4 BASELINE ENVIRONMENTAL CONDITIONS

4.1 INTRODUCTION

This chapter describes the existing environmental conditions within the project area, focusing on the factors and environmental components that may be impacted by, or have a direct impact on, the proposed Lunskoye seismic survey operations.

These include:

- regional setting;
- climate and meteorology;
- hydrology and oceanography;
- seabed morphology and sedimentology;
- coastal landscape and land use;
- geological environment and seismic stability;
- marine invertebrates and fish communities;
- marine mammals;
- the human environment.

Information on the baseline environmental conditions have been obtained from the following sources:

- Sakhalin II Project EIA (Volume 7, ERM 2002) submitted as part of the Russian Federation TEOC approval process;

- DVNIGMI, IMB DVO, RAS and SakhNIRO *'hydrographical and hydrochemical surveys including phytoplankton, zooplankton and benthos sampling in the vicinity of the Lunskoye Field, Piltun-Astokhskoye and Aniva Bay'*, 1998;

- SakhNIRO *'assessment of commercial fishing in the vicinity of the Lunskoye Field, Piltun-Astokhskoye and Aniva Bay'*, 1999;

- SakhNIRO *'trawling and acoustic surveys and assessment of the spatial distribution of commercial species of invertebrates and fish and the condition of fishery resources in the vicinity of the Lunskoye Field, Piltun-Astokhskoye and Aniva Bay'*, 1999.

4.2 REGIONAL SETTING

Sakhalin Island is located towards the eastern edge of the Sea of Okhotsk between 46° and 54° N. The island is 950 km long from north to south, and 160 km wide from east to west at its widest point and occupies an area of approximately 88,000 km^2 (see *Figure 1*). The Tatar Strait runs between

Sakhalin Island and mainland Russia, and has an average width of 100 km, narrowing to 10 km at Pogibi in the north. The Japanese island of Hokkaido lies to the south of Sakhalin Island, separated by La Perouse Strait (also known as Soya Strait). At its narrowest, the strait is 60 km wide.

The Sea of Okhotsk is a large basin that indents the Asian continent. It is 2,500 km in length from southwest to northeast, and some 1,500 km wide. It is a continental marginal sea with an average depth of 821 m and a maximum depth of 3,520 m. It is the second largest sea of this kind in the Pacific Ocean region (1). The sea is bordered by Sakhalin Island and Asia to the west, Siberia to the north, the Kamchatka Peninsula to the northeast, the Kuril Island Arc to the southeast and Hokkaido Island to the south (see *Figure 1)*.

The baseline environmental characteristics of the Lunskoye field described in the proceeding sections are presented in the wider regional context of the Sea of Okhotsk.

4.3 CLIMATE & METEOROLOGY

4.3.1 *The Sea of Okhotsk*

Seasonal Variations

The Sea of Okhotsk is situated in the monsoon climatic zone of the temperate latitudes. However, it is often considered to be one of the sub-Arctic seas due to its proximity to the seasonal Siberian High (2), which determines the severity of winters in the region (US NODC, 2001). These two opposing meteorological trends result in a mixed climate, with mild summers influenced by minor tropical cyclones and the influence of the Soya current (3). The climate to the south of the sea is considered to be warmer than the regional average, with colder climates experienced towards the north.

The winter monsoon arrives in the Sea of Okhotsk in October, and persists until April. The monsoon winds are predominantly northerly and northwesterly in direction, with average wind speeds of 6 ms^{-1} that often develop into storms. Minor precipitation occurs in this region, with only westerly winds bringing snow. Sea ice is extensive in all but the southern margins of the sea.

Spring in the Okhotsk region is characterised by minor precipitation, and air temperatures rise slowly in coastal zones owing to the melting of sea ice. Wind speeds decrease, whilst fogs and low-lying cloud increases.

(1) The largest marginal sea of the Pacific Ocean is the South China Sea.
(2) The Siberian High is an area of high pressure which forms over Siberia in winter, and which is particularly apparent on mean charts of sea-level pressure (National Snow and Ice Data Centre, Arctic Climatology and Meteorology, 2002).
(3) An extension of the Tsushima Current that flows northward from the Japan Sea into the Okhotsk Sea via La Perouse Strait .

Summer monsoons arrive between May and September, and result in an increase in precipitation and long-lasting heavy fogs around the coast. Cyclones and rainstorms may be experienced during this period. The stormy conditions persist into the autumn, when cyclones, high winds, high precipitation and occasional hailstorms may be observed.

Average annual air temperatures over the sea range from 0 to 7°C in the north to 5°C in the south. The months with the coolest temperatures are January and February when minimum temperatures are -25°C, and the warmest months are July and August, when typical maximums of 18°C are observed.

Wind and Storm Conditions

The Sea of Okhotsk is considered to be one of the world's roughest seas. Coastal zones often experience strong windstorms, with average wind speeds of 20 to 25 ms^{-1} being registered. The months with the highest frequency and severity of storms are February, November and December. The average duration of these storms is approximately 8 to 10 hours. Summer storms are generally 5 to 7 hours in duration, and the month with the minimum frequency of storm events is July.

Fogs

The recurrence of sea fogs increases during the summer months. This can be verified by the recorded increase in recurrence from 5 to 10% in the cooler periods, to 20 to 40% during July and August. The period of generally high recurrence usually lasts from May to September in coastal zones, with an average of 9 to 18 days of fog per month towards the south, and 3 to 6 days per month in other areas. The average fog duration is 8 to 11 hours in the south, and 5 to 7 hours in other areas, with the longer lasting fogs occurring mainly overnight and into the early morning. Fogs of shorter duration are generally experienced during the day (1).

4.3.2 *Sakhalin Island*

The climate on Sakhalin Island varies considerably between the north, south, east and west coasts, which is a feature of the island's large latitudinal extent. Three main climatic zones can be distinguished.

1: The North Sakhalin Climate Zone

The coastline west of the Lunskoye Field is located within the north Sakhalin climate zone. In winter this zone is characterised by winds, low levels of snowfall and isolated areas of permafrost (2). The average minimum temperature is -22.8°C, but temperatures have reached as low as -48°C. Humidity levels of 70 to 78% are normal at this time of year. Winds of 4 to

(1) This pattern is only observed during the months of May to September, with no discernable pattern emerging during winter fogs.
(2) Permanently frozen subsoil.

7 ms^{-1} from the north and northwest are average, with peak winds of 37 to 40 ms^{-1}. Air temperature stays below 0°C for approximately 200 days a year, rising above zero towards the end of April to the beginning of May, causing sea ice in coastal regions to begin to drift. The air temperature may return to 0°C or below during the spring and summer months. Summers are cool with average air temperatures from July to October of 8.9°C to 9.5°C offshore, and humidity levels of 84 to 93%. August is the warmest month, with average temperatures of 11.5°C to 18°C offshore. Maximum temperatures of 37°C have occasionally been recorded.

The average yearly temperature and precipitation levels are -1°C and 600 mm per year respectively. Fog is observed for approximately 80 days per year, predominantly during the summer months.

2: The Mid Sakhalin Climate Zone

The mid Sakhalin climate zone has higher levels of precipitation and warmer temperatures than the northern zone, with an average annual temperature of 1.4°C and precipitation of 792 mm. Winter is therefore characterised by higher levels of snowfall with some 150 cm of snow being deposited each year. The average height of snow cover is 58 cm, with a maximum of 96 cm and a minimum of 32 cm. Average temperatures in the winter are –15.5°C, and air temperatures stay below zero for some 235 days per year. Humidity levels are approximately 71%.

Average temperatures in August are 16.4°C, with maximum-recorded temperatures of 36°C. Average humidity levels are 89% in this central zone. Average wind speeds are of the magnitude of 3.6 ms^{-1}. In summer, winds with a southerly and southeasterly direction and a velocity of some 3.2 ms^{-1} prevail. During the winter months northerly and northwesterly winds of approximately 3.9 ms^{-1} are most commonly recorded.

3: The South Sakhalin Climate Zone

The southern region of Sakhalin Island is subject to a more moderate climate than other regions with an average annual temperature of 2 to 3°C and precipitation of 800 mm. The average temperature is –14°C in the winter months, with a minimum recorded temperature of –40.4°C. Westerly winds predominate, with speeds of 2 to 4 ms^{-1}.

Temperatures in summer are 22°C on average, with a maximum-recorded temperature of 35°C. Winds are light and southerly in direction. Fog occurs mainly in summer, for approximately 60 days per year.

Wind and Storm Conditions

According to data and research from SakhUGMS (TEO Volume 7 Book 1-EIA: Chapter 1, 2002) the Sakhalin region experiences some 100 cyclones each year concentrated around late summer and early autumn. These cyclones originate

in the equatorial zone, and can reach speeds of up to 40 ms^{-1}. The majority of these cyclones pass above the far northern coast of Sakhalin Island, and do not exert a significant effect on the marine environment to the northeast of the island. Over the last 41 years, tropical cyclones have entered the northeastern territories of Sakhalin Oblast sixteen times.

4.3.3 *Air Quality*

Background atmospheric pollution levels in Sakhalin Island and surroundings waters are on average low, with occasional short-term peak events caused by forest fire or shipping sources, and dispersion from regional urban centres.

On a local scale, urban areas such as the regional capital Yuzhno-Sakhalinsk and industrial areas such as coal-fired power station sites record peak pollution levels (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

The pollution dispersion capacity of the region is generally moderate due to the windy meteorological conditions. Calm periods and inversions (1) can occur during any season, but are more common in the winter when the recurrence of inversion conditions is 66 to 76%. July is the month with minimum recorded recurrence of inversions.

Transboundary pollution transfer has been shown to be negligible by modelling studies on Sakhalin and Hokkaido islands. This is because of global air transfer in the region and consistent wind conditions (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

4.4 *HYDROLOGY & OCEANOGRAPHY*

4.4.1 *Sea of Okhotsk*

Water within the Sea of Okhotsk is exchanged with the Pacific Ocean via the Kurils and the Sea of Japan through La Perouse Strait. The sea has a large meridian length, which results in diverse climatic and hydrological conditions. The extreme northern boundary of the sea lies in the upper waters of Penzhinski Bay 64° 42′ N, and the extreme southern point is in the Notsuke Channel at 43° 43′ N. Udsk Bay at 54° 50′ N is the most westerly point of the sea, with the Penzhina River marking the far eastern boundary at 164° 45′ E.

4.4.2 *Wave Climate*

During storm events in the Sea of Okhotsk wind driven waves can reach a maximum height of 17 m, with wave periods of 13 to 14 seconds (s). The development of cyclonic activity in the southern part of the sea in winter produces 14 to 15 m waves with an 11 to 12 s wave period. In spring the wave energy decreases resulting in heights of 9 to 11 m with a 9 to 11 s wave period,

(1) An atmospheric condition whereby the air temperature rises with increasing altitude, holding surface air down and preventing the dispersion of pollutants (Houghton Mifflin Company, 2000).

and in summer waves are generally under 7 m in height at a 6 to 8 s wave period. Autumn sees the heights increase to 11 to 12 m with a period of 9 to 11 s. Southern and northwestern areas may experience extremes of wave height and storm events throughout all seasons.

4.4.3 *Current Conditions and Circulation Patterns*

The general circulation of the Sea of Okhotsk is cyclonic, which is exhibited by the movement of the Okhotsk Gyre in the centre of the sea. Water exchanges with the Japan Sea occur through La Perouse Strait, and Pacific waters enter through the northern straits, exiting through the southern straits of the Kuril Islands (Komex, 2002). An important hydrographic feature of the sea is the outflow of Okhotsk intermediate waters (1) through the Bussol and Krusenshterna passages into the North Pacific, which is considered to be a possible source for the North Pacific Intermediate Water (NPIW) (2) (Komex, 2002). Another important feature is the Amur River, which enters the sea through the Sakhalin Gulf and Tatar Strait. The Amur is the only large river in Siberia that drains into the Sea of Okhotsk rather than the Arctic Ocean. The outflow into the sea provides 68% of the sea's freshwater supply together with sediment load, and influences sea ice formation, hydrography (3) and productivity within the sea (Komex, 2002).

The seasonal sea ice cover, its formation and melting, affects surface currents and water column temperature stratification (thermocline).

4.4.4 *Water Temperature*

Over the winter months, the southern area of the Sea of Okhotsk experiences water temperature minima of –1.5°C in the coastal zone, with a temperature increase offshore towards the outer boundary of the Kamchatka continental shelf. In northern and mid areas, sea ice conditions prevail.

Temperatures rise to a maximum of 8 to 9°C in northern areas, and 12 to 13°C in southern areas at the height of summer warming intensity (in August). In the far southern areas, cold pacific water with a temperature of 9 to 10°C flows along the southern Kamchatka coast.

Water temperatures in the surface layers of the Lunskoye Field feature seasonal variations within a 12°C range, with winter temperatures averaging some –1.8°C and summer temperatures reaching 10 to 12°C. As expected, this range decreases with water depth, and the bottom water layer at approximately 30 m depth has a seasonal temperature variation of approximately 7°C.

(1) Okhotsk intermediate waters are formed in a layer from 150 to 200m to 500 to 800m depth.
(2) The NPIW ventilates the waters of the North Pacific Ocean.
(3) The scientific description and analysis of the physical condition of surface waters *eg* boundaries and flow.

4.4.5 *Salinity*

The maximum water salinity in the Lunskoye Field is 33.5 parts per thousand (‰) and the minimum salinity is 27 ‰. Salinity is generally at its minimum in May to June, and September to October due to an influx of freshwater from the Amur River estuary and sea ice melt. The formation of sea ice will cause salinity concentrations to increase, raising the density of the surface waters, whilst melting will release cold, freshwater thereby reducing the density of surface waters.

4.4.6 *Water Masses in the Sea of Okhotsk*

There are three distinct water masses in the Sea of Okhotsk. Although variable throughout the year, the main characteristics are described below.

- The Sea of Okhotsk water mass is located between the sea surface (0 m) to depths of 150 to 200 m. It is formed through convection (1) during the winter months, and at its core has a temperature of –1.7°C to 0.6°C and a salinity of 32 to 33.5 ‰. The upper layer from 0 m to depths of 10 to 20 m is warmed during the summer months and acts as an independent water mass.

