters are important feeding grounds for numerous species. Inshore waters support huge quantities of lobster krill and Loligo squid, which in turn are major food resources for higher predators. At certain times of the year, associated with breeding and moulting, animals return to land and therefore coastal waters contain high densities of vulnerable species. White et al. (2001) found inshore waters to be of very high vulnerability throughout the year (see Section 5.4.7).

Tourism

If an uncontrolled release or major loss of containment were to occur, the negative publicity could impact the Islands tourism industry. Many visitors come to experience the pristine environment and wildlife, even if oil did not reach the shore the negative publicity would tarnish the image of the Islands.

13.2.3 Characterising and Quantifying the Impact of an Uncontrolled Release

As oil is released into the sea it undergoes a number of physical and chemical changes. These changes are dependent on the type and quantities of oil spilled and the weather conditions experienced over time by the spill (Figure 67).

Evaporation and dispersion are the main mechanisms that act to remove oil from the sea surface.

- Evaporation is the main mechanism by which the mass of oil is reduced immediately after a spill. It also causes considerable changes in the density, viscosity and volume of the spill over time. The light fractions of the oil (aromatic compounds such as benzene and toluene) evaporate quickly. Evaporation is enhanced by warm air temperatures and moderate winds. The oil remaining in the slick will have a higher viscosity and specific gravity.
- Once the lighter fractions have evaporated from the oil spill the evaporation process slows down and natural dispersion becomes the dominant mechanism in reducing slick volume. This process is dependent upon sea surface turbulence, which in turn is affected by wind speed.

Mathematical models can be used to predict the extent and duration of impacts resulting from a spill.

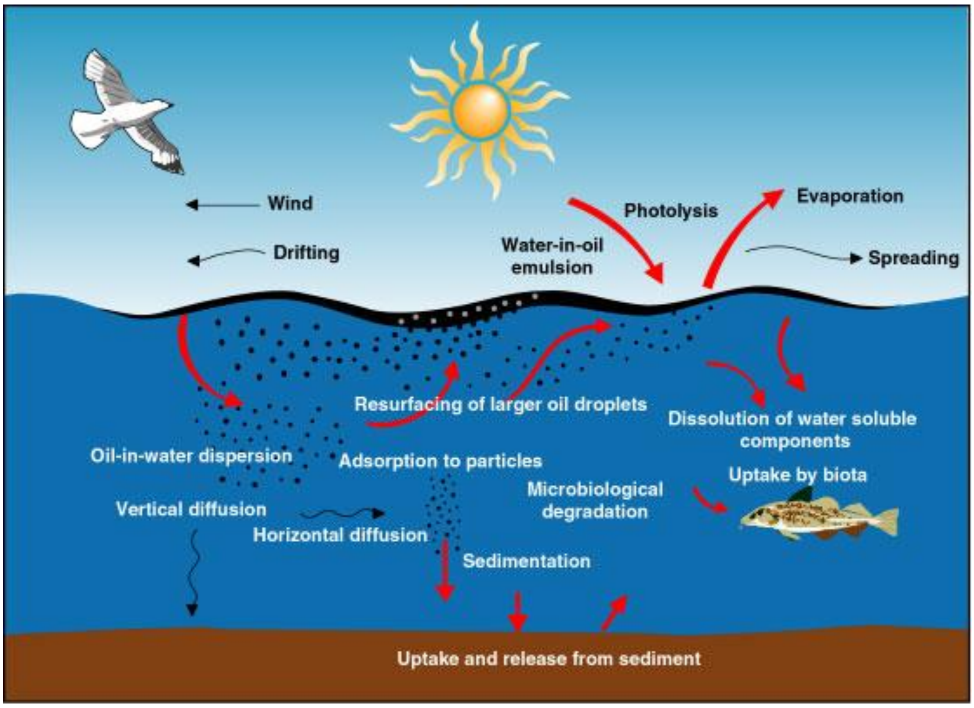


Figure 67: Behaviour and fate of oil in the marine environment (after Andreassen and Sørheim, 2013)

13.2.3.1 Oil spill modelling

The oil spill modelling was carried out by Genesis (2014a). The aim of the modelling was to recognize and understand:

- Where an oil slick is likely to travel;
- How an oil slick is likely to be dispersed over time (on the surface and in the water column);
- Where oil concentrations are likely to pose a risk in the water column;
- The likelihood and extent of oil arriving on the shoreline.

Modelling was conducted using the Oil Spill Contingency and Response (OSCAR) model developed by SINTEF (Stiftelsen for industriell og teknisk forskning – The Foundation for Scientific and Industrial Research) in Norway. OSCAR consists of a dispersion model based on wind and 3D current data and a component-specific fate model whereby the physical-chemical, toxicity and biodegradation properties of the components of a discharge are modelled.

A regional circulation model was used to generate the currents in the study area. The model was generated by Proudman Oceanographic Laboratory, who are now part of the National Oceanography Centre (NOC) in Southampton. NOC incorporated data from the Patagonian Shelf Model developed by Glorioso and Flather (1997) into POLPRED. The model includes the Falkland Current as a steady state flow, and does not include the effects of wind. Given the presence of hydrocarbons in different depth layers in different scenarios and the need to accommodate wind forcing of the surface layers, the data was subsequently depth-layered by Oceanwise using a depth-dependent algorithm to take advantage of the 3D nature of OSCAR. During the course of 2014 Premier has taken steps to improve on the existing oceanographic data sets on which predicted oil spill modelling has been based. A new coupled inshore tidal and oceanographic circulation model is under development and is due to be fully completed in 2015. This has been undertaken by a collaboration between BMT Argoss, BMT WBM and the UK Met Office. A Specification Report is available on request (SeaLion Hydrodynamic Modelling, Model Specification, Ref: A14043, Sept 2014). The Fisheries Dept and other stakeholders have reviewed the model set up and are collaborating with PMO by providing historic data for model ground trothing. Premier is committed to continuing to improve the model when new oceanographic data becomes available from third parties and to also seek cost effective solutions to gather further data themselves for model validation.

Spill scenarios were stochastically (non-deterministically) analysed with time series weather and current data, demonstrating how the behaviour of the hydrocarbons change in variable metocean conditions. Stochastic outputs examined shoreline, surface and water column statistics. Deterministic model runs were undertaken to predict the behaviour and fate of the plume over time in terms of surface accumulation, water column concentrations and oil reaching the shore.

In addition, deterministic analysis was undertaken of each scenario using a specific set of metocean conditions to give further detail on the behaviour of the release. Typically, the choice of deterministic run is based on worst-case conditions for wax beaching.

13.2.3.2 Model Thresholds

The OSCAR model uses a Lagrangian (particle tracking) approach, which enables tracking of the movement and location of individual particles in a 3D environment. Here, each particle represents a body of oil that is either dispersed in droplets, dissolved, or in the form of a surface layer. Each particle represents a bulk mass that is a fraction of the overall release, but which behaves according to the properties of the individual droplets or dissolved components or surface layer that it represents. During the simulation, these particles tend to lose mass to evaporation, decay or deposition and the model will terminate particles or cease recording them when the oil property represented falls below a certain value. Normally these are values of concentration or surface thickness that are chosen to reflect a level of insignificance.

Uncontrolled Release

For the uncontrolled release scenarios a threshold level of 25 ppb has been chosen as a water column concentration threshold, which is below established levels of impact. For surface thickness, a value is often chosen that represents a significant thickness for response purposes (e.g. 1- 10 microns) or a thinner value that represents visibility of liquid oil and/or potential impacts on bird plumage, e.g. 0.04 - 0.2 microns, although it is noted that there is no consensus on thicknesses of surface oil that correspond to impacts. For this particular oil type, however, the overwhelming properties of the wax components mean that a surface thickness parameter is not meaningful, and a scale has been devised to reflect the density of wax droplets, or ‘waxlets’, on the sea surface.

The scale of waxlet density chosen to represent results is 1, 5, 50, 200 and 1000 grams per square metre. These are not intended to imply significance in terms of impacts, but to convey factual information regarding the model predictions and allow a means of visualising the results. In general, the model predicts that sub-millimetre sized particles will result once a modest amount of dispersion and wave action has taken place, and it is therefore unlikely that waxlet densities at the lower end of the scale provided would be visible.

13.2.3.3 Modelling Uncertainties

Release Volumes

The scenarios considered are based on worst-case assumptions. Uncontrolled releases are rare events that are often controlled within a matter of days using subsea intervention techniques.

Oil Characterisation

The oil modelled is extremely waxy and is difficult to characterise using conventional oil weathering methods and metrics. Taking into account expert advice and experience of how such oil is likely to behave, oil weathering properties have been adopted which are intended to create the most realistic behaviour within the model as possible, and this is an approach that has been used on at least one other project worldwide where there is a high wax content. By examining intermediate steps in the model calculations, the choices for the model parameters have been checked and found to be reasonably consistent with expected behaviour. The overall modelling results are also consistent with expectations.

It should be noted that although a hydrocarbon similar to that of Sea Lion crude, has been modelled, there is a slim possibility that the hydrocarbon encountered might display different characteristics, as these are un-explored targets. Sea Lion crude has been used for the modelling as it is more persistent in the marine environment, and is considered a worst-case scenario. The diesel scenarios shown below give an indication of how a lighter hydrocarbon might react if released.

Metocean Data

The metocean dataset used in the oil spill modelling covers three years of depth-averaged data from an established regional current model. This provides a wide range of weather conditions within several annual cycles of weather. This is considered to be the best dataset available for the area and, given the large spatial coverage; it is believed that this data is sufficient for drawing conclusions on the fate of oil in this area (Genesis, 2014a). Earlier modelling used one year 3D current meter data recorded at Sea Lion throughout the model grid, but this was not considered to be as representative as it was not spatially variable. In reality there will be some variation across the domain. It is acknowledged that there are limitations in this model. Little oceanographic data have been collected in a systematic way for this area with the exception of two monthly transects conducted from 18 m to 1,000 m directly east of Slanley and also south east from lively Island (off the east coast of East Falkland). Fisheries Department data clearly show the presence of eddies and mesoscale features across the Falkland Current (see Glorioso 2002). Arkhipkin et al (2010) also show mesoscale features and eddies to the south of Cape Meredith, West Falkland. The challenge is to gain the data to identify and understand traits such as; eddies and mesoscale features caused by upwellings and bottom topography across the Falkland Islands and especially in the areas that are being either explored or developed. The GAP analyses programme has an element that specifically deals with oceanography in relation to oil spill modelling and identifying features that are important to productivity and foraging predators. The strategy, in its infancy, will potentially utilise a number of different methodologies including drifter buoys, gliders and CTD surveys. The data available for the area surrounding the Sea Lion Field is currently limited. The data set used here is the only one that covers an area large enough in this case.

13.2.3.4 The OSCAR Model - Release parameters

The site of the Isobel Deep well was chosen as the position of the uncontrolled release in the model because this is the nearest location to land (worst-case scenario). Genesis modelled a stochastic release scenario for an uncontrolled release.

Table 65 lists the input parameters used in the model scenario.

Table 65: Parameters modelled in uncontrolled release scenario

Scenario	Position	Depth (m)	Quantity	Duration	Release Diameter	Release Temp
Stochastic uncontrolled release	Isobel Deep	2 days at surface and 76 days at 362 m (seabed[1])	2,000 bbl/d (c.280.7 tonnes)	78 days	13 3/8" (339.72 mm)	60°C

[1]Depths are those used by the model bathymetry database. They may not correspond exactly with actual surveyed depths. The outputs are not significantly affected by small differences in depth.

The oil properties adopted for the uncontrolled release modelling are taken from the Sea Lion Field, which is an extremely waxy crude. The wax content is higher than any oil present in the OSCAR oil weathering database and, therefore, a user-defined oil type was been created (Genesis, 2014a). A similar approach has been used in other modelling studies with waxy crudes; for example, the Shah Deniz Phase 2 Project in the Caspian Sea (BP, 2013), where modified database properties were used to best reflect the hydrocarbon properties using the advice of an oil specialist. Details of the key Sea Lion Field oil properties and Sea Lion Pseudo-assay generated by OSCAR to model biodegradation and toxicity are detailed in Genesis (2014a).

It is noted that the most northerly exploration well, Chatham, may be in a gas/condensate field. Releases from such a field would be very much lower in persistent hydrocarbons and effects would be much more localised than those shown for Sea Lion crude.

13.2.3.5 Model Results

Overall behaviour of the oil from a uncontrolled release over 180 days

The behaviour predictions over time are illustrated in

Figure 68. The variation in surface oil over time is due to the combination of differing weather conditions, whereby the crude is dispersed into the water column during periods of rough weather. This relationship can be seen in the corresponding increase in dispersed oil when surface oil decreases. In calm weather, the buoyant wax resumes position on the surface. The wax biodegrades at a relatively steady rate throughout the uncontrolled release period (78 days in this model, the estimated time taken to plug a well such as that modelled here), and continues after the uncontrolled release ends.

Wax that reaches the shoreline is referred to as 'stranded', and this forms a relatively small proportion of the total oil released. A larger fraction is predicted to deposit in coastal sediments as the wax in the water column approaches the shoreline.

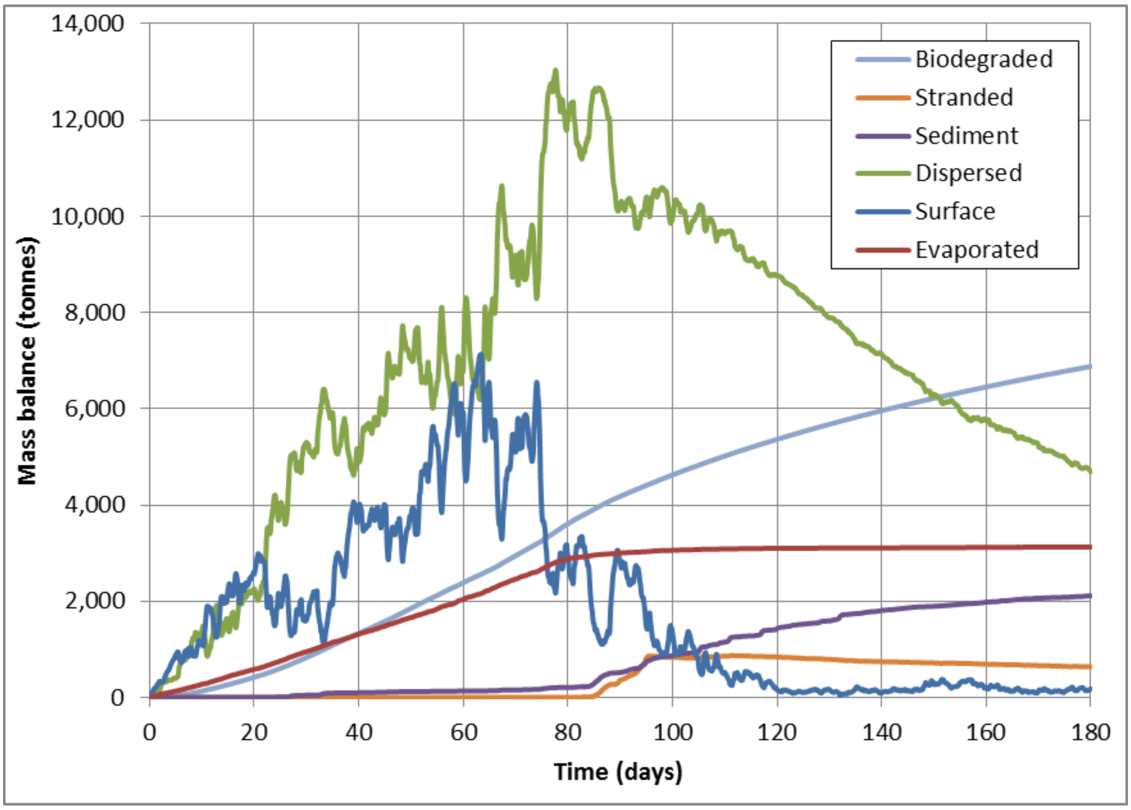


Figure 68: Behaviour of oil over time during an uncontrolled release

Surface Statistics

Figure 69 shows the probability of wax above the threshold of 1 g/m^2 appearing on the sea surface at any time over the model duration (180 days) based on 50 different sets of metocean conditions within the overall available window (a stochastic analysis). As this is such a low density crude, and the waxlets are persistent and will travel far over such a long period, there is a high probability of some waxlets reaching the north Falklands coastline (probability of 5-10%). This output does not reflect the size of the surface manifestation of wax at any one time, which is much smaller. The main direction in which the wax travels is northwards in line with underlying current circulation. The wax also travels in a south-easterly direction when driven by prevailing winds.

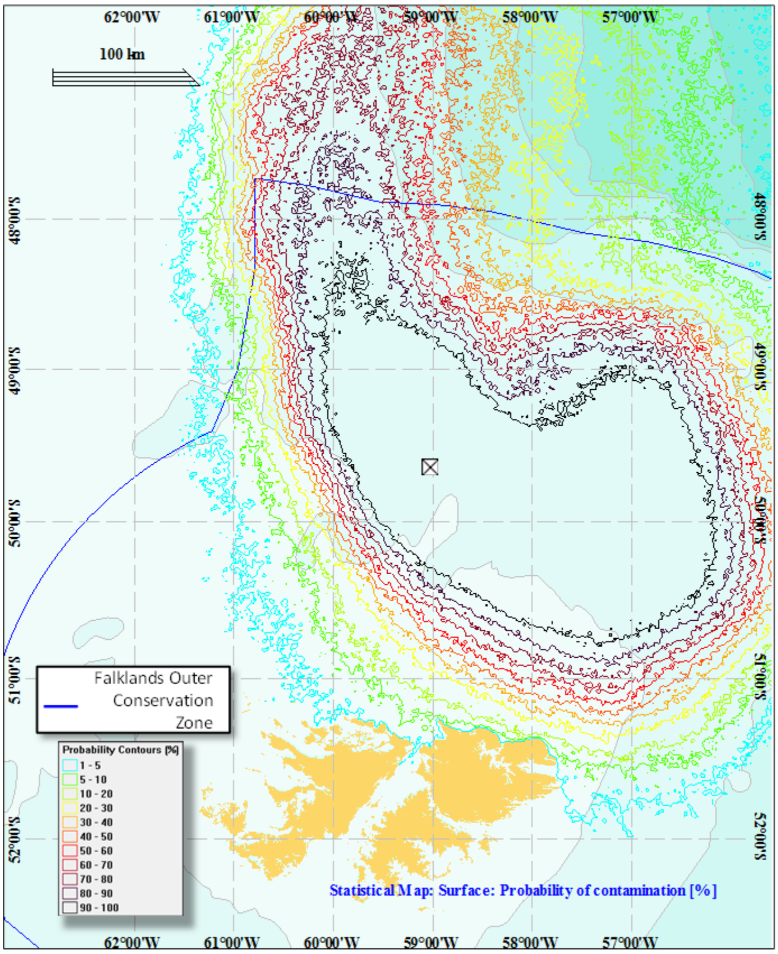


Figure 69: Stochastic Probability plot for an uncontrolled release

Figure 70 illustrates the minimum arrival time for surface waxlets in days. The wax will be of little significance after 30 days at sea. After 0.5 days the wax could potentially travel up to 18 km. After one day it could potentially travel 60 km, and 125 km in 10 days. There is a likelihood that surface wax will cross international boundaries into Argentinian waters after nearly 30 days and the high seas after about 20 days, but this wax would consist of very small waxlets in a highly dispersed state and would not be in a visible form.

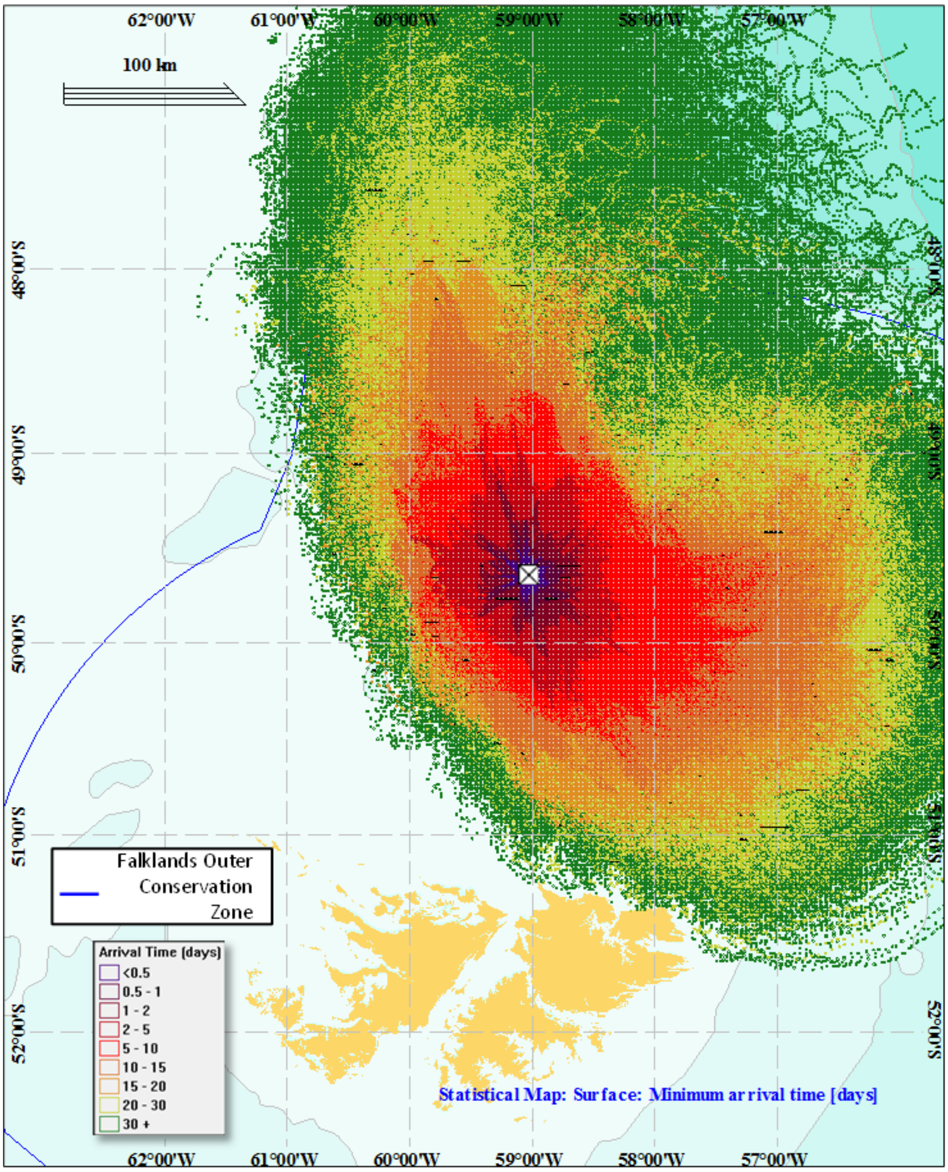


Figure 70: Minimum surface arrival times from an uncontrolled release

The worst-case identified from the stochastic scenario was run deterministically in order to identify the density of surface waxlets (Figure 71). The main figure shows the surface density of the wax at any time over 180 days. The snapshot to the left shows a typical surface oil density 10 days after the start of the uncontrolled release. As this surface extent is moved around by currents and winds throughout the uncontrolled release duration and afterwards, it produces a swept path that is represented by the main graphic.

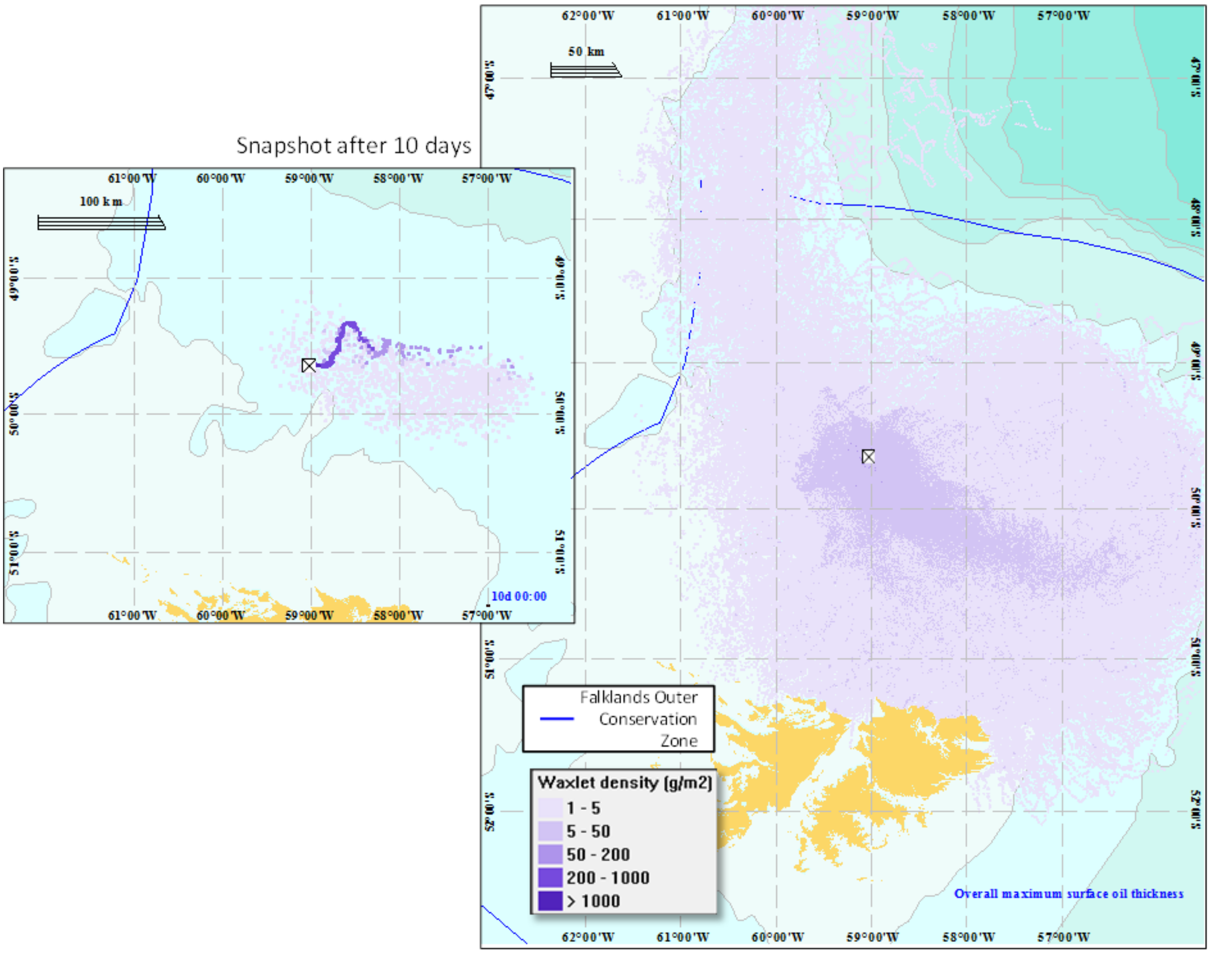


Figure 71: Impacted area and typical surface extent – uncontrolled release.

The modelling predicts that the highest probability of wax reaching the shore is 40% from an uncontrolled release, it also predicted a worst-case mass of 860 tonnes reaches the shoreline 42 days after the start of the uncontrolled release. The average mass predicted to reach the shore is a much lower value of 39 tonnes after a total of 72 days – any hydrocarbon will also arrive at the coast in a highly dispersed state. In the event of a Sea Lion type crude (which has been modelled) the resultant solid waxlets are predicted to be non-adhesive and non-cohesive and will present a relatively low risk of direct impacts to avifauna. East Falkland has a higher probability of waxlets beaching than islands to the west, with the most northerly headlands of Cape Dolphin, Cape Bougainville and Seal Bay / McBrides Head showing the highest overall probabilities, up to 40% under the worst-case scenario. The likelihood of waxlets reaching shore declines to the west across West Falkland, reaching a minimum on the western Jason Island chain. Likewise to the east and south of McBride's Head towards Volunteer Point and Cape Pembroke the likelihood of waxlets beaching declines.

Water Column Statistics

The maximum water column dissolved concentrations are shown in Figure 72. These are the maximum concentration at any point over the model duration of 180 days. A cross section through the water column shows that the plume rises to the surface and the highest concentrations are in the top 40 m of the water column. The concentration is a maximum of 500 ppb (parts per billion) calculated over the chosen grid size.

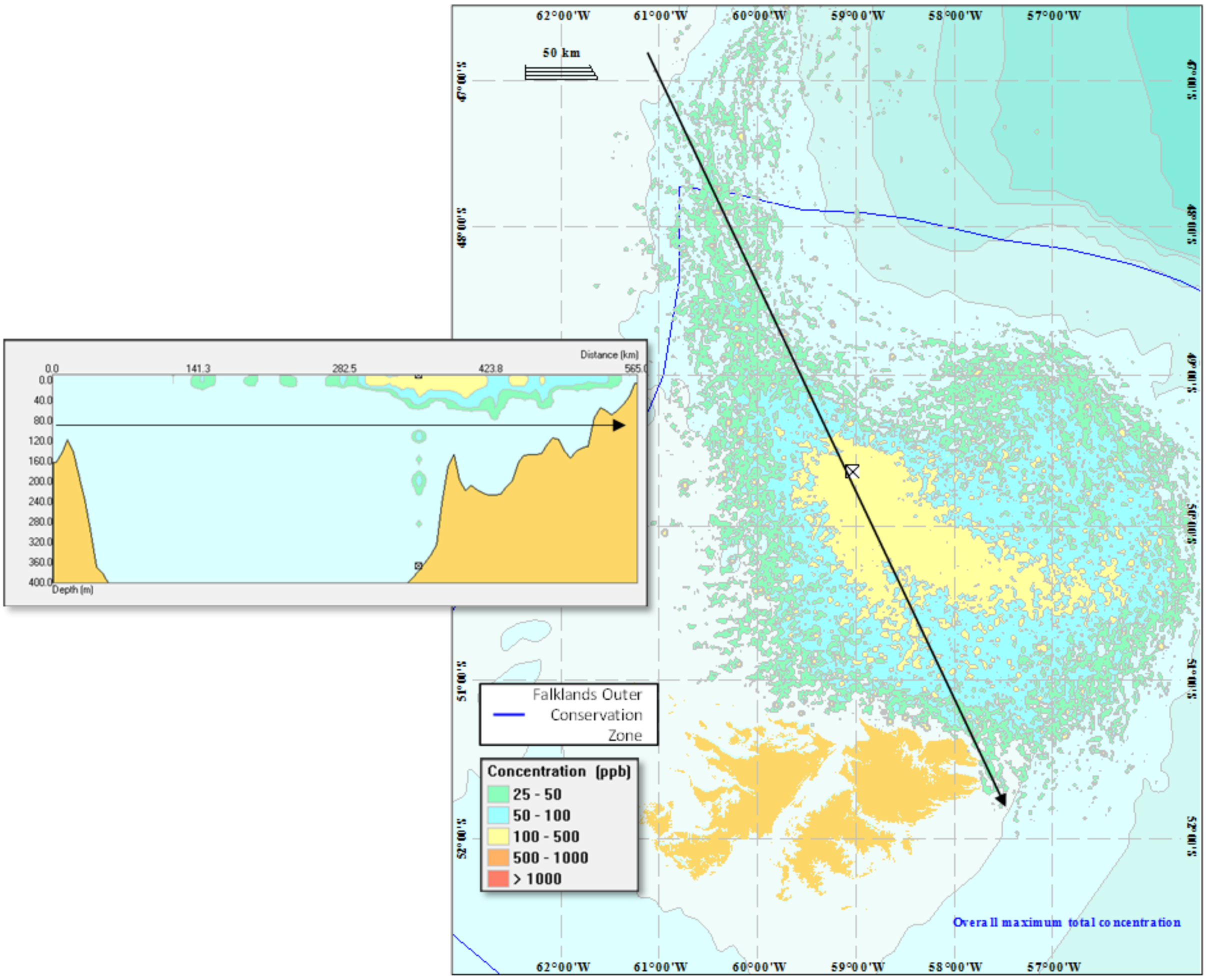


Figure 72: Typical dissolved water column concentrations over the total duration for a uncontrolled release

Shoreline Statistics

The probability of waxlets reaching the shore is shown in Figure 73. The highest probability of the wax reaching the Falklands shoreline is 40%. Figure 74 shows the predicted shoreline arrival time of the wax; the shortest time is approximately 25 days. In the worst-case, the model predicts that a mass of 860 tonnes reaches the shoreline within 42 days after the end of the uncontrolled release. By comparing the surface density in Figure 74, the wax will arrive at the coast in a highly dispersed state. The average mass predicted to arrive ashore is much lower; 39 tonnes 72 days after the end of the uncontrolled release.

The large difference between the average and the maximum indicates that it is unlikely for large volumes of wax to arrive at shore. By analysing the metocean conditions, it can be seen that this only occurs when there is a persistent wind from the north over several weeks.

