A. Speiser Environmental Consultants cc
VAT Reg. No.: 3452708015 Reg. No.: cc 2003/0606
Alexandra Speiser
MSc MPhil
P.O. Box 40386 Windhoek Namibia Tel:+264 61 244 782 Cell: 081 124 5655 e-mail:amspeiser@yahoo.com

SCOPING REPORT INCLUDING ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML 220 OF LK MINING, REQUIRED FOR AN ENVIRONMENTAL CLEARANCE CERTIFICATE

<u>Compiled for:</u>
LK Mining (Pty) Ltd

PO Box 1575

Windhoek,

Namibia

<u>Compiled by:</u>
A. Speiser Environmental Consultants CC
PO Box 40386
Windhoek,
Namibia

DOCUMENT CONTROL

Report Title	Scoping Report including Environmental Impact Assessment & Environmental Management Plan for the offshore diamond mining activities on the proposed ML 220 of LK Mining, required for an Environmental Clearance Certificate
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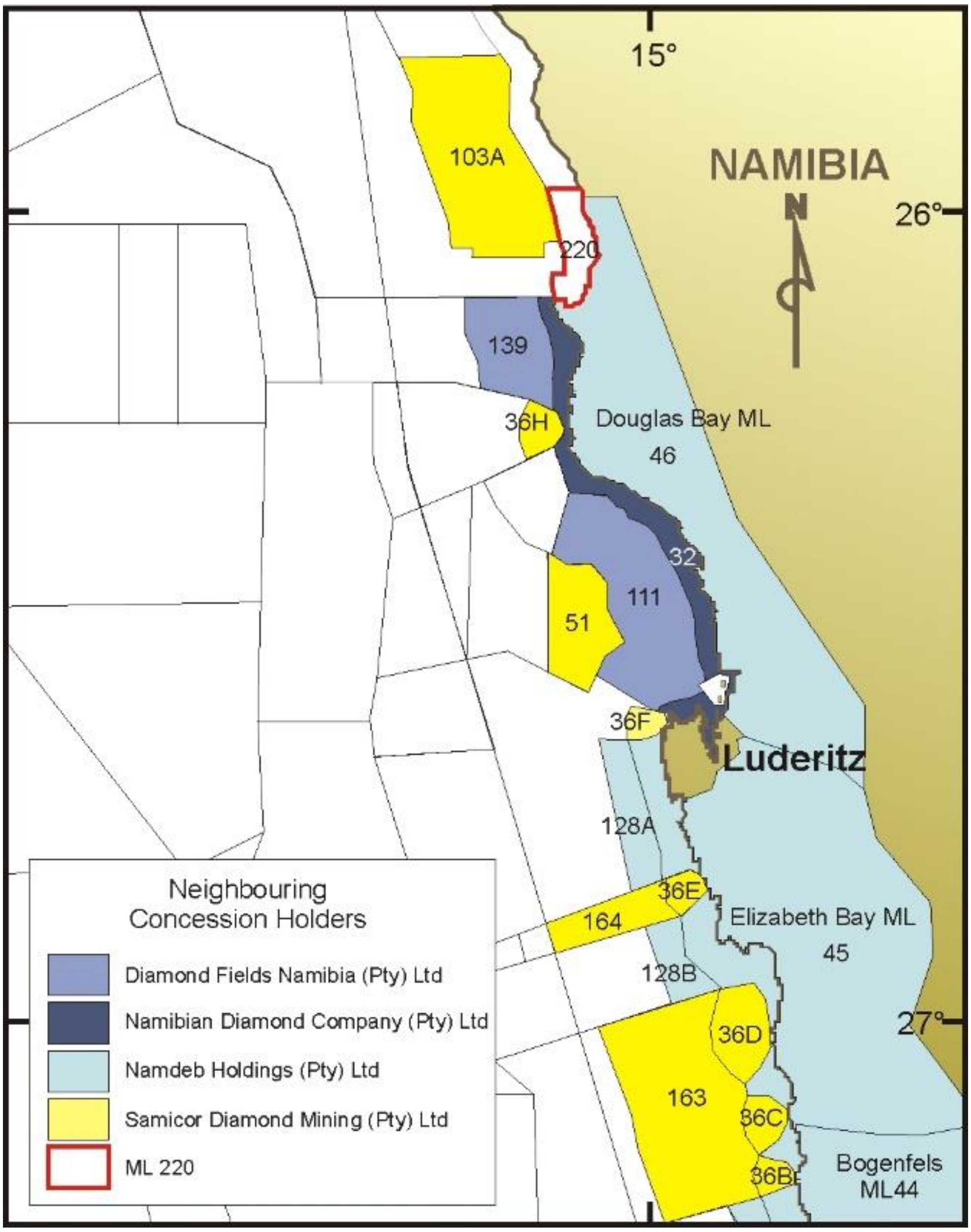
EXECUTIVE SUMMARY