- The intermediate water mass is located between 150 to 200 m and 500 to 800 m depth. The origin of the water mass has been traced to the flood deformation of the pacific water upper layer that results in flood waves entering the sea through the Kuril channels. The temperature and salinity of this body increase with depth from 0.1°C to 2°C, and from 33.3 to 33.8 ‰.

- The deep Pacific water mass is located between 600 to 800 m and 1000 to 1500 m depth. It is characterised by a deep temperature maximum of 2.4°C, an oxygen minimum of less than 1 millilitre per litre (mll^{-1}) and a salinity of 34.3 to 34.4 ‰.

4.4.7 *Sea Ice Formation*

The Sea of Okhotsk

Sea ice formation begins towards the end of October in the desalinated estuaries of the Penzhinski Bay. By December, ice is forming on the open sea, extending gradually southwards. By January, ice generally covers the Kamchatka coast and has reached the southern coast of Sakhalin Island, and by March to April the majority of the continental shelf zone is covered with drift ice. This is considered to be the peak of ice cover in the Sea of Okhotsk. Only the southernmost areas of the sea close to the Kuril island arc avoid complete ice cover, being partially covered or ice-free in average winter conditions. During severe winters, drift ice masses may be driven by winds

(1) Heat transfer in a gas or liquid by the circulation of currents from one region to another.

towards the Kuril Islands, where channels can be blocked until ice melt. There are, on average, 280 days a year when ice covers the northern areas of the sea, whereas the southern coasts of Kamchatka and the Kurils experience ice cover for a maximum duration of 90 days a year.

Sea ice melt typically commences in April, with the development of cyclonic conditions. The ice boundary rapidly retreats to the north, and by the end of June the sea and coastal areas are generally free from ice cover.

Sakhalin Island and the Lunskoye Field

Quantities of ice on the northeastern Sakhalin Shelf, where the Lunskoye Field is located, are generally high during the winter period (see *Figures 9 -11*). Ice thickness is 1.2 to 1.5 m, although deformation usually occurs in this area, increasing the volume of ice in some locations. The overall thickness of the pack ice is some 3 to 4 m, with ice keels (1) of 10 to 15 m. Extreme ice keels may reach 20 m depth, but are considered to be rare. Keels on the undersides of ice ridges can be driven by the wind, gouging long trenches into the sea floor as they move, in a process called ice gouging. Ice gouging is generally observed in water depths shallower than 10 to 15 m, but may occur in up to 20 m of water when larger keels are present.

The pack ice in the region of northeastern Sakhalin Island is dynamic, and is in near continual motion because of winds, currents and tides. Drift speeds are on average 0.4 ms^{-1} with extremes of up to 1.5 ms^{-1}. Movement is generally southerly in direction with occasional movements to the north, east and west. Cyclical tidal drift may be observed on shorter timescales.

An important feature of the ice cover is the periodic appearance of polynya, which are bands of thin ice or open water that run parallel to the coast between shore ice and the thicker pack ice offshore. The polynyas have a duration of days to weeks, and are usually formed between January and March. The features have been regularly observed within the Lunskoye Field, and are thought to be influenced by wind direction.

4.4.8 *Gas and Fluid Venting*

The Sea of Okhotsk has the highest potential methane production rate in the northern hemisphere. This is because shelf areas around Sakhalin Island, together with Magadan and the area surrounding the Kuril Islands belong to a region of extremely active methane and fluid venting (Komex, 2002). The methane forms reservoirs that are in direct contact with the bottom water layers of the sea, and in shelf areas can have a direct exchange with the atmosphere. The predominant control on the release rate of this methane is the seasonal sea ice cover, which regulates gas exchange.

(1) Ice keels occur when two sheets of ice collide and force a mass of ice downwards to form a 'keel' like structure below the sea surface.

The stability of the gas reservoirs in the Sea of Okhotsk is dependent on fault zones and fissures in the sea floor sediments, fluctuations in deep-sea temperatures and sea level. Methane is widely found as hydrate deposits on the shelf and slope areas of the sea. These methane hydrate deposits are known as clathrates (1), and their stability has significant implications for the atmosphere and global climate, as methane has a high global warming potential (2).

4.4.9 *Marine Water Quality*

Marine water quality data is predominantly focused on the spring and summer months when there is no sea ice cover in Sea of Okhotsk and Lunskoye Field.

Oxygen Concentrations and Distribution

In the waters around the Lunskoye Field surface water oxygen concentrations are approximately 8 to 8.5 milligrams per litre (mgl^{-1}) in the spring and 6.5 to 7 mgl^{-1} in the summer, equivalent to 105% and 100% saturation respectively. Oxygen concentrations decrease with depth in the water column, falling to a minimum level of 5.5 to 6 mgl^{-1} (75% saturation). Horizontal concentrations are generally uniform. Maximum oxygen concentrations exceeding 9 mgl^{-1} (more than 115%) are observed in spring and summer at approximately 20 m depth, and are thought to relate to phytoplankton blooms. Oxygen concentrations exceed, or are equal to, saturation levels throughout the ice-free period (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

Oxygen Demand

Biological oxygen demand (BOD) (3) is an index of the degree of organic pollution in water. Levels are reported to show an increasing BOD trend with increasing water depth in the Sakhalin region, with BOD_5 (4) increasing from 1.26 ms^{-1} to 2.12 ms^{-1} in the Lunskoye Field. These BOD levels indicate that the Lunskoye Field is unpolluted (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

(1) Inclusion complexes in which molecules of methane are completely enclosed within the crystal structure of frozen water molecules. The stability of clathrates is limited by temperature and pressure, with complexes being stable at low temperatures and/or high pressures.
(2) According to the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR), the Global Warming Potential (GWP) for methane calculated over 20, 100 and 500 year time horizons is 62, 23 and 7 respectively. GWP is defined as the impact of the instantaneous release of 1kg of a trace substance relative to the release of 1kg of the reference gas (which is carbon dioxide) (IPCC, 2001). The concept of Global Warming Potential (GWP) was introduced to provide a means whereby scientists and policy makers could compare and combine the warming effects of the individual gases to support the development of policies and measures designed to mitigate climate change.
(3) The amount of oxygen used for biological oxidation by a unit volume of water at a given temperature and for a given time (European Environment Agency, 2002).
(4) Decomposing organics require oxygen. The BOD_5 test measures the oxygen consumed by organisms as they decompose organics over a five-day period. BOD_5 is used as a proxy for the concentration of organics in water.

pH Levels

In the Sakhalin region pH generally decreases from 8.2 in the surface waters to 8.0 to 8.1 in waters of 50 to 100 m depth (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

Nutrient Concentrations

In the Lunskoye Field nitrate and phosphate concentrations are minimal in surface waters during the spring and summer, increasing with depth. This is due to the consumption of nutrients by phytoplankton. Lateral distribution patterns are influenced by an influx of silica and nitrites from the River Amur and lagoonal waters (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

Suspended Particulates

Concentrations of suspended particulates show a small vertical variation in the Lunskoye Field with 2.0 to 4.0 mgl^{-1} observed between 0 to 15 m depth, and 4.0 to 6.0 being recorded in the bottom layers. This marginal increase is predominantly due to the mobilisation of seabed sediment by bottom water currents (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

Contaminant Trends and Concentrations

The seawater analysis results from the oil field areas offshore Sakhalin Island indicate that the Lunskoye Field has not been directly or indirectly subjected to intense and polluting economic activity. On a wider scale, Sakhalin's marine environment is, on average, defined as unpolluted-lightly polluted with a small number of significantly polluted sites relating to coastal development and point source release of untreated sewage and fishing wastes (TEO Volume 7 Book 1-EIA: Chapter 1, 2002). Untreated industrial and household sewage wastes from Sakhalin coastal developments represent a significant discharge to the Sea of Okhotsk. 1996 data indicates that the sea received some 256 million m^3 of wastewater, of which 46 million m^3 was untreated. *Table 4.1* reports the general findings of the oil field seawater analyses together with corresponding Russian standards *'maximum admissible concentrations'* (MAC) where available.

Table 4.1 Sea Water Contaminant Trends and Concentrations

Contaminant	Location	Concentrations	Trends	MAC
Metals	Lunskoye and Piltun-Astokskoye	Correspond with the background concentrations recorded for the Sakhalin shelf region	None recorded	-
Phenols	Lunskoye and Piltun-Astokskoye	The background concentration is reported to be 1 mgl^{-1}. Concentrations in the study area varied between 0 to 4.0 mgl^{-1}	Irregular variation with no attributed cause	-
Petroleum hydrocarbons	Lunskoye and Piltun-Astokskoye	2.5 to 30 μgl^{-1}	Irregular variation	Concentrations are below the MAC
Detergents	Lunskoye and Piltun-Astokskoye	0 to 35 μgl^{-1}	None recorded	Concentrations are below the MAC level of 100 μgl^{-1}
Untreated industrial and household sewage	Coastal waters around Sakhalin Island	None recorded	Influx into the marine environment is generally related to coastal developments	-

(Source: TEO Volume 7 Book 1-EIA: Chapter 1, 2002)

4.5 SEABED CHEMISTRY, MORPHOLOGY & SEDIMENTOLOGY

4.5.1 Bathymetry and Seabed Features

The bathymetry of the Sea of Okhotsk has two distinct character areas:

- the Kamchatka continental shelf with insular shoals (1);
- the sea floor, incorporating a complex region of basins, troughs and ridges.

The Kamchatka Continental Shelf

The Kamchatka continental shelf covers 40% of the total area of the Sea of Okhotsk and runs from Penzhinski Bay in the north of the sea, to the First Kuril Strait in the south. The shelf is gently sloping, and in some areas level. The boundary is conventionally marked along the 200 m isobath (2).

(1) A shallow place in a body of water, possibly a sandy elevation *eg* a sandbank or sandbar.
(2) A line drawn on a map linking points at the same depth below the water surface.

The northern section of the shelf is located towards the western Kamchatka coast. This area is dominated by a large plain with a number of shoals, which increase in frequency towards the shore. The shelf width averages 150 km in the north, narrowing to some 100 km towards the central shelf zone. To the south, the shelf width narrows to 50 km, connecting the Kamchatka Peninsula with the islands Shumshu and Paramushmir at Lopatka Cape.

To the west the gradient of the continental shelf increases, turning into steep continental slope. Submarine slope angles are varied, ranging between 2 to 3° and 25 to 30°.

The Seabed

The remaining 60% of the sea area consists of basins, troughs and ridges. The highest ridges and banks are the Academy of Science Rise, the Institute of Oceanography Rise, the Kashevarov Bank and the St. Iona Bank. The largest basins are the Derugin, TINRO and Kuril basins. The Derugin Basin is located to the northeast of Sakhalin Island and has a maximum depth of 1,780m. The TINRO Basin is off the western coast of Kamchatka and has a maximum depth of 991 m. The deepest basin is the Kuril Basin, with maximum depths of some 3,500 m. The basin is considered to be a backarc basin (1) associated with the volcanically active Kuril Islands and is situated along the arc's northwestern edge. This area of the Sea of Okhotsk is a subduction zone (2), playing a significant mass transfer and cycle role for the sea (Komex, 2002).

The Lunskoye Field

The sea floor in the Lunskoye Field is smooth and gently sloping offshore with occasional minor outcrops.

4.5.2 *Seabed Sediments*

Gas and Fluid Vent Sediments

There are a number of active gas and fluid vents in the Sea of Okhotsk, and these vents have deposits of mineral precipitates associated with the chemistry of vented substances. Carbonate deposits, which are generally associated with cold vent sites, have been observed in the sea. Barite deposits are also associated, and have been found in large quantities in the Derugin Basin. The deposits have formed a large number of chimneys, edifices and blocks of several metres in height on the sea floor (Komex, 2002).

(1) A depression landward of a volcanic arc in a subduction zone, which is lined with trapped sediment from the volcanic arc and the plate interior.
(2) At the boundary between two tectonic plates, one plate will sink into the asthenosphere (a layer in the earth's mantle) producing a trench, and introducing material into the oceanic system thereby affecting the transfer of mass within the system.

Seabed sediments in the Lunskoye Field

Fine-grained greenish-grey sands cover the majority of the seabed in the Lunskoye Field. Coverage is almost continuous (68%), with areas of coarse sands (18%), aleurite-pelite [(1)] fractions (8%), small areas of gravel appearing in the north (6%), and areas with no sediment towards the northwestern and central areas. The depth of sediment ranges from 3 to 4 cm to 1 to 1.5 m elsewhere in the field. These surface sediments are underlain by a layer of gravel with a maximum thickness of 0.8 m. Beneath this gravel is a layer of greenish-grey soft plastic clay.

There are two gas accumulation outcrops within the field, and an area of boulders of unknown origin has been observed towards the northern boundary.

The two main inputs of sedimentary material to the Lunskoye Field originate in the north and from beaches on the upper part of the shelf.

4.5.3 *Seabed Sediment Contamination Analysis*

Metal Analysis

There are currently no Russian metal standards that can be directly applied to marine seabed sediments. Until such standards can be developed an analogy is often used between the metal concentrations of seabed sediments and terrestrial soils, for which heavy metal MACs have been introduced. Data from sediment analyses undertaken in the Piltun-Astokhskoye, Lunskoye and Aniva Bay areas were evaluated against terrestrial soil cover MACs, which indicated that the Lunskoye Field was not influenced directly or indirectly by anthropogenic pollutant metal sources. Metals tested included iron, zinc, barium, chromium, copper, arsenic, lead, cadmium and mercury (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

Radionuclide Activity

Radionuclide activity analysis of Lunskoye Field sediments indicate that α and β radiation levels are within the normal expected range for clean sediment (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

Hydrocarbons

Hydrocarbon analysis of Lunskoye Field seabed sediments indicates no petroleum or polyaromatic hydrocarbon pollution (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

(1) Pelites are metamorphic rocks derived from clay-rich sediments.

4.6 COASTAL LANDSCAPE

The coastline of Sakhalin Island can be divided into three character types:

- steep coastlines with low mountains terminating at the sea – land boundary which occur predominantly in the mid-latitudes of the island;
- level coastlines with lakes and shallow bays, which occur predominantly in the Sakhalin Shelf to the north of the island;
- intermediate undulating coastlines punctuated by bays and river mouths.