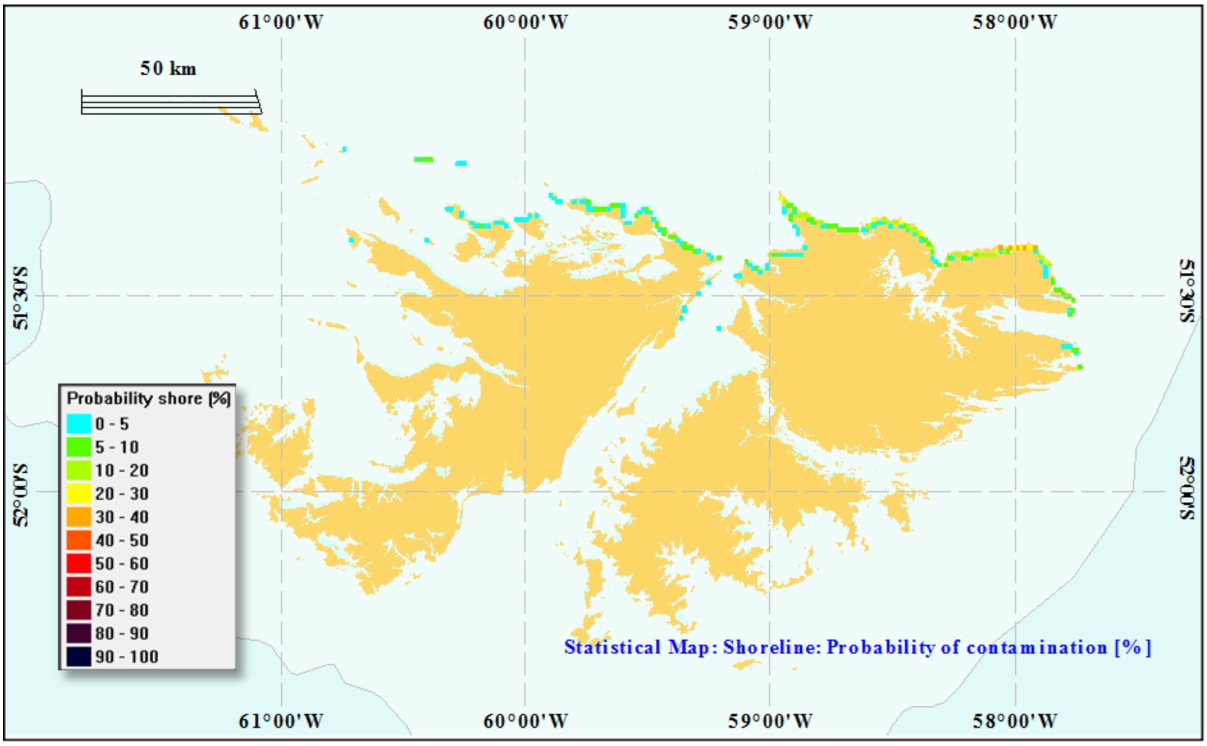


Figure 73: Stochastic probability of wax reaching the shore during a uncontrolled release

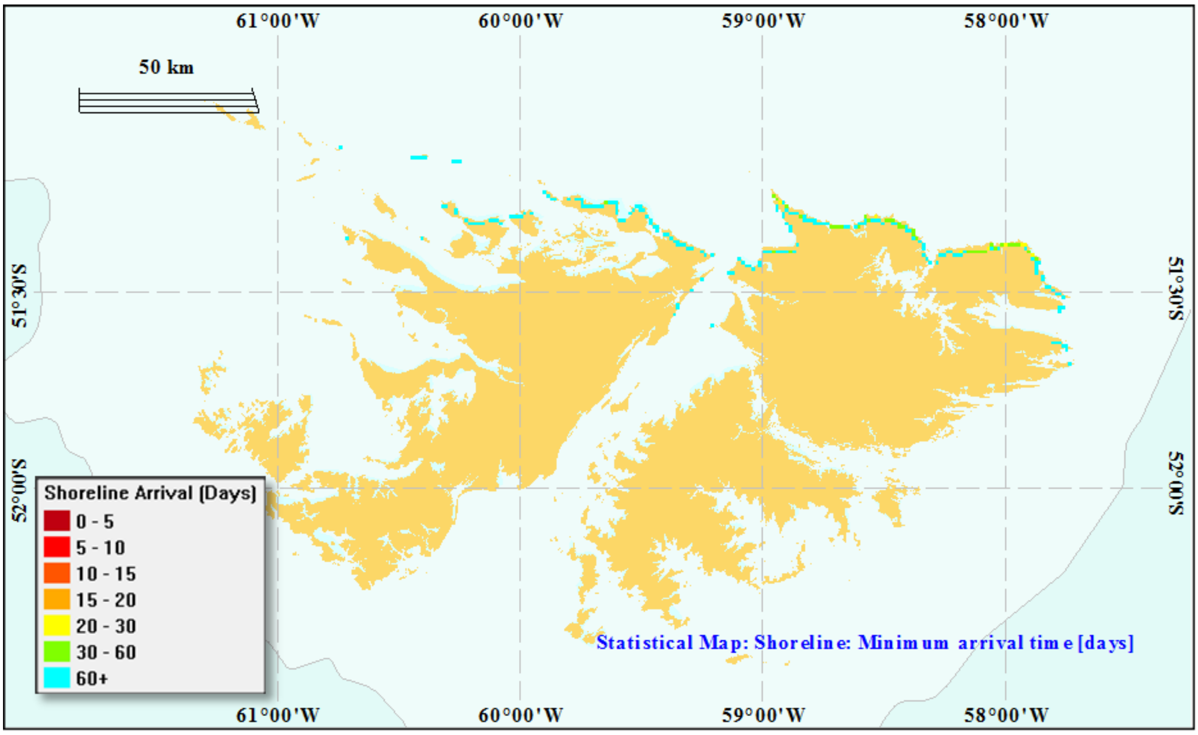


Figure 74: Shoreline arrival time (days) during an uncontrolled release

Model Predictions after the oil has been at sea for a long time

It is normal to run scenarios for the entire duration of an uncontrolled release, and for some time following an inventory release, to determine the behaviour and location of oil before taking a view on whether this poses a risk to receptors. In this case there is modest shoreline beaching and some dispersed wax remains at sea at the end of the uncontrolled release. There are reasons to view the longer-term surface predictions as conservative, as the particles at sea will tend to combine with suspended solids and sink. It is also not certain that the model physics for very weathered waxlets is representative. The representation of the waxlets as a density, which appears to evenly cover grid cells of 1 km square in the uncontrolled release model run, is a reasonable way to envisage the wax during the early stages of a release but may lose relevance when the waxlets are extremely small and widely dispersed. It is possible to employ a higher threshold to 'screen out' smaller concentrations of wax, but this has not been done in the interest of transparency (Genesis, 2014a).

Overall, the interpretation of results at long timescales should be conducted with caution and experience. In general, the model results may exaggerate the apparent impact of dispersed waxlets and so are conservative (Genesis, 2014a).

13.2.4 Risk Assessment Summary

13.2.4.1 Severity and Receptor Sensitivity

The uncontrolled release scenario was based on the well closest to the Falkland Islands and therefore presenting a higher potential for wax reaching the shoreline. The behaviour of Sea Lion crude at sea is atypical of a crude oil given the extremely high wax content, which is higher than any analogue in the SINTEF database. Crudes with high wax content tend to behave in a specific way whereby the crude rapidly congeals on release as it cools to ambient temperature, below its pour point. The crude transforms into semi-solid pellets with the properties of wax (waxlets). The amount of energy experienced during the release determines the initial size of the waxlets, with small waxlets likely to be formed during an uncontrolled release. Subsequent waxlet size is determined by prevailing shear forces from waves and turbulence. Eventually, waxlets will attach to suspended solids and sink, or be biodegraded in the water column.

The oil has very high wax content and will form waxy droplets at ambient temperatures also the low potential asphaltene content indicates that the oil will not form a stable oil in water emulsion. A significant surface slick is not predicted from a release of a Sea Lion type crude oil under the scenario modelled, instead a raft of wax droplets is predicted to form and migrate from the area predominantly near the water surface. Waxlets will not coalesce and will become more and more dispersed with distance, and are only likely to be visible near the release where there is a close aggregation of particles.

The modelling conducted in this study predicts that toxic water column impacts are not above a widely accepted level of concern, due to the waxy nature of the oil, except directly above an uncontrolled release or directly beneath a surface accumulation, and that this occurs for short periods.

The severity of impact to each environmental receptor will be different and dependent on the environmental conditions, and subsequent the dispersion of oil, experienced in the weeks following any spill.

Plankton

An area of high zooplankton abundance occurs in the vicinity of the well sites, with abundances peaking in January and February, (Agnew, 2002). There are complex seasonal patterns of plankton production, and higher predator abundance, in the NFB that are not fully understood; however, the timing of any incident that results in a major spill will clearly have implications for the overall impact on the marine environment.

Although oil spills may have lethal effects on individual plankton, the effects on whole plankton communities generally appear to be short-term, through a combination of high reproductive rates and immigration from outside the affected area. Any effects will be greater during the summer when the area surrounding the exploration area support high densities of zooplankton. At other times, the area is less significant for zooplankton but is still very productive. Contamination of marine prey including plankton and small fish species may then lead to aromatic hydrocarbons accumulating in the food chain.

The severity of an uncontrolled release to plankton has been assessed as **'Moderate'**.

Benthic Communities

Surveys of the Sea Lion area conducted in March 2012 revealed little variation in sediment across the seabed with the absence of any extensive seabed features. Typically the survey area was dominated by easily disturbed, very fine silt, with some occasional patches of more cohesive sediment. The epifaunal communities were relatively uniform across the observed area. There were no species or habitats equivalent to those of conservation significance under the UK's Offshore Marine Conservation Regulations 2010 (which implements the EC Habitats Directive 92/43/EEC) observed within the surveyed area.

Preliminary results from the Isobel/Elaine survey area showed fairly uniform epifaunal and showed no evidence of habitats potentially considered as Annex I (European Habitats Directive). The presence of scleractinian (hard) corals in the form of an occasional cup coral over the softer sediments suggests a presence of some CITES Appendix II listed species in the area although these are not currently Red listed (IUCN). There were no records of geogenic or biological reefs or coral gardens, although isolated examples of octocorals are likely to be found on the larger individual drop stones located across the survey area. The notable feature of the area was the high densities of brittle star encountered at all stations.

Model predictions indicate that little oil, in the form of wax, enters the sediment in the first 80 days following the start of an uncontrolled release. At this stage, waxlets will be dispersed over a wide area and the impact will be Moderate. After 80 days, the amount of wax deposited in sediments increases. Wax is resistant to mechanical and biological breakdown and may persist for some time. The amount of wax in the sediment was approximately 10% of the total released at the end model period, 180 days after the uncontrolled release.

It is not clear what the impact of waxlets will be on benthic organisms, it is assumed that they have the potential to block gills and filter feeding apparatus. Surveys following the Macondo incident found that the most severe relative reduction of faunal abundance and diversity extended to 3 km from the wellhead covering an area about 24 km^2. Moderate impacts were observed up to 17 km towards the southwest and 8.5 km towards the northeast of the wellhead, covering an area 148 km^2 (Montagna et al., 2013). Benthic effects were correlated to total petroleum hydrocarbon, polycyclic aromatic hydrocarbons and barium concentrations, and distance to the wellhead. Healthy coral communities were observed at all sites >20 km from the Macondo well, including seven sites previously visited in September 2009, where the corals and communities appeared unchanged (White et al., 2012). The impact of the Macondo blowout on benthic organisms was therefore over a relatively small area despite the scale of the incident and the nature of the oil (light crude). The oil type and scale of the Macondo incident are not comparable with the uncontrolled release scenario modelled here. However, based on the model prediction a small proportion (<10%) of oil will send up in the sediment spread over a considerable area given that the majority wax is likely to be on the surface and or dispersed within the water column for the first *circa* 80 days post uncontrolled release therefore the sediments are going to be subject to low concentrations of wax (Genesis, 2014a). Given the nature of the unique wax the effect on benthic filter and deposit feeders are unknown.

The severity of an uncontrolled release on the benthos has been assessed as **'Major'** due to the unknown long-term consequences for benthic fauna.

Seabirds

When considering the impacts of oil spills on seabird populations, the volume of oil released is not necessarily the most important factor (Hunt 1987, Tasker and Pienkowski 1987, Burger 1993), but rather the location of the spill relative to concentrations of vulnerable seabirds. A relatively small spill in close proximity to large numbers of vulnerable seabirds will likely have a much more severe impact (on seabirds) than a larger spill in an area with few seabirds.

Droplets of solidified oil would pose a reduced risk of contamination of the plumage of seabirds, as compared to emulsified crude oils. The stable nature of the waxlets minimises their impact on seabirds, as they are unlikely to stick to feathers and consequently they are unlikely to be ingested by birds. Significant risks to the marine environment are restricted to the immediate vicinity of the uncontrolled release. Away from the immediate release site, seabirds are not considered significantly at risk due to the semi-solid nature of the wax. If oil is encountered during the 2015 Drilling Campaign it is anticipated to be similar in nature to that found in the Sea Lion Field (i.e. waxy). It is expected that the same source rock will be encountered and therefore the same crude as Sea Lion would be expected. However, it is possible that a less waxy crude could be found, but a significantly lower wax crude is not anticipated.

The severity of an uncontrolled release on seabirds has been assessed as **'Major'** due the spatial extent of the slick (potentially covering important foraging areas) and the potential for chronic impacts on reproductive biology in long-lived late reproducing species.

Marine Mammals

Marine mammals that rely on fur for insulation, such as fur seals, are vulnerable oil contamination of their coats, which could lead to hypothermia. Fur seals groom extensively to maintain their coats and are therefore more likely to ingest hydrocarbons than other seals. The latter may not result in mortality in all but the most severe cases there have been suggestions that it may lead to short-term disruption of breeding (Atlantic OCS, 1988) and to some level of bioaccumulation of trace metals and intermediate metabolites (Ridoux et al., 2004). Whilst not causing significant immediate impact or mortality the longer term effects of such sub-lethal exposure are difficult to determine and are thus not fully understood.

Cetacean behaviour, diet and habitat use will determine the level of contact with an oil spill (Wursig, 1988). Species that forage in mid water or deep waters will be at less risk than species that feed at the surface. Species like right whales and rorquals that surface skim and lunge feed respectively are more sensitive. This may also be true for some dolphins that 'chase' prey to the surface. However, away from the immediate release site, marine mammals are not considered significantly at risk due to the semi-solid nature of the wax.

The severity of an uncontrolled release on marine mammals has been assessed as **'Moderate'** because the waxy nature of the oil will mean a lower exposure to volatile and toxic components of the crude.

Fish and Fisheries

Typically fish are not considered highly sensitive to impacts of oil spills. Adult individuals are mobile and are able to detect areas of heavy contamination for poor water quality. In the open ocean fish have the ability to move away from polluted areas. Adverse impact of oil spills on fish is most likely to be observed in the shallow coastal areas of the sea where oil could accumulate and the potential to 'escape' is limited by the land. Fish in early life stages are known to be more vulnerable to oil, compared to adults. Critical to understanding the potential impact of oil spills on fisheries in the Falkland Islands lies in the understanding of the timing and distribution of spawning grounds and egg and larval transport through oceanographic features. The understanding and knowledge of spawning grounds are poor. Spawning sites for southern blue whiting and red cod have been identified (Arkhipkin et al 2010) south of Cape Meredith and toothfish spawning sites have been identified on the southern and eastern parts of the Burdwood Bank (Laptikhovsky et al 2006). However these are significant distances from the Sea Lion Field and it is not likely that these will be impacted. Similarly, *D. gahi* spawning grounds are known to occur near shore and in great intensity on the eastern fringes of the Falkland Islands (Arkhipkin et al 2000) and are also unlikely to be impacted.

With regards to fisheries a significant proportion of the south Patagonian stock of *Illex argentinus* passes near this area on their northerly spawning migration in May/June. This resource is a significant component in regional fisheries and the wider ecosystem; however, we do not know how this species or fishery may be impacted. Other commercial species are present in the area (see Section 5.4.5), but the fishing effort in the area of the Sea Lion Field and the Isobel Deep well site is comparatively low. However, the oil would spread and is likely to overlap with the distribution of major finfish grounds on the edge of the continental shelf. This would likely result in closure of these grounds and subsequent economic impact for the fishing industry. The other major fishery in the area is the longline fishery for Patagonian toothfish. This fishery operates in the deeper waters to the north and east of the well sites. The results of modelling indicate that waxlets are likely to spread over part of the area fished and there is potential for these areas to be closed in the short-term. If there was a major spill, monitoring would need to be undertaken to assess whether there was any contamination of the fish caught within the area of influence of the spill.

The severity of an uncontrolled release on fish and fisheries has been assessed as **'Major'** because the slick will overlap with major fishing grounds, effecting different fisheries depending on the time of the year. An uncontrolled release will result in the closure of the fishing grounds due potential tainting and contamination.

Coastal

With regard to coastal impacts, the likelihood and quantities of oil reaching the shore from an uncontrolled release are low. The resultant solid waxlets are predicted to be non-adhesive and non-cohesive and will present a relatively low risk of direct impacts to avifauna. East Falkland has a higher probability of waxlets beaching on the coast than islands to the west, with the most northerly headlands of East Falkland showing the highest overall probabilities. This area is designated an IBA (see Section 5.4.8.5). The likelihood of waxlets reaching shore declines to the west across West Falkland, reaching a minimum on the western Jason Island chain. Likewise to the east and south of McBride's Head towards Volunteer Point and Cape Pembroke the likelihood of waxlets beaching declines.

The severity of an uncontrolled release on coastal environments has been assessed as **'Moderate'** as there is still some uncertainly over the longer term chronic impacts of this environment.

Tourism

Tourism is also likely to be affected. The marketing of tourism also provides the image and window into the Falklands for international perceptions. The potential fouling of iconic tourism destinations would impact greatly on the pristine image of the Falkland Islands. In general, the model predicts that sub-millimetre sized particles will result once a modest amount of dispersion and wave action has taken place, and it is therefore unlikely that waxlet densities at the lower end of the scale provided would be visible. Given the distance offshore and the relatively long travel times it is unlikely that other users of the sea would be affected by a spill.

The severity of an uncontrolled release on Tourism has been assessed as **'Major'** due to the long lasting negative impacts of perceived environmental degradation.

Overall Severity of the Impact

The overall nature of the oil and the planned timing of the campaign, when low densities of vulnerable receptors are present, means that the severity of the impact of an uncontrolled release on the marine environment is lower than it would be during a summer campaign. Model predictions indicate that most of the oil would evaporate, disperse or biodegrade within a month of the end of the uncontrolled release and surface slicks would not persist beyond this time. A waxy oil, like Sea Lion crude, will result in less environmental impact than a lighter crude. However, there are many unknowns in the model and the impact on environmental receptors. Under the severity criteria defined in Chapter 6.0, the impact of the scenario modelled here is assessed as Major**.** An uncontrolled spill would result in serious multi-year impact on the ecosystem of the NFB, although this impact would be reversible. A full Falkland Islands Business Unit response would be required to contain and recover oil offshore and potentially onshore.

13.2.4.2 Likelihood

Although known in the oil and gas industry, uncontrolled releases and major losses of containment are rare events. Strict regulations governing working practices and lessons learnt from previous incidents help to minimize the likelihood of accidental events. Following the Deepwater Horizon incident in the Gulf of Mexico, the Oil Spill Prevention and Response Advisory Group (OSPRAG) was established to review all UKCS regulations and pollution response arrangements and assess the adequacy of financial provisions for that response. This has resulting in significant amendments to the legislation oil spill prevention and response.

One of the key Government requirements for drilling applications is the preparation and approval of an Oil Pollution Emergency Plan (OPEP). Premier Oil are currently developing a specific OPEP for the exploration campaign, which will be submitted to FIG as a separate document. Strict regulations are followed to minimise the risk to the environment and human health. The fact that the wells are being drilled into relatively shallow reservoirs in the immediate vicinity of the Sea Lion reservoir gives a degree of confidence in the properties of the oil that have been modelled and likely well pressure. The well design will be peer reviewed by Premier Oil's well examiner and the Health and Safety Executive to ensure that the risk of an uncontrolled release is minimised. Design features, such as mud weight and a BOP that includes an auto shear, reduce the risk of uncontrolled releases. The mud will help to maintain primary well control and the BOP will seal the well in the event of a major incident. Uncontrolled releases are highly unlikely, nevertheless, they do happen occasionally within the oil and gas industry.

For an uncontrolled release to result in serious environmental damage;

- An uncontrolled release would have to occur;
- The BOP would have to fail;
- A significant quantity of oil would have to be discharged (if the well is under low pressure this might not occur);
- The oil spill would to spread sufficiently to contact sensitive receptors.

The scenarios chosen in this assessment to look at worst-case conditions and the maximum spill possible for the Isobel Deep well in accordance with DECC guidelines. The likelihood of an uncontrolled release occurring has been assessed as '**Remote**', it has happened in the industry but on extremely rare occasions.

13.2.4.3 Significance

The overall significance of an uncontrolled release is assessed as '**Moderate**'. There is a discernible risk to the environment; however, a number of measures to manage the risk are built into standard operating procedures (such as, the use of a BOP). Nonetheless, an Oil Pollution Emergency Plan will be prepared and emergency action and process defined prior to the start of drilling to outline the response capability for hydrocarbon spills.

13.2.4.4 Degree of Confidence

There are many unknowns and assumptions surrounding the modelling of oil spills, in terms of both the properties of the oil (anticipated high wax content) and environmental conditions (currents, wind and wave action). Wherever possible, worst-case scenarios have been assumed to ensure that the impact is not under-estimated. However, due to the uncertainties surrounding major accidental events the confidence in the significance of the risk presented in this assessment is '**Probable**'.

13.2.4.5 Cumulative Impacts

The well sites are in an area that is not usually occupied by other vessels and therefore the risks of added cumulative impact are minimal.

13.2.5 Mitigation Measures

Oil Spill Response

The remoteness, poor transport infrastructure and abundant wildlife in the Falklands pose unique challenges when responding to a major incident. Premier Oil are currently preparing a project specific Oil Spill Response Plan. If a spill occurred, tiered responses would be initiated, proportional to the spill. Key aspects of the response would be;

- ***Well intervention*** **–** these are means of stopping the flow of oil from the wellhead and could include the drilling of a relief well or the use of a subsea capping device;
- ***Surveillance*** - it is vital to track the progress of any spill with the aid of aerial surveys and tracking buoys;
- ***Dispersants*** - it is unlikely that dispersants would be effective on oil with a high wax content, like Sea Lion crude, and they are unlikely to be used, although they will be available in field in case hydrocarbons encountered are not as anticipated;
- ***Containment and recovery*** – under suitable weather conditions, booms and skimming devices can be used to recover oil at-sea. The supply vessels will be appropriately equipped to undertake this;
- ***Shoreline clean-up*** – an assessment of the sensitivity has been undertaken to prioritise sites in the event oil approaches the coastline (Premier Oil, 2014);
- ***Wildlife rescue and rehabilitation*** **–**specific response equipment to support wildlife rescue and rehabilitation will be available for the campaign.

13.2.5.1 Residual Impact

With the measures outlined above in place, it is not possible to reduce the likelihood of an uncontrolled release any further, however, an oil spill response will reduce the severity of the impact on the marine environment. In the unlikely event that a spill does occur, a plan is in place to cap the well and contain and recover oil from the sea. The success of these measures will be dependant on environmental factors such as the weather, which is unpredictable. The significance of an uncontrolled release may be reduced to '**Low**' for some receptors but the overall significance is likely to remain '**Moderate**'.

13.3 Accidental loss of containment during operations leading to diesel or chemical spills

13.3.1 Introduction

All rig and vessel operations will be powered by diesel engines. Diesel is a light, volatile mixture of hydrocarbons and is toxic to marine life. Large quantities of fuel will be transferred to supply vessels at FIPASS and delivered to the rig. During each transfer, there is the potential for small leaks and spills.

13.3.2 Sources of diesel spills

Loss of containment during fuel/chemical transfer

The drilling rig and vessels associated with the campaign are powered by diesel. This fuel has to be bunkered in Stanley transported to the rig and transferred aboard. At each stage of this process there is the potential for leaks and spills to occur.

Major loss of containment leading to the loss of the entire rig inventory of diesel

It is difficult to envisage a situation where the entire rig inventory of diesel fuel would be lost, however, there are some large moving objects at-sea that pose a risk to the rig. The most credible risk would be collision with a vessel

13.3.3 Potential Environmental receptors of diesel spills

Diesel fuel is rapidly dispersed but its volatile nature makes it more toxic than heavier crude oils. The impact will occur over a relatively small area close to the spill site and within the surface layers of the sea. Potential receptors are:

- Plankton
- Fish and Squid
- Seabirds
- Marine Mammals

For further discussion regarding the vulnerability of these groups to hydrocarbon pollution, see Section 13.2.2.

13.3.4 Characterising and Quantifying the Impact of Offshore Diesel Spills

Diesel and other fuel oils, contain a much higher proportion of light volatile hydrocarbons, and therefore evaporate and dissolve more readily than heavier crude oils. The proportions of each compound can vary in different diesel sources and each compound has a different level of toxicity on marine organisms.

13.3.4.1 Modelling diesel spills

Two scenarios that were considered to be representative of the potential risks for loss of diesel containment during the exploration campaign were modelled using the OSCAR that was also used to describe the behaviour of oil following an uncontrolled release (see Section 13.2.3 for details) (Genesis, 2014a). The scenarios included loss of containment whilst bunkering diesel fuel to the rig; and a total loss of rig diesel fuel inventory whilst in the field. Both scenarios were conducted at the Isobel Deep well, closest to land, which presents the worst-case scenario.

Diesel spill thresholds

For the Diesel spills scenarios the following thresholds have been referred to in the results:

- A minimum surface sheen of 0.3 µm (rainbow sheen under the Bonn Agreement Oil Appearance Code of oil thicknesses (Bonn Agreement, 2009);
- Total water column concentrations (dissolved hydrocarbons plus droplets) greater than 25 ppb, below which oil is not expected to have acute toxic effects (50 ppb is the lowest PNEC for acute toxicity of the oil components in the OSCAR database and is also mid-range of the concentrations of crude oil found to give sub lethal effects (Patin, 2004));

The input parameters for the two offshore scenarios are shown in Table 66.

Table 66: Input parameters for the offshore diesel spill model

Scenario	Well site	Release depth	Quantity released	Assumed release duration	Simulation duration	Release Temp
1 - Diesel transfer spill	Isobel Deep	Sea surface	30 tonnes	1 hour	30 days	Ambient 7^{o}C
2 - Diesel inventory loss	Isobel Deep	Sea surface	4,631 m^3 (4,088 tonnes)	1 hour	30 days	Ambient 7^{o}C

13.3.4.2 Scenario 1: Diesel Transfer Spill

The first scenario models the loss of containment during operations to bunker diesel from a supply vessel to the rig.

Overall behaviour

Figure 75 shows the behaviour prediction from the model for the loss of diesel during transfer scenario. As the release point is on the surface, evaporation begins very quickly, after which the diesel becomes dispersed in the water column. The diesel is only on the surface for a very short period of time after the release, less than one day.

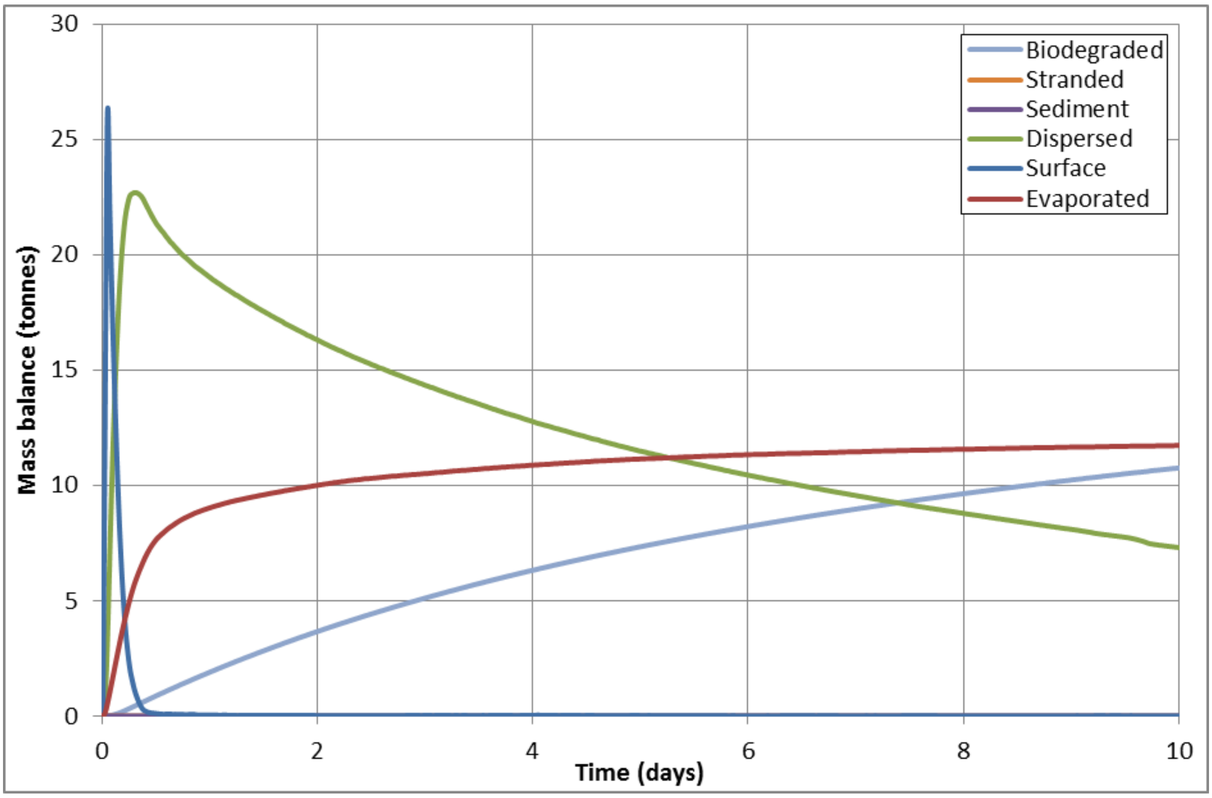


Figure 75: Behaviour of oil over time for diesel transfer spill

Surface statistics

Figure 76 shows the probability of surface diesel above the threshold thickness of 0.3 microns thick. Thickness greater than 10 microns (0.001 mm) extend up to *circa*10 km around the well.

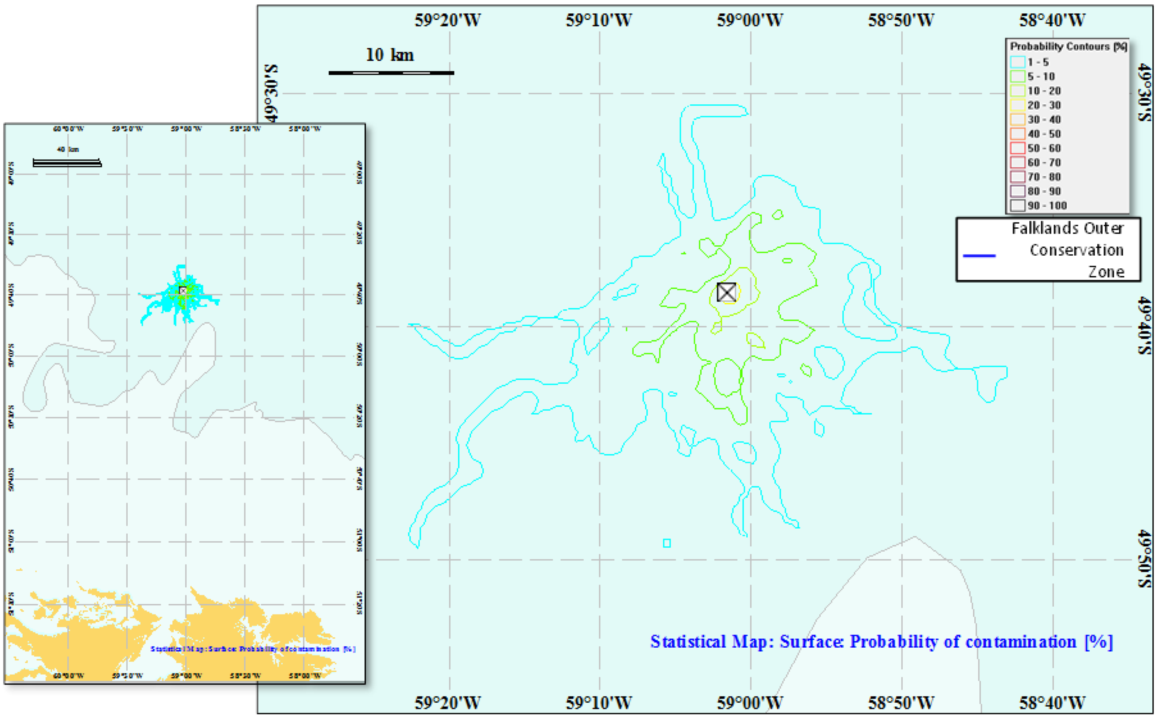


Figure 76: Stochastic probability plot for diesel transfer spill

Figure 77 shows the minimum arrival time of the diesel on the surface. The diesel does not persist for a long duration on the surface with the longest arrival time predicted to be approximately five days.

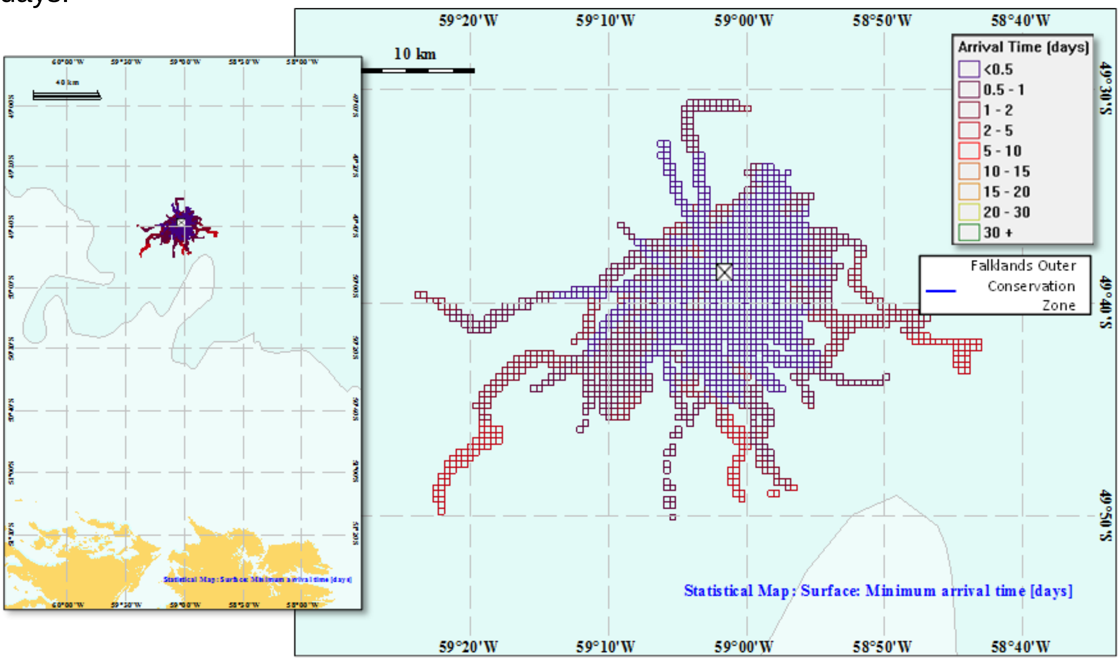


Figure 77: Stochastic plot for arrival time of diesel transfer spill

The maximum surface thickness is shown in Figure 78, which indicates that the thickness of the diesel does not exceed 50 microns. The surface sheen extends 8 km from the release point.