INTRODUCTION

LK Mining (Pty) Ltd (LKM) applied for a Mining Licence (ML 220) over their existing EPL 5965 area. The ML is located in Hottentots Bay, approximately 60 km north of Lüderitz (see **Figure below**). The ML covers an area of 4227 Ha. The Mining Licence application was filed by LKM with the Ministry of Mines and Energy (MME) in October 2019. The last outstanding document, before execution and grant of ML 220, is to apply and obtain an Environmental Clearance Certificate (ECC) from the Ministry of Environment, Forestry and Tourism (MEFT), subject to an approved Environmental Impacts Assessment (EIA) report and Environmental Management Plan (EMP).



Location of the proposed ML 220 in relation to Lüderitz and other licence areas.

MOTIVATION FOR THE PROPOSED MARINE MINING ACTIVITIES

The Directorate of Mines within the Ministry of Mines and Energy (MME) undertakes to exploit the country's mineral resources in a responsible manner which integrates mining into the various economic sectors for the socio-economic development of the country. In order to achieve this, MME issues mining licences to various entities for the mining of minerals within the country and its coastal waters.

LKM conducted exploration activities on EPL 5965 between 2016 to 2019 and delineated a viable diamond resource that could be mined. This has the potential to provide social and economic development in the region and country.

PUBLIC PARTICIPATION PROCESS

As part of the public scoping process a series of focus group and information-sharing meetings were held with key stakeholders in Walvis Bay, Swakopmund and Lüderitz at the end of March and beginning of April 2021. Advertisements announcing the proposed project and the availability of the BID were placed in Namibian newspapers as stipulated in the Environmental Management Act, 7 of 2007 and EIA Regulations.

The steps undertaken are set out in the table below.

IAP Consultation Process.

TASK	DESCRIPTION	DATE
Notification - regulatory authorities and IAPs		
Notification to MEFT	The project was lodged on the MEFT EIA portal. Application APP002452	25 March 2021
IAP identification	ASEC developed an IAP database, taking previous relevant projects/EIAs in the area into consideration and further updated it throughout the EIA Scoping process. A copy of the IAP database is attached in **Appendix B**.	Throughout the process
Distribution of background information document (BID)	BIDs were distributed via email to relevant authorities and IAPs on the IAP database. Hard copies of the BID were also distributed during some focus group meetings. The purpose of the BID was to inform IAPs and authorities about the proposed offshore mining project, the EIA process being followed, possible environmental impacts and means of providing input to the EIA (Scoping & assessment) process. A copy of the BID and the presentation is attached in **Appendix A**.	March 2021
Notice boards and flyers	A site notice was placed in Lüderitz at the Information Centre. The notice provided a short description of the proposed activities, the location of the mining area, information regarding the EIA process being followed and who to contact for further information. Photo of the notice is attached in **Appendix C**.	April 2021
Newspaper Advertisements	Block advertisements providing information about the project and the public meeting were placed as follows: • Market Watch as part of the following	March/beginning April 2021