The coastline in the vicinity of the Lunskoye Field comprises narrow inlets, shallow lakes and bays including Piltun, Chaivo, Lunsky, Nabilsky and Nivsky Bays (see *Figure 12).* The coastal zone consists mainly of low-lying marshland areas, with a chain of lakes of marine origin separated from the sea by sand dunes and spits.

No major watercourses discharge to the marine environment in the vicinity of the Lunskoye Field (see *Figure 13*).

4.7 GEOLOGICAL ENVIRONMENT AND SEISMIC STABILITY

4.7.1 *Sea of Okhotsk and Sakhalin Island*

The Sea of Okhotsk region is seismically unstable with regular earthquakes. Northern Sakhalin experiences predominantly crustal earthquakes with focal depths of 0 to 35 km. Earthquakes with wave magnitude (M_{LH}) of approximately 5.0 and greater are associated with large basement faults, and 90% of major earthquakes occur in areas of fault intersection. More minor earthquakes with M_{LH} equal to or smaller than 4.5 have a less predictable distribution throughout the area.

4.7.2 *Lunskoye Field*

The Lunskoye Field is part of the Niisk anticlinal (1) zone that extends for some 110 km along the shelf of northeastern Sakhalin, and includes the Lunskoye anticlinal fold. Within the field, systematic networks of predominantly strike-slip diagonal faults (2) divide the area into six major fault blocks with down-thrown blocks (3) to the north. The faulted Lunskoye anticline is the trapping structure for the field's hydrocarbon reserves (4).

(1) An anticline or anticlinal structure is formed when rock is folded into the shape of an arch.
(2) The fault surface is vertical or close to vertical in a strike-slip fault. The two fault blocks formed then move sideways past each other.
(3) Blocks cast downwards relative to other blocks of rock by the movement of faults.
(4) A hydrocarbon trap may comprise a layer of low permeability sediment, or as is the case for reserves within the Lunskoye Field, a structural trap such as an anticline.

4.8 MARINE INVERTEBRATE AND FISH COMMUNITIES

The Sea of Okhotsk is amongst the most productive areas of ocean in the world, supporting a high level of bioproductivity and diversity of species. This is due to the variety of natural conditions in the region such as the exchange of water with the North Pacific and Sea of Japan, circulation patterns, the large shelf environment, the substantial amount of organic matter produced on the shelf, and low pollution concentrations. The following sections describe the different species that make up the biological environment within the Sea of Okhotsk, Lunskoye Field and coastal environment of northeastern Sakhalin Island.

4.8.1 *Planktonic Communities*

Plankton are a collection of small or microscopic organisms, including algae, bacteria and protozoa, that float or drift in the water column at or near the surface. They may be classified as phytoplankton or zooplankton.

Phytoplankton

Phytoplankton are often the main primary producers in the marine environment and include the species groups diatoms, desmids (microscopic green algae) and dinoflagellates. During the summer months when the Sea of Okhotsk is free of sea ice, primary productivity rises rapidly and is dominated by siliceous plankton (Komex, 2002). Populations are unevenly distributed due to the circulation patterns in the sea and are concentrated around the Kamchatka Peninsula and in the northern areas (NOAA, 2002).

The offshore areas to the north and northeast of Sakhalin Island are characterised by large spring and summer phytoplankton blooms, which may be evident until October, and autumn diatom blooms (1) where diatom biomass can reach 5,000 to 10,000 mgm^{-3} (Komex, 2002).

The estimated annual production of bacteria and protozoa in the Sea of Okhotsk is 5.2×10^9 and 2.1×10^9 tonnes respectively (NOAA, 2002).

Zooplankton

Zooplankton populations are dominated by *Pseudocalanus minutes, Oithina similes*, *Metridia ohkotensis*, *M.pacifa*, *Calanus crisatus*, *C.plumchrus*, *C.glacialis*, *Thysanoessa raschii*, *T.longipes*, *T.inermis* and *Euphasia pacifica*. The total annual zooplankton production from the Sea of Okhotsk is 3×10^9 tonnes (NOAA, 2002).

The zooplankton also contain the macroplankton group, which represents planktonic organisms 200 to 2,000 micrometers (µm) in size and ichthyoplankton which are fish eggs, newly hatched eggs (fry), young fish,

(1) Large increases in plankton production, mainly associated with changes in nutrient level, water temperatures or de-stratification of water layers.

and adults of small fish. The most abundant ichthyoplankton are navaga, starry flounder, Berg's bullhead, herring and smelt. Monitoring information from the year 2000 indicates that the Lunskoye Field borders an area of high productivity with the greatest diversity of ichthyoplankton including fish eggs and mintai (walleye Pollock) and capelin larvae.

4.8.2 *Benthic Communities*

A large range of invertebrates populates the marine benthic environment of the Sea of Okhotsk. Those living within (infauna) or on (epifauna) the seabed are referred to as benthic organisms or benthos. Foraminifera (single celled organisms), sponges, copepods (shrimp-like crustaceans), bivalve molluscs, barnacles, echinoderms (invertebrates with radial symmetry *eg* sea urchins, starfish and sea cucumbers), polychaetes (segmented worms *eg* sandworms and lugworms), nemerteans (ribbon worms), decapods (crustaceans with five pairs of legs *eg* shrimps and crabs) and tunicates (sea squirts) have been observed (NOAA, 2002).

Benthos sampling within the Lunskoye Field has identified 183 species of marine macrozoobenthos (1) from 18 faunal groups, showing the benthic biota within the area to be highly diverse. The diversity of species is found to be highest among the bristleworms (Polychaeta) with 69 species being observed. The group with the second highest species diversity was found to be the amphipods (2) with 56 species, followed by bivalves (3) with 16 species being recorded (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

4.8.3 *Fish Communities*

The northeastern Sakhalin area is host to some 101 species of fish, and in the Lunskoye Field, 23 species of fish from 12 different families have been recorded. Species in the field are both migratory (marine and anadromous (4)) and non-migratory.

The Sakhalin Taimen, salmon and char (5) are anadromous fish, and the mintai is migratory within the marine environment. Salmon, char and the Sakhalin Taimen are observed mainly to the east of Sakhalin Island in the summer and autumn months, but migrate to freshwater to spawn. Eggs remain in this freshwater environment through hatching and embryonic larval development, before migrating downstream to the sea. Mintai migrate within the Sea of Okhotsk, and spawn to the east of Sakhalin Island (see *Section 4.12.4* and *Figure 14*).

(1) Multi-cellular animals inhabiting the sediments and detritus at the bottom of a water body.
(2) Small shrimp-like crustaceans. They are marine invertebrates that have an exoskeleton and jointed appendages.
(3) Bivalves are a class of organisms with two shells. The three main types are clams, oysters, and scallops.
(4) Migrating to freshwater to spawn.
(5) Otherwise known as the blueback trout, ilkalupik or martson trout.

4.9 MARINE MAMMALS

This section provides background information on the status, species composition, distribution, abundance, and seasonal dynamics of marine mammals in the general Sakhalin Island and Sea of Okhotsk region, and more specifically, in the vicinity of the Lunskoye Field. It then discusses in more detail the status of the endangered Okhotsk-Korean population of gray whale (western gray whale) within these areas. Classifications used include those of IUCN (see *Section 2.2.2*) and the *Red Book of the Russian Federation* (see *Section 2.4*).

4.9.1 Pinnipeds

The eastern Sakhalin Island region is one of the major reproductive regions for pinnipeds in the Sea of Okhotsk. The total numbers of pinnipeds in this area have not changed significantly since the 1980s (Perlov *et al.* 1996). Six species of pinnipeds occur in the area, including four species of true or ice seals, ringed seals (*Phoca hispida*), largha seals (*Phoca largha*), ribbon seals (*Histriophoca fasciata*) and bearded seals (*Erignathus barbatus*), which are closely associated with the ice through the winter to spring season; as well as two species of eared seals, the northern fur seal (*Callorhinus ursinus*) and the Steller sea lion (*Eumetopias jubatus*), which are mainly open-water visitors to the area.

The sections below provide species accounts, with a summary provided in *Table 4.2*. Pinniped distributions are shown in *Figure 15*.

Ringed Seals

Ringed seals (*Phoca hispida*), are generally regarded as the most numerous northern pinniped. They are classified as Least Concern on the IUCN *Red List* (IUCN, 1996 (1), see *Chapter 2)* and are harvested in the Sea of Okhotsk (see *Section 4.12.5*). Sealing was unregulated between 1955 and 1968 and the average annual catch during this time was about 78,500 ringed seals (Fedoseev, 2000). Since then, sealing has been restricted and is now subject to compliance monitoring and scrutiny by scientific review committees.

Ringed seals are found along the entire eastern coast of Sakhalin Island (Fedoseev 1971). Based on ten years of aerial surveys conducted between 1968 and 1990, estimated numbers in the Sea of Okhotsk ranged from 650,000 to 750,000, with an average of 725,000. The multiyear average in the waters of eastern Sakhalin Island was 130,000 (Fedoseev 2000). Between year variation in the population was low, about 20% (Fedoseev 2000), but two surveys along the eastern coast of Sakhalin Island in 1968 and 1969 showed greater fluctuations in numbers. In 1968 and 1969, respectively, the estimated ringed seal populations were 28,500 and 138,000 on northeastern Sakhalin Island, and 15,000 and 40,000 on southeastern Sakhalin Island (Fedoseev, 1971). More

(1) Some species included within the 2002 IUCN *Red List of Threatened Species* were not reassessed by the organisation. In these cases they are referenced with the date of the last assessment *eg* the status of ringed seals was assessed by the IUCN as being of *Least Concern* in 1996.

recently, a 'most likely average value' of 80,000 to 90,000 has been used by the Russian Federation to calculate total admissible catch for eastern Sakhalin Island (*pers comm* V. Vladimirov, 2002).

Ringed seals breed, whelp and moult on the ice, often forming large concentrations during the winter to spring months. As the ice thickens in late autumn and winter, ringed seals maintain openings in ice more than 2 m thick to breathe. As snow accumulates over breathing holes the seals may excavate lairs.

Ringed seals in the Sea of Okhotsk give birth on shore-fast ice, not in lairs as they do in other areas. The highest densities of breeding adults are found on stable land-fast ice, while non-breeders concentrate on the moving pack ice. The species remains in the region during the open water period and are found hauled out on land and in nearshore waters during the summer. During the spring, summer, and autumn, ringed seals spend most of their time swimming and feeding among the ice floes. They are often described as being cautious and easily disturbed by human activity (Nowak, 1999; Burns and Harbo, 1972; Burns and Frost, 1979 and Alliston, 1981).

Small numbers of ringed seals may occur onshore and in nearshore waters near the Lunskoye Field. In summer 1999, ringed seals were present at some rookeries (traditional locations of annual breeding aggregations) and scattered along the coast in the area surveyed, from Nyiskii Bay to Piltun Bay (Sobolevsky, 2000). In 2000, their distribution was similar in the larger area surveyed (Lunsky Bay to Piltun Bay), but their numbers had increased in Chaivo and Piltun bays (Sobolevsky, 2001).

Largha Seals

Largha seals (*Phoca largha*), also known as spotted seals, are classified as Least Concern on the IUCN *Red List* (IUCN 1996, see *Chapter 2*), and are harvested in the Sea of Okhotsk. Largha seals are found off the northeastern coast of Sakhalin Island throughout the year and are closely associated with the ice through much of this time (Sobolevsky, 1984). Based on ten years of aerial surveys conducted between 1968 and 1990, estimated numbers in the Sea of Okhotsk ranged from 180,000 to 240,000, with about 15 to 20% in the waters of eastern Sakhalin Island (Fedoseev, 2000). Two surveys along the eastern coast of the island in 1968 and 1969 showed that populations were fairly stable during that period, numbering 12,000 to 13,000 animals (Fedoseev, 1971). More recently, numbers off eastern Sakhalin Island have exceeded 40,000 (Trukhin, 1999). A 'most likely average value' of 30,000 to 40,000 has been used by the Russian Federation to calculate total admissible catch for eastern Sakhalin Island (*pers comm* V. Vladimirov, 2002).

Largha seals show an annual migration in the autumn and winter to the edge of the pack ice. Breeding takes place in late winter and spring and after breeding the seals stay on the ice to moult. Pups are born between February and March, and are weaned at one-month. The seals move back to shore in the spring as the ice retreats. During the summer, largha seals gather at

approximately 54 rookeries at the mouths of rivers and on coastal bars along the south and east coasts of Sakhalin Island, including Lunsky, Nabilskyi, and Aniva bays (Kosygin *et al.* 1986, Lagerev, 1988, Perlov *et al.* 1996). In July 2000, three rookeries with a total estimated 600 to 800 individuals, and in August 2000, four rookeries with a total estimated 4000 to 5000 individuals were observed on a sand spit at the entrance to Chaivo Bay, waiting for the annual migration of Pacific salmon (Sobolevsky, 2001). In August 2000, one rookery with more than 500 individuals was recorded at the mouth of Piltun Bay (Sobolevsky, 2001), and in 1998, 15 to 489 largha seals were counted during systematic shore-based counts in Piltun lagoon between 23 July and 28 September. There was a noticeable peak in late August that appeared to coincide with seasonal herring and salmon runs (Bradford *et al.* 1999). In July 2000, more than 50 and 38 individuals were in recorded at the mouths of Nabilskyi Bay and Lunsky Bay, respectively. In August, numbers increased to more than 100 at the mouth of Lunsky Bay, but remained the same at Nabilskyi Bay, possibly due to disturbance from the continuous presence of fishermen in the bay (Sobolevsky, 2001). Rookeries were not present at Lunsky and Nabilskyi bays in September, and almost no seals were found at the mouth of these bays in October (Sobolevsky, 2001).

Adult seals feed on fish, cephalopods and crustaceans, whereas newly weaned pups are thought to feed on small amphipods found around the ice floes (few data are available on ice biota from this region). When hauled out on ice or land, largha seals are very sensitive to approaches by aircraft, often moving into the water when the aircraft is still at a lateral distance of one km (Frost and Lowry, 1990; Frost *et al.* 1993; Rugh *et al.* 1993).