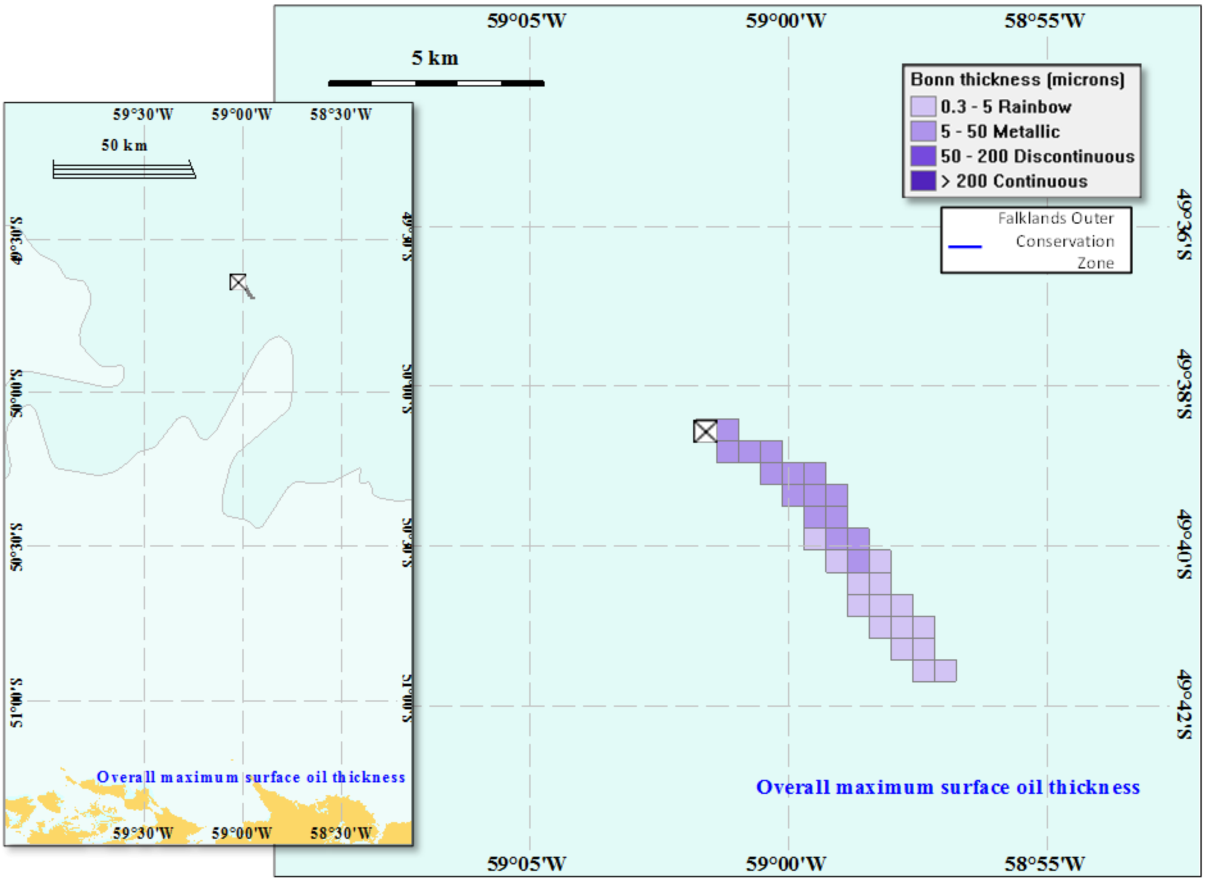


Figure 78: Deterministic plot showing maximum surface thickness for diesel transfer spill

Water column statistics

Figure 79 shows the maximum concentration in the water column over the entire model duration of 30 days. These are confined to a relatively shallow depth in the upper water column and move with the surface accumulation.

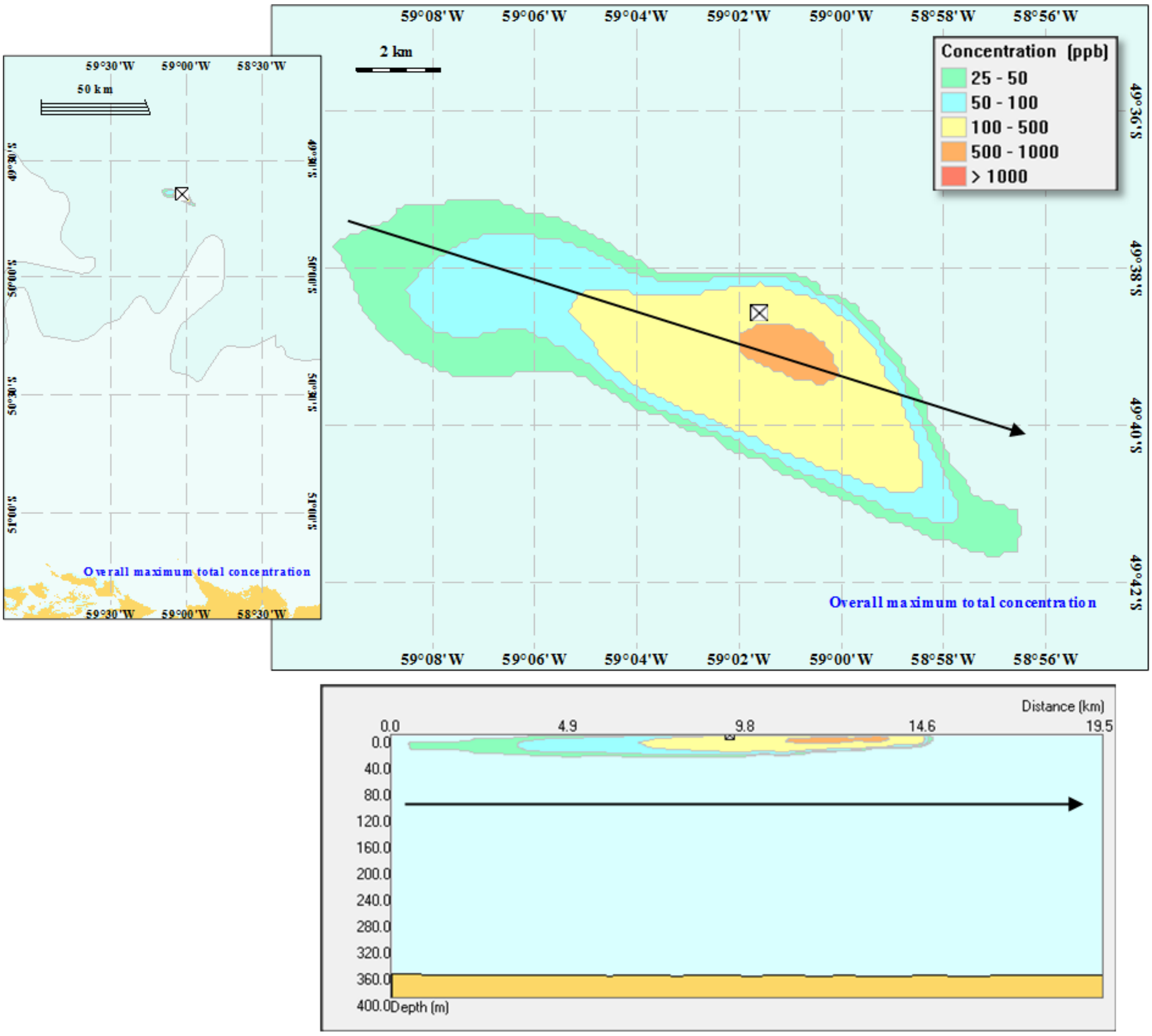


Figure 79: Maximum total water column concentration – diesel transfer spill

13.3.4.3 *Scenario 2: Diesel Inventory Loss of Drilling Rig*

The second scenario modelled investigated the likely dispersion pattern of diesel following the catastrophic loss of the *Eirik Raude's* entire diesel inventory (>4,000 tonnes).

The total loss of diesel from the rig would most likely occur if the rig suffered a catastrophic impact from a large vessel such as an oil tanker or an iceberg.

Overall behaviour

Figure 80 shows the predicted behaviour from the model of the diesel inventory loss scenario. The majority of the diesel is on the surface immediately after release, after which it quickly becomes dispersed in the water column. After approximately 10 days, evaporation and biodegradation processes begin to overtake loss by dispersion. Within 30 days after the loss of inventory no oil has become stranded or reached the sediment.

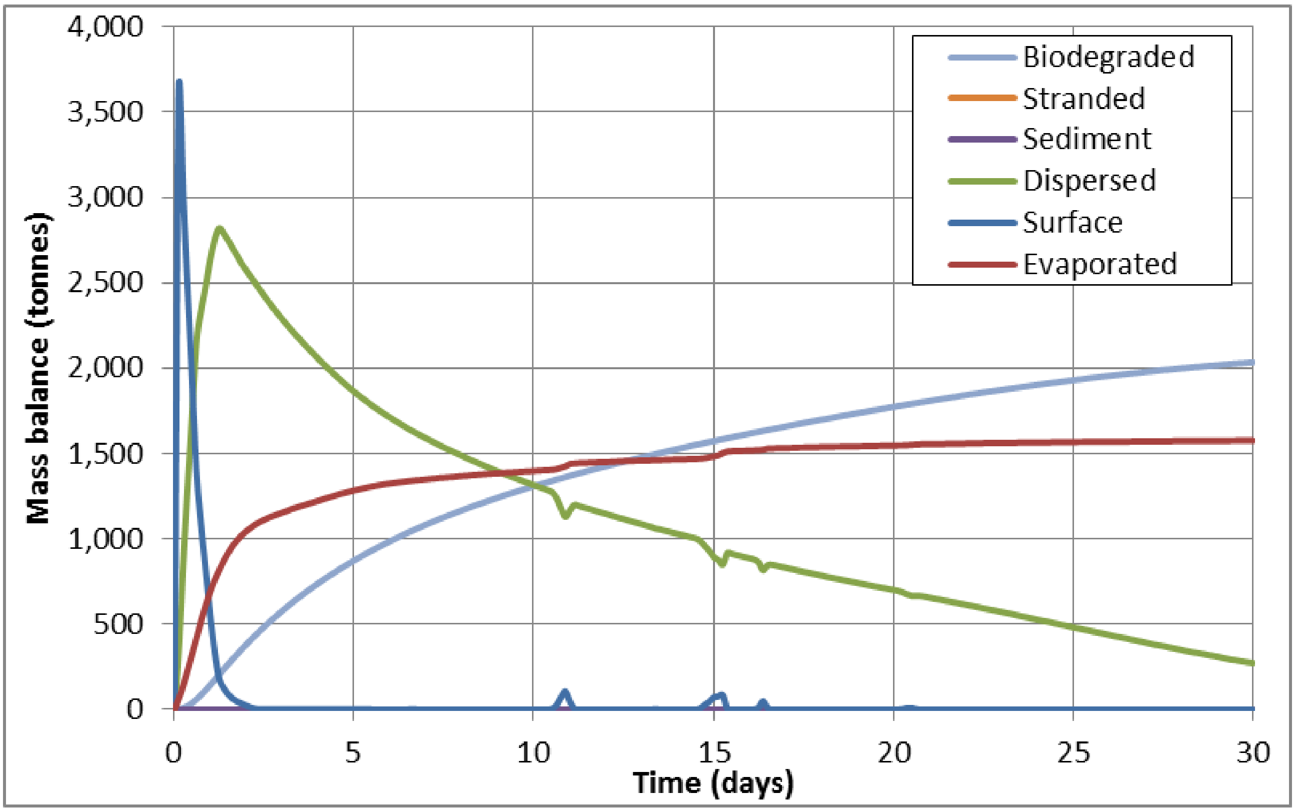


Figure 80: Behaviour of oil over time for diesel inventory loss

Surface statistics

The probability of the diesel occurring on the surface above a thickness of 0.3 microns is shown in Figure 81. The likelihood of diesel being on the surface is only high (30-40%) very close to the release point. The minimum arrival time of the diesel shown in Figure 82, shows the longest arrival time is up to 15 days although this is unlikely, as demonstrated by Figure 81. The diesel loss from the drilling rig does not at any point reach the Falklands shoreline or cross the FOCZ.

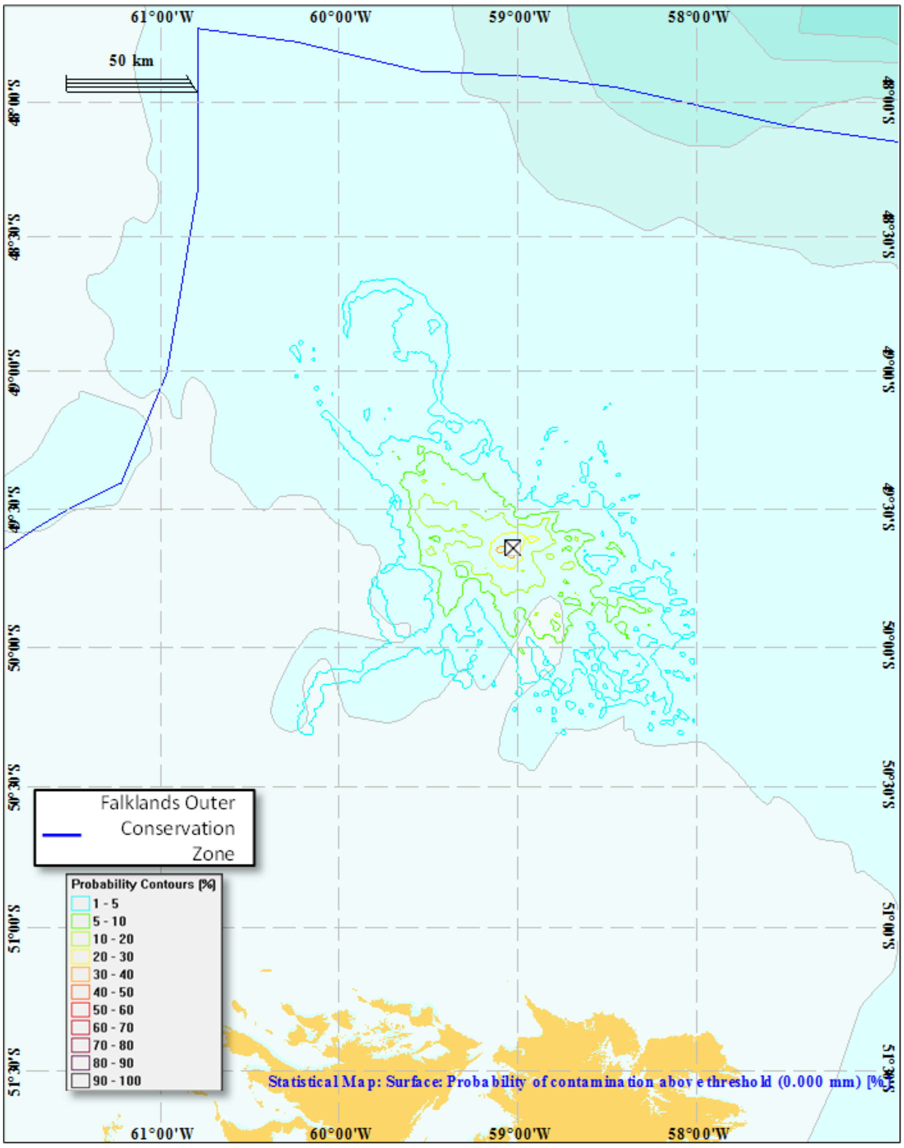


Figure 81: Stochastic probability plot for the diesel inventory loss

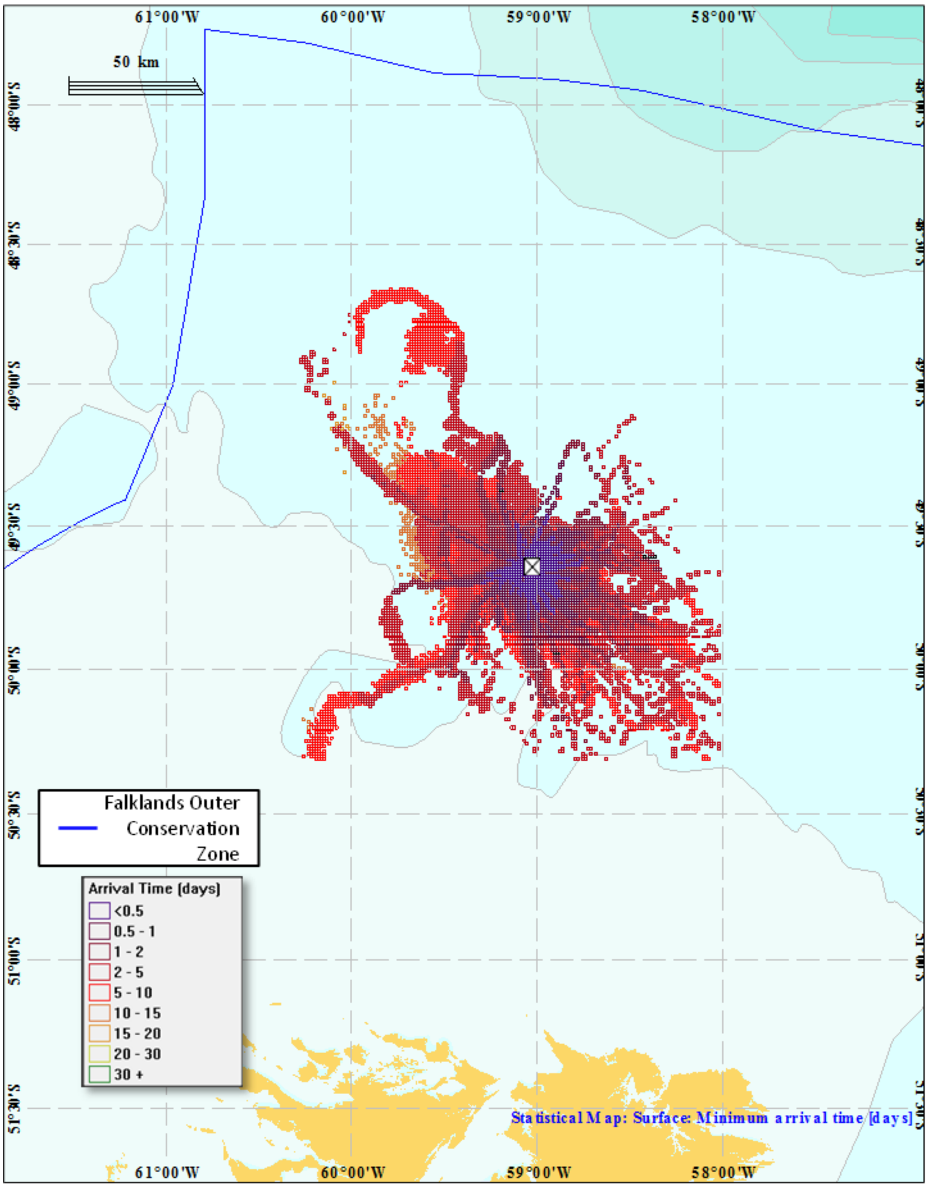


Figure 82: Stochastic minimum arrival times – diesel inventory loss

The worst-case metocean conditions identified during the stochastic modelling was selected to run the deterministic diesel inventory loss scenario to estimate an expected surface area impacted. This impacted area is shown in Figure 83. The main figure shows the maximum surface thickness at any time, and the snapshot to the left shows the surface thickness after 2.5 days. The maximum surface thickness reaches 75 km from the release point; the surface thickness exceeds 200 microns shortly after release. After 2.5 days the diesel is very dispersed and will not be fully visible on the surface.

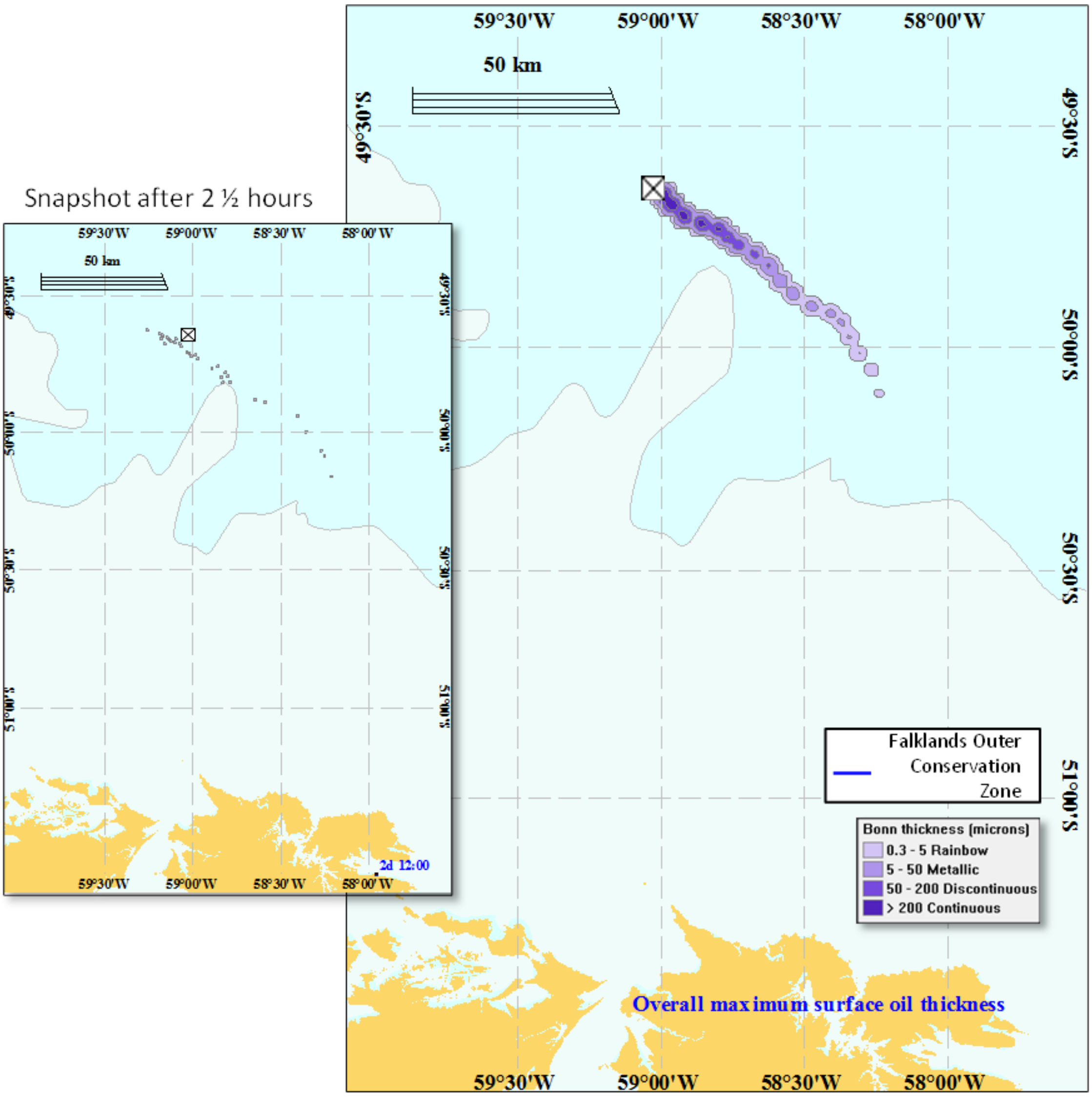


Figure 83: Deterministic maximum surface thickness for diesel inventory loss

Water column statistics

Figure 84 shows the maximum water concentration at any point for the diesel inventory loss scenario. The diesel contamination is confined to the top 40 m of the water column. The concentration exceeds 1,000 ppb close to the release point.

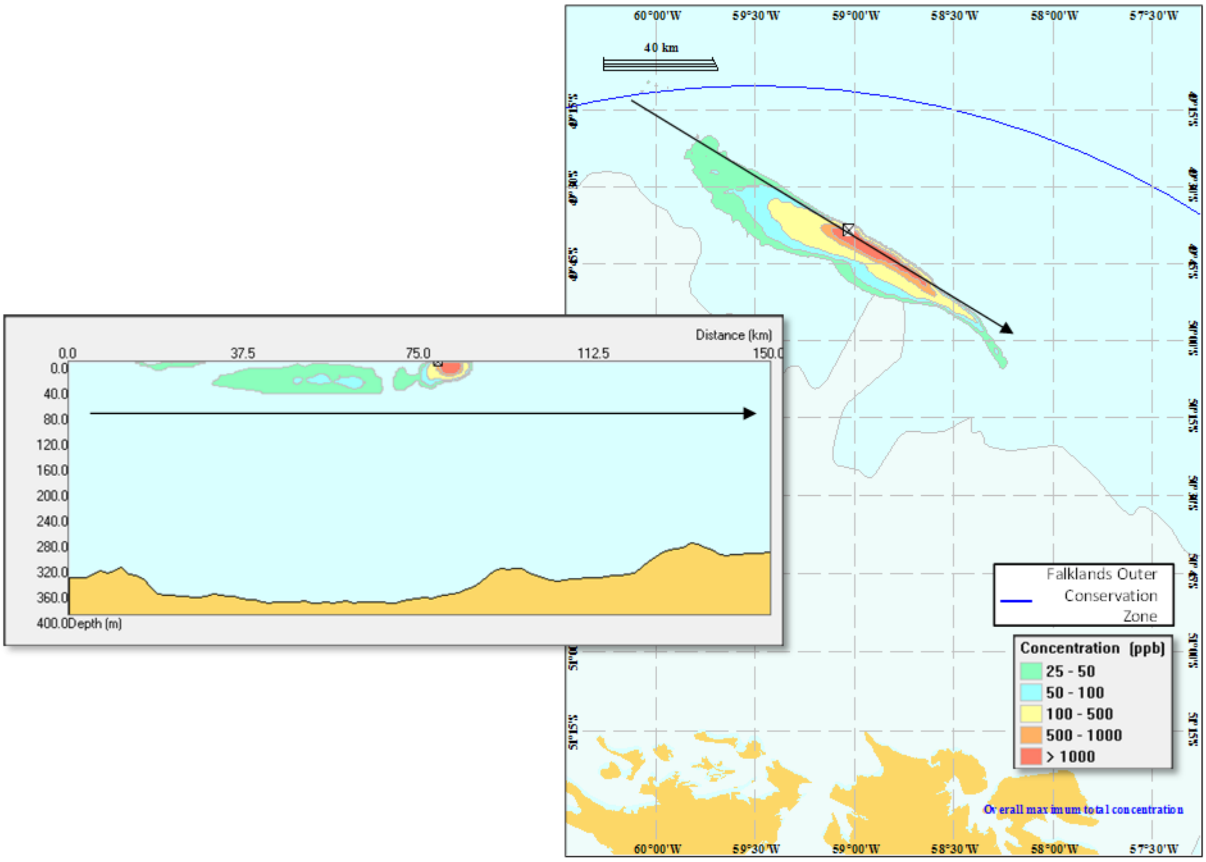


Figure 84: Maximum dissolved water column concentration - diesel inventory loss

13.3.5 Impact Assessment Summary

13.3.5.1 Severity

Diesel fuels contain volatile aromatic compounds, those of concern include; alkylbenzenes, toluene, naphthalenes, and PAH, which are potentially acutely toxic to marine life in the water column. Potential impacts on vertebrates include; changes in the liver and harmful effects on the kidneys, heart, lungs, and nervous system. Increased rates of cancer, immunological, reproductive, fetotoxic, genotoxic effects (Irwin 1997). PAHs are relatively long-lived in the environment and bioaccumulate in the fatty tissues of animals, resulting in vital organ malfunction (particularly liver and kidney).

Both diesel spill scenarios indicated that the spill would only remain on the sea surface for a short period of time before the diesel was dispersed in the water column. The area of potential impact, to both the surface and the water column, were only found to be significant close to the release point. Although short-lived, diesel is far more volatile than Sea Lion crude and will release toxic substances, such as PAHs into the water column. These chemicals are toxic to marine life and will have a localised impact. The larger the spill the greater is the area over which it will spread and the longer it takes to degrade to an insignificant concentration. The size of the spill does not necessarily relate directly to the scale of the impact, the impact is determined by how many receptors are exposed to the pollutant. Spatial and temporal variations in the distribution of receptors may influence the scale of the impact as much as the size of the spill, although smaller spills will disperse more rapidly. However, it is likely that the presence of the rig will act as a focal point for marine animals and therefore the greatest impact is likely to be close to the rig.

Plankton

In both scenarios, the diesel remains on or close to the surface of the water throughout the course of the model. Planktonic organisms will be contaminated over a small area for a short period of time. It is thought that, a combination of high reproductive rates and immigration from outside the affected area would see a quick recovery in the affected communities. Any effects will be greater during a period of plankton blooms or during fish spawning periods. The severity of the impact of diesel spills on plankton is assessed as '**Minor**'.

Fish and Squid

Fish and squid could be killed if they come into contact with high concentrations of diesel, eggs and larvae are particularly vulnerable as they occupy the surface layers of the sea. In the offshore environment, diesel spills will be dispersed very quickly and so fish may be more vulnerable to non-lethal effects and accumulation of toxins that can taint the flesh of fish. However, the impact of the spills modelled here is very localised and short-term in nature and the severity impact is assessed as '**Minor**'.

Seabirds

Procellariiformes (albatrosses, petrels and shearwaters) have an acute sense of smell and rely on olfactory detection of volatile oils to locate prey over great distances (Warham, 1990 and 1996). Diesel fuel and other volatile petroleum products are likely to be detected by seabirds from great distances and could be confused as a food source. However, the impact of oil spills on albatrosses and petrels appears slight compared with other seabirds, such as penguins. It has been suggested that the highly developed sense of smell in these species helps them to avoid contamination with surface oil (Brooke, 2004). Conversely, observations at-sea indicate that shearwaters do not avoid these areas (Vander Werf et al., 2005). The conservation status of albatrosses and some petrels means that even a small impact could be significant for the population.

Diesel rapidly spreads to form a sheen on the surface of the water. Scenario 1 of a transfer spill of 30 tonnes, indicates that the diesel will only be on the surface for a matter of hours and therefore the impact is short-lived and localised. Although there are gaps in the data, a general picture of seabird and marine mammal distribution within the NFB has been acquired through a combination of satellite tracking, visual and acoustic surveys. During the intended drilling period, the density of seabirds encountered in the vicinity of the well sites has been low. However, the presence of the rig is likely to attract birds (see Munro, 2011) and it is these animals that are at greatest risk of suffering from the chronic impact of small scale leaks and spills and loss of containment events. Amongst others, species such as royal, wandering and black-browed albatrosses, giant and white-chinned petrels are among the most numerous that associate with vessels at-sea. Several of these are classified as Endangered under IUCN guidelines (see Section 5.4.7) and are all covered by ACAP. For this reason, the severity of a small transfer diesel spill (30 tonnes) on seabirds is assessed to be '**Moderate**'.

Scenario 2, a far larger diesel spill, indicates that diesel will be on the surface for longer and will spread over a larger area. The potential impact increases in proportion to the size of the spill. Nonetheless, the area covered by the spill is still relatively small (on the scale of the NFB), the slick will be short-lived and any species of seabird impacted would recover relatively rapidly. The severity of a large loss of diesel fuel is assessed as '**Moderate**'.

Marine Mammals

Acoustic survey data of the exploration area indicates that marine mammals do not heavily use the area in the vicinity of the well sites during the seasons when the proposed drilling campaign is scheduled to take place. Marine mammals, particularly fur seals, that come into contact with a diesel spill may suffer adverse consequences, although any spill would impact a small area for a short period of time. Cetaceans are more vulnerable to inhaling toxic vapour and are less affected by contact with the skin, therefore would be most likely to be affected for a short period immediately following a spill before the diesel is dispersed from surface waters.

There is no indication that the presence of a rig attracts associating marine mammals, although they could be attracted by potential prey species that may shelter near the rig. The severity of a small chronic short-term release of diesel (Scenario 1) to severity of impact marine mammals has been assessed as '**Minor**'.

Like seabirds, the potential impact from a larger spill increases. However, large diesel spills are short-lived and localised and likelihood of marine mammals being exposed and suffering serious adverse effects is low. The severity of a large diesel spill (Scenario 2) on marine mammals is assessed as '**Minor**'.

Coastal Impact

In both scenarios, the diesel rapidly evaporates, biodegrades or is dispersed in the water column, none of the diesel is transported to the coast. Therefore the severity of the impact on the coastal environment is '**Slight**'.

13.3.5.2 Likelihood

Collisions with shipping

Shipping movements in the NFB have been analysed to investigate the risk of vessels colliding with the rig (Anatec, 2013). They report that on average 85 vessels pass within 10 nautical miles of the Sea Lion Field per year with 90% of these less than 5,000 DWT. Five of these vessels were tankers on passage between South Africa and Cape Horn. These are far larger vessels (>40,000 DWT) and therefore pose a greater threat in terms of the force of a collision. Overall, the annual risk of a collision with a passing vessel was calculated as $3.5x10^{-8}$ and the risk of a collision with a larger vessel (collision energy >200 MJ) was assessed as $1.2x10^{-8}$. Measures such as, a 500 m exclusion zone, a guard ship, AIS/radar surveillance and radio broadcasts to mariners (advising on the position of the rig and the exclusion zone) will further reduce the risk of collisions.

With all of the above in place as standard operating practice, the likelihood of small-scale diesel spills during fuel transfer has been assessed as '**Remote**'.

13.3.5.3 Significance

The significance of small-scale diesel spills has been assessed as '**Moderate**' for seabirds and '**Low**' for other environmental receptors. There is little more that can be done to mitigate the risk of these events occurring and therefore an oil response plan is required to reduce the severity of the impact on the marine environment.

13.3.5.4 Degree of Confidence

For any accidental event, there is a degree of uncertainty surrounding the environmental impact, due to assumptions made in the modelling.

The volatile nature of diesel fuel means that any spill will rapidly evaporate, disperse and biodegrade, the impact will be localised and short-lived. The impact will depend on the density of environmental receptors in the immediate vicinity of the rig, which is not possible to predict. The rig itself will influence the distribution of seabirds and may also influence the distribution of marine mammals and their prey. For these reasons, the confidence in the impact assessment of diesel spills on the marine environment is '**Probable**'.

13.3.5.5 Cumulative Impacts

The well sites are in an area that is not usually occupied by other vessels and therefore the risks of added cumulative impact are minimal.

13.3.6 Mitigation Measures

Premier Oil working procedures will provide the control and preventative measures that are designed to produce a zero discharge environment, these measures include;

- Operating equipment within specified safe limits;

- Conducting maintenance and inspection routines on time and diligently;
- Completing repairs within specified timescales;
- Reporting anything that is leaking or defective equipment;
- Investigating all leaks to determine root causes and take action to prevent reoccurrence; and
- Ensuring that all pipe-work is isolated, drained and purged as required by the permit to work before breaking containment.

Additionally, all hoses used to transfer diesel oil will be fitted with dry-break couplings, which will seal the end of the hose in the event of the hose becoming accidentally disconnected and limit the amount discharged. In the event that a spill occurs, support vessels will be equipped with oil spill response equipment to respond appropriately to all credible scenarios.

13.3.6.1 Residual Impacts

The measures outlined above are standard working practice over the UK continental shelf yet small oil spills (mostly less than one tonne) are still recorded (OSPAR, 2014). However, these spills are far smaller, and have lower severity, than the one modelled here and the likelihood of small spills occurring will be reduced. Overall the significance of the residual impact of small spills is assessed as '**Low**'.