<table>
<tr><th>TASK</th><th>DESCRIPTION</th><th>DATE</th></tr>
<tr><td></td><td>newspapers:
o The Namibian Sun (25 March and 1 April 2021)
o Die Republikein (25 March and 1 April 2021)
o Allgemeine Zeitung (25 March and 1 April 2021)
Copies of the advertisements are attached in Appendix C.</td><td></td></tr>
<tr><td colspan="3">Focus group meetings and submission of comments</td></tr>
<tr><td>IAP meetings</td><td>Focus Group meetings were held with the following entities:
<table>
<tr><th>Date</th><th>Organisation</th></tr>
<tr><td>31 March 2021</td><td>NamPort Walvis Bay</td></tr>
<tr><td>01 April 2021</td><td>Ministry of Fisheries and Marine Resources (MFMR) in Swakopmund</td></tr>
<tr><td>07 April 2021</td><td>Sperrgebiet Diamond Mining (Pty) Ltd</td></tr>
<tr><td>08 April 2021</td><td>NamPort in Lüderitz</td></tr>
<tr><td>08 April 2021</td><td>Lüderitz Town Council in Lüderitz</td></tr>
<tr><td>09 April 2021</td><td>MFMR and the Namibia Rock Lobster Fishing Association in Lüderitz</td></tr>
</table>
The Presentation is provided in Appendix A.</td><td>March/beginning April 2021</td></tr>
<tr><td>Comments and Responses</td><td>Minutes of the meeting and all comments received during the meetings or by email and telephone, are attached in Appendix D. The Issues and Responses Report is attached in Appendix E.</td><td></td></tr>
<tr><td colspan="3">Review of draft Scoping (including Impact Assessment) Report</td></tr>
<tr><td>IAPs and authorities (excluding MET) review of Scoping Report and EMP</td><td>The main Scoping (with assessment) Report (excluding Appendices) was distributed to all authorities and IAPs that are registered on the IAP database via e-mail. Electronic copies of the full report (including Appendices) are available from ASEC on request.

Authorities and IAPs have 21 working days to review the Scoping Report and submit comments in writing to ASEC. The closing date for comments is 07 July 2021.</td><td>June/July 2021</td></tr>
<tr><td>MET review of Scoping Report and EMP</td><td>A copy of the final Scoping (with assessment) Report, including authority and IAP review comments, will be delivered to MME on completion of the public review process for their review and recommendations to MEFT.

The Final documents will also be uploaded onto the MEFT online portal.</td><td>July 2021</td></tr>
</table>

DESCRIPTIONS OF THE PROPOSED OFF-SHORE DIAMOND MINING ACTIVITIES

The proposed ML 220 over Hottentots Bay lies approximately 60 km north of Lüderitz and covers an area of 42.3 km^2 (see **Figure below**). The ML extends from the shore to 2 km off-shore (~45 m depth) and stretches along the coast over a distance of 6 km. The area falls within the Namibian Island Marine Protected Area (NIMPA) (see **Section 6** of the main report).

LK Mining will use a small dredge-pump vessel with an on-board processing plant to mine in Mining Area 1. Additionally, further detailed geophysical exploration activities will be conducted over 'sampling areas 2, 3 & 4' (see **Figure below**) within the ML as well as ongoing sampling and resource development.

The mining activities and methodology will be the same as applied during the exploration activities, that were conducted between 2016 to 2019.