Largha seals are likely to be observed in the vicinity of the Lunskoye Field, in moderate numbers at the mouths of Lunsky and Nabilskyi bays in July and August, either in rookeries on shore or swimming in the water.

Ribbon Seals

Ribbon seals (*Histriphoca fasciata*) are classified as Least Concern by the IUCN (IUCN 1996), and are harvested in the Sea of Okhotsk. The average annual catch during the period of unregulated sealing (1955 to 68) was up to 13,000 (Fedoseev, 2000), but since that time sealing has been restricted. Ribbon seals are found off the northeast coast of Sakhalin Island with a concentration from Lunsky Bay to Chaivo Bay during the winter and spring (Fedoseev, 1997;Kosygin *et al.* 1985). Based on ten years of aerial surveys conducted between 1968 and 1990, estimated numbers in the Sea of Okhotsk ranged from 200,000 to 630,000, with an average of 350,000 to 450,000. The average in the waters of eastern Sakhalin Island was 110,000 (Fedoseev, 2000). Two surveys along the eastern coast of Sakhalin Island in 1968 and 1969 showed that fluctuations in numbers might be significant for ribbon seals (Fedoseev, 1971). In 1968 and 1969, respectively, the estimated ribbon seal populations were 47,000 and 27,000 on northeastern Sakhalin Island, and 30,000 and 10,000 in southeastern areas.

Between 1975 and 1990, a trend of rapid growth and early maturation led to population increases (Fedoseev and Volokhov, 1991). Average population

estimates for the 1988, 1989, and 1990 surveys were some 550,000 in the Sea of Okhotsk (Fedoseev, 2000). More recently, a 'most likely average value' of 110,000 has been used by the Russian Federation to calculate total admissible catch for eastern Sakhalin Island (*pers comm* V. Vladimirov, 2002).

Ribbon seals apparently prefer to haul out on thick ice where they give birth and moult in the spring. They are rarely observed hauled out on land. During the summer and autumn, the seals become completely pelagic and are typically found far from shore. They are reportedly easy to approach and are not easily disturbed (Nowak, 1999).

Because of their offshore distribution in summer, ribbon seals are not considered to likely occur near to the Lunskoye Field.

Bearded Seals

Bearded seals (*Erignathus barbatus*) are classified as Least Concern on the IUCN *Red List* (IUCN 1996, see *Chapter 2*), and are harvested in the Sea of Okhotsk. The average annual catch during the period of unregulated sealing (1955-68) was about 10,000 bearded seals (Fedoseev, 2000), but since that time sealing has been restricted. They are strongly associated with the ice and they tend to be concentrated to the north of the Sea of Okhotsk. Fedoseev (2000) estimated that there are 200,000 to 250,000 bearded seals in the Sea of Okhotsk, including 60,000 to 75,000 in the waters to the east of Sakhalin Island.

Bearded seals are usually found in shallow waters over the continental shelf, avoiding areas of continuous, thick, shore-fast, or drifting ice, but favouring moving ice with numerous open water gaps. During the winter and spring, (beginning in February, Kosygin *et al.* 1985), they occur along the entire northeastern coast of Sakhalin Island (Fedoseev, 1971). In summer, they are scattered along the northeast and west coasts in low numbers, occurring at some rookeries but not in large numbers (Nevelosky, 2000, 2001). The only known large haul-out locations are gravel beaches on the northwestern coast, where they come on shore in large numbers (approximately 2,000) during the summer to rest and moult (Kosygin *et al.* 1986). The seals often stay close to the water when hauled out and will typically dive immediately if disturbed (Burns and Harbo, 1972; Burns and Frost 1979; Alliston, 1981 and Nowak 1999).

Small numbers of bearded seals may occur on shore and in nearshore waters in the vicinity of the Lunskoye Field. In summer 1999, bearded seals were present at some rookeries and scattered along the coast in the areas surveyed (from Nyiskii Bay to Piltun Bay), but were not common and were observed only as single individuals (Sobolevsky, 2000). In 2000, the distribution was similar in the area surveyed (Lunsky Bay to Piltun Bay), but they occurred in groups of 5 to 10, and more were seen in coastal rookeries than in 1999 (Sobolevsky, 2001).

Northern Fur Seals

Northern fur seals (*Callorhinus ursinus*) are listed as Vulnerable on the IUCN *Red List* (IUCN, 2002) but are considered to be a harvested species in Russia. In the Sea of Okhotsk, the total population may be as high as 120,000 individuals. Approximately 75 to 80,000 individuals are found in a rookery on Robben (Tuyleni) Island, southeast of Cape Terpeniie, and in adjacent waters eastward of the Island (Vladimirov, 2001). Most northern fur seals are found along the southeastern coast of Sakhalin Island.

Feeding on small schooling fish and cephalopods, especially squid (Sobolevsky, 1984), the northern fur seal is a highly pelagic species, with only young fur seals spending appreciable amounts of time on land. Fur seals concentrate in areas of upwelling over seamounts and along continental slopes, and are rarely encountered close to shore except in the vicinity of rookeries. The species typically winter in the Sea of Japan, moving north in the spring to return to established rookeries. Most pups are born from late June to late July and are weaned at 3 to 4 months. While breeding males may remain at the rookeries for the entire breeding season, females return regularly to sea.

Large numbers of fur seals were killed for their pelts in the 19th and early 20th centuries; there have also been significant numbers killed incidentally by entanglement in fishing nets (Lander and Kajimura, 1982).

Northern fur seals may occur in small numbers on shore and in nearshore waters close to the Lunskoye Field. In summer 2000, they were observed at some rookeries during surveys from Lunsky Bay to Piltun Bay (Sobolevsky, 2001).

Table 4.2 ***Pinnipeds Occurring off the East Coast of Sakhalin Island***

Taxon (Common Name, Species)	Region of Maximum Abundance	Season of Maximum Abundance	Local Abundance[1]	Activity	Estimated Total # in Sea of Okhotsk[1]	Harvest	Red Book of Russia Status[2]	IUCN Status[3]
Steller sea lion *Eumetopias jubatus*	Robben (Tiulenii) Island & Kamen' Opasnosti Rock	March–November	>1,000	Pupping Molting, Feeding	9,500-10,000	No	2	EN-A1b (2002)
Northern fur seal *Callorhinus ursinus*	Robben (Tiulenii) Island	June–September	75,000-80,000	Pupping Molting	120,000	Yes, Sea of Okhotsk		VU-A1b (2002)
Bearded seal *Erignathus barbatus*	Entire east coast	February–May	60,000–75,000	Pupping Molting	200,000-250,000	Yes, Sea of Okhotsk		LR-lc (1996)
Largha or spotted seal *Phoca largha*	Entire east coast	Jan-June on ice; July–Oct on the coast	27,000-48,000	Pupping, Molting, Feeding	180,000-240,000	Yes, Sea of Okhotsk		LR-lc (1996)
Ribbon seal *Histrio-phoca fasciata*	NE coast with a peak from Lunsky Bay to Chayvo Bay	February–May	110,000	Pupping Molting	200,000-630,000	Yes, Sea of Okhotsk		LR-lc (1996)
Ringed seal *Phoca hispida*	Entire east coast	April–June	130,000	Pupping Molting	650,000-750,000	Yes, Sea of Okhotsk		LR-lc (1996)

[1] Fedoseev 2000
[2] Status 1 = endangered and under threat of extinction; 2 = vulnerable; 3 = rare and numbers are declining; 4 = small population, numbers difficult to estimate, and/or species is at the limits of its range.
[3] Codes for IUCN classifications: EN = Endangered; VU = Vulnerable; Lr-lc = Lower Risk-Least Concern. LR-lc not included in 2000, 2002 lists. Other classifications are from the 2002 IUCN Red List of Threatened Species, although the status of marine mammals has not been reassessed since 1996.

Steller Sea Lions

Steller sea lions, (*Eumetopais jubatus*), are listed as Endangered in the *Red Book of the Russian Federation* and on the IUCN *Red List* (IUCN, 2002). Steller sea lions have undergone dramatic declines in population across large portions of their range. Approximately 9,500 to 10,000 Steller sea lions now inhabit the Sea of Okhotsk (*pers comm* V. Vladimirov, 2002). During the open water season, over 1000 Steller sea lions form rookeries on Robben (Tuyleni) Island and a haulout on Kamen' Opasnosti Rock (near Cape Krilyon on the south coast) (Kuzin, 2001). During the summer, animals may be seen along the entire eastern side of Sakhalin Island and across the northern section of the island into Amurskiy Bay. In September 1982, more than 200 Steller sea lions were recorded along the western coast in the Tatar Straits (Berzin *et al.* 1984).

Wall-eyed pollock and octopus dominate the diet of Steller sea lion (Sobolevsky, 1984). Rookeries tend to be located on remote, rocky coasts and islands. The number of individuals at rookeries begins to increase in early May and reaches a maximum in July. Females give birth from mid-May to mid-July, with most births occurring in early June.

Steller sea lions are not generally observed in the Lunskoye Field area, and no individuals were observed in the summer 2000 surveys from Lunsky Bay to Piltun Bay (Sobolevsky, 2001). Their closest large rookery is more than 300 km to the south.

4.9.2 *Cetaceans*

Seventeen species of cetaceans are known to occur in the waters to the east of Sakhalin Island (see*Table 4.3*). Populations of four of those species, the bowhead whale (*Balaena mysticetus*), North Pacific right whale (*Eubalaena japonica*), fin whale (*Balaenoptera physalus*) and western gray whale (*Eschrichtius robustus*), have been greatly reduced through decades of mechanised and unregulated commercial whaling. Five species are currently listed in the *Red Book of the Russian Federation* (Krasnaya Kniga RFZ, 2001), and six species are listed as Endangered, or Vulnerable in the IUCN *Red List* (IUCN, 2002) (*Table 4.3*). One species, the western gray whale, is considered to be highly sensitive and has been listed as Critically Endangered by the IUCN.

The cetacean species most likely to be encountered near the Lunskoye Field in summer-autumn are western gray whales, minke whales (*Balaenoptera acutorostrata*), killer whales (*Orcinus orca*), harbour porpoise (*Phocoena phocoena*), and common dolphin (*Delphinus delphis*). Beluga whales (*Delphinapterus leucas*) are most likely to be seen during their spring migration. The other cetacean species listed in *Table 4.3* occur in greatest numbers to the south of the Lunskoye Field, from Terpeniie Point to Aniva Bay, and are likely to be rare or absent in the Lunskoye Field. No cetaceans are likely to be in the vicinity during the winter, with the possible exception of bowhead whales and beluga whales near the ice edge. Cetacean distributions are presented in *Figures 16* and *17*.

The sections below provide information on the species of cetaceans that can be observed within the Lunskoye Field area. Due to the international importance and sensitivity of the Critically Endangered western gray whale, this species is considered separately within *Section 4.9.3*.

Table 4.3 *Cetaceans Occurring off the East Coast of Sakhalin Island*

Taxon (Common Name, Species)	Region of Maximum Abundance	Season of Maximum Abundance	Local Abundance	Total numbers in the Sea of Okhotsk	Red Book of Russia status (2000)[1]	IUCN status[2]
Baleen whales (Mysticetes)						
Western gray whale *Eschrichtius robustus*	East coast, esp. off Piltun and Chaivo Bays	May–November	~100	~250?	1	CR-D (2002)
Bowhead whale *Balaena mysticetus*	North and east coasts, near the ice edge	February–March	50—100	300–400	1	EN-D (2002)
North Pacific right whale *Eubalaena japonica*	East coast, esp. around Cape Terpeniie	July–September	150–200	800-900?	1	EN-D (2002)
Fin whale *Balaenoptera physalus*	East coast	June–September	400–600	~2,700	2	EN-A1abd (2002)
Minke whale *Balaenoptera acutorostrata*	East coast	June–September	3,000–3,500	~19,000		LR-nt (2002)
Toothed whales (Odontocetes)						
White whale *Delphinapterus leucas*	NE coast north of Nyiskii Bay	May–June	400–500	20,000–25,000		VU-A1abd (2002)
Harbour porpoise *Phocoena phocoena*	East coast	Summer	Common	Common		VU-A1cd (2002)
Sperm whale *Physeter macrocephalus*	Around Cape Terpeniie & Cape Aniva	June–September	200–300	~1,000		VU-A1bd (2002)
Dall's porpoise *Phocoenoides dalli*	Terpeniie Bay	June–September	3,500–4,000	20,000–25,000		LR-cd (2002)
Orca (killer whale) *Orcinus orca*	East coast, esp. in/near Terpeniie Bay	June–October	300-400	2,500-3,000		LR-cd (2002)
Short-finned pilot whale *Globicephala macrorhynchus*	Cape Aniva	Summer	Not known	Not known		LR-cd (2002)

Taxon (Common Name, Species)	Region of Maximum Abundance	Season of Maximum Abundance	Local Abundance	Total numbers in the Sea of Okhotsk	Red Book of Russia status (2000)[1]	IUCN status[2]
Baird's beaked whale *Berardius bairdii*	Aniva Bay and east of Cape Terpeniie	June–October	250–300	1,000–1,500		LR-cd (2002)
Short-beaked common dolphin *Delphinus delphis*	East of Sakhalin Island	Summer	Not known	Not known		LR-lc (1996)
Pacific white-sided dolphin *Lagenorhynchus obliquidens*	Cape Aniva	Summer	Not known	Not known		LR-lc (1996)
Northern right whale dolphin *Lissodelphis borealis*	East of Terpeniie Bay, Cape Aniva	Summer	Not known	Not known		LR-lc (1996)
Cuvier's beaked whale *Ziphius cavirostris*	Southern Sakhalin Island	Summer	Not known	Unknown	3	DD (2002)
Bottlenose dolphin *Tursiops truncates*	Cape Terpeniie to Aniva Bay	Summer	Not known	Not common		DD (2002)

*1 Status 1 = endangered and under threat of extinction; 2 = vulnerable; 3 = rare and numbers are declining; 4 = small population, numbers difficult to estimate, and/or species is at the limits of its range.
*2 Codes for IUCN classifications: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR = Lower Risk (-cd = Conservation Dependent; -nt = Near Threatened; -lc = Least Concern); DD = Data Deficient. LR-lc is not included in 2000 or 2002 lists. Other classifications are from the 2002 IUCN *Red List of Threatened Species,* although the status of marine mammals has not been reassessed since 1996.