13.4 Emergency situation leading to drilling rig loss of station – loss of WBM from riser

13.4.1 Introduction

The use, purpose and properties of drilling muds are explained in Section 3.5.3. With more oil and gas fields being developed in the deep water and harsh environments, safe reliable positioning operations on floating offshore installations have become more important. This is particularly important for the dynamic positioning (DP) operation of a semi-submersible rig. The rig position is maintained by powerful thrusters on each corner of the rig, and has limited tolerance in any direction to remain 'on station'. The degree of tolerance is dependant on water depth, in this case tolerance will be approximately 3 m. In an event of loss of station, a DP drilling unit must shut in the well and disconnect the riser safely, before the connection is broken. Failure to disconnect may result in damaged riser, wellhead or BOP, and in worst-case an uncontrolled sub-sea release. Collisions with other vessels in the vicinity may also be applicable if in congested waters.

The risk of an uncontrolled release has already been assessed in Section 13.2, however, damage to the riser during drilling operations could result in a loss of the drilling mud and cuttings within the riser.

13.4.2 Reasons for failing to maintain station

Loss of station may be caused by a number of failures, the most common being related to failure of position references, operator error, thruster failure and DP computer failure (Figure 85). Figure 85 illustrates DP incidents and their causes between 1994 – 2003.

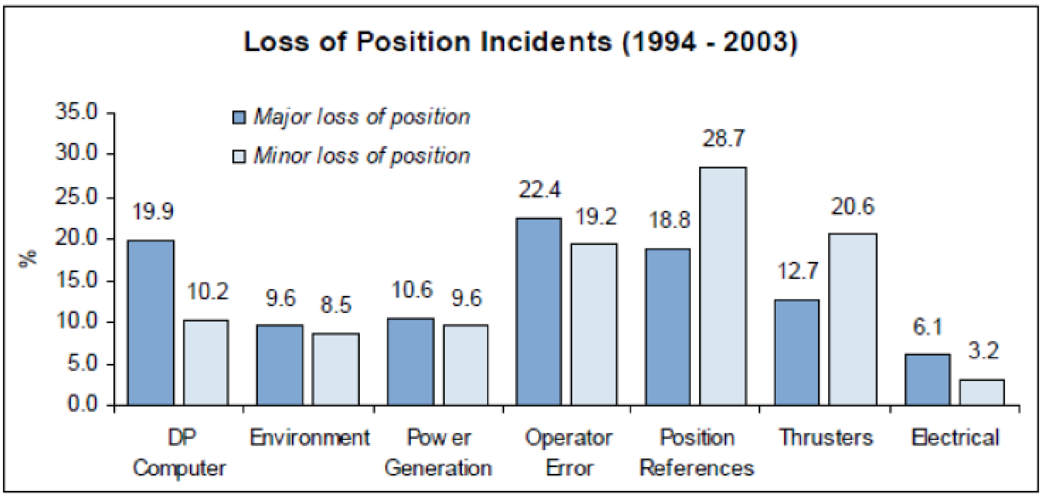


Figure 85: DP incidents and their causes (Tjallema, 2007).

This chapter draws on modelling the loss of water based mud from the riser during the unlikely event of the drilling rig losing station (Genesis, 2014a).

13.4.3 Potential Environmental Receptors

Assuming that an uncontrolled release is avoided, the main environmental consequence of losing station is the loss of the riser and its contents of Water Based Mud (WBM).

There are a number of potential environmental receptors to the accidental loss of containment of WBM from a riser. These include:

- **Seabed sediment** – discharge direct to the seabed and settlement of particles through the water column will impact sediment chemistry and particle size over the affected area.
- **Water quality** – suspension of mud and cuttings in the water column as well as discharge to surface waters will impact water chemistry and turbidity.
- **Phytoplankton and Zooplankton** – organisms with limited mobility will be impacted by changes in local water quality.
- **Benthic organisms** – discharge of drill cuttings and mud affects benthic organisms through direct burial, habitat change and sediment suspension at the seabed.
- **Fish** – mobile species such as fish may be affected if drilling coincides with certain life history stages such as spawning periods and juvenile stages when they inhabit particular spawning or nursery grounds, or if it coincides with productive feeding season and feeding grounds.

13.4.4 Characterising and Quantifying the Impact of WBM

A WBM spill due to a rupture of the riser during drilling was modelled using the DREAM (Dose-related Risk and Effect Assessment Model) published by SINTEF (v6.5.1), which incorporates the ParTrack sub-model used for modelling the dispersion and settlement of solids.

The methods supporting the modelling studies have been described in Section 12.4, the specific input parameters that relate to a spill from a ruptured riser and the model outputs are summarised in this chapter. The full details are available in the following report:

- Genesis, 2014. Oil spill modelling for Sea Lion Exploration Wells. Document number: J72925D-Y-TN-2400/D1. Prepares for Premier Oil.

13.4.4.1 Physical Release Parameters

The potential volume of mud that could be lost from the riser was estimated to be 100 m^3, equivalent to the worst-case volume of mud that would be in the riser at anyone time. It was assumed that the mud would be released through a rupture in the riser that at worst-case would be equal to the riser diameter (typical value assumed). A release duration of one minute was assumed for the total 100 m^3 mud, which is considerably denser than seawater and would therefore quickly drop out as soon as the riser ruptures. One minute was chosen as a conservative duration since the faster the release the less dispersion and hence more deposition in a confined area. The physical release parameters are summarised in Table 67.

Table 67: Physical release parameters used to model the dispersal of WBM

Scenario	Coordinates	Depth release	Quantity released	Assumed Release Duration	Simulation Duration	Release Diameter	Release Temp
WBM Riser rupture	49°28'34.03" 59°01'36.29" Isobel Deep	Half way down the water column	100 m^3	1 minute	1 day	30" (762 mm)	50°C

Environmental risk thresholds defined in the mud spill model

- Deposition thickness - Kjeilen-Eilertsen (2004) concluded that, in general, a deposited cuttings/mud thickness of 6.5 mm can be adopted as a threshold at which 5 % of the most sensitive species would be affected by smothering, which is deemed a tolerable risk level in EU Guidance (Commission Directive 93/67/EEC on risk assessment for new notified substances, the Commission Regulation (EC) No. 1488/94 on risk assessment for existing substances and the Directive 98/8/EC of the European Parliament and of the Council which covers the needs of the Biocidal Products Directive on chemical discharges) (Section 12.4.3).
- Where the predicted environmental concentration (PEC) is greater than the predicted no effect concentration (PNEC), a risk to at least 5% of the most sensitive species occurs. The sediment and water column risk predictions therefore use a threshold of 5% for the mud spill modelling (Section 12.4.3).

13.4.4.2 Mud Spill Modelling Outputs

The WBM spill was modelled over ten years in order to predict the persistence of the mud on the seabed. The spill was assumed to occur at the same time as the worst-case oil release scenario, determined by the stochastic analysis due to the metocean data used.

Sediment deposition

The predicted deposition thickness is illustrated in Figure 86. A 2.7 x 1.3 km grid surrounding the spill location with a cell size of 10 m (N.B. calculations averaged over 10 m) was used to predict deposition accuracy.

The distribution of mud was fairly uniform around the spill location, spreading away from the release location in a concentric pattern due to variable currents. This shows deposition on the sediment is minimal, reaching at most 0.005 mm south west of the release point. The predicted thickness is much lower than 6.5 mm therefore smothering effects are not anticipated.

Grain size of deposited material

Figure 87 illustrates the predicted median grain size change 24 hours after the riser spill. Median grain size ranges between 1 µm and 32 µm. The green areas correspond to grain sizes below background levels, while the brown areas correspond to grain sizes greater than background levels (average grain size 27 µm), both of which can induce particle stress on benthic fauna. Smit et al. (2006) propose a median grain size change threshold of 52.7 µm before adverse effects occur.

The model predictions for grain size change are below this threshold therefore no adverse effects are anticipated.

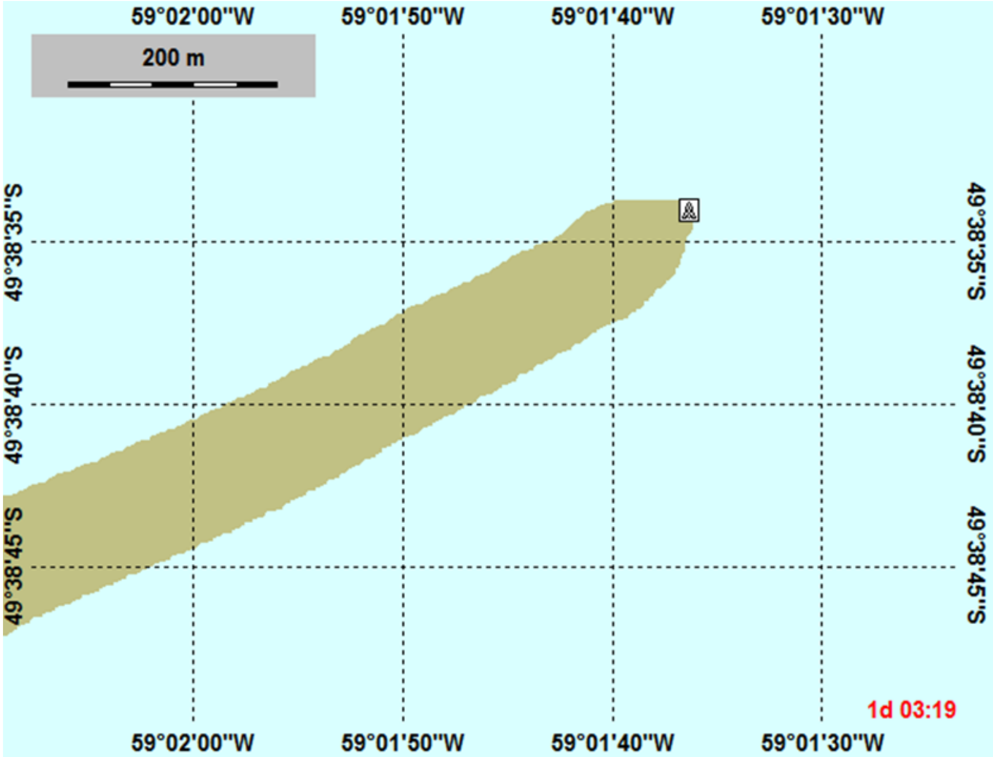


Figure 86: Deposition thickness one day after spill

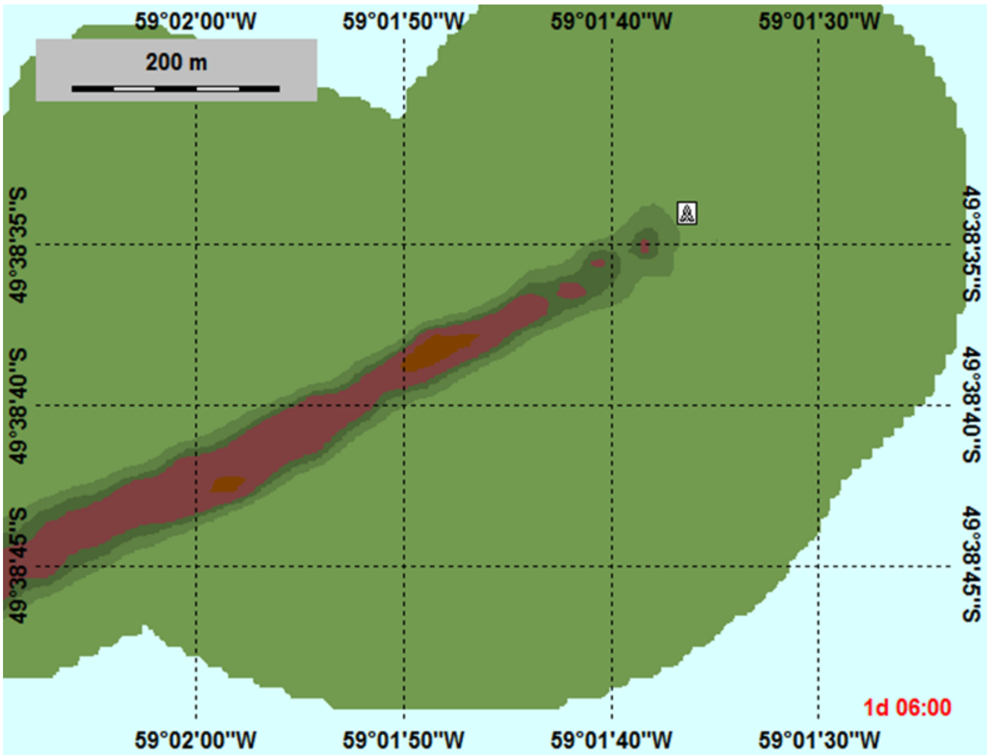


Figure 87: Grain size change after five hours

Risk to the sediment

Total risk to the sediment due to a combination of grain size change, burial thickness and pore-water oxygen depletion at cessation of drilling was modelled. The model predicted less than 0.005% risk to the sediment (Figure 88).

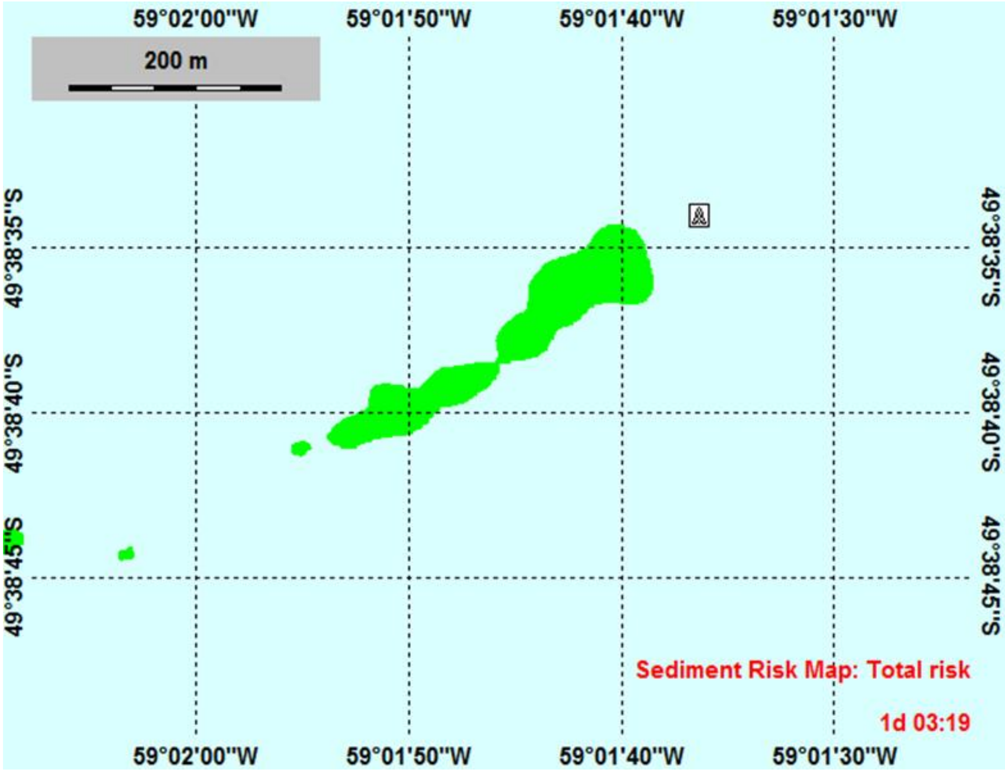


Figure 88: Risk to the sediment after one day

Risk to the water column

The mud and chemicals will be dispersed by the current resulting in risk to the water column. The plume quickly falls to the seabed within about five minutes and continues to disperse along in a westerly direction by the current. A greater than 5% risk to the water column extends at least 4 km from the spill location. The risk falls below 5% about 10 hours after the spill. It was predicted that a volume of at least 0.0146 km^3 where the risk exceeds 5% would be affected in the water column. The primary contributor to this risk is suspended barite particles, accounting for 83 % of the cumulative risk.

DREAM/ParTrack Model Uncertainties

The uncertainties associated with the DREAM/ParTrack model are discussed in detail in Section 12.4.4.

It is not believed that these uncertainties would significantly alter the spatial and temporal extent of the disturbance described by the modelling outputs (Genesis, 2014).

13.4.5 Risk Assessment Summary

13.4.5.1 Severity

Sediment Quality

Sediment quality impacts will be locally constrained. The distribution of mud was fairly uniform around the spill location, spreading away from the release location in a concentric pattern due to variable currents. This shows deposition on the sediment is minimal, reaching at most 0.005 mm south west of the release point, well below the threshold of 6.5 mm thickness (Kjeilen-Eilertsen, 2004) at which 5 % of the most sensitive species would be affected by smothering. The total risk to the sediment due to a combination of grain size change, burial thickness and pore-water oxygen depletion at cessation of drilling was not predicted to exceed 0.005% risk to the sediments.

Concentrations of a number of heavy metal components within the drilling mud will exceed the natural background sediment concentrations within exploration area, including cadmium, copper, mercury, lead and zinc. However, these metals are present in barite primarily as insoluble mineralised sulphide salts which will therefore have limited environmental mobility and a low toxicity (Neff, 2005). The severity of the impact on the sediment is '**Minor**'.

Plankton

High concentrations of suspended particulates may cause localised responses in zooplankton over a small temporal window, such as physical interaction with the gills, gastrointestinal tract and feeding behaviour, as opposed to chemical toxicity (Smit et al., 2006).

The severity of the impact to plankton is therefore considered to be **'Minor'** impact as there will be a short-term release in the unlikely event of a drilling unit loss of station. The environmental risk is predicted to be localised and the impact will be minor in nature.

Benthic Fauna

The discharge of mud to the seabed from an accidental loss of containment from the riser due to the uncontrolled loss of station by the drilling unit will have limited effects on the seabed. The sediment quality impacts will be locally contained with a predicted thickness of less than 0.005 mm south west of the release point. Benthic filter feeding organisms, such as bivalve molluscs, are known to experience toxic effects of suspended particulate matter causing clogging in the gills (Cranford et al., 1998). However, particles such as barite settle out rapidly from the WBM resulting in declining concentrations of barite in the water column, and even in the benthic boundary layer where most bivalves feed, therefore it is probable that barite has limited toxic effect to these organisms (Neff, 2010).

The severity of the impact to the benthic fauna is considered to be **'Minor'** affecting a relatively small area over a small temporal window.

Fish and Shellfish

Larvae and eggs of fish are more sensitive to an increased concentration of suspended sediment than adult life stages. However, fish are highly mobile organisms and are likely to avoid the areas of re-suspended sediments and turbulence during the drilling operations. Shellfish collectively, in general, tend to have lower mobility and can be sensitive to burial by sediments. The risk to the water column is predicted to be very localised in nature (0.0146 km^3) and the risk falls below 5% about 10 hours after the spill. The proposed well locations are situated within the Falkland Islands Northern Slope habitat zone (Section 5.4.5), which has been identified as an important feeding area for a number of fish species, whose abundance varies with season.

Given the localised and very short-term nature of this type of impact the overall severity to this receptor is considered to be **'Minor'.**

13.4.5.2 Likelihood

The *Eirik Raude* is a DP3 semi-submersible drilling rig. There are strict procedures in place to minimize loss of station. The DP system of the rig typically uses a fixed point of the clump weight to maintain position by ensuring appropriate tension on the line. System redundancy is designed to ensure that DP related equipment is always available. However, there are multiple recorded cases in the oil and gas industry where semi-submersible rigs have lost station. The likelihood of the loss of containment from a riser as a result of loss of station is considered **'Remote'.**

13.4.5.3 Significance

The overall significance of a loss of containment from a riser due to drilling unit loss of station is '**Low**' as the negligible environmental impacts are considered to be negligible.

13.4.5.4 Degree of Confidence

There are a number of uncertainties and assumptions that surround the events leading to loss of station and therefore loss of containment of the riser. Wherever possible, worst-case scenarios have been assumed to ensure that the impact is not under-estimated. However, due to the uncertainties surrounding major accidental events and the assumptions in the modelling approach the confidence in the significance of the risk presented in this assessment is '**Probable**'.

13.4.5.5 Cumulative Impact

During the drilling campaign there will be other sources of WBM in the NFB. However, it is possible that residue from previous campaigns is still present within the sediments. Although the impact of WBM is very localised, there may be a slight cumulative impact.

13.4.6 Mitigation Measures

There are a number of practices and procedures that will reduce the risk of loss of station and thus ultimately loss of containment of the riser;

- Redundancy is designed to ensure that DP related equipment are always available, which reduced the probability of the DP installations loss of position and the potential ensuing damage (see – DNV-RP-E306);
- DP trials on the rig will be undertaken when the rig reaches location and before operations commence;
- An exclusion zone of 500 m, guard vessel, radar, AIS and radio broadcasts to reduce the probability of vessel collision;
- Iceberg collision. Work to date shows that the risk of significant icebergs in the exploration drilling area is low, however, some icebergs have been spotted in recent years and Premier Oil will have an ice management plan in place for the duration of the drilling campaign. The plan will detail how icebergs will be monitored using satellites throughout the campaign, the minimum times to suspend a well and disconnect the rig in the event of an iceberg drifting towards the operation, and the options that will be available to re-direct and/or avoid icebergs;
- Meteorological analyses to be prepared for extreme weather events.
- Continual monitoring of long-range and short-range weather forecasts, so that if storm conditions are predicted to exceed the safe weather conditions for the rig, a controlled containment and release from the wellhead could be performed if required.

Table 68: Summary of the impact assessment for accidental events during the 2015 Campaign

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity*	Severity	Significance Pre-mitigation	Significance Post-mitigation	Certainty	Mitigation / Prevention / Control
Emergency Situation Significant loss of containment	Lethal and sub-lethal toxic effects	Plankton	Accidental	Remote	Low	Moderate	Moderate		Probable	Working practices will follow the industries best guidelines to prevent uncontrolled releases and other accidental events. An oil spill response plan will be enacted to; stop the uncontrolled release, contain and recover oil from the sea, surveillance will track the oil to inform the need for coastline clean-up, wildlife rescue and rehabilitation.
	Lethal and sub-lethal toxic effects	Benthic ecosystem		Remote	Very Low	Major	Moderate		Probable	
	Oiling of feathers leading to hypothermia, ingestion of toxins	Seabirds		Remote	Very High	Major	Moderate		Probable	
	Oiling of fur leading to hypothermia, inhalation of toxins	Marine mammals		Remote	High	Moderate	Moderate		Probable	
	Lethal and sub-lethal toxic effects	Fish and fisheries		Remote	Low	Major	Moderate		Probable	
	Impact on productive feeding and spawning grounds	Coastal		Remote	Mod	Moderate	Moderate		Probable	
	Negative publicity impacting tourist numbers	Tourism		Remote	Mod	Major	Moderate		Probable	

** See Section 6.0 for EIA methodology for unplanned events, and definitions of severity and significance.*

Table 68 continued: Summary of the impact assessment for accidental events during the 2015 Campaign

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance Pre-mitigation	Significance Post-mitigation	Certainty	Mitigation / Prevention / Control
Emergency Situation Accidental loss of containment leading to loss of rig diesel inventory	Lethal and sub-lethal toxic effects	Plankton	Accidental	Remote	Low	Minor	Low		Probable	Working practices will follow the industries best guidelines to prevent uncontrolled releases and other accidental events. An oil spill response plan will be enacted to; stop the uncontrolled release, contain and recover oil from the sea.
	Oiling of feathers leading to hypothermia, ingestion of toxins	Seabirds			Very High	Moderate	Moderate		Probable	
	Oiling of fur leading to hypothermia, inhalation of toxins	Marine mammals			High	Minor	Low		Probable	
	Lethal and sub-lethal toxic effects	Fish and fisheries			Low	Minor	Low		Probable	
Accidental Event Leading to a minor diesel spill	Lethal and sub-lethal toxic effects	Plankton	Unplanned	Rare	Low	Minor	Moderate	Low	Probable	Working practices will follow the industries best guidelines to prevent accidental events. Where possible, fuel hoses will be fitted with dry-break couplings to minimise the risk of small spills.
	Oiling of feathers leading to hypothermia, ingestion of toxins	Seabirds			Very High	Moderate	Moderate	Minor	Probable	
	Oiling of fur leading to hypothermia, inhalation of toxins	Marine mammals			High	Minor	Moderate	Low	Probable	
	Lethal and sub-lethal toxic effects	Fish and fisheries			Low	Minor	Moderate	Low	Probable	

** See Section 6.0 for EIA methodology for unplanned events, and definitions of severity and significance.*

Table 68: Summary of the impact assessment for accidental events during the 2015 Campaign

Activity	Aspect	Potential Impact	Type of Activity	Likelihood	Sensitivity	Severity	Significance		Certainty	Mitigation / Prevention / Control
							Pre-mitigation	Post-mitigation		
Emergency Situation Loss of containment of drilling mud from the riser	Increased turbidity	Water quality	Accidental	Remote	Very Low	Minor	Low		Probable	Redundancy is built into the dynamic positioning (DP) system to reduce the risk of loss of station, Ongoing testing and maintenance of the DP systems, a 500 m exclusion zone is maintained to reduce the risk of collisions with other vessels, environmental factors such as extreme wind and icebergs are constantly monitored .
	Clogging and damage to gills from Barite	Plankton			Low	Minor	Low		Probable	
	Clogging and damage to gills from Barite	Fish and fisheries			Low	Minor	Low		Probable	
	Change in mean grain size	Sediments			Low	Minor	Low		Probable	
	Clogging and damage to gills from Barite	Benthos			Low	Minor	Low		Probable	

** See Section 6.0 for EIA methodology for unplanned events, and definitions of severity and significance.*

14.0 Environmental Management Measures and Conclusions

14.1 Introduction

Through a systematic evaluation of the proposed exploration drilling campaign project related activities and their interactions with the environment, a variety of potential sources of impact were identified. The majority of activities were of limited extent and duration and deemed minor.

Those activities that were identified as being of potentially greater concern were assessed further in main risk assessment chapters. A number of environmental management actions were highlighted for consideration during final project planning and execution. Premier Oil will manage these actions in the framework of their project specific environmental management plan (EMP), as described in Chapter 4.0.

14.2 Environmental Management

The proposed exploration drilling campaign will be conducted in accordance with Premier Oil's Health, Safety and Environmental Policy. Premier Oil's Health, Safety, Environment and Security (HSES) Management System has been developed in line with ISO 14001:2004 and Industry organisation's Management System Models (OGP and Energy Institute).

Various contractors will be involved in the detailed planning and execution of the drilling campaign. Premier Oil will manage their contractor interfaces and performance through Bridging Documents, which will outline the required performance levels.

Specific management actions identified in the EIS (Primarily in the context of risk management and effects mitigation and monitoring), will be taken forward into detailed planning and through the project execution phase. Table 69 presents a summary of the environmental management mitigation and monitoring actions identified during the EIA, and the framework for the project EMP.

14.3 Overall Conclusion

The overall conclusion of the Environmental Impact Assessment is that with the implementation of the proposed mitigation and risk reduction measures, the proposed exploration campaign will not result in any significant adverse effects on the environment or those who may be affected by potential project environmental impacts.

Table 69: Environmental Controls, Mitigation and Monitoring Measures Identified in the EIA Summarised in the Framework for the Project EMP

Action No	EIA Mitigation and Monitoring Reference	Recommended environmental mitigation measure/monitoring	Objectives of the measure and main concerns to address	Responsible Person / Organisation	Location / timing to implement measures	Achievement Criteria or Standards	Date Started and Complete
1	Chapter 3.0 Project Description	Premier Oil to notify the Fisheries Department (FIGFD) of rig moves and new rig locations.	To prevent interference with fishing vessels in the drilling area.	Drilling Superintendent	Throughout the campaign, prior to each rig move.	Notification of FIGFD.	
2	Chapter 6.0 Underwater noise	Deployment of Marine Mammal Observer to implement JNCC guidelines for Vertical Seismic Profile (VSP) operations	To prevent trauma to marine mammals, caused by the discharge of airguns	VSP Co-ordinator (Ops Geologist Premier Oil)	During VSP operations, which occur for 12-15 hours per well	Successful implementation of JNCC guidelines and provisions of MMO report to FIG	
3	Chapter 6.0 Underwater noise	Use acoustic survey data to quantify the level of underwater noise produced during the Campaign	Verify the risk assessment in the current EIA	Environmental Lead (Premier Oil)	Measurements taken during the Campaign	This will better inform future EIAs	
4	Section 8.0 Atmospheric Emissions	All vessels employed during drilling and installation activities will comply with the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008, which controls the levels of pollutants entering the atmosphere.	Reduction in Greenhouse Gas Emissions and Air Quality Pollutants	Vessel masters	Prior to vessel mobilisation	All combustion equipment will be subject to regular monitoring and inspections and an effective maintenance regime will be in place, ensuring all combustion equipment runs as efficiently as possible.	

Table 69 continued: Environmental Controls, Mitigation and Monitoring Measures Identified in the EIA Summarised in the Framework for the Project EMP

Action No	EIA Mitigation and Monitoring Reference	Recommended environmental mitigation measure/monitoring	Objectives of the measure and main concerns to address	Responsible Person / Organisation	Location / timing to implement measures	Achievement Criteria or Standards	Date Started and Complete
5	Section 8.0 Atmospheric Emissions	The time spent drilling the well is the predominant factor in overall emissions and this is minimised through the careful planning of the well and by executing the well with a robust drilling platform, using state of the art combustion plant.	Reduce unnecessary emissions of greenhouse gases and local air quality pollutants.	Drilling Superintendent	Throughout the Campaign	Adherence to planned drilling schedule and contractor management.	
6	Section 8.0 Atmospheric Emissions	MARPOL controls on the quality of diesel limit the sulphur content of fuel to very low levels.	Control emissions of acid gas in the form of sulphur dioxide. Reduce impact of acid rain and local air quality issues.	Vessel Masters	Throughout the Campaign	Vessels will be audited as part of selection and pre-mobilisation.	
7	Chapter 9.0 Offshore light	Minimise rig and ERRV light emission from accommodation with blackout blinds and general lighting arrangements on the rig	To prevent bird strikes	Premier Oil Offshore HSE Advisor	On the rig and vessels at all times	Monitor and record number of bird strikes, where appropriate	
8	Chapter 9.0 Offshore light	When flaring, deploy a dedicated observer to quantify impact	To quantify the influence of flares on bird behaviour at night	Environmental Lead	During hydrocarbon flaring	Report findings to FIG	
9	Section 10.2 Physical presence of vessels in Stanley Harbour	Marine Superintendent to liaise with Harbour Master	Disruption to other users of Stanley Harbour	Marine Superintendent	Throughout the Campaign	Development of a Harbour Management Plan prior to project commencement	

Table 69 continued: Environmental Controls, Mitigation and Monitoring Measures Identified in the EIA Summarised in the Framework for the Project EMP

Action No	EIA Mitigation and Monitoring Reference	Recommended environmental mitigation measure/monitoring	Objectives of the measure and main concerns to address	Responsible Person / Organisation	Location / timing to implement measures	Achievement Criteria or Standards	Date Started and Complete
10	Section 10.2 Collision with other vessels in Stanley Harbour	Awareness of other users of Stanley Harbour, Marine Superintendent to liaise with Harbour Master	Guard against the release of pollution	Marine Superintendent	Throughout the Campaign	Development of a Harbour Management Plan and oil spill contingency plan for the TDF prior to project commencement	
11	Section 10.3 Collision with marine mammals	Premier Oil to increase awareness of supply vessels. Increased vigilance in inshore waters	Prevent injury to marine mammals	Marine Superintendent	Throughout the Campaign	Supply vessels to record any incidents to Premier Oil and FIG. Awareness for vessel crews during inductions	
12	Section 10.4 Marine biosecurity	Exchange ballast water off shore	Prevent the introduction of non-native species	Vessel masters	On passage and arrival in the FI EEZ	Follow IMO best practice guidelines, record keeping	
13	Section 10.4 Marine biosecurity	Ensure that vessel biofouling treatments are maintained	Prevent the introduction of non-native species	Vessel masters	Prior to departure from home ports	Follow IMO guidelines, record keeping	
14	Section 10.4 Marine biosecurity	Monitor TDF and Stanley Harbour for non-native species with settlement plates	Early detection of potential invasive species	Environmental Lead Premier Oil	Throughout the Campaign	Monthly inspection of settlement plates.	
15	Section 10.4 Marine biosecurity	Comply with IMO Guidelines on Bio-fouling	Evaluate the effectiveness of antifouling and verify the assessed risk of introducing non-native species	Environmental Lead Premier Oil	Prior to arrival in FI waters and throughout the campaign	Internal assurance that the biofouling is acceptable	

Table 69 continued: Environmental Controls, Mitigation and Monitoring Measures Identified in the EIA Summarised in the Framework for the Project EMP

Action No	EIA Mitigation and Monitoring Reference	Recommended environmental mitigation measure/monitoring	Objectives of the measure and main concerns to address	Responsible Person / Organisation	Location / timing to implement measures	Achievement Criteria or Standards	Date Started and Complete
16	Section 10.5 Helicopter noise disturbance to wildlife	Follow the MoD flight avoidance areas and Falklands Low Flying Avoidance Handbook July 2014, and develop project specific flight plan	Prevent disturbance to sensitive wildlife	Helicopter Operator, TBC	Throughout the Campaign	Project specific flight plan and maintenance of flight records to demonstrate adherence to the plan. Educational awareness for those planning flights and pilots	
17	Section 10.6 Terrestrial biosecurity	Ensure cargo is packed clean, fumigate and use insect traps where appropriate	Prevent the introduction of non-native species	Logistics Co-ordinator, Premier Oil	As cargo is packed in the UK	Logistics supply base reputable company with experience in packaging equipment for transport to locations around the world. Adherence to FIG biosecurity guidelines	
18	Section 10.6 Terrestrial biosecurity	Inspections of arriving goods	Prevent the introduction of non-native species	Premier Oil Logistics Supervisor	As cargo is unloaded in FI	Adherence to FIG biosecurity guidelines. Report breaches to the FIG Biosecurity Officer	
19	All Sections	Development of Falkland Island drilling campaign specific electronic environmental awareness training module to cover all environmental aspects associated with the campaign, and all worker roles.	Increase awareness amongst workers or environmental sensitivities in the drilling area, potential for incidents and impacts, best practice being employed during the campaign – how this relates to different roles.	Environmental Lead Premier Oil	On or prior to arrival in FI waters and throughout the campaign	The electronic training will be rolled out as part of the workforce. Achievement standard will be 90% uptake of the training by all workers on site.	