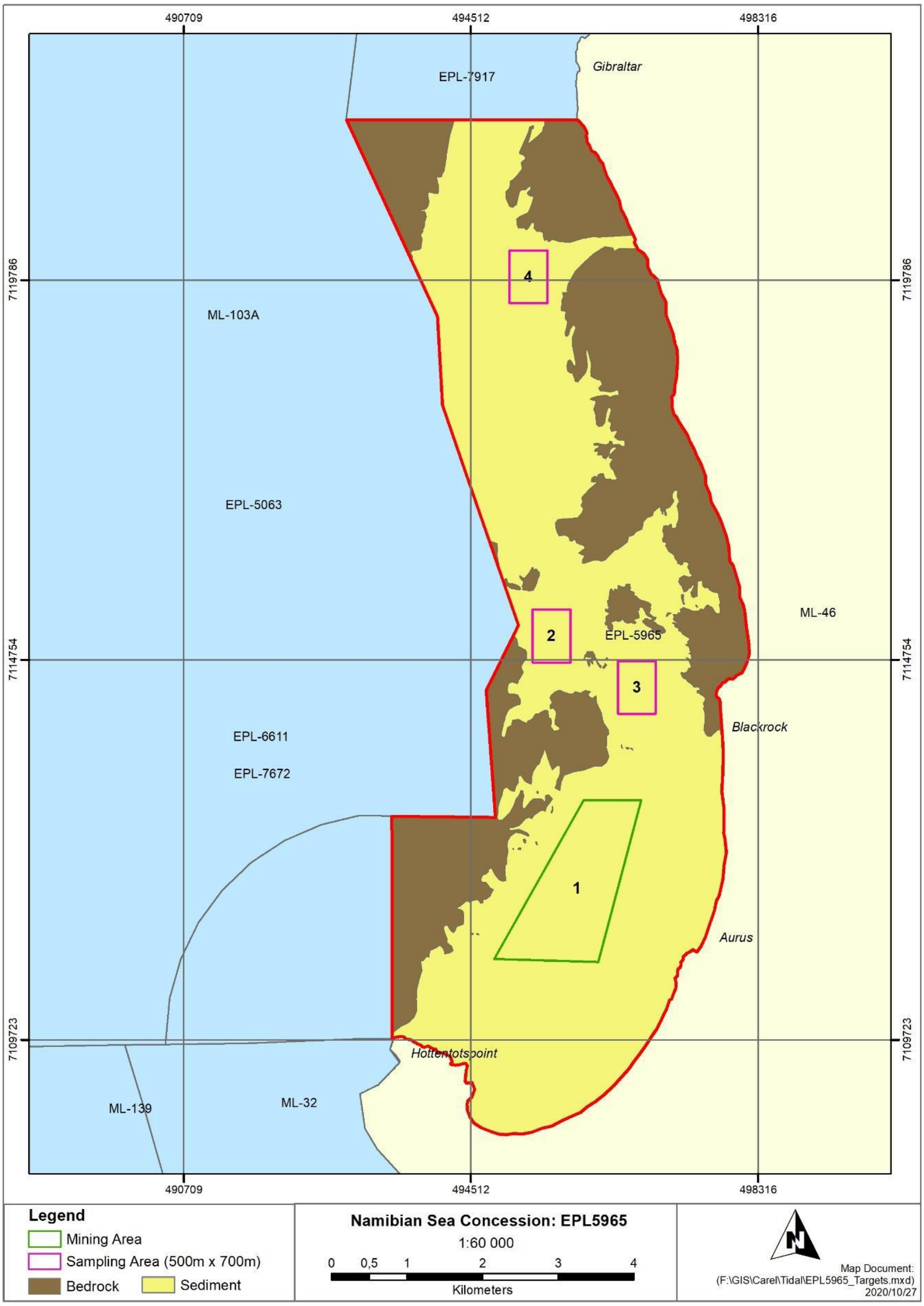
LK Mining plans to buy a supply vessel and convert it to a remote mining vessel. The mining vessel would use a suitable shallow/mid water gravel pump system for operating in the 14 – 40 m water depth range. The mining system would comprise a suspended steel mining tool fitted with a digging mining head, ~ 300 mm diameter suction hoses and an on-board mining pump. The opening of the mining tool would be fitted with grizzly cross-bars to allow sized gravel (nominally <100 mm) to pass through and prevent blockages in the suction system. Fixed-head remote exploration/mining systems, operating in the shallow and mid-water depth range, can efficiently extract gravel in areas of thicker overburden.

Mining would involve the removal of only the unconsolidated surficial sediments. The dredged sediment-slurry would be pumped to the surface and discharged onto a series of screens, which separate the oversize (>12 mm) and undersize (<1.2 mm) fractions. The tailings, which typically comprise ~99% of the dredged material, will be discharged overboard below the surface to the sea. The fine material forms turbid plumes that are carried away from the vessel by ambient currents, while the coarse material falls directly to the sea floor below the vessel. During the extraction process the operator generally attempts to deposit the coarse tailings in previously excavated areas to prevent re- mining of already processed material.