Bowhead Whales

Bowhead whales (*Balaena mysticetus*) found in the Sea of Okhotsk are listed as Category 1 (Endangered) in the *Red Book of the Russian Federation* (Krasnaya Kniga RFZ, 2001). The IUCN designates the species as a whole as Lower Risk-Conservation Dependent, but also designates distinct populations independently; the Sea of Okhotsk population is classed as Endangered (IUCN, 2002). Prior to commercial whaling, which began in the 19th century, the Sea of Okhotsk population of bowheads probably consisted of approximately 6,000 animals. During the 19th and early 20th centuries, the species was heavily harvested, especially in the western, central and northern parts of the Sea of Okhotsk. By the early 20th century, the population was on the verge of extinction. After a complete ban on whaling, its numbers appear to have been slowly increasing. Today, bowheads still only occur in two areas of the Sea of Okhotsk, in the northeastern part of its former range (Gizhiginskaya and Penzhinskaya bays), and towards the west, near Shantarskie Island and in Konstantin, Ulbanskii, and Tugurskii bays (Perlov *et al.* 1996). The total size of the Sea of Okhotsk population is currently estimated to be 300 to 400 animals (Vladimirov, 1994). During winter, 50 to 100 bowheads stay near the ice edge along the north and east coasts of Sakhalin Island.

Bowhead whales are only known to be present off the northeastern coast of Sakhalin Island in February and March.

North Pacific Right Whales

North Pacific right whales (*Eubalaena japonica*) were formerly classified as the same species as North Atlantic right whales (*E. glacialis*). Recent genetic studies have resulted in recognition that the North Pacific form is a separate species (Rosenbaum *et al.* 2000). North Pacific right whales are listed as Endangered (Category 1) in the *Red Book of the Russian Federation* (Krasnaya Kniga RFZ, 2001), and Endangered by the IUCN [(1)] (IUCN, 2002). The IUCN designation is likely to change with the reclassification of the North Pacific population as a separate species. Right whales are particularly susceptible to collisions with ships because they are slow, spend much time at the surface, and in some areas use habitats in the vicinity of major shipping lanes (Clapham *et al.* 1999).

North Pacific right whales were once abundant in the Sea of Okhotsk. Prior to industrial whaling, the number of individuals was perhaps around 10,000 animals in the region. However, over-exploitation from the 1840s to the 1920s drastically reduced the numbers of this species. At one time, population levels were so low it was thought that the species had become extinct. All right whales were protected from commercial whaling in the 1930s, and in 1946, the International Whaling Commission (IWC) declared the North Pacific

(1) The IUCN still considers the species to be a N. Pacific stock of *E. glacialis*.

right whale completely protected. Those measures resulted in a slow increase of the total population numbers, until by the 1970s there were perhaps 200 to 400 individuals throughout the North Pacific range. Current population estimates for the species are largely speculative and range from 100 to the low thousands, however, most authorities tend toward the lower end of this range (Brownell *et al.* 2001a). It has been proposed that as many as 800 to 900 right whales inhabit the Sea of Okhotsk (Vladimirov, 1994) and that 150 to 200 animals stay in waters off the east coast of Sakhalin Island during summer and autumn.

In the eastern region of Sakhalin Island, North Pacific right whales have been reported occasionally, and they may rarely move through, or adjacent to, the Lunskoye Field. Sporadic sightings in the past 30 years have indicated that the whales use various locations throughout the Sea of Okhotsk (Kuzmin, and Berzin, 1975), including Sakhalin Island's eastern coast. In 1967, approximately 70 North Pacific right whales were observed in the area of Terpeniie Bay, and solitary animals were seen along Sakhalin Island up to its northern tip (Berzin, and Vladimirov, 1989). Recently, both solitary individuals and small groups of North Pacific right whales have been reported off the east coast of Sakhalin Island (Shuntov, 1994). In 1992, nine North Pacific right whales were observed far offshore to the south of Piltun Bay. The same year, seven whales were observed in the area between the northern end of Sakhalin Island and Cape Terpeniie, and in 1993, two individuals were observed in the area east of Cape Terpeniie. One was sighted about 95 km off Lunsky Bay in 1992 (Myashita and Kato, 1998 in Brownell *et al.* 2001a), and one individual was found stranded in Lunsky Bay in 1939 (Tomilin, 1957 *in* Brownell *et al.* 2001a).

Fin Whales

Fin whales (*Balaenoptera physalus*) are are listed as Vulnerable (Category 2) in the *Red Book of the Russian Federation* (Krasnaya Kniga RFZ, 2001), and classified as Endangered by the IUCN (IUCN, 2002). The fin whale used to be one of the most numerous species of great whales. The population was drastically reduced by intensive whaling, but has since gradually increased in size and at present is estimated number approximately 2,700 individuals in the Sea of Okhotsk (Vladimirov, 1994), 400 to 600 of which inhabit the waters of eastern Sakhalin Island during the summer and autumn. Fin whales feed on fish, cephalopods, and planktonic crustaceans. Some individuals are present year round in the Sea of Okhotsk. They move into the area from the Pacific Ocean through the straits in the Kuril Islands and from the Sea of Japan through La Perouse Strait.

It is possible that fin whales may be observed in the vicinity of the Lunskoye Field, as although predominantly a pelagic species, individuals sometimes occur in shallow water, both along the coast and offshore (Perlov *et al.* 1996, 1997).

Minke Whales

Minke whales (*Balaenoptera acutorostrata*) are designated as Near Threatened by the IUCN (IUCN, 2002). They are the most numerous of the baleen whales remaining in the Sea of Okhotsk. They are widely distributed and tend to stay in large bays. They feed mainly on crustaceans and fish, although their diet varies greatly with the season. Minke whales are found along the entire east coast of Sakhalin Island. They are usually encountered in Terpeniie and Sakhalin bays (Sobolevsky, 1984). About 19,000 individuals occur in the Sea of Okhotsk (Buckland *et al.* 1992; Vladimirov, 1994), and 3,000 to 3,500 are estimated to inhabit the area east of Sakhalin Island. Minke whales are noted for their curiosity about ships (Perrin and Brownell, 2002).

Sperm Whales

Sperm whales (*Physeter macrocephalus*) are not considered endangered in the Sakhalin region but are listed as Vulnerable by the IUCN [(1)] (IUCN, 2002). They occur throughout the eastern and southern regions of the Sea of Okhotsk, but the waters offshore from the Kuril Islands appear to be the centre of distribution for this species in the region. During the summer and autumn period, the total population of sperm whales within the Sea of Okhotsk is estimated to be 1,000 individuals (Vladimirov, 1994). Sperm Whales mainly feed on cephalopods, but also eat some fish. Approximately 200 to 300 sperm whales are believed to inhabit waters seasonally along eastern Sakhalin Island; they are most frequently seen around Cape Terpeniie, Cape Aniva and adjacent waters. Because of the absence of focused research, most observations are anecdotal and often unreliable (Perlov *et al.*, 1996, 1997).

Sperm whales are not likely to be encountered in the Lunskoye Field area, as the whale is a deep-water species and is rarely seen over continental shelves, *ie* inshore of the shelf break.

Killer Whales

Killer whales, or orcas (*Orcinus orca*), are designated as Conservation Dependent by the IUCN (IUCN, 2002). They are found throughout the Sea of Okhotsk, especially along the coasts. This species is frequently encountered in the vicinity of the Kuril Islands, western Kamchatka, and in the northern and southern parts of the Sea of Okhotsk. In total, 2,500 to 3,000 animals are estimated to inhabit the Sea of Okhotsk (Vladimirov, 1994). Killer whales occur along the entire eastern coast of Sakhalin Island, and the total number estimated to occupy waters near Sakhalin Island may be as high as 300 to 400 animals.

Killer whales are likely to be observed in the Lunskoye Field area as it was the only abundant species, except for the western gray whale, recorded during aerial surveys of the waters from Lunsky Bay to Piltun Bay in 2000 and from

(1) The IUCN uses the name *Physalis catadon* for the sperm whale.

Nyiskii Bay to Piltun Bay in 1999 (Sobolevsky, 2000, 2001). Most sightings were of single individuals or small groups. The largest group seen, containing 25 to 30 individuals, was about 10 km from the coast in waters 40 to 45 m deep. This aggregation was thought to be possibly associated with the beginning of the hunchback salmon run along the coast (Sobolevsky, 2000).

White Whales

White whales (*Delphinapterus leucas*), also known as belukhas or belugas, are designated as Vulnerable by the IUCN (IUCN, 2002), but are not considered endangered in the Sakhalin region. They are abundant throughout the Sea of Okhotsk, although their distribution is variable. There are three populations of white whales in the Sea of Okhotsk (Perlov *et al.* 1996, 1997):

- the Sakhalin-Amur population (7,000 to 10,000 individuals);
- the Shantar population (3,000 to 5,000);
- and the North-Okhotsk population (about 10,000).

The total number of white whales inhabiting the Sea of Okhotsk during the summer and autumn is estimated to be 20,000 to 25,000 individuals (Vladimirov, 1994). White whales do not permanently inhabit the waters off eastern Sakhalin Island, but are present in relatively small numbers (400 to 500 individuals) in the waters off northeastern and northern parts of the island during spring migration. Areas where white whales are known to form large and stable concentrations are: Sakhalin Bay, bays on the Shantarskie Islands, and Gizhiginskaya and Penzhinskaya bays. These areas are a significant distance from the eastern coast of Sakhalin Island, but observations made more than a century ago indicated the existence of white whales in Terpeniie Bay and in the Poronai River. Arsen'ev (1939) reported that, in the 1930s, white whales were sometimes observed along the eastern coast of Sakhalin Island. Adult animals mostly feed on fish, whereas young animals also feed on invertebrates.

TINRO scientists conducted numerous surveys of the eastern coast of Sakhalin Island in the 1980s, and white whales were only found in 1989 when approximately 100 animals were observed among large ice floes near and southeast of Cape Elizabeth, at the northern tip of the island (Perlov *et al.* 1996, 1997). On 2 June 1989, up to 30 individuals were found in Nyiskii Bay, and about 50 animals moving northwards were seen north of the bay (between Chaivo and Piltun bays). Nyiskii Bay is likely to be the southern limit of the distribution of this species in the Sea of Okhotsk (Perlov *et al.* 1996, 1997).

White whales are only known to occur off Sakhalin Island during the spring.

Dall's Porpoises

Dall's porpoise (*Phocoenoides dalli*) is designated as Conservation Dependent by the IUCN (IUCN, 2002). It is an endemic species of the Northern Pacific and one of the most numerous species of cetaceans in the Sea of Okhotsk (20,000 to 25,000 individuals). They rarely form large concentrations, and feed on schooling fishes and cephalopods. Although sometimes seen near land, Dall's porpoises are most often observed far offshore in waters more than 180 m deep. The western North Pacific population of Dall's porpoise follow a well-defined annual migration in which the Japanese population moves northward to summer in the Sea of Okhotsk and around the Kuril Islands.

About 3,500 to 4,000 individuals occur in waters along the entire eastern side of Sakhalin Island, (Shuntov, 1995). Dall's porpoises are apparently more common south of Cape Terpeniie. In 1965 to 1971, A.E. Kuzin and A.S. Perlov regularly observed Dall porpoises southeast of Terpeniie Bay during the spring and summer, and east of Aniva Bay during the autumn and winter. V.P. Shuntov (1995) observed them in and around Terpeniie Bay, and east of Aniva Bay. In 1993, Dall's porpoises were seen singly and in small groups (3 to 5 animals) between Terpeniie Bay and Aniva Bay. Most observations have occurred between those two bays (Kuzin *et al.* 1984). Surveys in September 1990 revealed the presence of several groups of Dall's porpoises north and northeast of Cape Elizabeth. Twenty-one groups totalling 80 animals were recorded on 11 September, and 13 groups of 70 individuals were recorded on 12 September. Sobolevskii (2000) observed them often in Terpeniie Bay and to the northeast of Cape Terpeniie.

Dall's porpoises are not likely to be encountered in the vicinity of the Lunskoye Field, as they prefer deep, offshore waters (Jefferson, 2002).

Harbour Porpoises

Harbour porpoises (*Phocoena phocoena*) are designated as Vulnerable by the IUCN (IUCN, 2002). The harbour porpoise is a fairly numerous species and prefers shallower, inshore waters of the continental shelf (Bjørge and Tolley 2002). In the Sea of Okhotsk, the species inhabits waters near the Kuril Islands, along the west coast of Kamchatka, along the east coast of Sakhalin Island, in Sakhalin Bay, and north of the Shantarskie Islands (Perlov *et al.* 1996, 1997). Sobolevskii (2000) reported seeing single individuals and small groups in coastal areas adjacent to Lunsky Bay.

Baird's Beaked Whales

Baird's beaked whales (*Berardius bairdii*) are not considered endangered in the Sakhalin region but are designated as Conservation Dependent by the IUCN (IUCN, 2002). Baird's beaked whales are endemic in the North Pacific. The eastern and western Pacific populations are migratory, arriving at the continental slope in summer and autumn. They can usually be found in deep waters over the continental slope, but they do occur in shallow waters in the Sea of Okhotsk (Kasuya, 2002). Approximately 1,000 to 1,500 animals occur in

the Sea of Okhotsk along the islands of the Kuril archipelago, the coast of Kamchatka, east Sakhalin Island, in Sakhalin Bay, near Shantarskie and Ion islands, and in the southern part of the Sea of Okhotsk. About 250 to 300 individuals occur in waters along the southern part of Sakhalin Island, mainly in Aniva Bay and east of Cape Aniva. Recent observations of this species are scarce, and all of them have been made in the southern part of the Sea of Okhotsk near the southern coast of Sakhalin Island, in La Perouse Strait, and east of Cape Terpeniie (Perlov *et al.*, 1996, 1997).