Table 69 continued: Environmental Controls, Mitigation and Monitoring Measures Identified in the EIA Summarised in the Framework for the Project EMP

Action No	EIA Mitigation and Monitoring Reference	Recommended environmental mitigation measure/monitoring	Objectives of the measure and main concerns to address	Responsible Person / Organisation	Location / timing to implement measures	Achievement Criteria or Standards	Date Started and Complete
20	Section 13.2 Accidental Events Uncontrolled release	Blow out preventer incorporates auto-shear, Well design peer reviewed by well examiner and HSEx, Develop an Oil Spill Response Plan (OSRP)	Employ safe working practices to avoid major spills and subsequent impact on the environment	Drilling Superintendent	Throughout the campaign	OSRP to be reviewed by FIG prior to the start of drilling	
21	Section 13.3 Accidental Events Accidental loss of containment, diesel spill	Dry break couplings will be used, containment ordered and zero discharge environment, procedures and processes in place to avoid spills	Minimise the probability of a spill and the quantity of fuel that can be spilt	Drilling Superintendent / Marine Superintendent	Throughout the campaign	Adherence to Premier Oil HSE working practices (Golden Rules)	
22	Section 13.4 Accidental Events Loss of riser and drilling mud	DP3 rig, DP trials and verifications conducted prior to operations, auto shear if >10 m off station	Ensure that the rig maintains station at all times to avoid the loss of the riser and enclosed mud	Drilling Superintendent	Prior to starting the first well and throughout the campaign	Internal assurance that the DP system is functioning	
23	Section 14.0 Accidental Events Major incident leading to loss of rig	500 m exclusion zone patrolled by ERRV, local vessels aware of presence of rig via FLO and FishOps notices to mariners, rig hulls maintained regularly and inspected for integrity	To ensure that other vessels maintain a safe distance	Drilling Superintendent	Throughout the campaign	Regular and open communication with fishing community and notices regularly updated, Oceanrig maintenance regime audited regularly	
24	Section 14.0 Accidental Events Collision with other vessel in Stanley Harbour	Harbour Management Plan Marine Superintendent to liaise with Harbour Master	Reduce risk of vessel collisions within the harbour	Marine Superintendent	Prior to the arrival of supply vessels and throughout the campaign	Development of a Harbour Management Plan prior to project commencement	

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Premier Oil Exploration & Production Limited

Falkland Islands Business Unit

2015 Falkland Islands Exploration Campaign Environmental Impact Statement APPENDICES

Revision Info : Issue to Premier Oil
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	Originator	Verifier	Approver
Job Title	Andy Black – Environmental Consultant Dr. Liz Galley - Project Manager Dr. Paul Brickle – Project Director	Project Manager	Project Director
Name		Dr. Liz Galley	Dr. Paul Brickle
Signature			
Date	**02nd December 2014**	**02nd December 2014**	**02nd December 2014**

Appendix A: Chemical and Heavy Metal Properties of Sea Lion Sediments

Table 1. Chemical Properties of Sea Lion Sediments and Comparative Data Sets

Location	No. Stations	Depth (m)	TOM (%)	TOC (%)	THC (µg/g^{-1})	UCM (µg/g^{-1})	total n-alkanes (µg/g^{-1})	NDP (µg/g^{-1})	PAH (µg/g^{-1})
NFB Sea Lion EBS GSL 2012									
Sea Lion Area Survey	54	426-456	5.6 ±0.5	0.9 ±0.1	9.7 ±2.7	8.4 ±1.5	0.55 ±0.1	0.05 ±0.01	0.12 ±0.02
NFB Sea Lion Post-Drill GSL 2012									
Rockhopper Well 14/10-2	8	448-450	5.6 ±0.3	0.9 ±0.1	8.3 ±2.8	7.6 ±2.4	0.67 ±0.61	0.05 ±0.02	0.10 ±0.03
Rockhopper Well 14/10-6	8	445-455	5.4 ±0.3	0.9 ±0.1	7.7 ±4.3	7.2 ±4.2	0.49 ±0.14	0.04 ±0.01	0.10 ±0.04
Rockhopper Well 14/10-9	6	440-449	5.5 ±0.5	0.9 ±0.1	9.9 ±2.4	9.1 ±2.2	0.75 ±0.34	0.06 ±0.01	0.15 ±0.01
Rockhopper Well 14/15-4a	6	432-438	4.9 ±0.6	0.8 ±0.1	9.2 ±1.8	8.4 ±1.5	0.80 ±0.32	0.05 ±0.01	0.13 ±0.02
Shell Well 14/10-1	6	440-446	5.6 ±0.4	1.0 ±0.1	7.0 ±2.1	6.4 ±2.1	0.59 ±0.17	0.05 ±0.01	0.13 ±0.03
Comparison Data									
FOSA 1998 Surveys									
NFB 14/09 Little Blue (GSL 1998a)	15	415-456	5.7 ±3.1	na	0.1 ±0.09	0.1 ±0.08	0.02 ±0.01	0.02 ±0.01	0.06 ±0.06
NFB Little Blue post-drilling (GSL 1998i)	14	416	3.2 ±1.7	na	0.66 ±0.4	0.60 ±0.4	0.05 ±0.04	0.07 ±0.05	0.15 ±0.09
NFB 14/05 B1 (GSL 1998b)	14	462-482	4.3 ±1.9	na	0.25 ±0.0.1	0.22 ±0.1	0.03 ±0.03	0.03 ±0.02	0.07 ±0.06
NFB 1414a (GSL 1998c)	14	358-397	3.8 ±1.6	na	0.15 ±0.07	0.12 ±0.06	0.04 ±0.02	0.02 ±0.01	0.06 ±0.03
NFB 14/23a (GSL 1998d)	13	215-285	1.8 ±1.4	na	1.2 ±0.8	0.92 ±0.8	0.20 ±0.07	0.03 ±0.03	0.09 ±0.05
NFB 14/24 Braela (GSL 1998e)	13	230-253	2.9 ±3.2	na	2.4 ±1.7	1.6 ±1.5	0.7 ±0.5	0.05 ±0.06	0.12 ±0.14
NFB F1 14/19a (GSL 1998f)	13	353-367	4.5 ±2.5	na	0.2 ±0.05	0.17 ±0.05	0.04 ±0.02	0.02 ±0.02	0.05 ±0.05
NFB Minke 14/13b (GSL 1998h)	13	371-394	3.2 ±0.7	na	4.6 ±4.1	2.8 ±2.9	1.6 ±1.25	0.20 ±0.20	0.72 ±0.86
Other Surveys on the Falklands Continental Shelf									
sNFB BSL 2008	77	140-285	1.7 ±0.4	0.46 ±0.13	4.3 ±1.4	92-97%	0.21 ±0.05	0.001 ±0.002	0.001 ±0.002
SFB (Burdwood Bank) B&S 2010	23	1,200-2,100	3.5 ±0.6	0.31 ±0.1	12.8 ±5.0	88.8-91.9%	1.17 ±0.41	0.16 ±0.06	0.30 ±0.12
SFB Toroa BHP 2009	6	620 ±44	6.0 ±0.8	0.73 ±0.05	8.7 ±1.1	5.7 ±0.6	0.65 ±0.09	0.17 ±0.02	0.22 ±0.02
EPB Endeavour BHP 2009	Unknown	1,372 ±36	4.8 ±0.5	0.36 ±0.04	5.4 ±1.0	3.2 ±0.6	0.41 ±0.06	0.07 ±0.02	0.08 ±0.02
EPB Nimrod BHP 2009	Unknown	1,284 ±14	6.8 ±0.8	0.27 ±0.02	3.7 ±0.3	2.4 ±0.3	0.31 ±0.05	0.06 ±0.01	0.07 ±0.01
EPB Loligo BHP 2009	3	1,412 ±41	5.3 ±0.5	0.27 ±0.04	3.0 ±1.0	2.0 ±0.8	0.25 ±0.06	0.10 ±0.05	0.12 ±0.05

Table 2. Heavy Metal Concentrations of Sea Lion Sediments and Comparative Data Sets

Location	Al (mg.g^{-1})	As (µg/g^{-1})	Ba (µg/g^{-1})	Cd (µg/g^{-1})	Cr (µg/g^{-1})	Cu (µg/g^{-1})	Hg (µg/g^{-1})	Ni (µg/g^{-1})	Pb (µg/g^{-1})	Sn (µg/g^{-1})	V (µg/g^{-1})	Zn (µg/g^{-1})
NFB Sea Lion EBS GSL 2012												
Sea Lion Area Survey	47.8 ±5	3.6 ±0.3	335 ±37	0.3 ±0.2	46 ±4	22 ±4	0.03 ±0.01	18 ±1	7.5 ±1.0	1.8 ±0.7	78 ±4	71±6
NFB Sea Lion Post-Drill GSL 2012												
Rockhopper Well 14/10-2	50.7 ±1.9	3.6 ±0.3	378 ±43	0.2 ±0.2	45 ±2	20 ±3	0.03 ±0.01	17 ±1	7.3 ±1.0	1.5 ±0.1	76 ±1.0	73 ±10
Rockhopper Well 14/10-6	51.5 ±1.0	3.4 ±0.3	380 ±34	0.2 ±0.1	42 ±1	18 ±1	0.03 ±0.01	16 ±1	6.7 ±0.2	1.2 ±0.1	75 ±3	67 ±2
Rockhopper Well 14/10-9	47.2 ±2.9	4.0 ±0.3	336 ±21	0.1 ±0.1	47 ±3	20 ±1	0.04 ±0.01	18 ±1	7.4 ±0.3	1.8 ±0.3	84 ±4	78 ±6
Rockhopper Well 14/15-4a	47.9 ±3.3	4.2 ±0.1	372 ±42	0.2 ±0.1	48 ±1	19 ±1	0.02 ±0.00	18 ±1	7.8 ±0.2	3.0 ±0.5	86 ±2	77 ±3
Shell Well 14/10-1	50.7 ±1.6	3.5 ±0.2	372 ±9	0.2 ±0.2	44 ±2	18 ±2	0.02 ±0.01	18 ±1	7.0 ±0.4	2.6 ±1.7	81 ±5	78 ±12
Comparison Data												
FOSA 1998 Surveys												
NFB Little Blue GSL 1998a	52.8 ±7.0	na	382 ±34	<0.5	45 ±4.6	14.1 ±2.5	1.1 ±0.7	15.3 ±1.4	1.3 ±0.7	na	<0.5	67 ±4.6
NFB Little Blue P.D GSL 1998i	92.9 ±7.9	na	386 ±27	<0.1	64 ±20	13.5 ±1.6	4.9	16.7 ±1.2	<0.1	na	73.1 ±7.0	52.8 ±6.2
NFB B1 GSL 1998b	57.1 ±6.1	na	383 ±23	<0.5	43 ±3.8	15.7 ±2.3	1.3 ±0.7	14.7 ±1.8	0.9 ±0.3	na	70 ±4.9	59 ±5.8
NFB 14/14a GSL 1998c	55.9 ±8.8	na	384 ±28	<0.5	47 ±4.1	15.3 ±2.5	1.1 ±0.9	15.5 ±1.7	<0.5	na	69 ±4.3	57 ±5
NFB 14/23a GSL 1998d	71.2 ±10.0	na	289 ±56	<0.5	36 ±2.7	3.2 ±0.9	<0.5	<0.5	<0.5	na	70.8 ±8.3	29 ±2.0
NFB 14/24 Braela GSL 1998e	55.8 ±7.7	na	311 ±30	<0.5	31 ±2.4	3.1 ±1.1	<0.5	<0.5	<0.5	na	69 ±6.2	26 ±2.4
NFB F1 14/19a GSL 1998f	53.3 ±7.3	na	374 ±28	<0.5-2.0	45 ±2.1	16.1 ±1.8	<0.5-1.0	15.6 ±1.1	<0.5	na	69 ±5.8	57 ±5.7
NFB Minke 14/13b GSL 1998h	60.8 ±6.4	na	391 ±29	<0.5	57 ±7.6	16.9 ±2.6	<0.5	7.4 ±1.9	<0.5-1	na	87 ±4.8	61 ±4.3
Other Surveys on the Falklands Continental Shelf												
sNFB BSL 2008	35.3 ±13.4	3.6 ±1.4	236 ±61	0.4 ±0.1	27 ±6.5	5.5 ±1.6	0.01	6.4 ±1.5	5.8 ±1.6	na	29 ±8.0	27 ±9.7
SFB (PL018) B&S 2010	40.8 ±7.4	9.8 ±6.5	782 ±548	na	44 ±11	14.6 ±2.9	0.16 ±0.07	8.4 ±1.4	9 ±3.1	na	59 ±7.3	60 ±7.4
SFB Toroa BHP 2009	59.4 ±2.5	na	407 ±9	1.0 ±0.0	32±4.5	13.7 ±1.4	na	12.2 ±1.3	6.2 ±0.7	na	54 ±0.9	42 ±3.7
EPB Loligo BHP 2009	30.3 ±7.0	na	329 ±51	0.9 ±0.0	150 ±31	13.9 ±2.7	na	14.3 ±1.1	7.2 ±0.6	na	38 ±0.7	40 ±1.3
EPB Nimrod BHP 2009	30.5 ±7.4	na	342 ±93	0.4 ±0.1	136 ±25	10.7 ±1.6	na	13.3 ±1.3	6.2 ±1.2	na	67 ±2.2	75 ±6.7
EPB Endeavour BHP 2009	23.5 ±5.9	na	307 ±69	1.1 ±0.1	129 ±28	9.1 ±2.0	na	7.5 ±0.6	6.1 ±0.8	na	37 ±1.9	55 ±16.3

Appendix B: Benthic Fauna

Table 1. The Ten Most Abundant Species In the Sea Lion Field

Species	Survey & species dominance ranking	
	2012a	2012b
Onuphis pseudoiridescens	1	1
Allotanais hirsutus	2	4
Yoldiella spp	3	2
Mendicula spp.	4	5
Fabriciinae sp 5	5	6
Phoxocephalidae sp H	6	3
Aricidea (Acmira) *minifica*	7	7
Phoxocephalidae sp M	8	8
Amphipoda sp D	9	-
Gammaridae sp Z	10	-
Amphipoda sp AI	-	9
Gammaridae sp L	-	10

Source: Gardline. 2012a baseline survey; 2012b post-drilling survey. Blue = Crustaceans; Red = Polychaetes; Yellow = Molluscs.

Table 2. Number of Taxa and Species of Each Taxonomic Group at each Survey Station, and Percentage of the Total Each Group Forms, During 1998 FOSA Surveys.

Site*	Taxa	Annelida		Crustacea		Mollusca		Echinodermata		Foraminifera		Other
		Species	%	Species	%	Species	%	Species	%	Species	%	%
A	144	63	43.8	36	25	20	13.8	7	4.9	7	4.9	7.6
B	127	53	41.7	34	26.8	16	12.6	7	5.5	6	4.7	13.4
C	179	60	33.5	58	32.4	26	14.5	17	9.5	-	-	10.1
D	124	56	42.5	33	26.6	15	12.1	15	7.3	-	-	12.4
E	144	61	42.4	44	30.6	19	13.2	8	5.6	-	-	8.2
F	157	61	38.9	43	27.4	19	12.1	15	9.6	-	-	12
H	171	68	39.8	52	30.4	15	8.8	17	9.9	-	-	11.1
I	154	65	42.25	42	27.3	18	11.7	8	5.2	8	5.2	8.4

*A = Little Blue A; B = B1; C = 14/14-A; D = 14/23-A; E = Braela 14/24; F = F1 14/19-A; H = Minke 14/13; I = Little Blue post-drill

Table 3. The Ten Most Dominant Species at Each Survey Station during the 1998 FOSA Surveys.

Species	Sample location* and species dominance ranking							
	A	B	C	D	E	F	H	I
Archaeotanais hirsutus	1	-	-	-	-	-	-	1
Onuphis aff holobranchiata	2	-	3	-	-	2	1	2
Foraminiferan sp C	3	1	4	-	-	5	5	3
Cyclammina spp.	4	7	5	5	6	4	4	4
Urothoe spp	5	4	2	3	3	3	2	5
Edwarsiidae spp.	6	-	-	-	-	-	-	6
Lumbrineris sp.B	7	-	-	-	-	-	-	7
Mediomastus sp.	8	-	-	-	-	-	-	8
Aricidea sp B	9	8	7	6	-	6	-	9
Phoxocephalidae sp A	10	3	1	4	5	1	3	10
Spiophanes spp	-	2	-	-	-	-	6	-
Scoloplos spp	-	5	-	-	-	-	-	-
Sternapsis scutata	-	6	-	-	-	-	-	-
Cirriformia spp	-	9	-	-	-	-	-	-
Phoxocephalidae sp B	-	10	10	-	-	-	-	-
Sabellidae sp A	-	-	6	-	-	7	8	-
Nematoda spp	-	-	8	-	-	8	9	-
Melythasides spp	-	-	9	-	-	-	-	-
Aricidea sp C	-	-	-	1	1	-	10	-
Cirratulidae spp	-	-	-	2	2	-	-	-
Aricidea sp D	-	-	-	7	7	-	-	-
Levinsemia spp.	-	-	-	8	4	-	-	-
Ophelina sp A	-	-	-	9	8	-	-	-
Ophiuroidea sp A	-	-	-	10	-	-	-	-
Thyasira spp.	-	-	-	-	9	-	-	-
Ampelisea spp.	-	-	-	-	10	-	-	-
Lumbrineris sp A	-	-	-	-	-	9	7	-
Amphiura spp.	-	-	-	-	-	10	-	-

*A = Little Blue A; B = B1; C = 14/14-A; D = 14/23-A; E = Braela 14/24; F = F1 14/19-A; H = Minke 14/13; I = Little Blue post-drill; Red = Polychaetes, blue = Crustaceans; yellow = Molluscs; green = Foraminifera; grey = Anthozoa; purple = Echinodermata

Appendix C: Marine Mammal Survey Data

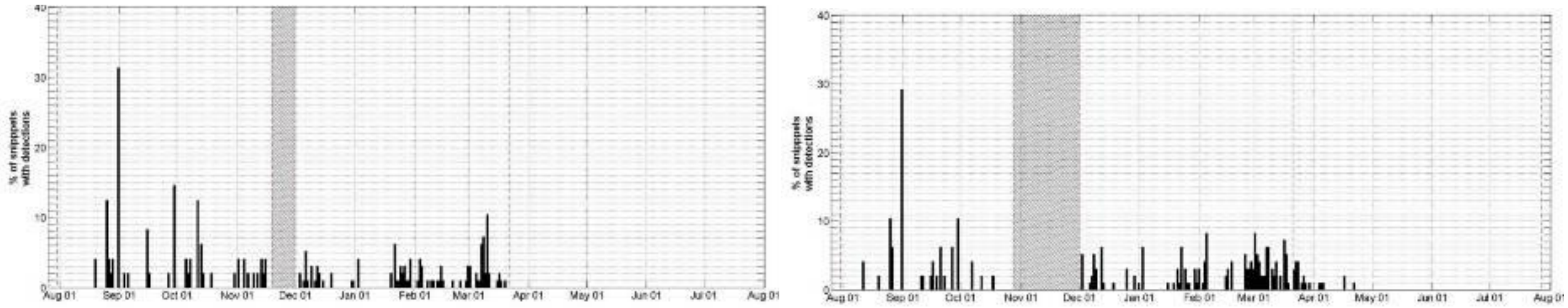


Figure 1: Daily proportion of fin whale call detections, AMAR 1 – left, AMAR 2 - right. Red dashed lines indicate deployment dates, shaded area indicated data gaps (Hipsey et al., 2013).

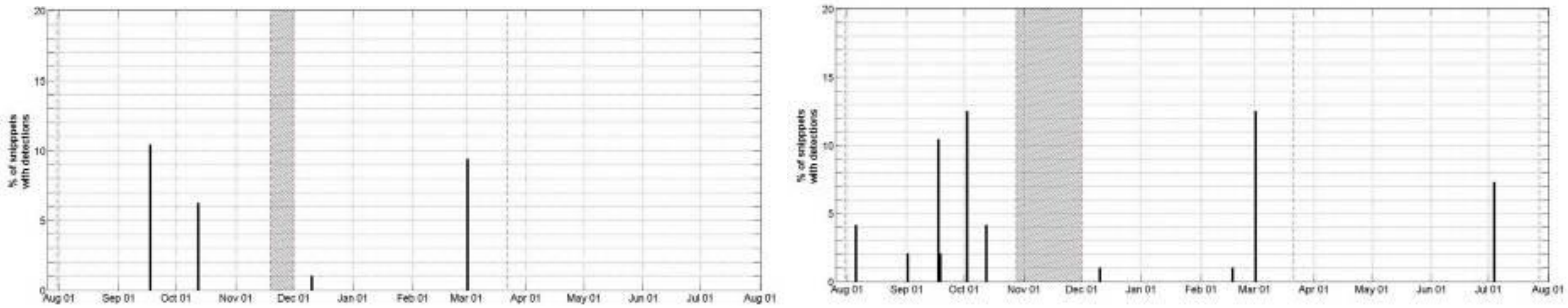


Figure 2: Daily proportion of killer whale call detections, AMAR 1 – left, AMAR 2 - right. Red dashed lines indicate deployment dates, shaded area indicated data gaps (Hipsey et al., 2013).

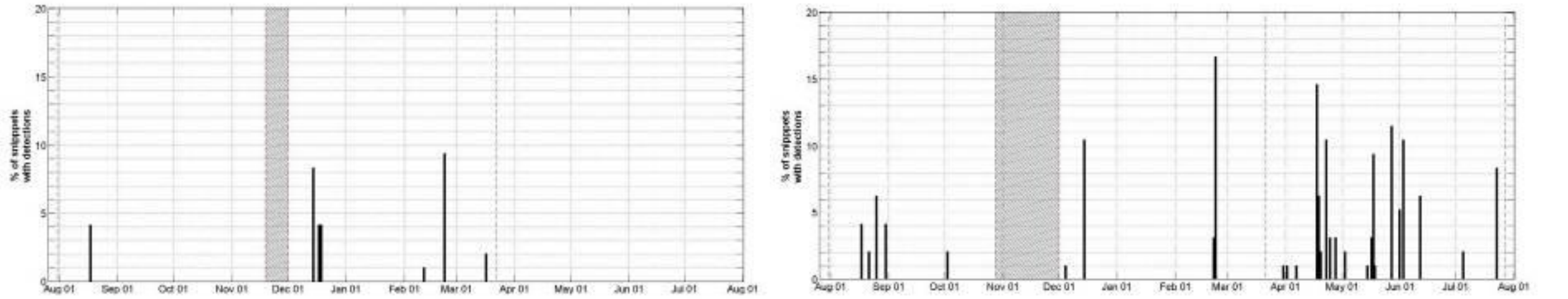


Figure 3: Daily proportion of pilot whale call detections, AMAR 1 – left, AMAR 2 - right. Red dashed lines indicate deployment dates, shaded area indicated data gaps (Hipsey et al., 2013).

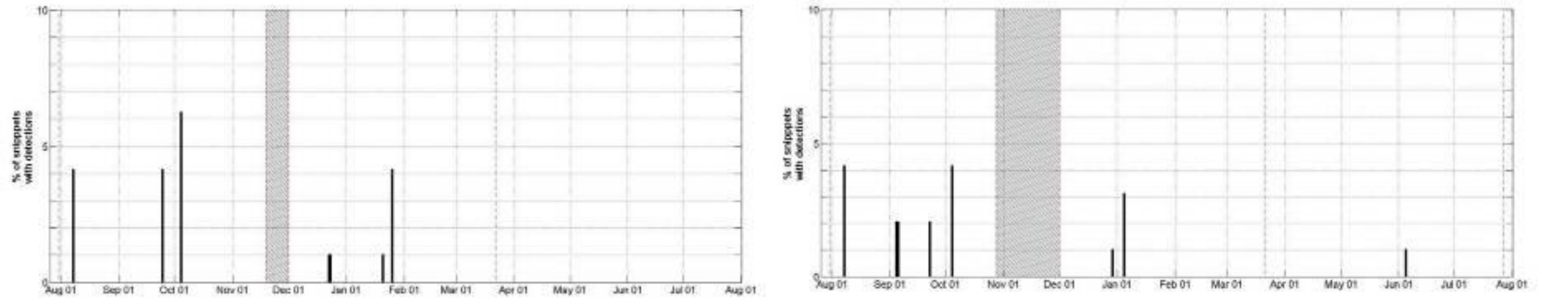


Figure 4: Daily proportion of Southern right whale call detections, AMAR 1 – left, AMAR 2 - right. Red dashed lines indicate deployment dates, shaded area indicated data gaps (Hipsey et al., 2013).

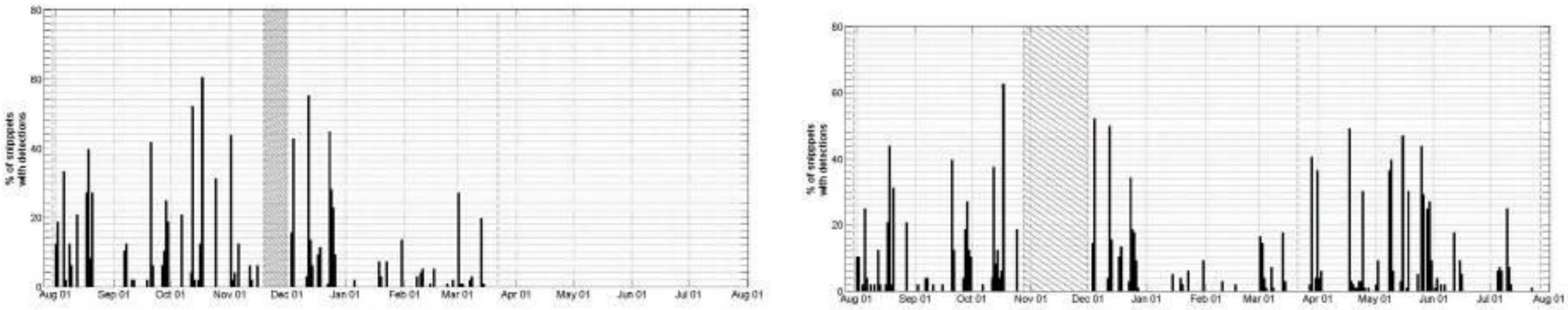


Figure 5: Daily proportion of sperm whale call detections, AMAR 1 – left, AMAR 2 - right. Red dashed lines indicate deployment dates, shaded area indicated data gaps (Hipsey et al., 2013).

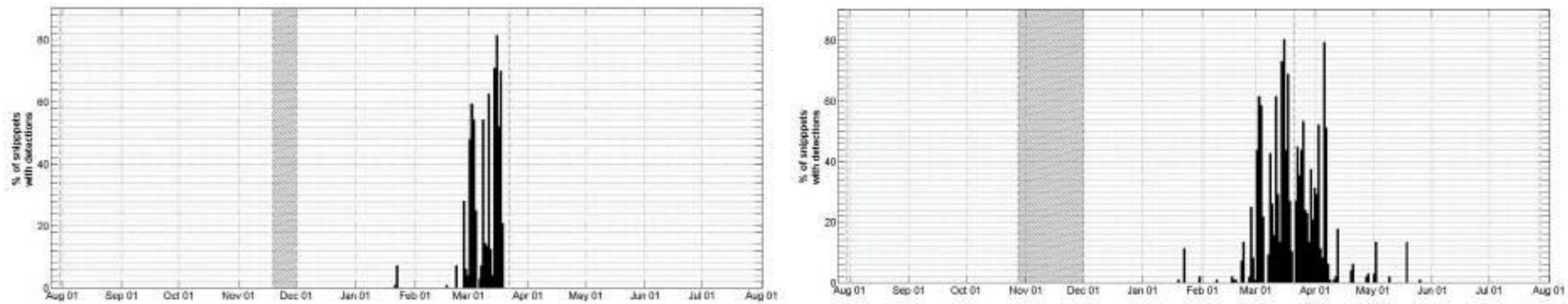


Figure 6: Daily proportion of leopard seal call detections, AMAR 1 – left, AMAR 2 - right. Red dashed lines indicate deployment dates, shaded area indicated data gaps (Hipsey et al., 2013).

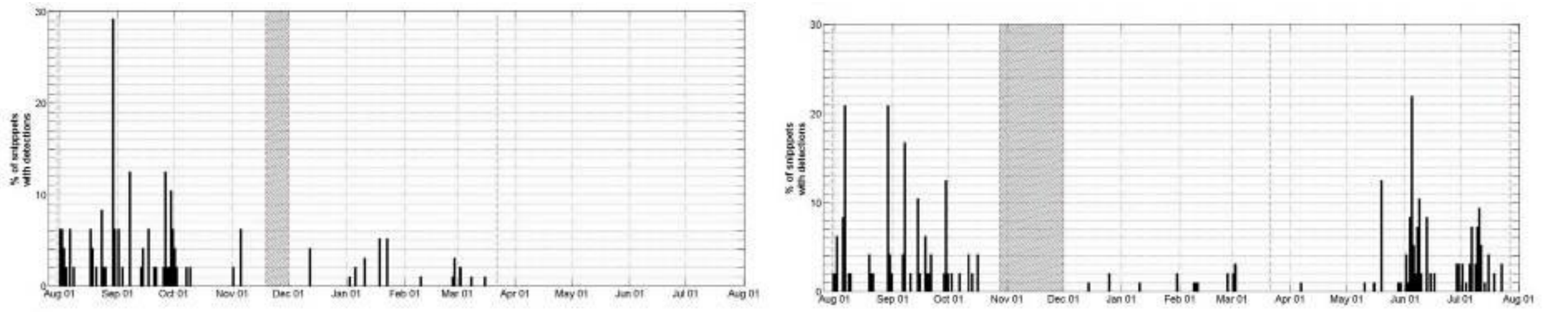


Figure 7: Daily proportion of unidentified odontocete call detections, AMAR 1 – left, AMAR 2 - right. Red dashed lines indicate deployment dates, shaded area indicated data gaps (Hipsey et al., 2013).

Table 1: Summary of the Number of Individuals and Sightings of Marine Mammals from the JNCC At-Sea Survey and the Number of Marine Mammals Strandings on the Falkland Islands, with their Conservation Status

Species Common Name	Scientific name	Number of animals	Number of sightings	Number of stranding	IUCN	CMS	CITES
Peale's dolphin	*Lagenorhynchus australis*	2617	864	-	DD	Appendix II	Appendix II
Fur seal species	*Arctocephalus spp.*	937	442	-	LC	Appendix II	Appendix II
Hourglass dolphin	*Lagenorhynchus cruciger*	886	177	-	LC	-	Appendix II
Long-finned pilot whale	*Globicephala melas*	872	27	-	DD	Appendix II	Appendix II
Commerson's dolphin	*Cephalorhynchus commersonii*	336	100	-	DD	Appendix II	Appendix II
Southern right whale dolphin	*Lissodelphis peronii*	231	5	-	LC	-	Appendix II
Dolphin species	*n/a*	184	57	-	-	-	-
South American sea lion	*Otaria flavescens*	81	77	-	LC	Appendix II	-
Minke whale	*Balaenoptera acutorostrata*	68	60	-	LC	Appendix II	-
Fin whale	*Balaenoptera physalus*	57	27	-	EN	Appendix I, II	-
Unidentified pinniped	*n/a*	56	46	-	-	-	-
Sei whale	*Balaenoptera borealis*	45	31	-	EN	Appendix I, II	Appendix I
Large whale species	*n/a*	44	40	-	-	-	-
Southern bottlenose whale	*Hyperoodon planifrons*	34	18	5	LC	-	Appendix I
Sperm whale	*Physeter macrocephalus*	28	21	-	VU	Appendix I, II	Appendix I
Killer whale	*Orcinus orca*	18	7	-	DD	Appendix II	Appendix II
Beaked whale species	*Mesoplodon species*	17	7	-	-	-	-
Southern elephant seal	*Mirounga leonina*	13	13	-	LC	-	Appendix II
Medium/small whale species	*n/a*	12	10	-	-	-	-
Humpback whale	*Megaptera novaeangliae*	7	5	-	LC	Appendix I	Appendix I
Southern right whale	*Eubalaena australis*	7	6	-	LC	Appendix I	Appendix I
Arnoux's beaked whale	*Berardius arnuxii*	-	-	4	DD	-	Appendix I
Andrews' beaked whale	*Mesoplodon bowdoini*	-	-	3	DD	-	Appendix II

Species Common Name	Scientific name	Number of animals	Number of sightings	Number of stranding	IUCN	CMS	CITES
Gray's beaked whale	*Mesoplodon grayi*	-	-	4	DD	-	Appendix II
Hector's beaked whale	*Mesoplodon hectori*	-	-	3	DD	-	Appendix II
Strap-toothed whale	*Mesoplodon layardii*	-	-	10	DD	-	Appendix II
Cuvier's beaked whale	*Ziphius cavirostris*	-	-	4	DD	-	Appendix II
Dusky dolphin	*Lagenorhynchus obscurus*	-	-	4	DD	Appendix II	Appendix II
Bottlenose dolphin	*Tursiops truncatus*	-	-	4	LC	Appendix II	Appendix II
Spectacled porpoise	*Phocoena dioptrica*	-	-	3	DD	Appendix II	Appendix II
Pygmy right whale	*Caperea marginata*	-	-	1	DD	Appendix II	Appendix I
False killer whale	*Pseudorca crassidens*			2	DD	-	Appendix II