The fraction of interest (post-screened plant feed) is fed through a crusher to fragment the shell and clay components, mixed with ferrosilicon (FeSi) and pumped under pressure to an on-board Dense Media Separation (DMS) plant. Low density materials (floats) are separated from the concentrated plant feed and discarded overboard following magnetic recovery of the FeSi. The remaining high density fraction is dried and passed through a X-ray sorting process to separate the diamonds from the residual gravels. Non-fluorescent (gravel) material is discarded overboard with the float material, and the fluorescent fraction containing the diamonds is then hand sorted, within a confined glove box, for diamonds under strict control and monitoring on board the vessel. Plant feed rates for this technology at present average 8 tonnes per hour for the smaller vessels and up to 100 tonnes per hour for the deeper water vessels.

Mining would commence over Mining Area 1, which at 228 ha covers 5.4% of the total licence area. The current mine plan is for seven years, and through additional resource development over Target Areas 2, 3 and 4 the mine plan could be extended another 3 years, at least.

Target areas 2, 3 and 4 each measure 500 x 700 m. It is proposed to take a total of 35 point samples over a 100 m sampling grid in each target area. Each sample will disturb an area of ~ 20 m^2, with a total area of 2,100 m^2 being disturbed. The point sampling will be followed by a bulk sampling phase during which a total of 12 block samples (50 x 50m) will be taken over another total area of 30,000 m^2. In total, sampling and resource development will thus be conducted over a total area of 32,100 m^2, which equates to <0.07% of the total licence area.



ML 220 showing the location of Mining Area 1 and the three resource development areas. The distribution of unconsolidated sediments and bedrock across the licence area is also shown.

Sampling and mining operations would be conducted to depths of between 14 m and 24 m from a fully self-contained mining vessel with an on-board processing plant. The vessel would operate a semi-mobile mining platform, anchored by a static positioning system, commonly on a four anchor spread. Positioning winches will enable the vessel to be located precisely over the mining block where it would 'crab' across the target area removing overburden and ore down to bedrock. The mining vessel would thus have limited manoeuvrability and other vessels should remain at a safe distance.

Supporting infrastructure and other activities

The sampling/mining vessel would use the Port of Lüderitz to provide supporting infrastructure (e.g. specialist engineering services, refuelling, waste disposal, victualling). Crew changes would take place in the port and in emergencies small craft would be used for medical evacuations.

The vessel will take fresh water from the Lüderitz port, enough for each voyage. The vessel also has capacity, through reverse osmoses, to produce fresh water from sea water for consumption.

Sewage and Waste

MARPOL Annexure IV contains requirements to control pollution of the sea by sewage and Annexure V on waste. The discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; sewage which is not comminuted or disinfected has to be discharged at a distance of more than 12 nautical miles (nm) from the nearest land waste. Food wastes comminuted or ground must be discharged over 3 nm from the nearest land.

As ML 220 is within 3 nautical miles of the land, LK Mining will dispose of their sewage at the waste water treatment plant in Lüderitz and all waste at a certified land fill facility in Lüderitz.

Refuelling of vessels

The vessel will be refuelled at Lüderitz harbour under controlled conditions.

Employment

The majority of crew members will be Namibian, however, some of the specialists on board might need to be sourced from outside Namibia. The aim is to employee as many Namibians as possible. The crew will consist of 14 people, rotating 7 on duty for 12 hour shifts each on 28-day cycles with the other crew. After 28 days the shift will be changed in Lüderitz. It is anticipated that the vessel will operate for 11 months per year.

LK Mining will also have an office in Lüderitz.

DESCRIPTION OF THE CURRENT ENVIRONMENT

This section has been compiled extracting information from the *Atlas of Namibia* (Mendelsohn *et al*., 2009) and the LK Mining – Environmental Scoping Report (with assessment) and Environmental Management Plan of LK Mining's offshore diamond exploration activities on Exclusive Prospecting Licence 5965' (SLR, 2016) as well as the following specialist reports:

- Marine ecology specialist study (PISCES, 2021) included as **Appendix G**;
- Fisheries specialist study (CapMarine, 2021) included as **Appendix H**;
- Marine archaeology specialist study (QRS, 2021) included as **Appendix I**; and
- Socio-economic specialist study (A. Ashby Associates, 2021).