Cuvier's Beaked Whales

Cuvier's beaked whales (*Ziphius cavirostris*) are listed as a Category 3 (rare) species in the *Red Book of the Russian Federation* (Krasnaya Kniga RFZ, 2001), and as Data Deficient [(1)] by the IUCN (IUCN, 2002). According to the *Red Book of the Russian Federation*, the area of distribution of Cuvier's beaked whale covers almost the entire Sea of Okhotsk, including Sakhalin Island (Geptner *et al.*, 1976; Tomilin, 1971). In *'Mammals of the Soviet Union'* (v. 2, part 3, 1976), it is stated that,

"based on somewhat unreliable sources, Cuvier's beaked whales have been encountered off the Kuril Islands and off the southern coast of Sakhalin Island (Sleptsov 1961)"

Perlov *et al.* (1997) reported that they had never recorded Cuvier's beaked whales in the Sea of Okhotsk, but that this species does occur near southeastern Kamchatka and the Kommander Islands, where stranding occurs almost every year.

Cuvier's beaked whale is an offshore, deep-diving species (Heyning, 2002), so it is unlikely to be found near the Lunskoye Field.

Pacific White-sided Dolphins

Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) are not rated in the *Red Book of the Russian Federation* and are classified as Least Concern on the IUCN *Red List* (IUCN, 1996). This species is among the most numerous species inhabiting the northwestern part of the Pacific Ocean. They are often found in large groups (average of 90), but sometimes concentrate in groups of up to 3,000 individuals (Waerebeek and Würsig 2002). They appear to be most common in the southern part of the Sea of Okhotsk, *ie* along the Kuril Islands, at Cape Aniva, and in La Perouse Strait (Perlov *et al.* 1996, 1997). Pacific white-sided dolphins are mostly pelagic, moving offshore in spring and summer in rough synchrony with movements of anchovy and other prey (Waerebeek and Würsig 2002).

(1) Inadequate information is available to make an assessment of the risk of extinction for the species (IUCN, 2001).

Short-beaked Common Dolphins

Short-beaked common dolphins (*Delphinus delphis*) are classified as Least Concern on the IUCN *Red List* (IUCN, 1996). They are found throughout the temperate and tropical waters of the Pacific. They are highly gregarious and may be seen in groups of more than 1,000 animals. The short-beaked common dolphin is the most common dolphin in offshore waters (Perrin, 2002). The world population is believed to be several million strong. Short-beaked common dolphins occur in the southern part of the Sea of Okhotsk, *ie* along the Kuril Islands and in waters along the west coast of Kamchatka. This species also inhabits the waters east of Sakhalin Island and north of the Shantarskie Islands (Perlov *et al.* 1996, 1997).

Bottlenose Dolphins

Bottlenose dolphins (*Tursiops truncatus*) are classified as Data Deficient on the IUCN *Red List* (IUCN, 2002). They are fairly uncommon in the Sea of Okhotsk. They occupy the southern half of the Sea of Okhotsk and may be found up to the central Kuril Islands, and from Cape Terpeniie south to Cape Aniva and Aniva Bay (Perlov *et al.* 1996, 1997). Bottlenose dolphins are primarily coastal, but also occur over the continental shelf, especially over the shelf break (Wells and Scott, 2002).

Bottlenose dolphins are unlikely to be found in the Lunskoye Field area, as they are not common in the Sea of Okhotsk, and occur further to the south.

Short-finned Pilot Whales

Short-finned pilot whales (*Globicephala macrorhynchus*) are classified as Conservation Dependent on the IUCN *Red List* (IUCN, 2002). They typically form cohesive groups of 15 to 20 animals. Seasonal movements involving northward migration in the spring/summer and southward migration in autumn/winter are timed to follow the movements of their primary prey, squid. In the Sea of Okhotsk, short-finned pilot whales are found near the Kuril Islands, north of Hokkaido, at Cape Aniva, and in La Perouse Strait (Perlov *et al.* 1996, 1997). They are found on the continental shelf break and in slope waters (Olson and Reilly 2002)

Short-finned pilot whales are unlikely to be found in the Lunskoye Field area because they prefer deeper water, and are thought to occur further south.

Northern Right Whale Dolphins

Northern right whale dolphins (*Lissodelphis borealis*) are classified as Least Concern on the IUCN *Red List* (IUCN, 1996). They are found in the temperate waters of the North Pacific, and have been observed in the southern part of the Sea of Okhotsk. Northern right whale dolphins are deepwater dwellers, moving in response to the movements of squid. Groups of several thousand animals have been observed, but more typically groups range between 100 to 200 individuals. They have been seen near the Kuril Islands, off the southwest

coast of Kamchatka, north of Hokkaido, east of Terpeniie Bay, at Cape Aniva, and in La Perouse Strait (Perlov *et al.* 1996, 1997).

4.9.3 *Western Gray Whale*

Background

There are two extant populations of gray whales (*Eschrichtius robustus*), both dwelling in the Pacific Ocean: (1) the Eastern North Pacific or California-Chukotka population, and (2) the Western North Pacific or Okhotsk-Korean population (Jones *et al.* 1984; LeDuc *et al.* 2000). An Atlantic population was extirpated prior to the 19th century (Jones *et al.* 1984).

Currently, there are approximately 26,000 California-Chukotka gray whales (hereafter referred to as the eastern gray whale) that over-winter in the lagoons of Baja California and summer in the Bering and Chukchi seas (Rugh *et al.* 1999). The eastern population is not endangered and has been extensively studied. Most of the general biological and behavioural information in this document has been drawn from the eastern population, as the western population has not been studied to the same extent.

The other population of gray whales is the Western North Pacific or Okhotsk-Korean population (hereafter referred to as the western gray whale). It is believed to breed in the South China Sea during the winter months. The only presently-known summering and feeding area of the western gray whale is located off the northeast coast of Sakhalin Island (Brownell and Chun 1977; Sobolevsky 1998, 2000, 2001; Weller *et al.* 1999, 2000, 2001a,b, 2002a; Würsig *et al.* 1999, 2000). Generally, gray whales feed in shallow (less than 20 m) waters within 5 km of the coast.

The western gray whale is listed as a Category I (endangered) species in the *Red Book of the Russian Federation* (Krasnaya Kniga RFZ, 2001). The population was recently reclassified as Critically Endangered (extremely high risk of extinction) by the IUCN (IUCN, 2000, 2002). The IUCN *Red List* criterion (see *Chapter 2*) used to support the reclassification was primarily that the population size was estimated to number fewer than 50 mature individuals (IUCN, 2001).

It is estimated that there were initially 1,500 to 2,000, and possibly as many as 10,000 individuals in the western gray whale population (Rice and Wolman, 1971; Yablokov and Bogoslovskaya, 1984), but over-exploitation by commercial whaling drastically reduced the population. The population was reported to be "probably extinct" in the early 1970s (Bowen, 1974). Subsequent sporadic sightings, however, indicated that the western gray whale was not extinct (Brownell and Chun, 1977). Initial aerial surveys in the 1980s and 1990s indicated that small groups of gray whales were present at several locations in the Sea of Okhotsk, with regular sightings of feeding whales in shallow coastal waters offshore from Piltun Bay (Berzin *et al.* 1988, 1990, 1991; Vladimirov, 1994). There have been repeated observations of gray whales offshore of the Piltun area over the past two decades (Berzin *et al.* 1988,

1990, 1991; Blokhin *et al.* 1985; Votrogov and Bogoslovskaya, 1986; Brownell *et al.* 1997; Sobolevsky, 1998, 2000, 2001; Weller *et al.* 1999, 2000, 2001b, 2002a; Würsig *et al.* 1999, 2000), whereas sightings elsewhere in the Sea of Okhotsk have been infrequent (Weller *et al.* 2001a).

In the mid-1990s, estimates of the numbers of western gray whales ranged from 120 individuals (Brownell, 1999; Blokhin, 1996) to approximately 250 (Perlov *et al.* 1996; Vladimirov, 1994). More recent estimates are approximately 100 individuals in the Piltun area, based on monitoring studies sponsored in whole or part by SEIC and Exxon-Neftegas Ltd. (ENL) (Sobolevsky, 2000, 2001; Weller *et al.* 2000, 2001b, 2002a; Würsig *et al.* 1999, 2000). The group of approximately 100 animals summering in the Piltun area are believed to represent a significant (though presently unknown) proportion of the overall Western Pacific population. Photo-identification studies have indicated that recognisable individuals demonstrate strong site fidelity and return to the northeast coast of Sakhalin Island annually (Weller *et al.* 2001a). However, the entire historical range of the western gray whale has not been surveyed, and therefore the size of the entire Sea of Okhotsk population of western gray whales is unknown; some additional western gray whales may occupy other currently unknown feeding areas.

Distribution

The historical centres of distribution of western gray whales in the Sea of Okhotsk included Sakhalinskaya Bay, Ulbanskii, Shelikhov, Akademiia, and Tugurskii bays, the coastal waters of Sakhalin Island, Penzhinskaya and Gizhiginskaya bays in the northern Sea of Okhotsk, and in the waters west of Kamchatka (Krupnik, 1984; Yablokov and Bogoslovskaya, 1984; Perlov *et al.* 1997). The long-held belief that their wintering grounds were along the south coast of the Korean Peninsula has not been recently substantiated (Rice 1998). Wintering grounds are now believed to be located in the South China Sea, possibly along the coast of Guangdong province and/or around Hainan Island (Rice, 1998). However, specific calving sites have not yet been identified.

The gray whale is a long-range, seasonal migratory species. Western gray whales begin arriving off northeast Sakhalin Island in late May, after ice has left the area, and some remain until late November, when ice returns (Weller *et al.* 1999, Sobolevsky, 2000). Migration routes used by western gray whales are presently unknown, but most specialists believe that the majority of animals migrate through La Perouse Strait, south of Sakhalin Island, and up the east coast (*pers comm* V. Vladimirov, 2002), whereas others believe that some individuals migrate through Tartar Strait, west of Sakhalin Island, and past the north coast (Yablokov and Bogoslovskaya, 1984; Sobolevsky, 2000). If they migrate along the east coast of Sakhalin Island, they presumably would pass the Lunskoye area on their way north to their summer feeding grounds, mostly in May to June, and on their way south to their winter breeding grounds, mostly in October to November. Eastern gray whales usually stay in coastal waters during migration, except when crossing the mouths of bays, so they are likely to migrate

inshore from, or perhaps through, the Lunskoye Licence Area.

A total of 315 western gray whale sightings were recorded during systematic surveys of a coast-wide extensive sampling grid and a nearshore intensive grid centred on Piltun Bay in 1999 and 2000. Most (305, or 97%) were within the 20 m isobath, and the majority were within 5 km of shore.

Most western gray whales feed near or north of the mouth of Piltun Bay; fewer are encountered south of Piltun Bay. During the feeding period, western gray whales feeding near Piltun Bay do not form dense aggregations, but scatter along the coast. The feeding area is approximately 90 km long and 2 km wide. From July to August, the area near the mouth of Piltun Bay appears to be their preferred feeding area. However, during surveys in 2001 groups of western gray whales also were observed feeding in deeper waters (35 to 40 m water depth) southeast of Chaivo Bay. As many as 83 western gray whale sightings were recorded on one day of surveys in that offshore area, and during that day western gray whales were still present and feeding in the Piltun Bay area. Both feeding areas have been used by large numbers of whales during aerial surveys conducted in late July and late August 2002 (*pers comm* S. Blokhin). Depending on the extent of exchange between the coastal and offshore feeding areas (presently unknown), the actual number of western gray whales present off northeast Sakhalin Island could be greater than 100 individuals.

The discovery of the deep-water feeding area off Chaivo in 2001 raises the possibility that there are other, as yet undocumented feeding areas. To date, there has been no strong evidence of regular feeding in the Lunskoye area, although aerial survey coverage there has not been good. The first year that aerial survey coverage extended as far south as Lunsky Bay was 2000; coverage on those extensive surveys was approximately 20%, transects extended from the coast to beyond the 50 m depth contour, and surveys were flown during 23 to 24 June, 19 to 20 July, 26 August, 6 September, 13 October, and 19 to 20 November. In 2001, similar surveys were flown; those that included the Lunskoye area were on 18 July, 13 September, 24 September, 9 October, 23 October, and 18 November. The 2002 surveys of the Lunskoye area included both extensive and intensive (100%) coverage once per month, although surveys did not begin until late July. Four whales were seen about 3 km inshore from the northwest corner of the Lunskoye Field on 28 July, and no whales were seen in subsequent months. There was no evidence of feeding for the four that were recorded in July.

Habitat and Food Supply

The gray whale is unique among baleen whales in that it feeds mainly on benthic prey (Zenkovich, 1934, 1937; Tomilin, 1937; Mizue, 1951; Pike, 1962; Rice and Wolman, 1971; Zimushko and Lenskaya, 1970; Thomson, 1983; Thomson and Martin, 1983; Nerini, 1984). Typical prey includes amphipods, isopods, and bivalve molluscs. Gray whales have also been known to feed occasionally on fish and other nektonic organisms (Norris *et al.* 1984; Nerini

1984; Darling *et al.* 1998; Dunham and Duffus, 2001).

When feeding in the benthic environment, gray whales roll to one side, making close contact with bottom sediments with the side of the head, and sucking benthic and epibenthic organisms (along with bottom sediments) into their mouths. They then expel water and most of the inorganic sediment (which is often visible on the surface as a mud plume), while retaining food organisms along the baleen plates (Thomson, 1983; Thomson and Martin, 1983; Nerini, 1984).

Gray whales depend on a high biomass of prey organisms per unit area for feeding, and may consume from 400 to 1200 kg of food per day during the summer feeding period (Zimushko and Lenskaya, 1970; Brodie, 1975; Thomson, 1983; Thomson and Martin, 1983). It is not clear why western gray whales aggregate in the area around the mouth of Piltun Bay. It is possible that the nutrient-rich waters from Piltun Bay provide a significant source of nutrients for benthic communities in the area, creating 'prime' feeding habitats (Weller *et al.* 1999).

Studies by divers offshore from Piltun Bay in 1995 indicated much higher biomass of benthic food resources at a depth of 7 m (427 gm^{-2} than in deeper water, at a depth of 12 m (85 to 137 gm^{-2}) (Sobolevsky *et al.* 2000). It is possible that the biomass of western gray whale prey is greater in the vicinity of Piltun Bay and offshore Chaivo Bay, where whales have been observed feeding, compared to the surrounding benthic community.