Appendix D: Seabird Sightings at Sea – PL001 and NFB Survey 2011

Bird Species Common name	PL001: 11/01/11 - 02/05/11[1]			NFB: 25/11/10 - 05/05/11[2]			Falklands Breeding Population Size[3]	Global Population Size[4]	% Global Population Size[3]	CMS App II, ACAP Annex I [3]	IUCN Red List Category[3]	Population Trend[3]	IBA[3]
	Rank	No. of Birds	No. of group sightings	Rank	No. of Birds	No. of group sightings							
Black-browed albatross	1	3118	1790	1	5043	1733	535,000 pairs[5]	700,000 pairs	76%	YES	**NT**	Decreasing	A1 A4ii
Great shearwater	2	2106	1325	3	1004	336	15 pairs	5,000,000 pairs	<0.1%	-	LC	Stable	-
Soft-plumaged petrel	3	1257	1000	6	318	255	ND	5,000,000 individuals	-	-	LC	Stable	-
White-chinned petrel	4	1100	1011	2	1633	698	1,000 pairs	1,200,000 pairs	<0.1%	YES	**VU**	Decreasing	A1
Prion spp. (inc Blue petrel)	5	552	454	5	488	325	ND	3,000,000 individuals	-	-	LC	Stable	-
Giant petrel species	6	411	370	4	574	391	-	-	-	-	LC	Increasing	-
Sooty shearwater	7	338	144	11	17	15	10,000-20,000 pairs	20,000,000 pairs	0.10%	-	**NT**	Decreasing	A1 A4ii
Wilsons storm petrel	8	229	213	7	262	166	ND	4-10,000,000 pairs	-	-	LC	Stable	-
Atlantic petrel	9	173	161	23	2	2	ND	1,800,000 pairs	-	-	**EN**	Decreasing	-
Southern royal albatross	10	172	138	12	16	16	ND	7,900 pairs, 27,200 individuals	-	YES	**VU**	Stable	-
Cape petrel	11	170	105	20	4	3	ND	2,000,000 individuals	-	-	LC	Stable	-
Manx shearwater	12	158	9	NR	NR	NR	ND	1,000,000 individuals	-	-	LC	Decreasing	-
Southern giant petrel	13	132	127	NR	NR	NR	19,500 pairs	46,800 pairs	42%	YES	LC	Increasing	A1 A4ii
Northern giant petrel	14	125	111	NR	NR	NR	ND	11-14,000 pairs	-	-	LC	Increasing	-
Falkland Islands skua	15	78	62	NR	NR	NR	ND	ND	-	-	LC	Stable	-
Large albatross species	16	65	49	13	14	10	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Large skua	17	64	47	16	7	7	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Bird Species Common name	PL001: 11/01/11 - 02/05/11[1]			NFB: 25/11/10 - 05/05/11[2]			Falklands Breeding Population Size[3]	Global Population Size[4]	% Global Population Size[3]	CMS App II, ACAP Annex I [3]	IUCN Red List Category[3]	Population Trend[3]	IBA[3]
	Rank	No. of Birds	No. of group sightings	Rank	No. of Birds	No. of group sightings							
Wandering albatross	18	59	58	10	20	14	ND	6,100 pairs	-	YES	**VU**	Decreasing	-
Southern fulmar	19	52	42	9	22	17	ND	4,000,000 individuals	-	-	LC	Stable	-
Grey-backed storm petrel	20	44	40	NR	NR	NR	ND	200,000 individuals	-	-	LC	Decreasing	-
Magellanic penguin	21	42	22	8	70	28	100,000 pairs	1,300,000 pairs	8%	-	**NT**	Decreasing	A1
Tern species	22	25	1	22	2	2	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Northern royal albatross	23	14	14	NR	NR	NR	ND	17,000 individuals	-	ACAP Annex I	**EN**	Decreasing	-
Grey-headed albatross	24	13	13	NR	NR	NR	ND	250,000 individuals	-	YES	**EN**	Decreasing	-
Arctic skua	25	9	8	NR	NR	NR	ND	500,000-10,000,000 individuals	-	-	LC	Stable	-
Rock shag	26	9	7	17	6	6	ND	ND	-	-	LC	Unknown	-
Storm petrel species	27	9	9	14	14	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Diving petrel	28	6	6	18	5	5	ND	16,000,000 individuals	-	-	LC	Decreasing	
Royal albatross species	29	6	6	NR	NR	NR	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Fairy prion	30	4	4	NR	NR	NR	+1,000 pairs	5,000,000	<0.01%	-	LC	Stable	-
Little shearwater	31	4	3	27	1	1	ND	900,000 individuals	-	-	LC	Decreasing	-
White-bellied storm petrel	32	3	3	NR	NR	NR	ND	300,000 individuals	-	-	LC	Decreasing	-
Gentoo penguin	33	2	2	24	2	2	65,857 pairs	387,000 pairs	17%	-	**NT**	Decreasing	A1, A4ii
Grey petrel	34	2	2	NR	NR	NR	ND	80,000 pairs	-	YES	**NT**	Decreasing	-
Rockhopper penguin	35	2	2	15	11	6	210,418 pairs	1,230,000 pairs	17%	-	**VU**	Decreasing	A1 A4ii
Terrestrial species	36	2	2	NR	NR	NR	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Long-tailed skua	37	1	1	NR	NR	NR	ND	150,000-5,000,000 individuals	-	-	LC	Stable	-

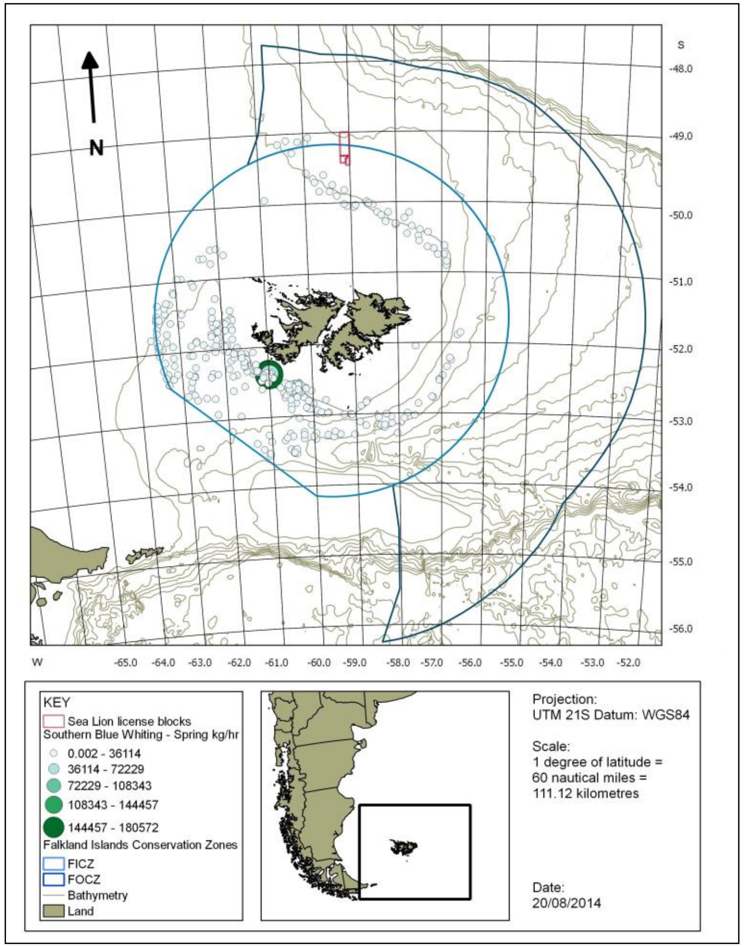
Bird Species Common name	PL001: 11/01/11 - 02/05/11[1]			NFB: 25/11/10 - 05/05/11[2]			Falklands Breeding Population Size[3]	Global Population Size[4]	% Global Population Size[3]	CMS App II, ACAP Annex I [3]	IUCN Red List Category[3]	Population Trend[3]	IBA[3]
	Rank	No. of Birds	No. of group sightings	Rank	No. of Birds	No. of group sightings							
South American tern	38	1	1	NR	NR	NR	6,000-12,000 pairs	ND	-	-	LC	Decreasing	-
Black-bellied storm-petrel	NR	NR	NR	21	3	2	ND	500,000 individuals	-	-	LC	Decreasing	-
Cattle egret	NR	NR	NR	30	1	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Diomedea albatross sp.	NR	NR	NR	25	1	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Peregrine falcon	NR	NR	NR	29	1	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Shy albatross	NR	NR	NR	26	1	1	ND	15,350 pairs	-	YES	NT	Unknown	-
Snowy sheathbill	NR	NR	NR	28	1	1							
Unidentified penguin	NR	NR	NR	19	5	5	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Falkland Islands IBA Location
Black-browed Albatross - FK001, FK003, FK019, FK007, FK008, FK011, FK014, FK017
White-chinned Petrel - FK009, FK011
Sooty Shearwater - FK003, FK009, FK013, FK015, FK020, FK016
Southern Giant Petrel - FK002, FK004, FK005, FK007, FK010, FK012, FK013, FK015, FK016
Magellanic Penguin - FK002, FK022, FK004, FK018, FK005, FK019, FK007, FK008,
Gentoo Penguin - FK001, FK002, FK022, FK004, FK018, FK019, FK007, FK008, FK010, FK011, FK012, FK013, FK014, FK015, FK020, FK016, FK021, FK017
Rockhopper Penguin - FK001, FK003, FK004, FK019, FK006, FK007, FK008, FK009, FK011, FK012, FK013, FK014, FK015, FK020, FK017

[1] Geomotvie and MRAG 2011.
[2] Polarcus 2011.
[3] Birdlife 2013.
[4] Breeding pairs or mature individuals
[5] Recorded in 2010 (Wolfaardt 2012).

Appendix E: Fish Distribution Maps

The following maps show the catch per unit effort (kg/hr) for some of the most abundant species within Falklands waters. Figures are derived from Falkland Islands Government Fisheries Department research cruises and commercial vessels with scientific observers on board. The centre of each symbol represents the trawl location. Note that the scale is not consistent between maps.



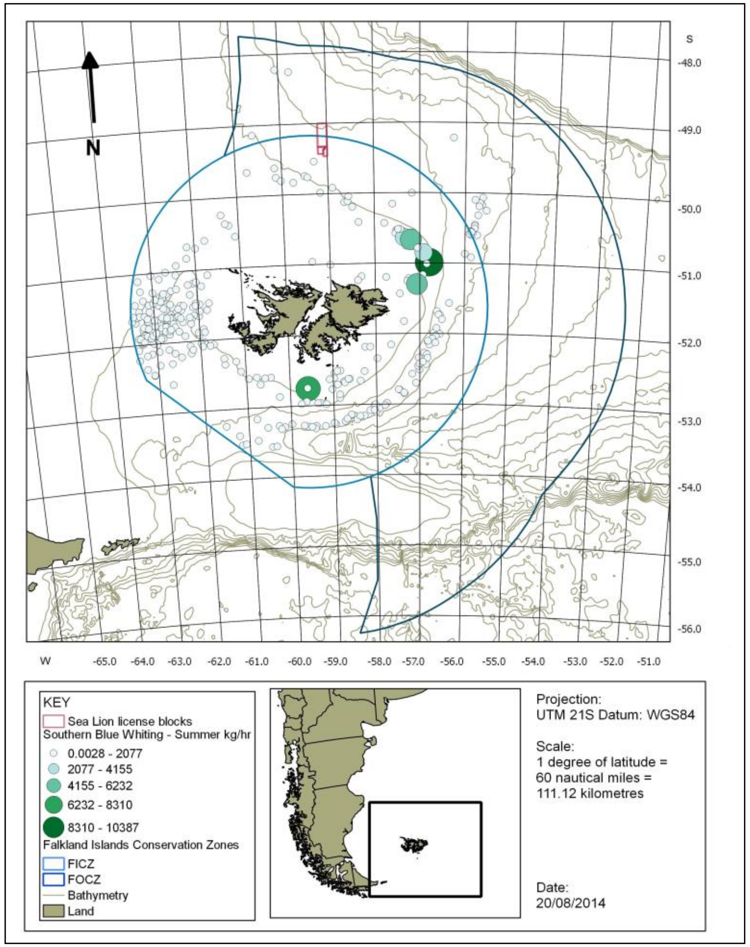


Figure 1 and 2: Distribution of Southern Blue Whiting (*Micromesistius australis*) during the Spring and Summer Months.

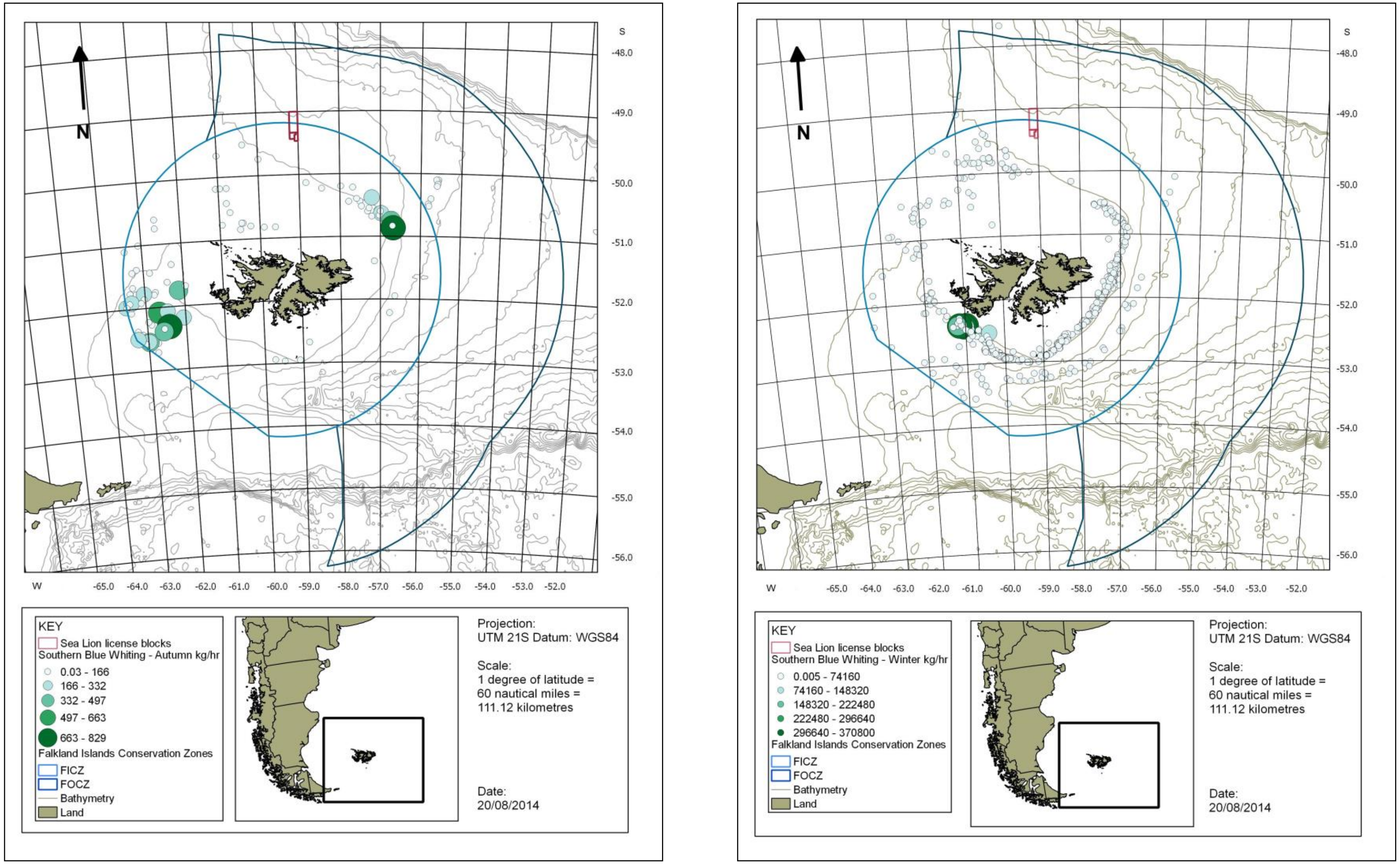
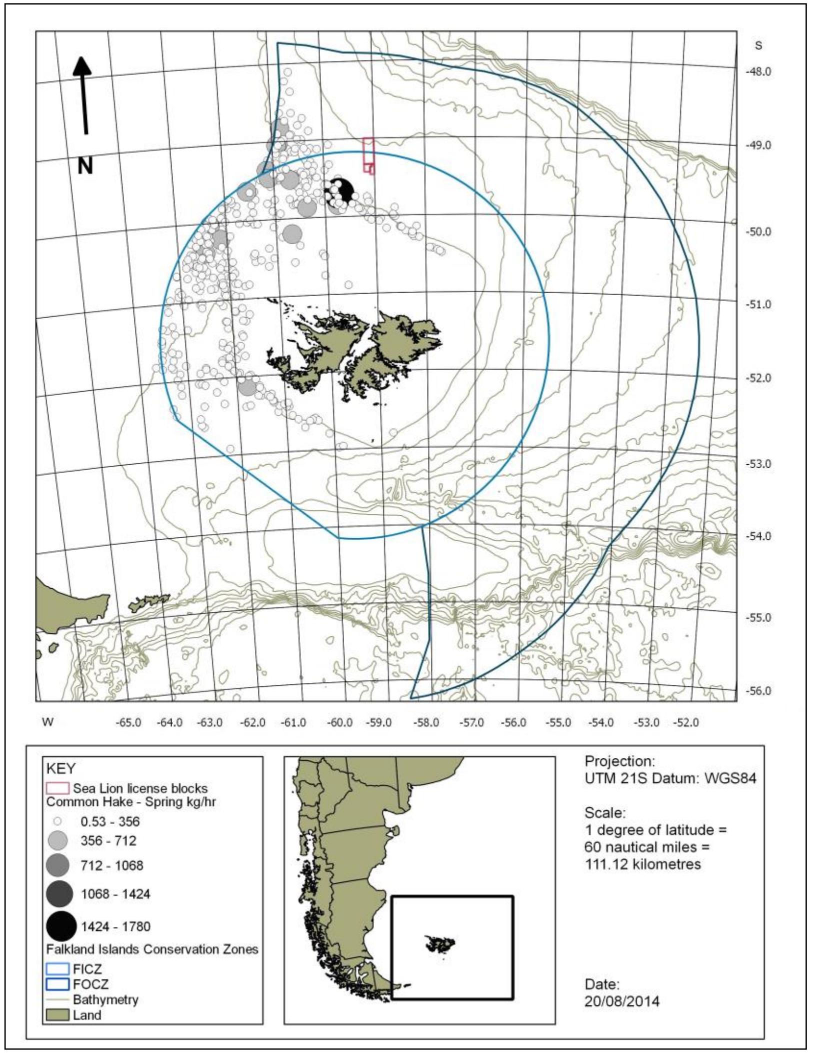


Figure 3 and 4: Distribution of Southern Blue Whiting (*Micromesistius australis*) during the Autumn and Winter Months.



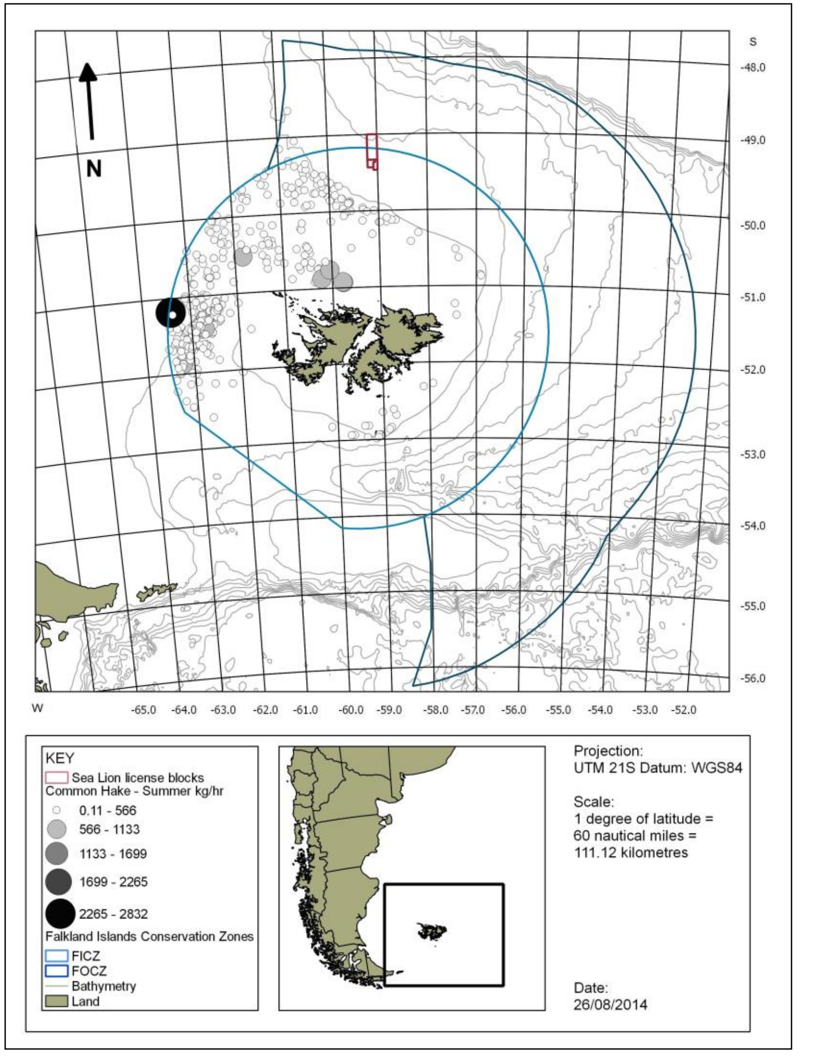
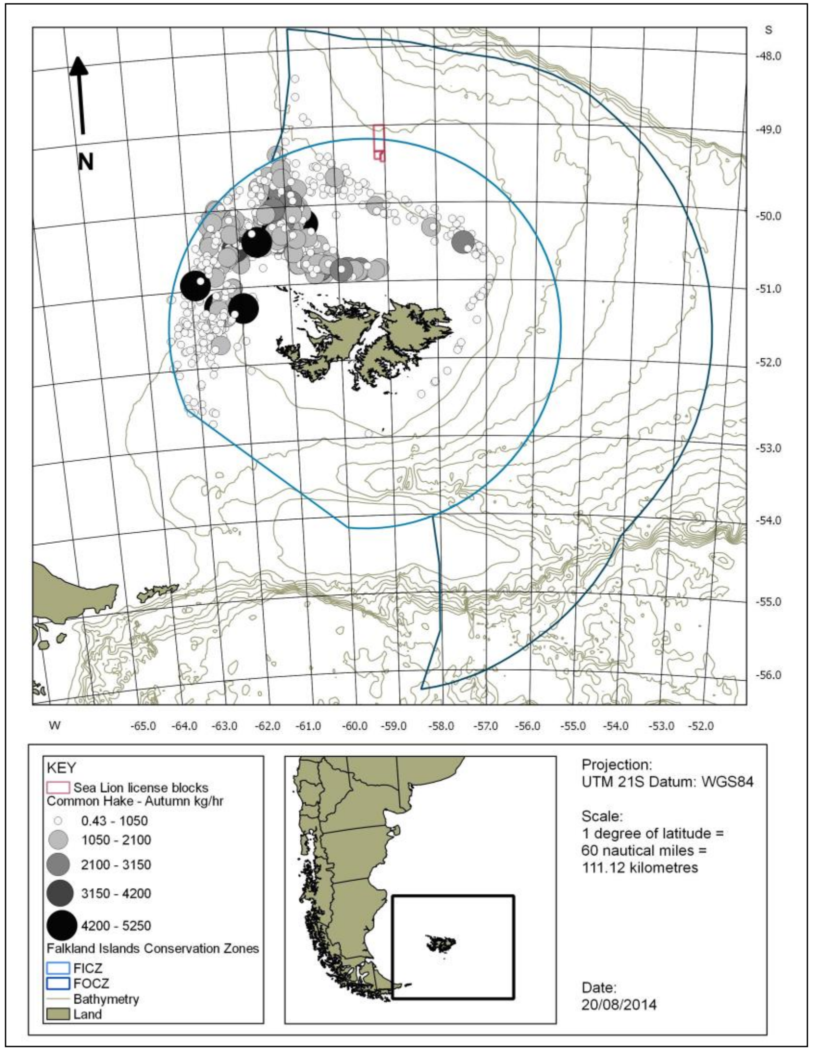


Figure 5 and 6: Distribution of Common Hake (*Merluccius hubbsi*) during the Spring and Summer Months.



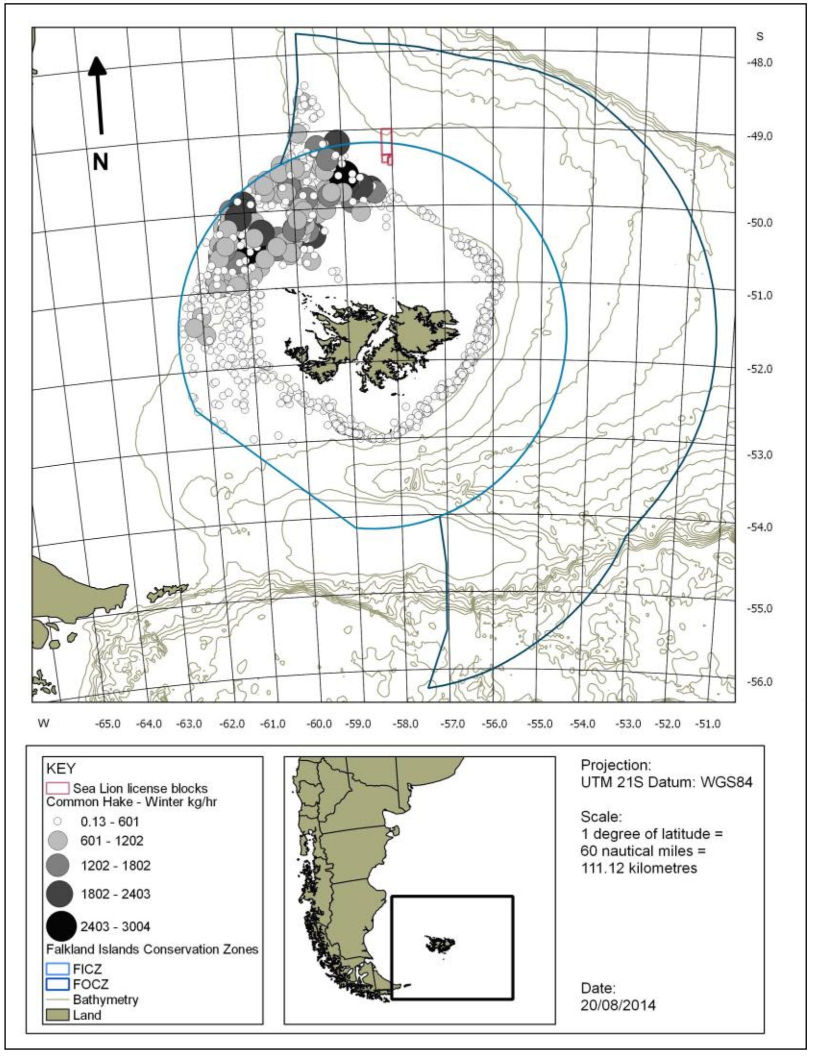
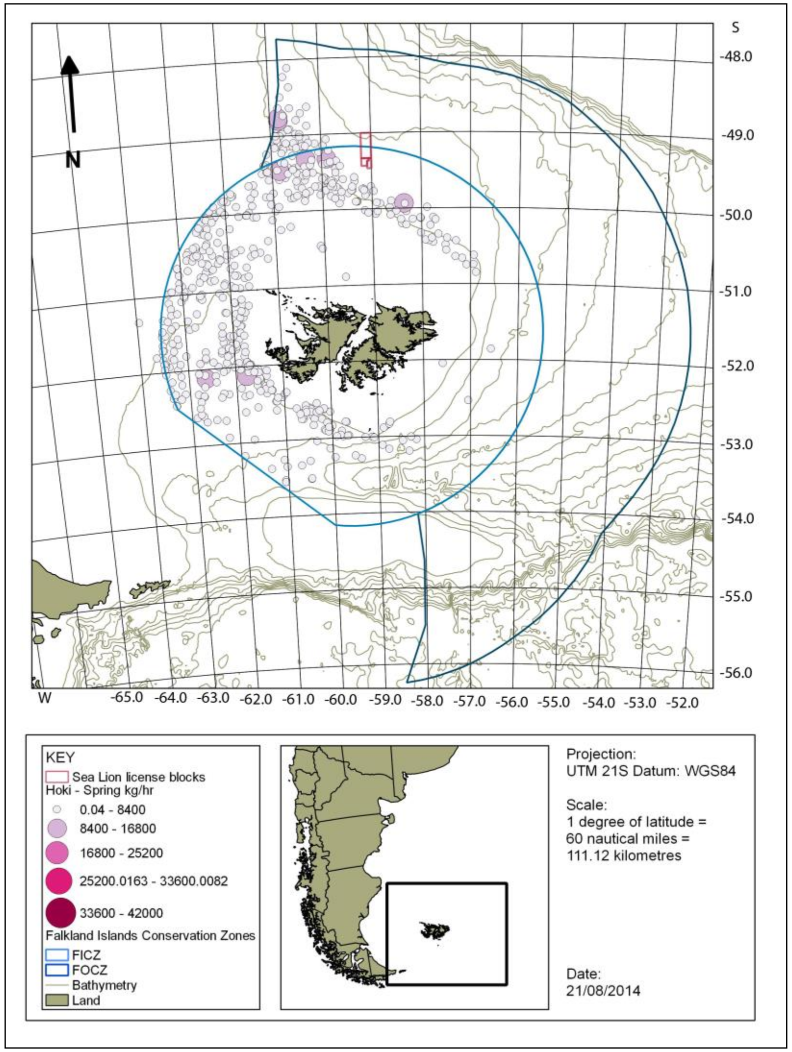


Figure 7 and 8: Distribution of Common Hake (*Merluccius hubbsi*) during the Autumn and Winter Months.



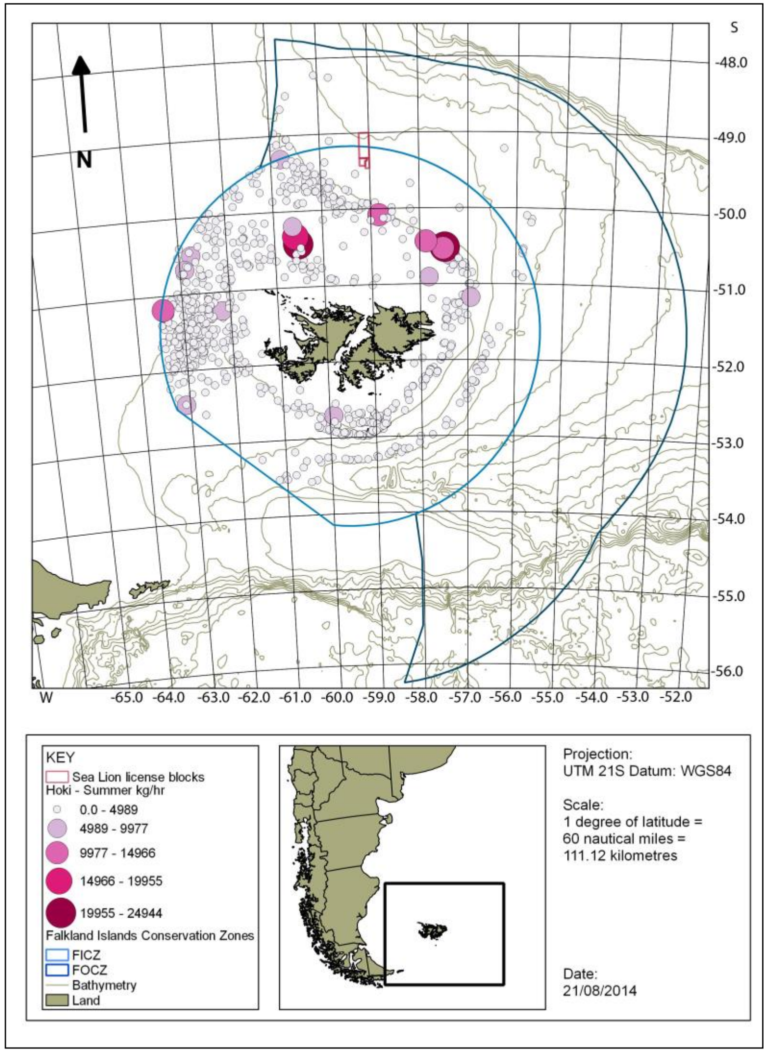
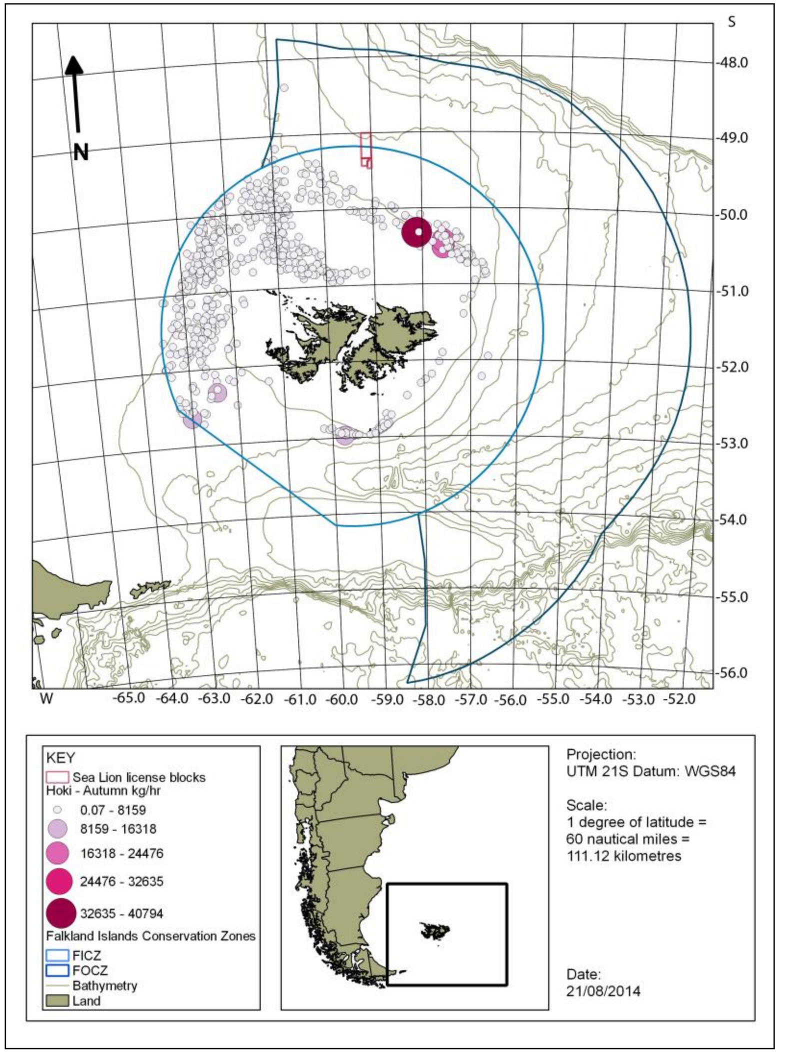


Figure 9 and 10: Distribution of Hoki (*Macruronus magellanicus*) during the Spring and Summer Months.