Climate

ML 220 is situated within the Coastal Fog Zone. The average annual temperature is less than 16˚C. Wind is a dominating feature of the coast.

Geology and Geomorphology

The geological history of the continental shelf dates back to the Late Jurassic - Early Cretaceous (125 to 130 MY. BP) when the fragmentation of West Gondwanaland and the subsequent separation of South America from Africa occurred.

The underlying coastal geological formations around Lüderitz are composed primarily of gneisses and schists of the Namaqua Metamorphic complex.

Seabed Topography, Bathymetry and Sediments

The surficial sediments in the intertidal and shallow subtidal areas are generally dominated by moderately to well-sorted fine to medium sand with median particle sizes of 200- 400 µm.

The typical sediment sequence in Hottentots Bay, and within the proposed mining area, extends over ~3 m and comprises an overlying layer of Holocene mud/silt (20-50 cm) over a shell or sandy-shell horizon. Lenses of Glauconitic mud occur at the base of this horizon.

Waves

The Southern Namibian Coast is classified as exposed, experiencing strong wave action rating between 13-17 on the 20 point exposure scale (McLachlan 1980). The coastline is influenced by major swells generated in the Roaring Forties, as well as significant sea waves generated locally by the persistent southerly winds. The dominant peak energy period for swells is ~13 seconds, whilst wind induced waves have shorter wave periods (~8 seconds). Storms occur frequently, particularly during winter and spring.

The wave pattern within the licence area is largely protected by the north facing embayment of Hottentots Bay, which provides shelter from the prominent southerly wave patterns and significantly reduces the wave height.

Tides

In common with the rest of the southern African coast, tides in the study area are regular and semi-diurnal. The maximum tidal variation is approximately 2 m, with a typical tidal variation of ~1 m.

Turbidity

In a shallow embayment such as Hottentots Bay and in the nearshore regions of the licence area, swell and wind-induced waves and currents result in the constant resuspension of sediments. Consequently, nearshore waters are naturally turbid, and underwater visibility seldom exceeds 1 m.

Biological Environment

Biogeographically the coastline of the study area falls on the boundary between the cold temperate Namaqua Province, which extends from Cape Point up to Lüderitz, and the warm-temperate Namib Province, which extends northwards from Lüderitz into southern Angola (Emanuel *et al.* 1992). The coastal, wind-induced upwelling characterising the Benguela ecosystem, is the principle physical process that shapes the marine ecology of the study area. Pallett (1995) has assigned the coastline of southern Namibia as an area of high sensitivity, as the entire coastal strip contains hummock vegetation which supports many endemic animals, offshore islands and reefs harbouring various breeding seabird and Cape fur seal colonies, as well as virtually undisturbed rocky shores and sandy beaches.

ML 220 falls into the Lüderitz Inshore and Lüderitz Inner Shelf habitats. Habitats occurring along the shoreline of ML 220 include Lüderitz Intermediate Sandy Beach, Lüderitz Mixed Shore, Lüderitz Exposed Rocky Shore, Lüderitz Reflective Sandy Beach, and Lüderitz Sheltered Rocky Shore. The inshore and coastal habitats in the area have all been assigned a threat status of 'Least Concern', (Holness *et al.* 2014). The coastline of the study area predominantly comprises sandy beaches punctuated by numerous rocky shores. Consequently, marine ecosystems along the coast comprise a limited range of habitats that include:

- sandy intertidal and subtidal substrates,
- intertidal rocky shores, subtidal reefs and hard grounds,
- the water body.

The benthic communities within these habitats are generally ubiquitous throughout the southern African West Coast region, being particular only to substratum type, wave exposure and/or depth zone. They consist of many hundreds of species, often displaying considerable temporal and spatial variability. The biological communities 'typical' of each of these habitats are described in the specialist report (**Appendix G**).