Presently, there is only a limited understanding of the benthic resources available to western gray whales in the shallow waters off northeast Sakhalin Island. The most recent systematic aerial surveys indicate that western gray whales may be distributed over a much wider section of the northeast Sakhalin Shelf than originally suspected (Sobolevsky, 2000, 2001). There is currently no quantitative data to support the idea that food resources are 'unique' in the Piltun area.

Hearing

Behavioural evidence suggests that baleen whales, including gray whales, hear very well at low frequencies, below 1 kHz. Baleen whales have also been shown to react to sonar and other sounds between 3 to 4 kHz. Some baleen whales (not specifically gray whales) react to pinger (1) sounds up to 28 kHz, but not to pingers or sonars that emit sounds above 36 kHz. In addition, baleen whales produce sounds at frequencies up to 8 kHz. Gray whale calls include significant components from about 20 to 4,000 Hz, and especially from 100 to 2000 Hz (Dahlheim and Ljungblad, 1990; Richardson *et al.* 1995). Baleen whales, including gray whales, probably hear well at frequencies ranging from <100 Hz to some undefined frequency above 8 kHz. Baleen whales may be able to hear low frequency sounds (possibly as low as 10 Hz), and under

(1) An acoustic source that produces short, high-frequency pulses.

some circumstances they may be able to hear low-frequency sounds from strong sources as much as a few hundreds of kilometres away.

Condition of Gray Whales

In 1999 and 2000, a notable proportion of adult western gray whales appeared to be malnourished and 'skinny', but no fatalities were observed. During the photo-identification surveys in 1999 and 2000, 14% (10 out of 70) and 47% (27 out of 58) of whales, respectively, were judged to be skinny (Weller *et al.* 2000, 2001a).

Similar signs of emaciation were displayed during the same period by eastern gray whales. Many apparently malnourished whales died during winter in the lagoons of Baja California and during their northward migration in 1999 (Le Boeuf *et al.* 2000). In 2000, nearly twice as many eastern gray whales died in the wintering lagoons of Baja California than in 1999 (Le Boeuf *et al.* 2000). High mortality in eastern gray whales was not documented during winter 2000-2001 or during the 2001 northward spring migration (Brownell *et al.* 2001b).

The causes of emaciation in both North Pacific populations of gray whales are not clear. Several lines of evidence have suggested over-exploitation of the food supply for the eastern Pacific population, and/or a possible large-scale climatic/oceanographic regime shift that affected productivity in the North Pacific region as a whole (Le Boeuf *et al.* 2000). It is also possible that some other factor(s), such as disease or human-induced stresses during winter, migration, and/or the summer feeding period, may have simultaneously and similarly affected one or both of the populations of gray whale. The cause is considered most likely to be a complex cumulative and time variable effect. It is highly unlikely that a population of approximately 100 whales has simply over-exploited its food supply.

In the vicinity of the Lunskoye Field, western gray whales are thought to migrate up the east coast of Sakhalin Island to feeding grounds off Chaivo and Piltun bays, and are likely to pass to the inshore of the Lunskoye Field in spring and autumn. Some individuals may feed there, but the known feeding areas are farther north.

4.10 MARINE AND COASTAL BIRDS

4.10.1 Introduction

The two pipeline landfall areas for the offshore platforms are located on Sakhalin's northeastern coast. This stretch of coastline is characterised by a rich ornithofauna, including rare species registered in the *Red Book of the Russian Federation* and the IUCN *Red List of Threatened Species* (2002). The species diversity found in the area is primarily due to the large numbers of species that migrate along the coast in the spring and autumn.

The bays along the coast provide habitats and migration stopovers for a large number and variety of birds. Species can be present in the area for periods of time ranging from hours to months. For example, species whose migratory paths pass through the area may be observed for a short time only, whereas other species which nest and feed in the area are present for longer periods.

The Piltun, Chaivo, Lunsky and Nabilsky Bays are the most important areas along the northeastern coastline for waders and seabirds migrating in the spring and autumn. In the spring, approximately 1 million waterfowl, 1 million albatrosses, petrels, gulls and auks and 1 million to 1.5 million waders migrate through the area. In autumn, these populations increase by 20 to 30% (see *Figures 18* and *19*) (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

Table X below reports the common bird species of the northeast coast of Sakhalin Island (TEO Volume 2A Book 8-EPB: Chapter 8, 2002), including their patterns of occurrence and importance.

Table 4.4 Common Bird Species of the North-east Coast of Sakhalin Island

English Name	Scientific Name	Pattern of Occurrence	Red Book of the RF status (1)	IUCN Status (2)
Seabirds and Seaducks				
red-throated diver	*Gavia stellata*	Br		
black-throated diver	*Gavia arctica*	Br	Status 2	
northern fulmar	*Fulmarus glacialis*	Mg		
sooty shearwater	*Puffinus griseus*	Mg		
short-tailed shearwater	*Puffinus tenuirostris*	Mg		
fork-tailed storm-petrel	*Oceanodroma furcata*	Mg		
great cormorant	*Phalacrocorax carbo*	Br		
pelagic cormorant	*Phalacrocorax pelagicus*	Br		
red-faced cormorant	*Phalacrocorax urile*	Mg		
tufted duck	*Aythya fuligula*	Br		
greater scaup	*Aythya marila*	Br		
black scoter	*Melanitta nigra*	Br		
white-winged scoter	*Melanitta fusca*	Br		
harlequin duck	*Histrionicus histrionicus*	Br		
long-tailed duck	*Clangula hyemalis*	Mg		
marbled murrelet	*Brachyramphus marmoratus*	R	Status 3	VU
common goldeneye	*Bucephala clangula*	Br		
red-breasted merganser	*Mergus serrator*	Br		
Goosander	*Mergus merganser*	Br		
red-necked phalarope	*Phalaropus lobatus*	Br		
common gull	*Larus canus*	Br		
slaty-backed gull	*Larus schistisagus*	Br		
black-headed gull	*Larus ridibundus*	Mg		
black-legged kittiwake	*Rissa tridactyla*	Br		
common tern	*Sterna hirundo*	Br		
Aleutian tern	*Sterna aleutica*	Br	Status 3	
common guillemot	*Uria aalge*	Br		

(1) Red Book of the Russian Federation (2000): Status1 = endangered and under threat of extinction; 2 = vulnerable; 3 = rare and numbers are declining; 4 = small population, numbers difficult to estimate and / or species is at the limits of it's range.
(2)Codes for IUCN classifications: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR = Lower Risk (-cd = Conservation Dependent; -nt = Near Threatened; -lc = Least Concern); DD = Data Deficient.

English Name	Scientific Name	Pattern of Occurrence	Red Book of the RF status (1)	IUCN Status (2)
Brunnich's guillemot	*Uria lomvia*	Br		
parakeet auklet	*Cyclorrhynchus psittacula*	Mg		
crested auklet	*Aethia cristatella*	Br		
least auklet	*Aethia pusilla*	Mg		
tufted puffin	*Lunda cirrhata*	Mg		
Waterfowl				
whooper swan	*Cygnus cygnus*	Br		
bewick's swan	*Cygnus columbianus bewickii*	Mg	Status 3	
white-fronted goose	*Anser albrifrons*	Mg		
bean goose	*Anser fabalis*	Mg		
Brent goose	*Branta bernicla*	Mg	Status 3	
eurasian wigeon	*Anas penelope*	Br		
falcated duck	*Anas falcata*	Br		
green-winged teal	*Anas crecca*	Mg		
Mallard	*Anas platyrhynchos*	Br		
northern pintail	*Anas acuta*	Br		
garganey	*Anas querquedula*	Br		
northern shoveler	*Anas clypeata*	Br		
Predatory Birds				
white-tailed sea-eagle	*Haliaeetus albicilla*	Br	Status 3 and LR/nt	
steller's sea-eagle	*Haliaeetus pelagicus*	Br	Status 3 and VU C1	
Osprey	*Pandion haliaetus*	Br		
peregrine falcon	*Falco peregrinus*	Mg	Status 2	
Waders				
little ringed plover	*Charadrius dubius*	Br		
lesser sandplover	*Charadrius mongolus*	Mg		
bar-tailed godwit	*Limosa lapponica*	Mg		
black-tailed godwit	*Limosa limosa*	Mg		
Whimbrel	*Numenius phaeopus*	Mg		
common redshank	*Tringa totanus*	Br		
common greenshank	*Tringa nebularia*	Br		
wood sandpiper	*Tringa glareola*	Br		
common sandpiper	*Actitis hypoleucos*	Br		
great knot	*Calidris tenuirostris*	Mg		
red knot	*Calidris canutus*	Mg		
red-necked stint	*Calidris ruficollis*	Mg		
long-toed stint	*Calidris subminuta*	Br		
curlew sandpiper	*Calidris ferruginea*	Mg		
Dunlin	*Calidris alpina*	Br		

(1) Key: Br – Breeding, Mg – Migration, R – resident

In addition to migratory species, resident and breeding species of the northeastern Sakhalin coast are described in the remainder of this section. These include birds that may not necessarily nest along the coast, but have

hunting or feeding grounds in the area. This is particularly applicable to predatory birds, which have large ranges and hunting grounds. The sections below provide a summary of the species and information on their locations along the northeastern coastline. Sections cover:

- seabirds and seaducks;
- wildfowl;
- predatory bird species;
- waders.

4.10.2 *Seabirds and Sea Ducks*

Sea Ducks

Sea ducks accumulate in large numbers in the coastal waters near the mouths of Chaivo, Piltun and Astokh bays as well as within the bays themselves (TEO Volume 2A Book 8-EPB: Chapter 8, 2002).

Spring migration continues from the end of April to the end of May / beginning of June. During this period, the numbers of diving ducks can comprise up to 49% of the total bird population of the area. Commonly observed species of diving duck include the common goldeneye (*Bucephala clangula*), tufted duck (*Aythya fugligula*), greater scaup (*Aythya marila*) and red-breasted merganser (*Mergus serrator*).

Autumn migration for ducks occurs from September to October. Dominant species in autumn are the white-winged scoter (*Melanitta fusca*) and harlequin duck *(Histrionicus histrionicus)*, the latter comprising 21% of the total sea duck population in the autumn migratory period (TEO Volume 2A Book 8-EPB: Chapter 8, 2002).

The offshore areas along the northeastern shore of Sakhalin Island are important for sea ducks, *eg* white-winged scoter and harlequin ducks, especially during the moulting period. These species stay in the area throughout the summer.

Gulls and Terns

After ducks, gulls are the second largest group of birds (Fauna Information and Research Centre, 2001). They nest in small numbers in the area, but are present in large numbers during migration. The main spring migration starts in May, however, the number of birds does not decrease (as is the case for other species) but remains high over the whole summer period. Gulls congregate mostly in the mouths of the bays and on the seashores. The number of gulls increases considerably in August and September, when young birds start to move away from the breeding grounds. Migration continues until November. In the autumn, gulls form large congregations (up to 1,000 birds) along the coastline's main migration paths.

The migration of terns is less pronounced than that of the gulls. Terns are most numerous during the nesting period when the birds concentrate around their colonies, located on islands within the bays. In the Piltun, Chaivo, Lunsky and Nabilskyi Bays, 10-23 thousand pairs of common terns (*Sterna hirundo*) nest (Fauna Information and Research Centre, 2001). More than 500 pairs of Aleutian terns (*Sterna aleutica*) have also been recorded (TEO Volume 2A Book 8-EPB: Chapter 8, 2002).

Auks

In October, during the autumn migration, more than half of the population comprises auks, amongst which murrelets and guillemots are usually dominant (TEO Volume 2A Book 8-EPB: Chapter 8, 2002).

4.10.3 *Waterfowl, Waders and Divers*

Swans and Geese

During the spring migration, up to 10,000 swans (whooper swans, *Cygnus cygnus*) and Bewick's swans (*Cygnus columbianus bewickii*)) inhabit Piltun, Chaivo and Nabilsky bays. Species of geese observed include the bean goose (*Anser fabalis*) and white fronted-goose (*Anser albrifrons*). Geese generally migrate through the area in mid September, without stopping to feed or moult.

Ducks

Populations of nesting ducks include the tufted duck, greater scaup, harlequin duck and common goldeneye. Population numbers in Lunsky Bay are generally low, with individuals preferring to nest in Piltun and Chaivo Bays. Populations in these two bays can reach hundreds of individuals. Nesting generally commences at the end of May and continues until the beginning of September (TEO Volume 2A Book 8-EPB: Chapter 8, 2002).

River duck species are often present in the bays. Species that have been observed include wigeon (*Anas penelope*), northern pintail (*Anas acuta*), mallard (*Anas platyrhynchos*), northern shoveler (*Anas clypeata*) and green-winged teal (*Anas crecca*) (Fauna Information and Research Centre, 2001).

4.10.4 *Predatory Bird Species*

There are four predatory species of birds that inhabit the coastline and bays of northeastern Sakhalin Island. These species are the Steller's sea-eagle (*Haliaeetus pelagicus*), white-tailed eagle (*Haliaeetus albicilla*), osprey (P*andion haliaetus*) and peregrine falcon (*Falco peregrinus*), all of which are included in the *Red Book of the Russian Federation*. The eagles are also included in the IUCN *Red List of Threatened Species* (2002) (see *Table 4.4*)(TEO Volume 7 Book 1-EIA: Chapter 1, 2002 and Fauna Information and Research Centre, 2000).

Between 20 and 22 pairs of Steller's sea eagle nest within Lunsky Bay, 15-18 pairs in Nabilskyi Bay, 5 pairs in Piltun Bay and 5 pairs in Chaivo Bay (TEO Volume 7 Book 1-EIA: Chapter 1, 2002). They are scavengers and hunters preferring a diet primarily of salmon. The timing, duration and extent of winter migration movements depend on the ice conditions and food availability in the Lunsky area. Ospreys and white-tailed eagles nest close to Lunsky bay and fish within the bay waters and the surrounding river mouths.

In addition to these species, peregrine falcons are visitors to the Lunsky Bay area during the spring and autumn migration periods, hen harriers (*Circus cyaneus*) have been reported hunting over the marine spit of Lunsky Bay, and northern goshawks (*Accipiter gentiles*) have been observed within the area on rare occasions, although they are normally associated with densely forested habitats.