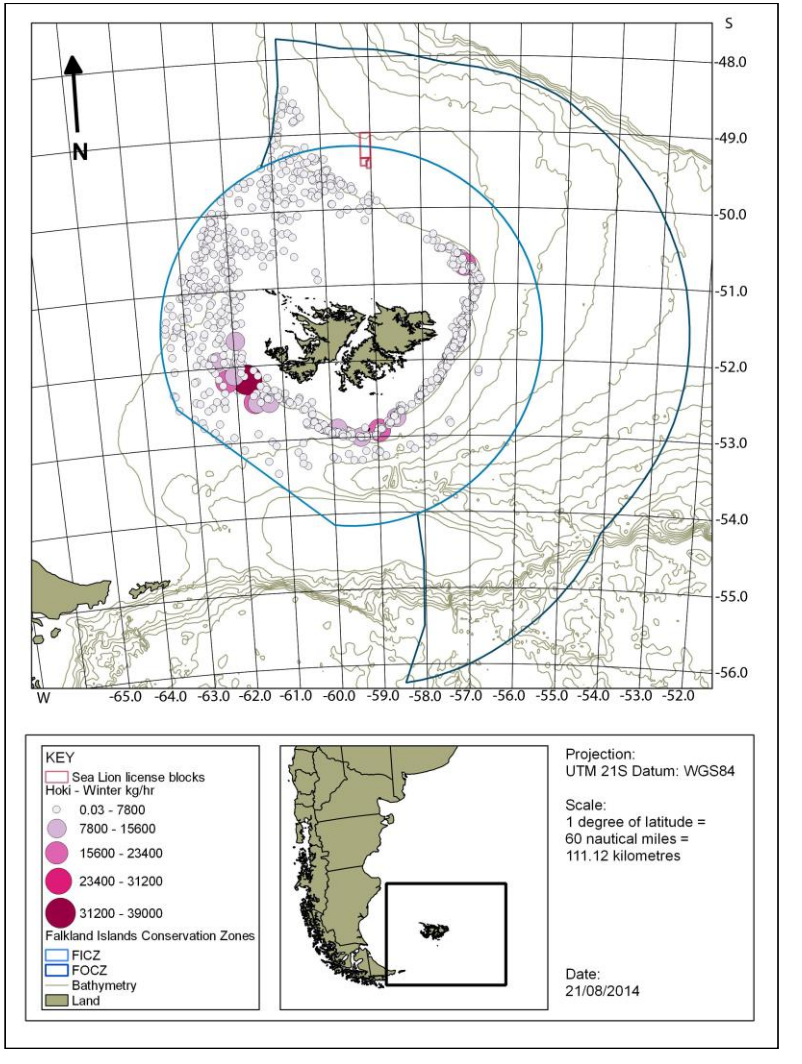
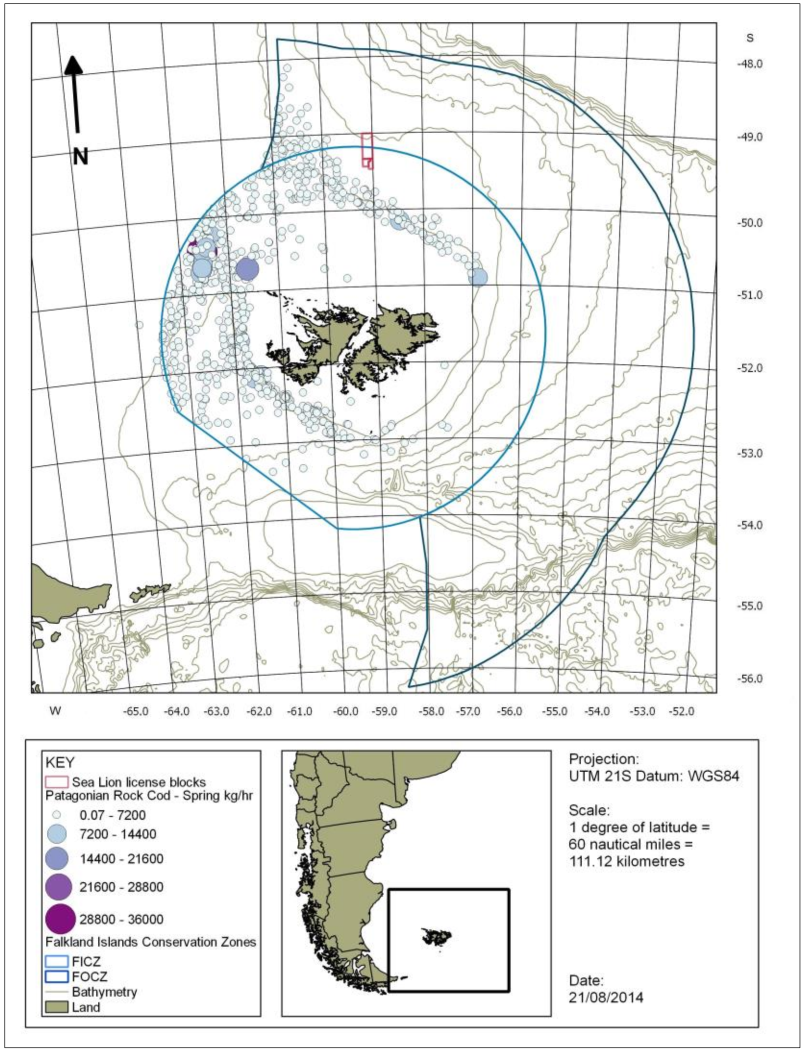


Figure 11 and 12: Distribution of Hoki (*Macruronus magellanicus*) during the Autumn and Winter Months.



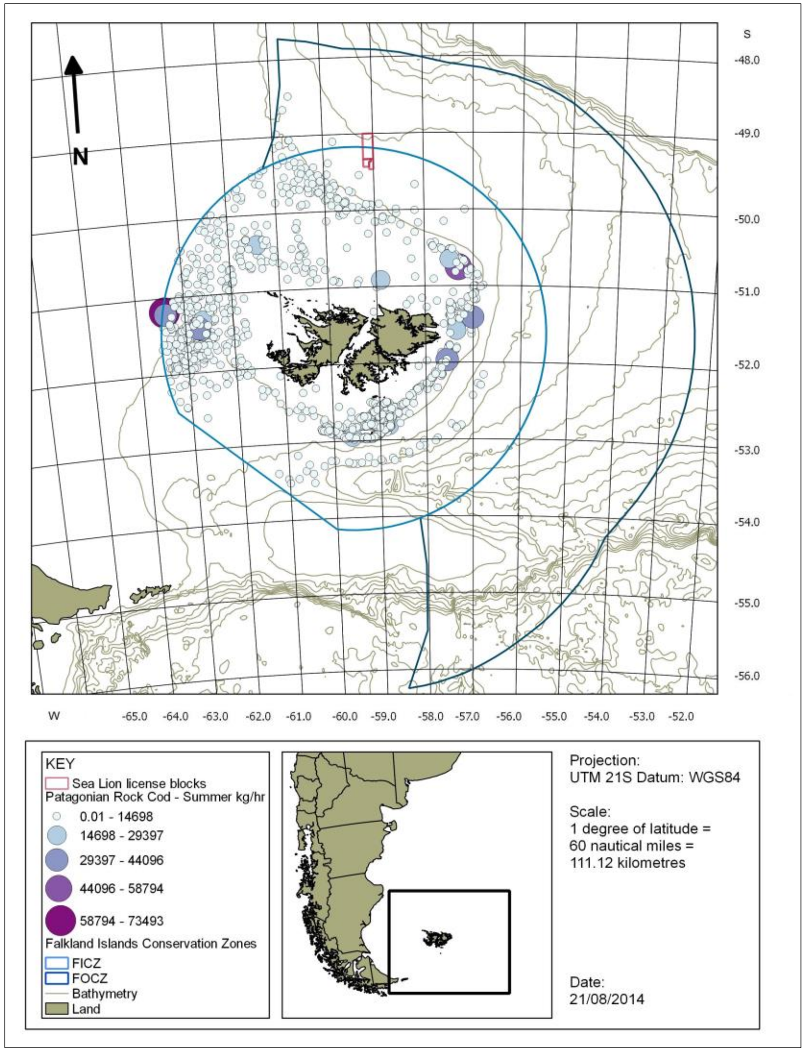
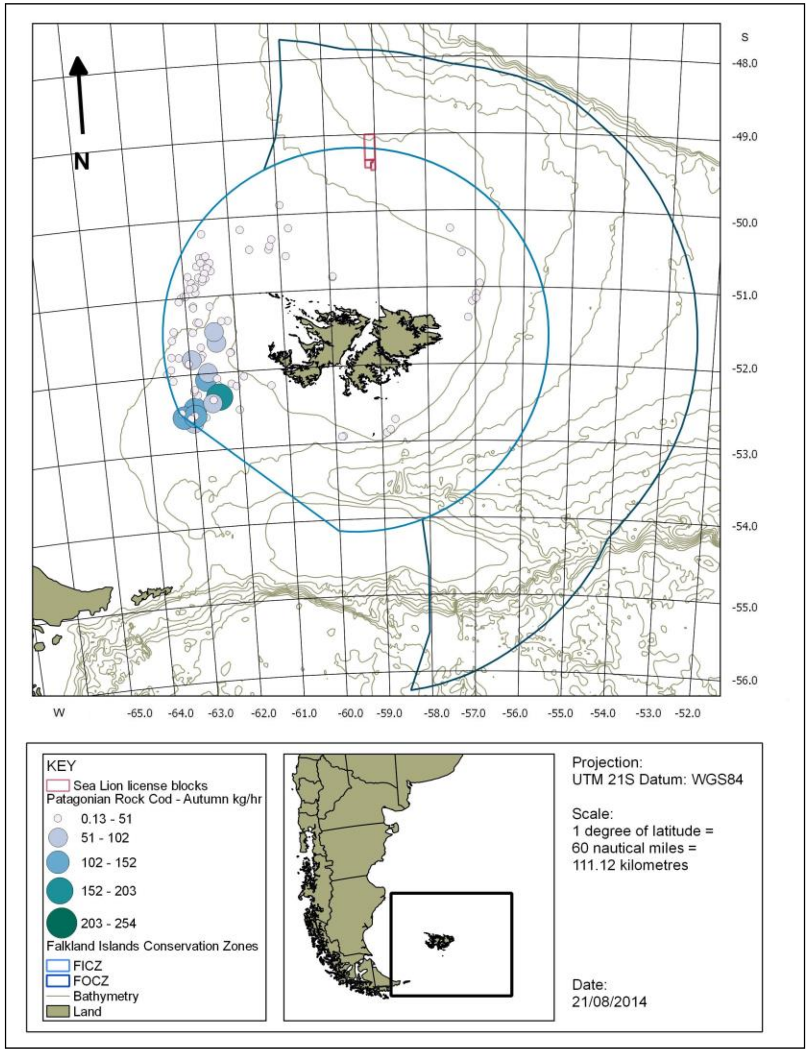


Figure 13 and 14: Distribution of Patagonian Rock Cod (*Patagonotothen ramsayi*) during the Spring and Summer Months



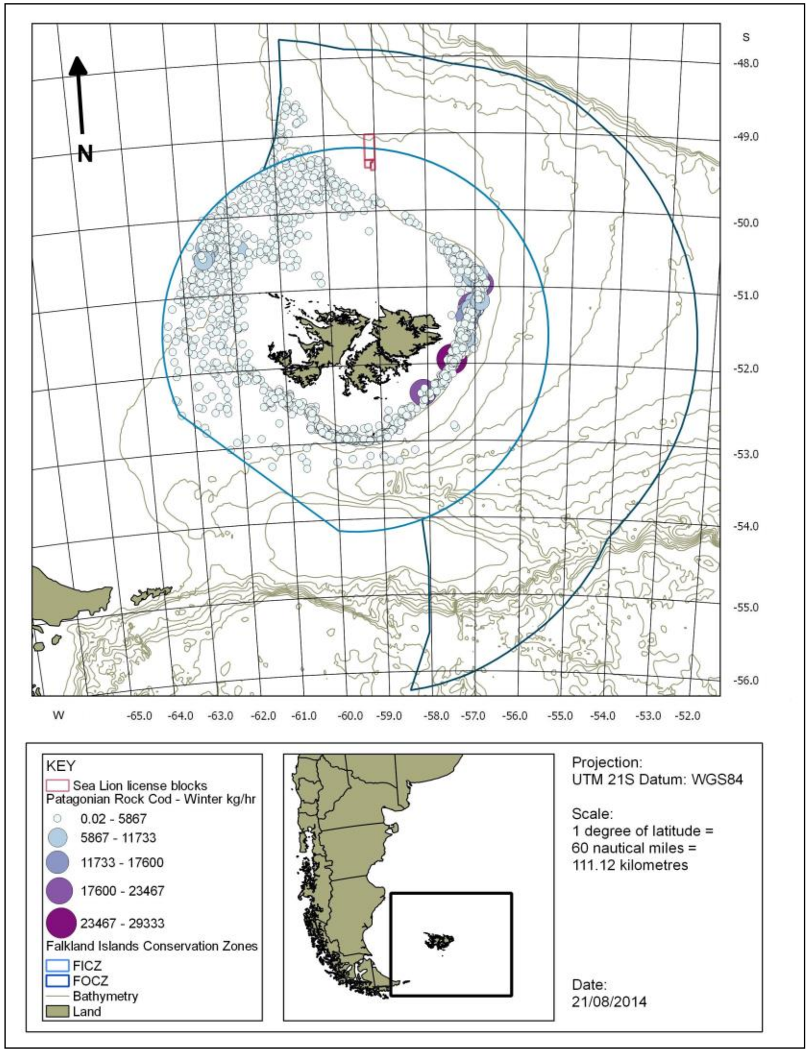
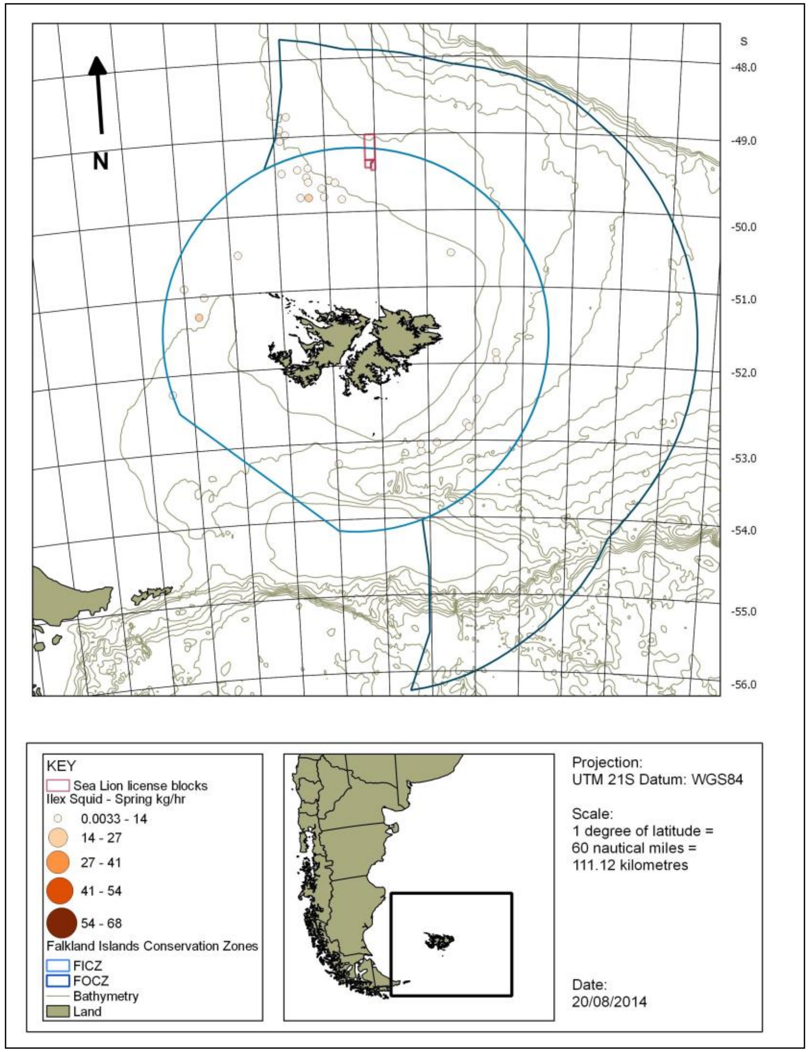


Figure 15 and 16: Distribution of Patagonian Rock Cod (*Patagonotothen ramsayi*) during the Autumn and Winter Months



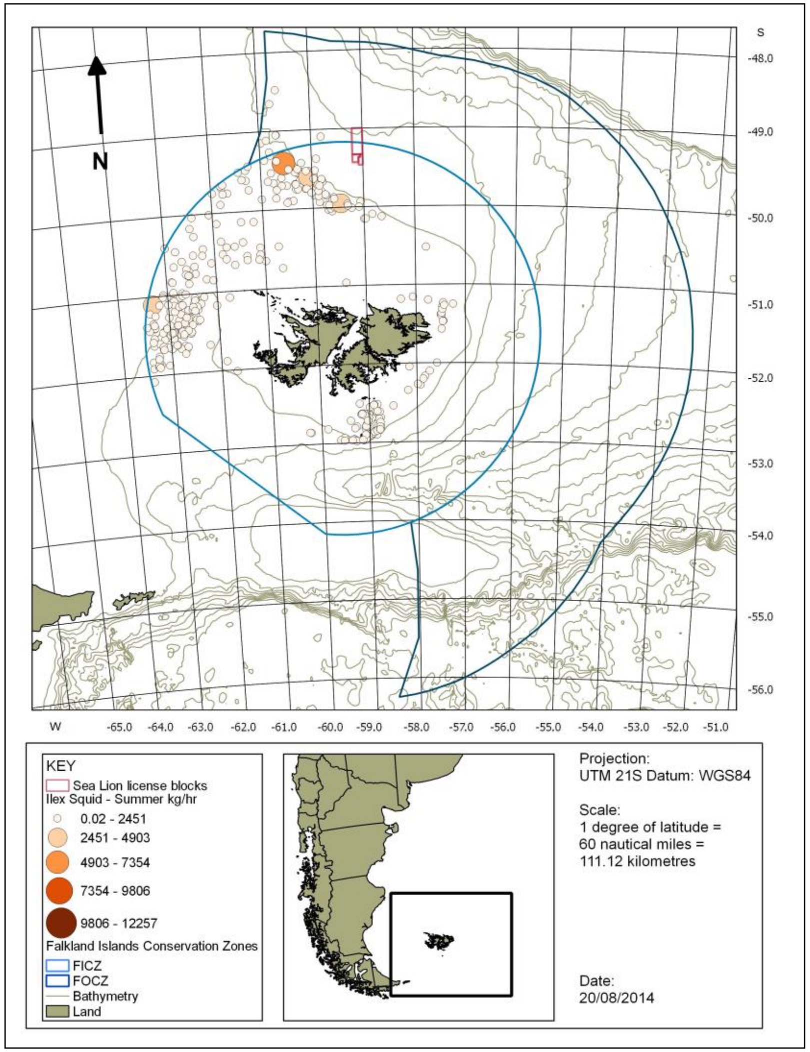
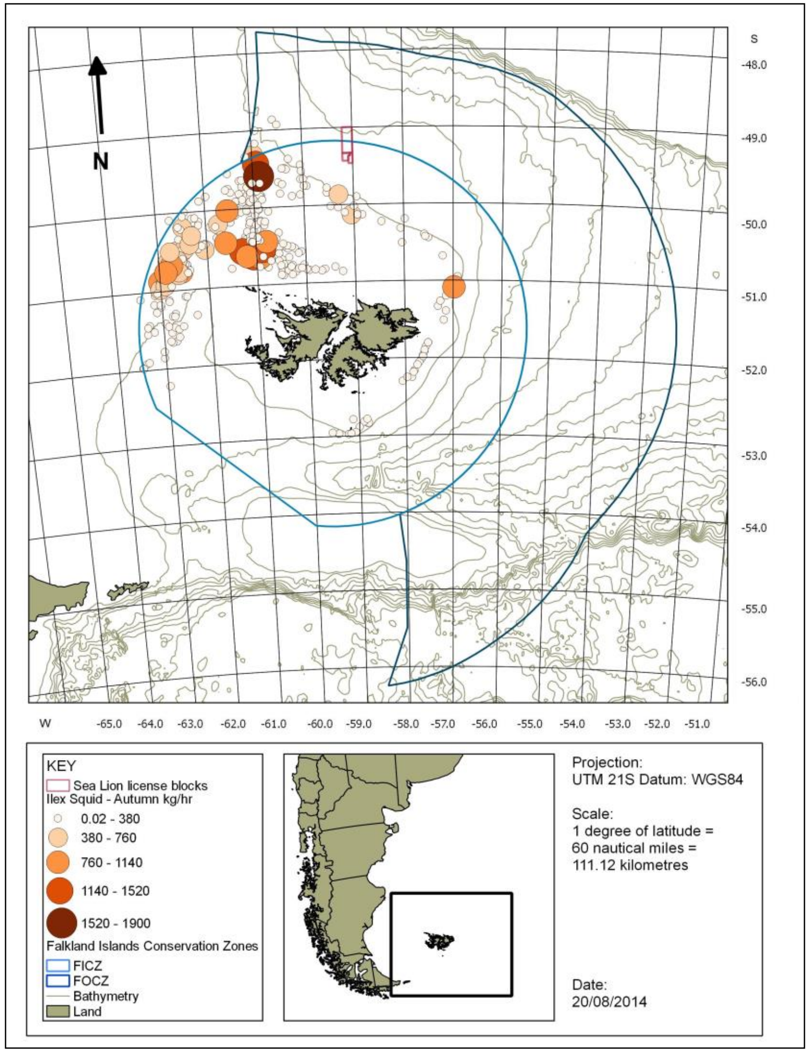


Figure 17 and 18: Distribution of Argentine shortfin squid (*Illex argentinus*) during the Spring and Summer Months



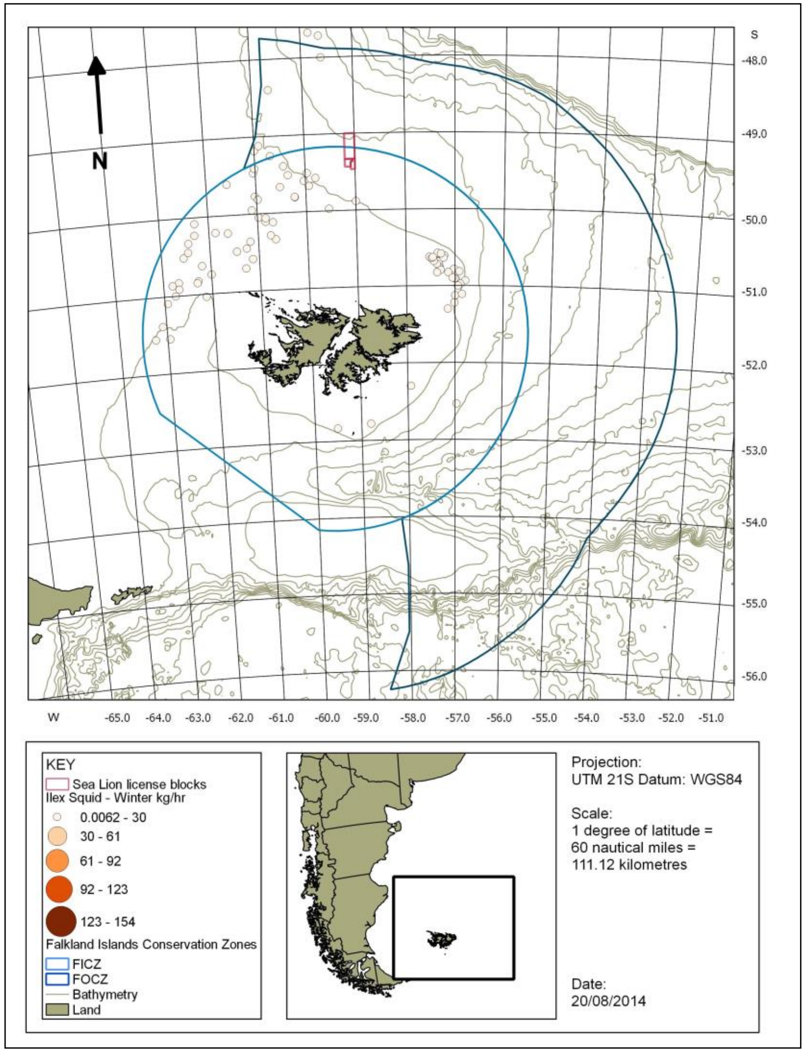
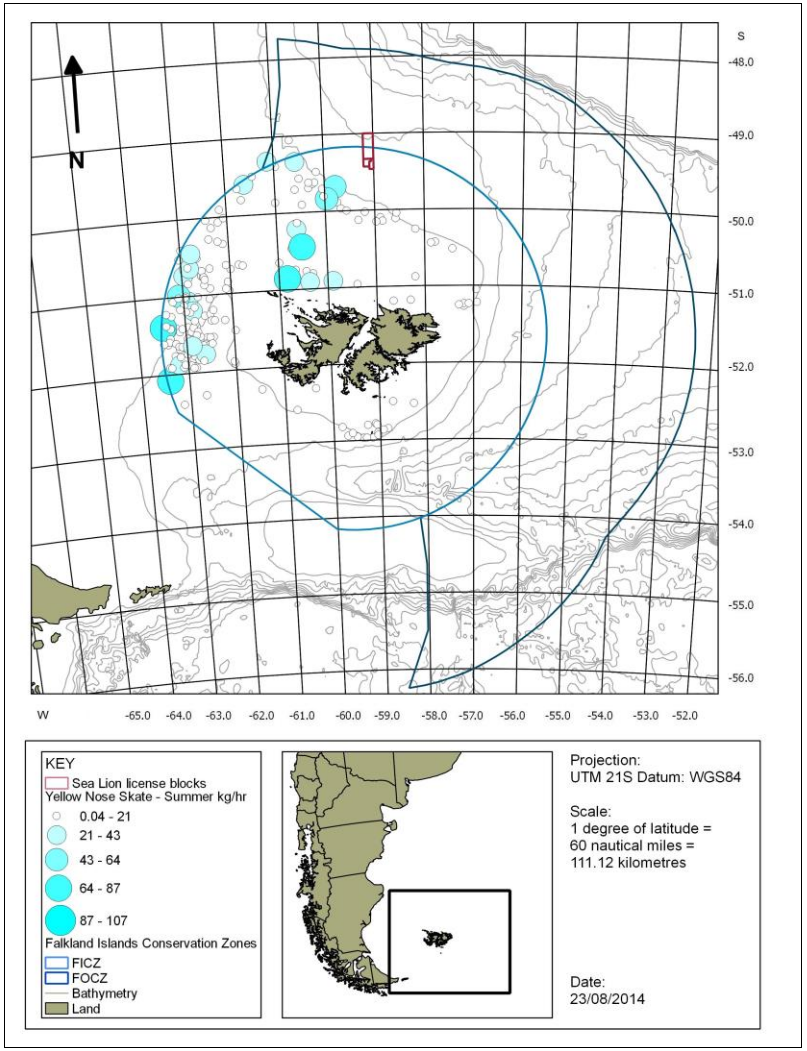


Figure 19 and 20: Distribution of Argentine shortfin squid (*Illex argentinus*) during the Autumn and Winter Months



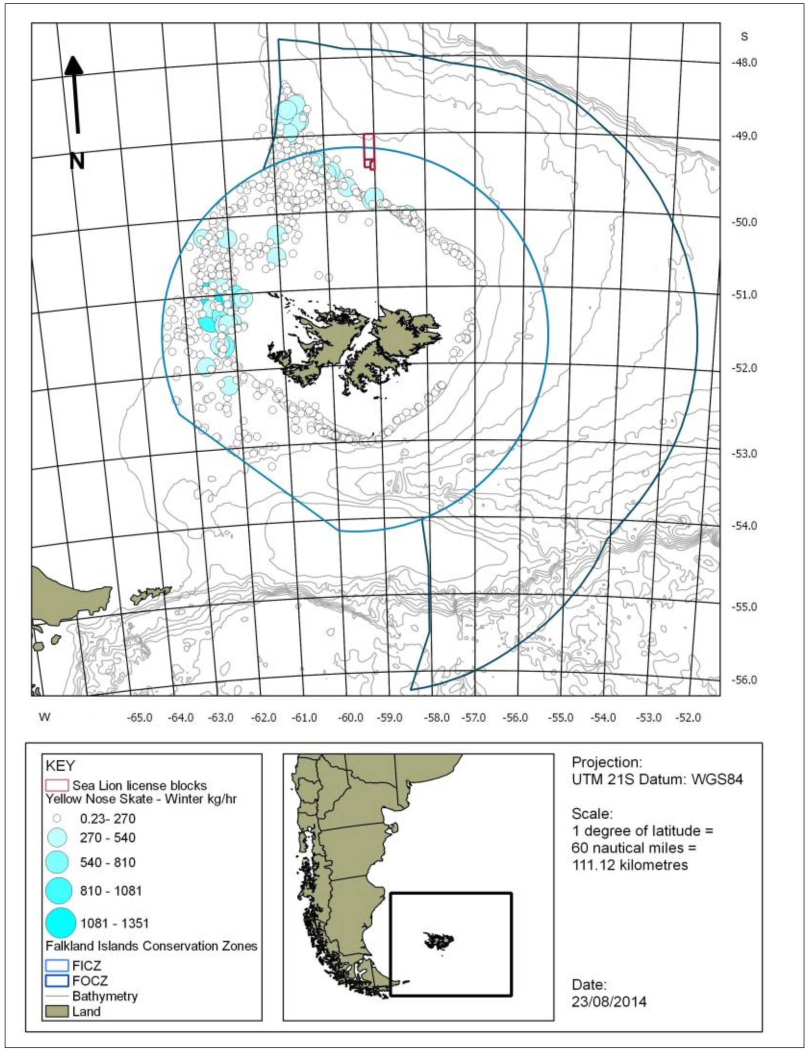
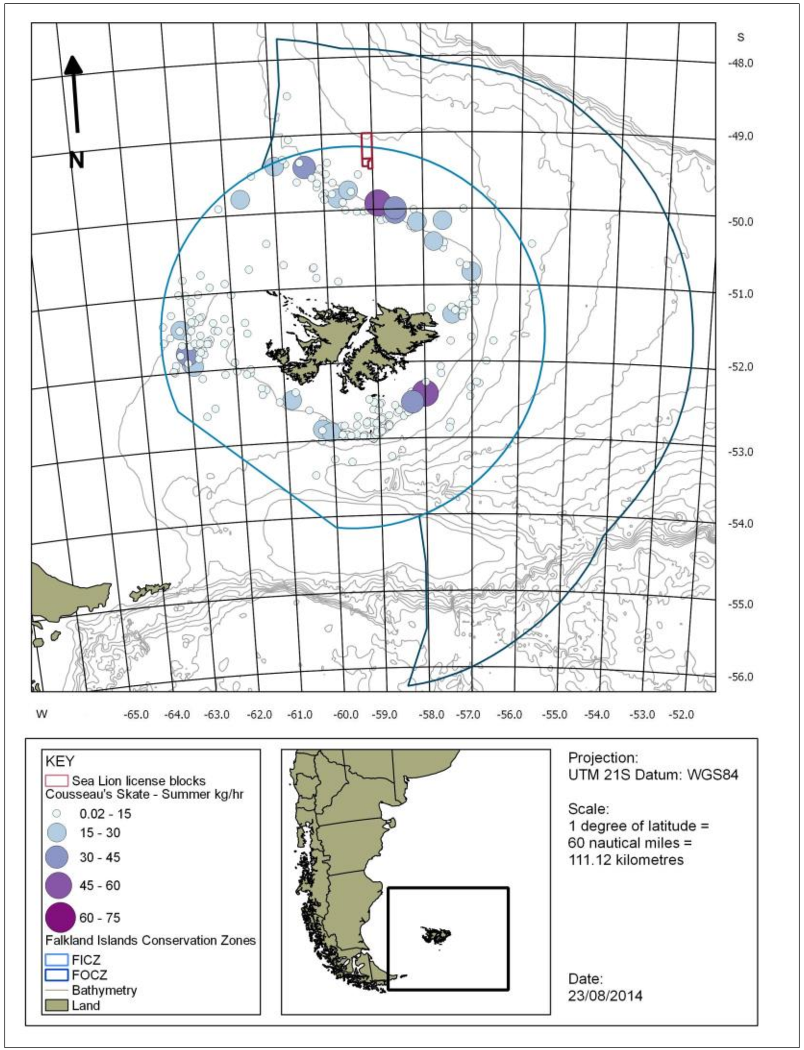


Figure 21 and 22: Distribution of Yellownose Skate (*Zearaja* chilensis) during the Summer and Winter Months



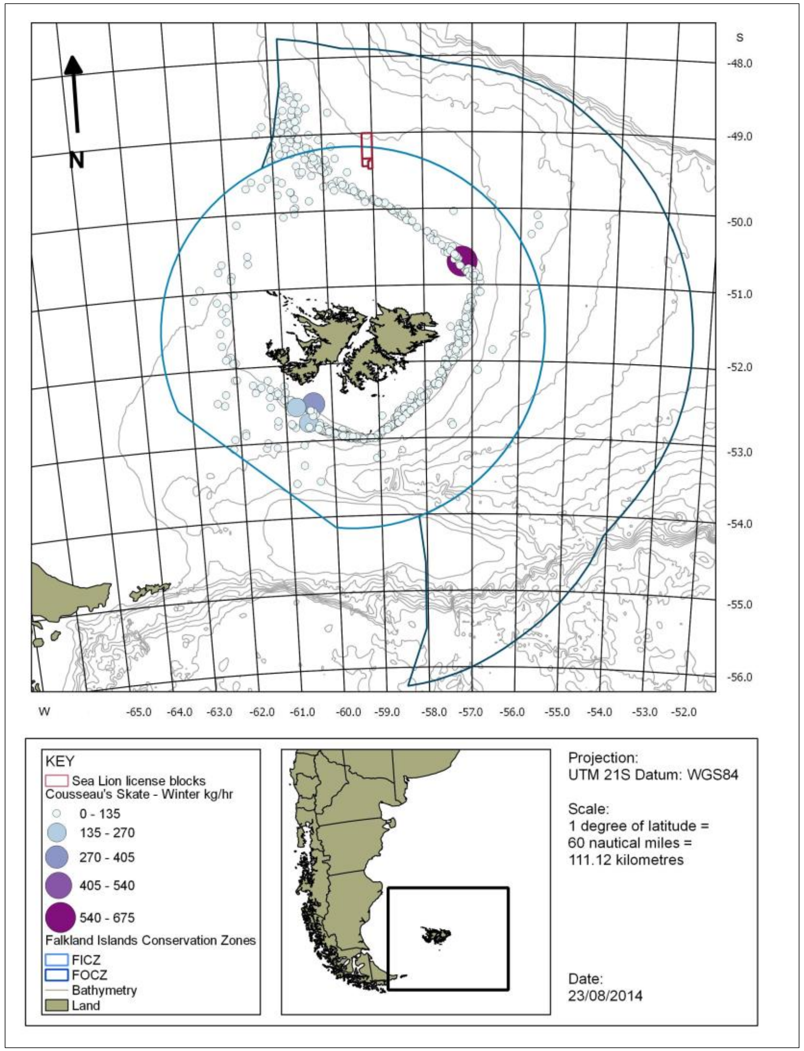


Figure 23 and 24: Distribution of Cousseau's Skate (*Bathyraja cousseauae*) during the Summer and Winter Months