Biological Resources

Rock Lobster Sanctuaries

Two rock lobster sanctuaries exist in the vicinity of the project area (**Figure 52**, left in Section 6). The Ichaboe lobster sanctuary, which lies about 20 kms south of ML 220, was proclaimed in 1951 and extends from Danger Point to Douglas Point in Douglas Bay. No western boarder has been defined making it extend to the outer boundary of the Exclusive Economic Zone (EEZ). The sanctuary has been effective in preserving the natural size structure of the rock lobster population, which in the sanctuary has resulted in a significantly higher abundance of large-sized lobsters compared with commercially fished areas (Currie *et al.* 2009).

The whole of the Lüderitz Bay, which lies 60 kms south of the licence area, was proclaimed a rock lobster sanctuary in 1939. The bay serves primarily as a recruitment settlement area and high numbers of lobster *puerulus* larvae and juvenile lobsters are reported to occur there, due to the protective environment provided by various bays, small fjords, two islands and a lagoon area (Keulder 2005; Currie *et al.* 2009). Neither commercial nor recreational fisheries are permitted in either of these sanctuaries.

Human Utilization of Marine Resources

Namibian commercial fisheries catch and effort data were sourced from the Ministry of Fisheries and Marine Resources (MFMR) for the period 2005 to 2019, where available. Data on fishing rights holdings and industrial bodies was sourced from the 2019 edition of the Fishing Industry Handbook[1]. Information on species distribution was taken from the Benguela Current Large Marine Ecosystem (BCLME) Annual State of the Stocks Report 2011[2].

The study is based on a number of assumptions and is subject to certain limitations listed below. The outcome of the impact assessment is, however, not expected to be affected by these assumptions and limitations:

- The official governmental record of Namibian commercial fisheries data was used to show fishing catch per unit effort (CPUE) relative to the licence area. These data are derived from logbooks that are completed by skippers whilst at sea and then transcribed into electronic format by the Ministry of Fisheries and Marine Resources (MFMR). It is assumed that there would be a proportion of erroneous data due to inaccurate reporting and recording, but that this is likely to be minimal in comparison to the total volume of the dataset. Where obvious errors in the reporting of fishing positions were identified these were excluded from the analysis.
- Fishing positions are reported by the skippers as the start latitude and longitude of each fishing event and the accuracy of the reported positions is assumed to be to the nearest nautical minute.
- The dataset used to map the spatial distribution for each fishery covers at least a ten-year period and includes the most recent available data.
- The effects of sound on the CPUE of fish and invertebrates have been drawn from the findings of international studies. To date there have been no studies focused directly on the species found locally. Although the results from international studies are likely also to be representative for local species, current gaps in knowledge on the topic lead to uncertainty when attempting to accurately quantify the potential loss of catch for each type of fishery. Research into the effects of sound on marine fauna is ongoing.

[1] Fishing Industry Handbook South Africa, Namibia and Moçambique (2019) 47th edition George Warman Publications, Cape Town, South Africa

[2] Benguela Current Large Marine Ecosystem State of Stocks Review 2011 (2nd Edition; Ed C. Kirchner). Benguela Current Commission.

Description of Receiving Environment

Namibia has one of the most productive fishing grounds in the world, based on the Benguela Current System (FAO, August 2015). Namibia is Africa's fourth largest capture fisheries nation behind Morocco, South Africa and Mauritania, and 36th worldwide.[3] Namibia's 200 nautical mile Exclusive Economic Zone (EEZ) supports some 20 different commercially exploited marine species. The three main Namibian commercial species (hake, sardine and horse mackerel) comprise the primary species of historical importance in Namibia. Other species of more recent importance include orange roughy, the deepwater crab trap fishery, monk, rock lobster and the large pelagic fisheries for tuna. The majority of sectors are considered by MFMR to be sustainably utilised.

The fishing industry is a cornerstone of the Namibian economy, generating approximately N$10 billion in export revenue (2016) - the second most important forex earner after mining, while it sustains some 16 800 direct jobs (Ministry of Fisheries and Marine Resources, 17 February 2017) - 70% of which are in the hake sector.