4.10.5 *Waders*

The shallows surrounding the small islands that lie along the Piltun spit and at the entrance of the bay provide feeding habitat for 21 different species of waders and almost 10,000 birds. Twelve pairs of the Sakhalin subspecies of dunlin (*Calidris alpina actites*) have been observed. These were recorded at nesting sites within Nabilsky Bay.

In spring, Chaivo bay is an important stopping point for some 1,700 waders. The common migratory species are lesser sandplover (*Charadrius mongolus*), dunlin and red-necked stint (*Calidris ruficollis*) (TEO Volume 2A Book 8-EPB: Chapter 8, 2002). Thirteen species of waders have been recorded in Lunsky Bay during migration periods. The autumn migration is generally from the end of July to the beginning of October (TEO Volume 2B Book 8, June 2002). During the spring migration, the above named species are joined by great knots (*Calidris tenuirostris*) and whimbrels (*Numenius phaeopus*) (Fauna Information and Research Center, 2001).

4.11 *PROTECTED AREAS*

4.11.1 *Important Bird Areas*

In 1999 to 2000 an area of the northeastern coast of Sakhalin bounded by the coordinates 51°10′-53°20′ N and 143°00′-143°20′ E was awarded the status of an Important Bird Area (IBA) of Russia. At present the use of natural resources in this area is not prohibited.

4.11.2 *Natural Monuments*

Lunsky Zaliv is a Natural Monument Complex of regional importance with preserves, reserves, natural monuments, Natural Habitats of Rare Mammals, Natural Habitats of Rare Bird Species and Water Habitats of Rare and Law-Protected Mammal and Bird Species. The site occupies some 221 km^2 of land.

The main objectives of this Natural Monument designation are:

- to protect migratory waterfowl and shore bird species;
- to conserve the nesting sites of the Steller's sea eagle.

Protected species in this area include Steller's sea eagle mentioned above together with the white-tailed eagle, fish hawk, Aleutian tern, marbled murrelet and peregrine falcon.

Nabilsky Bay has Natural Monument 'Chayachi Island' and Water habitats of Rare and Law-Protected Mammal and Bird Species (see *Figure 19*).

In Daga Bay, to the north of the Lunskoye Field, there is a protected area named 'Lyarvo Island'. This site incorporates approximately 1 km^2 of land designated by the Sakhalin regional executive committee for the protection of nesting colonies of terns (common tern and the Aleutian tern) and gulls.

4.11.3 *Ramsar Candidate Sites*

The marshland from Lunsky bay to the north of Piltun Bay is incorporated into the long-term plan of water and swamp areas ('*Shadow List*') for future entry into the Ramsar Convention register of lands of international importance.

4.12 THE HUMAN ENVIRONMENT

The following sections describe the social environment on Sakhalin Island and the components that may potentially constrain or be influenced by the proposed seismic survey programme. These include:

- regional demographics;
- economics and employment;
- indigenous peoples and traditional trades;
- commercial fishing;
- the hunting of marine mammals and birds;
- algae collection and cultivation;
- tourism, recreation and amenity;
- ports and vessel navigation;
- land-based infrastructure;

- military interests;
- offshore oil and gas production facilities and transport infrastructure;
- other submarine infrastructure;
- maritime archaeology and cultural heritage.

4.12.1 *Regional Demographics*

Sakhalin Island and the Kuril Islands form the territory of the Sakhalin Oblast, which is divided into 17 districts, or *rayons*. The Sakhalin region currently has a population of approximately 700,000. The major population centres are the southern Kholmsk region and the Oblast regional capital Yuzhno-Sakhalinsk. Over 85% of the population live in the main towns of Okha, Yuzhno-Sakhalinsk, Kholmsk and Nevel'sk. Okha is the current centre of the oil and gas industry (Trade Partners UK, 2002).

The demography of the region indicates that the population is in decline. This is due to two reasons:

- low birth rates are evident throughout the Oblast region, and there is a low proportion of children and teenagers within the population;

- there has been a significant migration of the population away from the area, with more than 125,000 individuals emigrating in the 1990s.

The Russian Federation Government can primarily attribute the trend in emigration to the removal of monetary incentives. The aim of the incentives had been to encourage individuals to remain in the extreme Sakhalin Island environment. Within the island, a significant trend in migration has also been recorded from rural areas of the island towards Yuzhno-Sakhalinsk.

Sakhalin Island's population is predominantly Russian (82%). The remaining 18% of the population consists of Ukrainian, Korean, Belorussian, Tatarian, Mordvinian, Chuvashian and indigenous groups. Orthodox Christianity is the main religion practiced on the Island, and in some indigenous populations is found alongside the traditional Shamanist religion (NUPI Centre for Russian Studies, 2002).

4.12.2 *Economics and Employment*

The Sakhalin region represents 0.5% of Russian Gross Regional Product (GRP) (1) and has a 13% unemployment level. The cost of living is 50% higher than the Russian average, which is attributed to a higher level of business expenses and a corresponding rise in prices.

The primary employment sectors are oil and gas, fishing and fish processing, communications and transport (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

(1) Index of economic development.

4.12.3 *Indigenous Peoples and Traditional Trades*

Indigenous Sakhalin groups live primarily in the north, with 3,395 individuals being recorded in January 2000. The groups have been documented since the late 18th century, and currently five indigenous groups can be distinguished:

- Nivkhi (N'ivhgn-N'igvn);
- Orochi;
- Evenk;
- Nanay;
- Oroki (Uilta).

During the Soviet period from 1917 to 1991 the state provided benefits for these groups in the form of financial enterprise subsidies, free medical services and education, but after this time financial support was withdrawn. The discontinuation of subsidies has had a detrimental effect on the traditional trades of the Nivkh and Orok, with farms and collective fishing practices disappearing in some communities. Onshore oil and gas developments have also impacted traditional trades; with Orok deer herding practices experiencing adverse affects relating to land take.

Traditional Trades Relating to the Aqueous Environment

Marine fishing, salmon river fishing and hunting for marine mammals occurs throughout all regions inhabited by indigenous groups (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

4.12.4 *Commercial Fishing*

Fishing Industry

The Sea of Okhotsk is of national importance to Russia as a fishing ground, supporting a high diversity of species. Sakhalin's fishing industry is predominantly concentrated towards the south of the island, although fishing activities and settlements occur throughout the island's coastal areas. Fishing operations are conducted on all scales, from small coastal fishing to large ocean trawlers (BISNIS, 2002). The majority of the fishing fleet has seen rapid deterioration and is technologically primitive as a result of the economic reforms in the early 1990s. Over fishing and domestic and foreign poaching in the Sea of Okhotsk is considered to have affected the majority of the major fish stocks.

Distribution maps showing commercially important species show the presence of fish, crab and shrimp within or in close proximity to the Lunskoye Field (TEO Volume 7 Book 1-EIA: Chapter 1, 2002). However, fishing activity in the Lunskoye Field is considered to be minor, with small local vessels confined predominantly to the near coastal waters (*pers comm* SEIC, 2002).

Target Species

Families with the highest commercial value are:

- *Salmonidae eg* including trout and salmon;
- *Clupeidae eg* herring, shads, sprats, sardines and pilchards;
- *Gadidae eg* navaga, mintai (walleye pollack) and cod;
- *Pleuronectidae eg* plaice and halibut (flounders).

Within these families the main target catch species are mintai, herring, flounders (*eg* starry flounder), salmon, navaga and halibut. Other species include sardine, Pacific saury, capelin, sand eels, smelts and argentine.

Mintai are the dominant fish species in the Sea of Okhotsk, determining the dynamics of the commercial (food fishery) catch, whereas salmon provide the highest revenue per individual fish. The following sections provide more detail on these two species.

Mintai

Of the family Gadidae, the mintai is a marine or brackish fish that lives between 0 and 975m depth. The species inhabits the entire water basin of the Sea of Okhotsk, migrating within the sea along the Kamchatka and northern sea coasts. There are considered to be three main spawning areas, on the western Kamchatka shelf, Shelikhov Bay and the central sea (Lebed elevation). There is also a smaller spawning ground on the eastern coast of Sakhalin Island. Spawning varies both spatially and seasonally, changing according to location and climate. Spawning occurs on the western Kamchatka shelf between the end of March and the beginning of April, at the beginning of May in Shelikhov Bay, the start of April for the Lebed elevation and the end of May to the beginning of June on Sakhalin's eastern coast.

As the spawn develops it drifts on advection currents, accumulating again prior to hatching in western Kamchatka, Shelikhov Bay and northern and central areas of the sea due to local circulatory patterns. Mintai yearlings also remain close to the original spawning areas, being both spatially and seasonally stable until their second year, when the sexually immature fish begin significant seasonal migrations within the sea. These migrations continue throughout maturation into adulthood.

Mature mintai populations show significant seasonal variation. In the winter and spring, populations accumulate to the north of the sea around the main spawning grounds. After the spring, the fish spread throughout the basin generally moving south, mixing with adults from other spawning areas, and moving to deeper waters. This change in spatial distribution corresponds to a shift of productive zones from the south in the summer, to the north in the autumn.

Commercial fishing of mintai occurs in the pre-spawning period when the fish form dense and relatively stationary groups.

Salmon

Of the family *Salmonidae*, salmon are considered to have the highest economic value. There are many different species of salmon present around Sakhalin including humpback, dog, blue-back, silver, king and cherry salmon. The most important for commercial fishing are the humpback and dog salmon. The humpback salmon is important due to its large yield, providing some 97% of the total salmon caught [(1)], whilst the dog salmon provides the remainder of the catch. The other salmon species may be caught as a supplement to the yield and are generally the target catch for sports fishing activities.

Salmon stocks have been declining since the mid 1950s. This is thought to be a result of over fishing and surface water quality deterioration in spawning rivers.

Marine Invertebrates

Benthic species with potential commercial value within the Lunskoye Field include four species of crab, 36 species of shrimp, 28 species of gastropod, two species of echinoderm and three species of bivalve. Areas of the commercial shrimp and crab fishing grounds overlap the Lunskoye Field (see *Figure 14*).

4.12.5 *Hunting of Marine Mammals and Birds*

Marine Mammals

Commercial, aboriginal and research groups hunt seals and other marine mammals in the Sea of Okhotsk. Populations have remained constant in recent decades indicating a sustainable level of hunting is being achieved. Seal hunting generally occurs during the winter months.

Hunting of seals in the Lunskoye area is mainly confined to shoreline areas and occurs through sea ice during the winter months. There is no permitted hunting of cetaceans.

Birds

The hunting of ducks is officially prohibited in the Lunsky Bay area; however, illegal hunting practices have been observed in the bay during the autumn migrations when the largest numbers of birds are present. During this period it has been reported that numerous shots have been heard, and that the birds in the area display random flight behaviour in response to this threat (Fauna Information and Research Center, 2001).

(1) Figures are based on 1989-1999 data (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

4.12.6 *Algae Collection and Cultivation*

In the Sea of Okhotsk algal species with commercial value include:

- kelp (*Laminaria japonica*) which is found predominantly in the northern areas of the sea, and is often cultivated using rock planting, long-line and rope-curtain techniques;
- brown algae (*Undaria pinnatifida*);
- red algae (*Porphyra Spp*.).

In the Lunskoye Field and surrounding areas there is no evidence of any algae collection or cultivation activities. Any collection in the area will be on a small scale local to populated coastal areas (US-Japan Cooperative Program in Natural Resources, 2002, and *pers comm* SEIC, 2002).

4.12.7 *Tourism, Recreation & Amenity*

Sakhalin's fledgling tourist industry currently consists of approximately 50 local companies offering tourism services including canoeing, yachting, diving, ship tours, fishing and ice fishing.

The area of coastline onshore from the Lunskoye Field is primarily marsh and swamplands, and there is not considered to be any tourist activity.

4.12.8 *Ports & Vessel Navigation*

The importing and exporting of goods by sea is the primary method of transport for Sakhalin Island. Goods are transported by cargo ship or ferry to and from any of the island's 11 seaports. The two main ports are Korsakov and Kholmsk in the south, where ice-free conditions prevail for most or all of the year. Major merchant shipping routes do not extend northwards of these southern ports. During the winter only icebreakers and specially strengthened vessels can operate in the seas to the north of Sakhalin Island due to the volume and thickness of sea ice, which restricts the importing and exporting capabilities of these areas (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

There are two ports in the vicinity of the Lunskoye Field, Nabilsky and Kaigon. Both ports are situated to the north, approximately 40 and 50 km respectively by sea from the field's perimeter. The ports are considered to support small-scale local vessel traffic only (*pers comm* SEIC, 2002).

4.12.9 *Land-Based Infrastructure*

Sakhalin Island has limited existing infrastructure, especially in Northern Sakhalin where there are few adequate roads (Trade Partners UK, 2002). In the south, where there is a greater degree of urbanisation and a milder ice-free

climate, land-based infrastructure is more developed (see *Figure 12*) (TEO Volume 7 Book 1-EIA: Chapter 1, 2002).

4.12.10 *Oil & Gas Infrastructure*

There are currently no oil and gas developments in the vicinity of the Lunskoye Field. The nearest development at present is the Molikpaq platform, which is located approximately 120 km to the north.

4.12.11 *Other Submarine Infrastructure*

There are no existing submarine cables or other submarine infrastructure in the vicinity of the Lunskoye Field.

4.12.12 *Maritime Archaeology & Cultural Heritage*

Archaeological History

The Lunskoye Field area was above sea level during the Late Pleistocene to Early Holocene approximately 11,00 years ago, and therefore fossils and other finds would be expected to reside within the seabed sediments. The Laboratory of Archaeological Research at the Yuzhno-Sakhalinsk State Pedagogical Institute considers the potentially find-rich areas to be up to sea depths of 100 to 120 m, with the highest concentrations occurring within 10 to 20 m (Yuzhno-Sakhalinsk State Pedagogical Institute, 1998).

Shipwrecks

Two shipwrecks are thought to rest along the coast some distance to the north of the Lunskoye Field. They are both American whaling vessels from the 19th century, but their resting locations and potential archaeological and cultural heritage value have not been determined at this time (Yuzhno-Sakhalinsk State Pedagogical Institute, 1998).

4.12.13 *Military Interests*

There are no known military interests in the Lunskoye Field or surrounding areas.