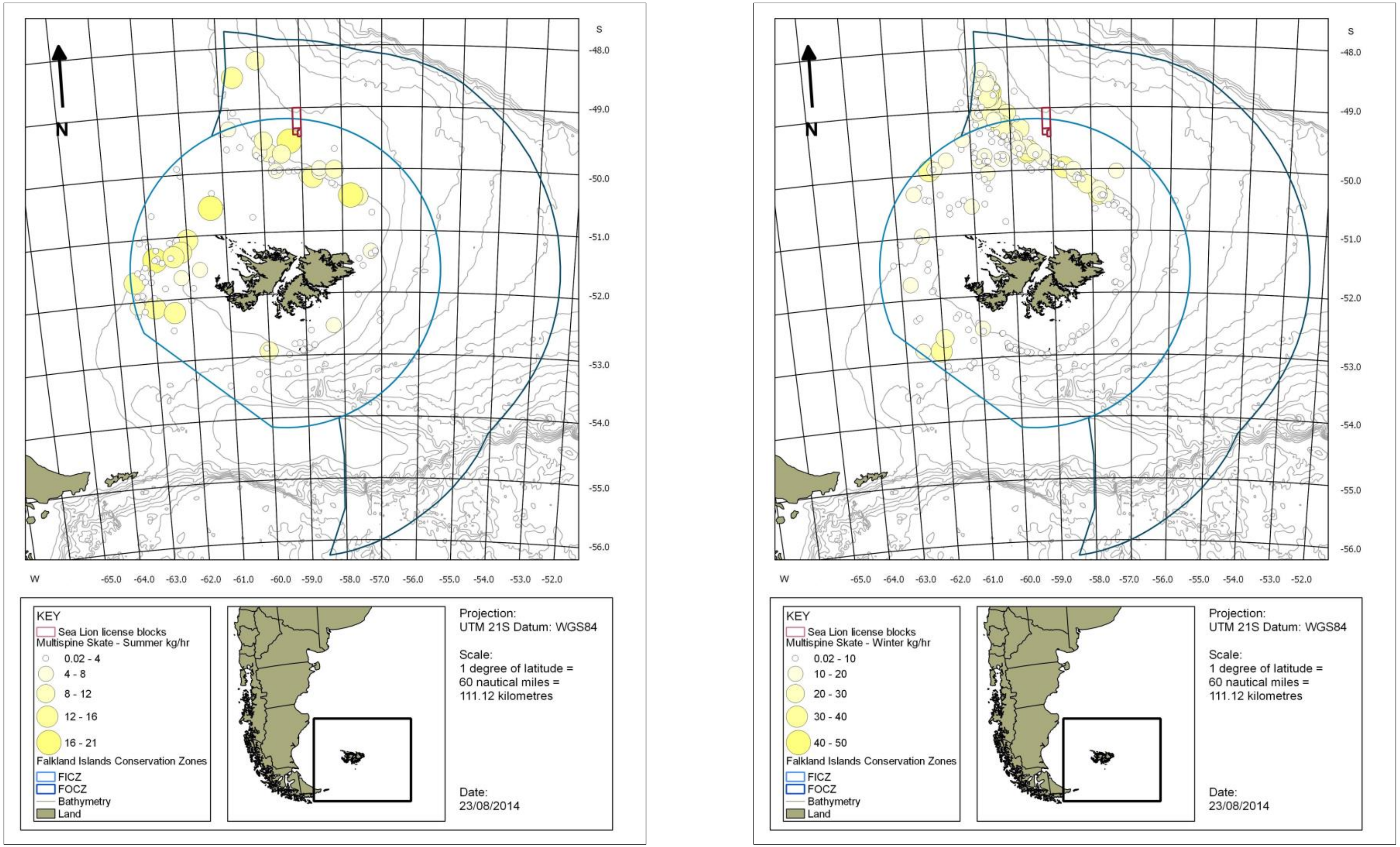
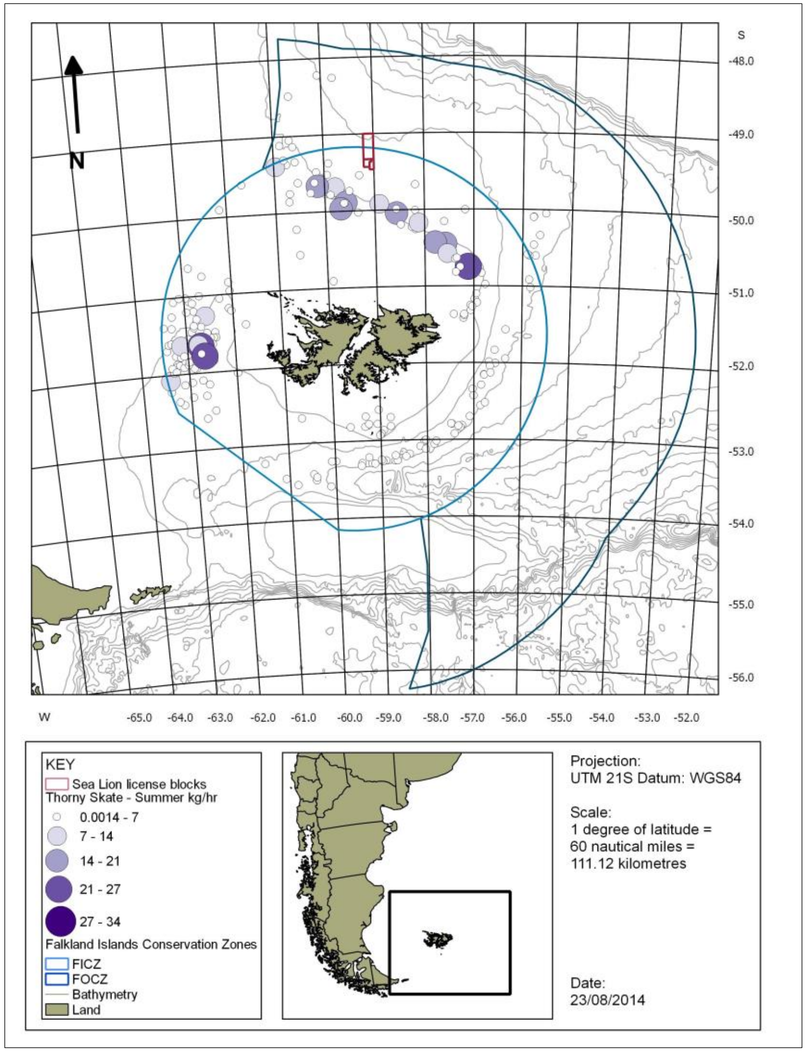


Figure 25 and 26: Distribution of Multispine Skate (*Bathyraja multispinis*) during the Summer and Winter Months



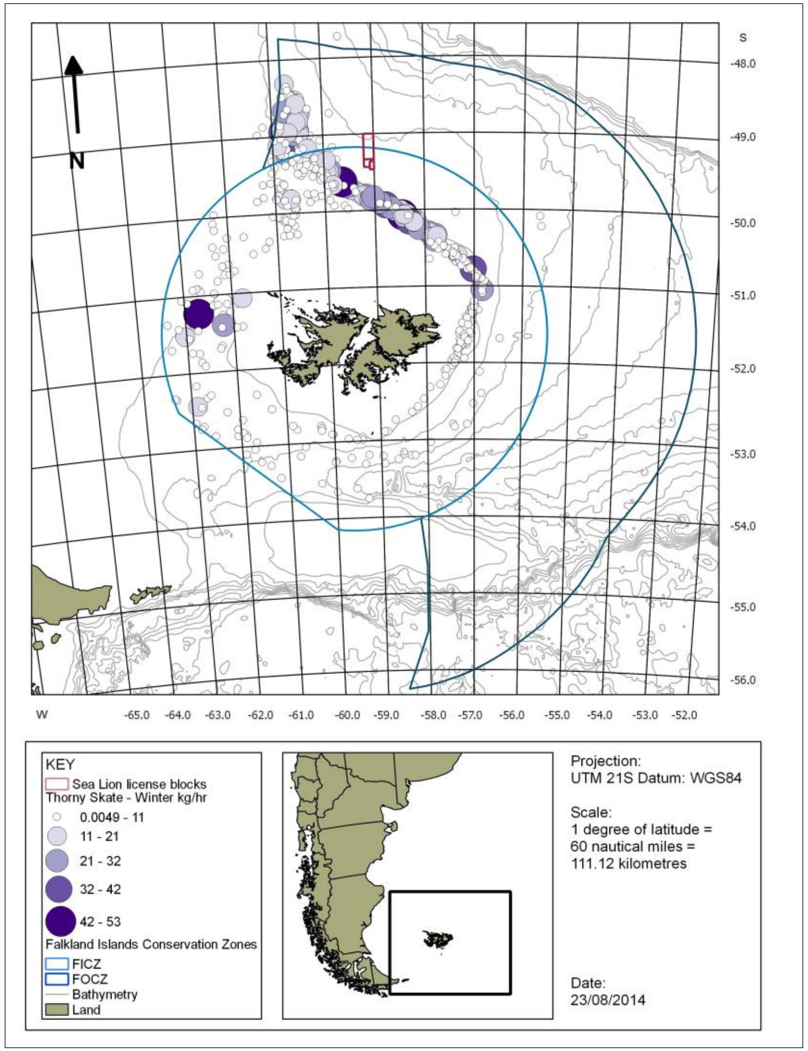


Figure 27 and 28: Distribution of Southern Thorny Skate (*Amblyraja doellojuradoi*) during the Summer and Winter Months

Appendix F: Environmental Impact Assessment Summary Table

Operation	Aspect	Activity Description	Potential Effects and Significance	Legislation/PMO policy/Mitigation/ Monitoring	Residual Significance
All operations	Greenhouse gas emissions	Generation of atmospheric emissions from vessel movements, drilling, potential flaring	Combustion of fuel contributing to greenhouse gases (direct CO_2, CH_4, N_2O, indirect NOx, SO_2, CO, VOCs); local air quality (via photochemical pollution formation (NO_X, SO_2, VOCs)); and ocean acidification (CO_2). Total greenhouse gases generated from the campaign would more than double the annual emissions from the Falkland Islands and therefore represents a significant increase in emissions. Falkland Islands emissions are incorporated under the United Kingdom's emissions inventory for reporting under the Kyoto Agreement, the impact on UK emissions must also be considered. In this context emissions from the campaign amoun to ~0.02% of total UK emissions and campaign flaring emissions would be ~0.7% of UK flaring. The offshore conditions in the North Falkland Basin would rapidly dissipate any effects on air quality, which would be temporary and localised. CO^2 generated during the campaign would have a negligible effect on the oceans pH.	All vessels used during the campign will comply with MARPOL and the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008, which controls the levels of pollutants entering the atmosphere. Vessel will be audited. Well schedules will be optimised to minimise time drilling.	Low

Planned activity	Severity	Sensitivity	Significance
	Slight	Very Low	LOW

<table>
<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">Rig and Vessel operations</td><td rowspan="3">Underwater noise</td><td rowspan="3">Rig and vessel movements, drilling and VSP</td><td colspan="4">Vessel activities produce predominantly low frequency (<1,000 Hz) continuous sounds that are less than 190 dB re.1μPa at source. VSP airguns produce high intensity (230-240 dB re.1μPa), low frequency (10-150 Hz) pulsed sounds. Marine mammals are considered to be of the greatest conservation concern in relation to underwater noise pollution, they are protected species that are known to use sound to communicate over large distances, navigate and detect potential prey or predators. Marine animals within 100 m of the airgun could experience hearing loss, which in terms of the North Falkland Basin is a very localised area.</td><td rowspan="3">JNCC guidance will be followed, marine mammal observers will be deployed to search for marine mammals within a mitigation zone (500 m radius) for a period of 60 minutes prior to firing of airguns, soft-start procedures will be followed and VSP activity will commence during daylight hours.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>High</td><td>MODERATE</td></tr>
<tr><td rowspan="3">Rig and Vessel operations</td><td rowspan="3">Disturbacne to seabed</td><td rowspan="3">Temporary use of clump weight for DP system. A clump weight is a relatively small (465 kg) weight that sits on the seabed and is connected to the rig by a tension wire. This system is used to automatically maintain the rig's position.</td><td colspan="4">The deployment of a clump weight will cause a degree of disturbance to the seabed. This represents such a small area it was regarded as insignificant.</td><td rowspan="3">A Longbase Line (LBL) system will be used, which relies on the accurate positioning of transponders. This also minimises disturbance on the sea bed.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Rig and Vessel operations</td><td rowspan="3">Physical presence</td><td rowspan="3">The presence of the rig and its 500 m radius exclusion zone.</td><td colspan="4">The rig and exclusion zone could potentially interfere with commercial fishing or shipping. All vessels will be excluded from a 500 m radius of the rig. This will cause virtually no impact as the well locations are not on busy shipping lanes or fishing grounds.</td><td rowspan="3">All vessels in the area will be informed of the rig's position and intentions by radio broadcast and AIS, which will allow vessels to reroute with minimal disruption.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
</table>

<table>
<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">Rig and Vessel operations.

Drilling operations</td><td rowspan="3">Generation of artifical light</td><td rowspan="3">During 24 hour operations the rig and support vessels will require lights to ensure safe operations at night.</td><td colspan="4">Attraction of marine life, e.g. plankton, fish, squid and seabirds to artifical light offshore. Subsequent collision risk for seabirds with the rig or vessels. Impact on zooplankton, fish and squid very small and localised - minor severity. Impact on seabirds localised and short-term, less than 1% of the local population at risk</td><td rowspan="3">Heli-deck landing lights will be switched off when not in use (if not required to be left on for safety reasons) to reduce potential impacts of these skyward facing lights on any bird species that may be present. In addition, the ERRV and supply vessel deck lighting will be switched off when not in use (if not required to be left on for safety reasons). The use of blackout blinds/curtains will eliminate light from living spaces. The majority of lights on the rig will be directed inwards to allow safe working conditions.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>LOW</td></tr>
</table>

<table>
<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">Rig and Vessel operations</td><td rowspan="3">Discharges to sea</td><td rowspan="3">Discharges of vessel drainage, firewater, sewage and galley waste from rig and vessels</td><td colspan="4">Release of contaminants leading to deterioration in seawater quality and localised increase in Biological Oxygen Demand (BOD) around the discharge point.
Impact on water quality, plankton, fish and squid will be very small, localised and temporary.</td><td rowspan="3">Sewage will be treated prior to disposal at sea. Vessels will be audited to ensure compliance. Food waste will be macerated as required by MARPOL and The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008.</td><td rowspan="3">Negligle</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Rig and Vessel operations</td><td rowspan="3">Discharges to sea</td><td rowspan="3">Discharge of closed drains following separation, and firewater foam to sea during system test.</td><td colspan="4">Release of contaminants leading to deterioration in seawater quality and localised increase in BOD around the discharge point.
Impact on water quality, plankton, fish and squid will be very small, localised and temporary.</td><td rowspan="3">Main deck, helideck, machinery spaces drainage routes to the closed drains. Drainage water is treated to remove oil content down to 15 mg/l of oil concentration prior to discharge in accordance with MARPOL 73/78 Annex I requirements.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
</table>

<table>
<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">Drilling operations</td><td rowspan="3">Discharges to sea</td><td rowspan="3">Discharge of drill cuttings, WBM, cement and chemicals to marine environment.</td><td colspan="4">Increased turbidity in the water column, sedimentation leading to smothering of benthic organisms, modification of sediment particle size and habitat.
Discharges would impact small areas of seabed and small volume of water relative to the available habitat on the Northern Slope. Impacts would be short term, with potential for rapid recovery. Modification of sedments would persist for over 10 years in a very small area.</td><td rowspan="3">Drilling fluids will be recirculated and cuttings separated from the mud for re-use of the mud to minimise discharges. The majority of WBM chemicals will Pose Little Or NO Risk (PLONOR) to the environment, where safety or operational criteria dictates non-PLONOR chemcials use will be monitored and minised.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Low</td><td>Minor</td><td>LOW</td></tr>
<tr><td rowspan="3">Drilling operations</td><td rowspan="3">Use of landfill</td><td rowspan="3">Generation of non-hazardous and hazardous waste for disposal in UK/FI</td><td colspan="4">The majority of waste generated during the campaign will be transported back to the UK in the returning coaster vessels for landfill in the UK.</td><td rowspan="3">Small quantities of waste may be disposed of in the Falkland Islands, in line with Premier Oil's WMP, and will not include direct disposal of waste to Eliza Cove or Mary Hill Quarry.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Drilling operations</td><td rowspan="3">Intake of seawater</td><td rowspan="3">Intake of seawater to make potable water on the rig</td><td colspan="4">Potential organism uptake in seawater intakes. Plankton and possibly fish eggs or larvae could be removed from the ecosystem. This is on such a small scale that it is insignificant, in comparison with the overall egg/larval production, more an issue in terms of the potential for machinery to over heat due to blocked filters.</td><td rowspan="3">Guards and filters are used to reduce the number of marine organisms that enter with seawater.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
</table>

<table>
<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">Drilling operations</td><td rowspan="3">Discharges to sea</td><td rowspan="3">Discharge of heated seawater from heating /cooling medium or Reverse Osmosis unit</td><td colspan="4">Warm water or increase saline water discharges have the potential to impact seawater quality and marine organisms.
Discharges to surface waters will dilute and disperse rapidly in the offshore environment. Plankton may experience small, short-term, localised effects (frequent likelihood). Fish are highly mobile species and are expected to avoid temperatures outside their tolerance range.</td><td rowspan="3">Discharges will be in line with all previous drilling rigs in the Falklands and rig's water maker will reduce use of in-country water resources.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Shore based operations</td><td rowspan="3">Physical presence onshore</td><td rowspan="3">Laydown yard east of Stanley</td><td colspan="4">The use of land resources and the impact on native flora and fauna.
Disturbance of native flora within a National Nature Reserve (Stanley Common). A short length of track will has been laid to join the existing road with the TDF.</td><td rowspan="3">The majority of the infrastructure was in place prior to the start of the campaign.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Shore based operations</td><td rowspan="3">Waste</td><td rowspan="3">Generation of domestic waste from operations at the laydown yard</td><td colspan="4">The majority of waste generated during the campaign will be transported back to the UK in the returning coaster vessels for landfill in the UK.</td><td rowspan="3">The majority of waste from the laydown yard will be shipped to the UK with the waste generated offshore. Small quantities of waste may be disposed of in the Falkland Islands, in line with Premier Oil's WMP, and will not include direct disposal of waste to Eliza Cove or Mary Hill Quarry.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
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<tr><th>Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">Shore based operations.

Drilling operations</td><td rowspan="3">Use of electrical and freshwater resources</td><td rowspan="3">Domestic electrical and freshwater use in support of laydown yard activity.

Use of local water supply for preparation of drilling mud.</td><td colspan="4">Emissions from electricity generation, added burden on the freshwater supply. The scale of the electricity and water use is considered insignificant</td><td rowspan="3">The TDF has freshwater storage tanks which will be constantly trickle-fed with water from the Moody Brook reservoir. This will disconnect any peak in campaign demands from the supply to Stanley.</td><td rowspan="3">Negligible</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Very Low</td><td>LOW</td></tr>
<tr><td rowspan="3">Shore based operations</td><td rowspan="3">Light onshore</td><td rowspan="3">Generation of light during 24hr operations in relation to local population and wildlife</td><td colspan="4">Artifical light can attract and disorientate seabirds.

Stakeholder raised concerns that the potential for east-facing lighting from the TDF and bright lighting on vessels facing into the prevailing westerly winds may affect night-time flying at Stanley Airport. The laydown yard will be located on the outskirts of Stanley, artifical light from the base is not expected to significanlty add to light emitted by FIPASS. Potential for disruption by night flights causes concern for local residents.</td><td rowspan="3">Permanent lighting will be designed and implemented in accordance with the Health and Safety in Ports (SIP009) Guidance on Lighting, prepared by Port Skills and Safety and UK HSE. Consultation with FIGAS to minimise impacts through lighting design.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>LOW</td></tr>
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<tr><td rowspan="3">Shore based operations</td><td rowspan="3">Noise onshore</td><td rowspan="3">Generation of noise during 24hr operations arising from vessel engines moored alongside the TDF, vessel loading/unloading activities and operation of forklift trucks at the laydown yard</td><td colspan="4">Noise modelling undertaken for the TDF indicated operations at the laydown yard and TDF on a calm dry night would have negligible impacts to Stanley residents, approximately one kilometre away.</td><td rowspan="3">Vessel movements will be reduced where possible through optimised planning, making efficient use of vessel loads. All vessel engines shall be switched off whilst not in use and not left to idle, where possible. Loading or unloading operations at night shall not normally occur and if necessary will be minimised where practicable</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>LOW</td></tr>
<tr><td>Shore based operations</td><td>Accomodation</td><td>Demands for temporary accommodation in Stanley</td><td colspan="4">During the campaign approximately 85 additional personnel will be based in Stanley, which will place pressure on the limited number of available beds in Stanley for visitors.

Options are currently being reviewed and the possibility of building a temporary accomodation unit in Stanley is being considered. Although it is likely that a minority of individuals will be accommodated in local hotels and guest houses.</td><td>Plans are still being developed and the location or footprint of a temporary accomodation unit are unknown. Once plans have been finalised an accomodation specific EIA will be prepared to support planning application.</td><td>N/A</td></tr>
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<tr><td rowspan="3">Inshore operations</td><td rowspan="3">Physical presence</td><td rowspan="3">Vessels associated with the campaign will increase traffic in Stanley Harbour. Space for manoeuvering in the harbour is limited and the additional traffic could disrupt exisiting fishing and cargo use of the harbour.</td><td colspan="4">During the campaign an estimated 53 vessel refueling visits will be required at FIPASS, lasting approximately 6-20 hrs each. Consequently the disruption to other users is considered to be moderate given the limited space at FIPASS.</td><td rowspan="3">Premier Oil will appoint a Marine Superintendent to liaise with the Harbour Master, FIPASS management, Stanley Services and other users to keep everyone well informed. A navigational risk assessment will be completed to inform the preparation of a Stanley Harbour Management Plan.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Moderate</td><td>MODERATE</td></tr>
<tr><td rowspan="3">Crew Transport</td><td rowspan="3">Noise onshore</td><td rowspan="3">Generation of noise, flight path over sensitive seabird colonies and local communities</td><td colspan="4">Low flying helicopters over sensitive breeding colonies of penguins can invoke strong responses leading to trampling of adults, chicks and eggs. Helicopters may also be a nuisance to local settlements and disturb livestock on farms.

The impact of a single helicopter is likely to be short-term and rapidly reversible. However the combined impact of numerous daily flights could have serious implications for the survival of moutling birds and young livestock. The severity to local residents is considered to be low and as direct flight lines do not pass over settlements, sensitivity is low. The risk assessment below pertains to seabirds and livestock.</td><td rowspan="3">Premier Oil will use the flight avoidance map as the basis for flight planning, follow the FI Low Flying Handbook Guidance, and brief helicopter pilots in flight avoidance protocols.</td><td rowspan="3">Low</td></tr>
<tr><td rowspan="2">Planned activity</td><td>Severity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>High</td><td>MODERATE</td></tr>
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Operation	Aspect	Activity Description	Potential Effects and Significance	Legislation/PMO policy/Mitigation/ Monitoring	Residual Significance
General presence of industry	Tourism	Presence of oil industry could have adverse effect on tourism	The presence of oil and gas activites in the Falkalnd Islands could have an adverse effect on the image as a wilflide destination. The drilling operation is currently planned to occur over the Falkland Islands winter, within the main drilling activity occuring offshore to the north of the Islands out of view of visiting tourists. Planned activity — Severity: Slight; Sensitivity: Moderate; Significance: LOW	The campaign is currently scheduled for the winter –spring months which is outwith the prime tourist season.	Low
Unplanned Event	Introduction of marine invasive species	Non-native species may be transported and introduced through ballast water and biofouling on the hull of vessels.	Marine invasive species typically impact inshore benthic communities of native species. Invasive species may not be evident for a number of years, but their long-term impacts could be severe and irreversible. Vessel will be required to follow IMO guidelines for ballast water and biofouling Severity: Major; Sensitivity: High; Likelihood: Remote; Significance: MODERATE	The Eirik Raude and support vessels will comply with IMO Guidelines. However, there remains a residual risk largely due to uncertainties in the assessment. Monitoring will be required to keep a check on the potential presence of marine invasive species, settlement plates will be attached to the TDF to provide an early warning.	Moderate

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<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Dropped object</td><td rowspan="3">Large items that are accidentally dropped overboard during drilling operations could pose a hazard to trawl fishing in the area.</td><td colspan="4">Oil and gas industry historical data indicate that the risk of an incident is relatively low at about 1 incident in 60 drilling campaigns. Annual fishing statistics show that there is very little fishing in the area.</td><td rowspan="3">Premier Oil Golden Rules for preventing serious events will be followed during the campaign and include; secure all tools, material and equipment; take measures to prevent dropped objects when working over grating; remove tools on completion of the job; erect barriers around drop zones; inspect structures and equipment at risk of falling.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Low</td><td>Possible</td><td>LOW</td></tr>
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<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Release to sea</td><td rowspan="3">Accidental minor spill of diesel, oil, chemical during loading operations</td><td colspan="4">Release of contaminants leading to deterioration in seawater quality and toxic impacts on marine life.

Diesel spill would only remain in surface waters for a short time, but releases toxic substances that will have small a localised impact on water quality, plankton, fish and squid. The presence of the rig may attract birds that are more vulnerale to toxic surface pollution and several species in the area are classifed as Endangered.</td><td rowspan="3">All diesel transfer hoses will be fitted with dry-break seals, where possible, which will limit the amount discharged in the event a hose is accidentally disconnected. Additionally Premier Oil and provide working procedures which outline control and preventative measures. Premier Oil will also develop a computer based environmental awareness training package that will taken by all of the work force during their induction.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>Very High</td><td>Remote</td><td>MODERATE</td></tr>
<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Release to sea</td><td rowspan="3">Storm water overwhelming rig deck drains resulting in discharge of contaminated water

Unplanned discharge from rig open or closed drain system</td><td colspan="4">Release of contaminants leading to deterioration in seawater quality and toxic impacts on marine life.

Drainage management will be in place on the rig via processes and procedures to minimise overloading of the oily water separator during storms and heavy rain.</td><td rowspan="3">Premier Oil provide working procedures which outline controls and preventative measures. Premier Oil will also develop a computer based environmental awareness training package that will taken by all of the work force during their induction.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Low</td><td>Remote</td><td>LOW</td></tr>
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<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Marine mammal mortality</td><td rowspan="3">Collision between support or supply vessel with marine mammals</td><td colspan="4">An increase in general shipping traffic throughout the campaign could lead to an increase in the risk of vessel collisions with marine mammals.

Large numbers of marine mammals are present in inshore waters coinciding with the period of the campaign. Of these whales, sei whales are Endangered. The campaign will increase shipping near Stanley by 25%, however lack of historically reported incidents suggests that few collisions occure around the Falkland Islands.</td><td rowspan="3">Mariners should be made aware of the issue and how it relates to the Falkland Islands (see IFAW (2013) leaflet).
Along with the usual duties of a watch keeper, additional vigilance is required to detect cetaceans in inshore waters.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>High</td><td>Remote</td><td>MODERATE</td></tr>
<tr><td rowspan="3">Unplanned Event</td><td rowspan="3">Invasive species</td><td rowspan="3">Introduction of terrestrial alien species at laydown yard via equipment import from UK</td><td colspan="4">Risk of introducing invertebrates, seeds and soil (containing micro-organisms) that can adhere to the outside of containers or be hidden in cargo. Species that may be transported in cargo from the UK are very likely to survive.

If invasive species were introduced the impact through parasites, disease, competitors or predators may not be immediately evident. Long-term implications could be severe and difficult to reverse. Vessels will be arriving throughout the campaign and a large amount of cargo will be brought onshore. The introduction of invasive species has happened in industry elsewhere.</td><td rowspan="3">All materials are clean when packed or loaded in the port of origin, particularly items of fresh fruit and vegetables. Personnel will be briefed on the significance of non-native species.
Falkland Islands Biosecurity Guidelines will be adhered to.
Cargo will be inspected on arrival for biosecurity breaches.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Moderate</td><td>Moderate</td><td>Possible</td><td>MODERATE</td></tr>
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<tr><th rowspan="2">Operation</th><th rowspan="2">Aspect</th><th rowspan="2">Activity Description</th><th colspan="4">Potential Effects and Significance</th><th rowspan="2">Legislation/PMO policy/Mitigation/ Monitoring</th><th rowspan="2">Residual Significance</th></tr>
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<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Release to inshore waters</td><td rowspan="3">Vessel collision in Stanley Harbour, potential for small leaks or tanks to overflow during re-fueling leading to loss of diesel</td><td colspan="4">Whilst Stanley Harbour is not recognised as a habitat of great conservation value, it is home to steamer ducks and other coastal species, as well as Commerson’s dolphin, and is used recreationally by Stanley residents.

Collision with a fully re-fueled vessel could lead to a total inventory loss of 800 tonnes diesel. This would be spread between various segrated tanks and would be very unlikely that all or any would be lost. However as a worst-case this could represent a sizeable spill in sheltered coastal waters.</td><td rowspan="3">The same precautionary measures that apply to all vessels bunkering at FIPASS will apply to the rig supply vessels. A Harbour mangement plan will be in place. The support vessels will be fully equipped to deal with spills offshore and the same equipment would be used to deal with small spills inshore.Oil spill response equipment will also be available at the TDF.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Minor</td><td>High</td><td>Remote</td><td>LOW</td></tr>
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<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Major loss of containment of hydrocarbon</td><td rowspan="3">Emergency situation leading to a significant loss of containment or an uncontrolled release</td><td colspan="4">Prolonged release of crude oil to the water column which could impact water quality, plankton, benthic organisms, seabirds, marine mammals, fish and fisheries, coastal fauna and tourism.

The predicted oil is very waxy and has a high viscosity and is expected to form waxy droplets on the surface following release. However, a lighter oil could be encountered. Impacts to plankton are considered to be short-term and recoverable. Impacts to benthic filter feeders are unknown. Seabirds and marine mammals are not considered significantly at risk due to the semi-solid nature of the wax droplets, although this may differ if a different hydrocarbon is encountered. The direction of the prevailing conditions is likely to spread the spill over fishing areas and could result in short-term closed areas. The coastline of East Falkland is at greatest risk of beaching. The impact to tourism is considered to be major.</td><td rowspan="3">The well design will be peer reviewed by Premier Oil's well examiner and the Health and Safety Executive to ensure that the risk of an uncontrolled release is minimised.
The well will be fitted with a blow-out preventer that will seal the well in the event of a major incident.
Premier Oil are preparing an Oil Spill Response Plan that would initiate a tiered response in the event of a spill.</td><td rowspan="3">Moderate</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Major</td><td>Very high</td><td>Remote</td><td>MODERATE</td></tr>
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<tr><th rowspan="1">Operation</th><th>Aspect</th><th>Activity Description</th><th colspan="4">Potential Effects and Significance</th><th>Legislation/PMO policy/Mitigation/ Monitoring</th><th>Residual Significance</th></tr>
<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Release to sea</td><td rowspan="3">Loss of containment of WBM from the riser due to rig failing to maintain station</td><td colspan="4">Increased turbidity in the water column, sedimentation leading to smothering of benthic organisms, modification of sediment particle size and habitat.

Discharges would impact small areas of seabed and a small volume of water relative to the available habitat on the Northern Slope. Impacts would be short term, with potential for rapid recovery. Modification of sediments would persist for over 10 years in a very small area.</td><td rowspan="3">Redundancy is designed in to ensure DP related equipment are always available. DP trials will be undertaken when the rig reaches location. An exclusion zone of 500m will be maintained. Mariners will be advised of the rig location to avoid collision, Meteorological analysis of extreme weather events will be assessed. Continual monitoring of long-range and short-range weather forecasts.</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Likelihood</td><td>Significance</td></tr>
<tr><td>Minor</td><td>Very low</td><td>Remote</td><td>LOW</td></tr>
<tr><td rowspan="3">Accidental Event</td><td rowspan="3">Loss of containment</td><td rowspan="3">Emergency situation leading to a significant loss of containment or an uncontrolled release.

Use of clean-up materials following loss of containment during clean-up (oil, contaminated materials, PPE etc.)</td><td colspan="4">If a major spill occurred, the clean-up operation would generate a large volume of hazardous waste, which would have to be disposed of responsibly.
This would potentially have a serious environmental impact in its own right but under the circumstances of a major incident, the impact would be relatively insignificant.</td><td rowspan="3">Contaminated waste from a spill clean-up would be managed in line with Premier Oil's Waste Standard, and a specific Waste Management Plan will be in place in the event of a spill. It is expected that waste of this kind will be exported to the UK</td><td rowspan="3">Low</td></tr>
<tr><td>Severity</td><td>Sensitivity</td><td>Sensitivity</td><td>Significance</td></tr>
<tr><td>Slight</td><td>Low</td><td>Very Low</td><td>LOW</td></tr>
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Operation	Aspect	Activity Description	Potential Effects and Significance				Legislation/PMO policy/Mitigation/ Monitoring	Residual Significance
Accidental Event	Loss of containment	Emergency situation leading to a significant loss of containment or an uncontrolled release	Air Quality would be affected by light oils, such as diesel, which evaporate quickly and release noxious compounds into the atmosphere. Heavier crude oil takes longer to breakdown and therefore releases gases slowly over a period of weeks or months. Following an oil spill, Volatile Organic Compounds, Polycyclic Aromatic Hydrocarbons, Hydrogen Sulphide and other noxious compounds are released, which all impact on air quality. In the offshore environment, atmospheric pollution is rapidly dispersed.				The impacts of a blow-out would be far reaching but air quality was not deemed to be of great significance.	Low
			Severity	Sensitivity	Likelihood	Significance		
			Minor	Low	Low	LOW		
Accidental Event	Release to sea	Major incident such as collision with another vessel resulting in loss of rig inventory	Loss of the total diesel fuel inventory, 4,631m^3. Resulting in release of contaminants and subsequent deterioration in seawater quality and toxic impacts on marine life. Spilt diesel only remains in surface waters for a short time, but releases toxic substances that would have a small localised impact on water quality, plankton, fish and marine mammals. The presence of the rig may attract birds that are more vulnerable to toxic surface pollution and several species in the area are classifed as Endangered. The risk to the coastline is slight as diesel quickly evaporates and disperses from surface waters therefore is unlikely to reach the coastline.				An exclusion zone of 500m will be maintained. Mariners will be advised of the rig location to avoid collision. All vessels in the area will be informed of the rig's position and intentions by radio broadcast and AIS. The ERRV will patrol the 500m exclusion zone and ensure other vessels do not approach.	Low
			Severity	Sensitivity	Likelihood	Significance		
			Moderate	Very High	Remote	MODERATE		

Operation	Aspect	Activity Description	Potential Effects and Significance				Legislation/PMO policy/Mitigation/ Monitoring	Residual Significance
Accidental Event	Physical presence	Major incident resulting in loss of rig	Disruption to shipping in the area. There is very little vessel traffic in the area.				Mariners and FIGFD will be advised of the rig location to avoid collision. Meteorological analysis of extreme weather events will be assessed.	Negligible
			Severity	Sensitivity	Likelihood	Significance		
			Slight	Low	Very Low	LOW		