Fisheries Management and Research

The commercial exploitation of fish stocks is managed by MFMR, which is advised by the Ministry's National Marine Information and Research Centre (NatMIRC) in Swakopmund. The Total Allowable Catch for each species is set annually by the Minister on recommendation by an advisory council. Commercial fisheries are represented at industry level by the Confederation of Namibian Fishing Industries, and at fish species sector-specific level by the Midwater Trawling Association of Namibia, the Namibian Hake Association, Namibian Monk and Sole Association, Namibian Tuna and Hake Longlining Association and the Pelagic Fishing Association of Namibia.

MFMR conducts regular research (biomass) surveys for demersal, mid-water and small pelagic species. For example, the demersal trawl surveys take place in January and/or February over the period of one month. MFMR surveys normally follow fixed transects from inshore to offshore. Surveys have a systematic transect design, with a semi-random distribution of stations along transects designed to statistically optimise the number of stations according to the area of every 100 m depth zone out to 500 m. Transects normally run perpendicular to the coastline are 20-80 nm long and are spaced between 20 and 25 nm apart. Most of the sampling stations (trawls) take place during daylight hours.

Swept-area biomass surveys for hake are conducted annually to obtain an index of abundance, determine the geographical distribution and collect biological information of the stock. From 1990 to 1999, these surveys were conducted with the Norwegian R/V *Dr Fridtjof Nansen* (Sætersdal *et al* 1999). Since 2000, Namibian commercial trawlers (using the same trawl gears as that of the *Dr Fridtjof Nansen*) were used for the surveys. Since 2002, the commercial trawler *F/V Blue Sea 1*[4] has been used to conduct these surveys.

Scientific acoustic surveys are carried out between February and March each year to estimate the biomass of small pelagic species (using the survey vessel F/V *Welwitchia*). These surveys cover the Namibian shelf from the coastline to the 500 m depth contour (and up to the 2000 m contour northwards of 18°30´S). The vessel surveys along pre-determined transects that run perpendicular to depth contours (East-West / West-East direction).

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[3] Wikipedia, February 2017. https://en.wikipedia.org/wiki/Fishing_industry_by_country

[4] Namibia now also has new research vessel, the *FV Mirabalis* undertaking routine fishery surveys

Stock Distribution, Spawning and Recruitment

The principle commercial fish species in Namibia undergo a critical migration pattern which is central to the sustainability of the small pelagic and hake fisheries. In Namibian waters, hake spawning commences north of the powerful Lüderitz upwelling centre (27°S) and continues up to the Angola–Benguela Front (16–19°S). Sardines and horse mackerel also spawn in the region between Lüderitz and the Angola–Benguela front. Circulation patterns at depth reveal complex eddying and considerable southward and onshore transport beneath the general surface drift to the north-west (Sundby *et al.* 2001).

As eggs drift, hatching takes place followed by larval development. Settlement of larvae occurs in the inshore areas. Sardine spawning peaks 30–80 km offshore during September–October off the central Namibian shelf, with larvae occurring slightly further offshore and recruits appearing close inshore, so there appears to be a simple inshore–offshore movement over the Namibian shelf. Spawning also occurs in mid-summer in the vicinity of the Angola–Benguela Front (Crawford *et al.* 1987). During late summer (December – March) warm water from the Angolan Current pushes southwards into central Namibian waters, allowing pelagic spawning products to be brought into the nursery grounds off central Namibia. There is a high likelihood of substantial offshore transport associated with this convergent frontal region (Shannon 1985).

Socio-economic Aspects

The economy of the //Kharas Region is driven by the mining, commercial agriculture and government services sectors. Opportunities for jobs have encouraged people to come and settle in the region over many decades. With the economy slowing, unemployment has significantly increased from 24% in 2012 to 32% in 2018. Youth (people aged between 15-34 years) are worst affected, followed by women. Nevertheless, people in //Kharas Region experience lower levels of poverty or severe poverty compared to many other regions in Namibia.

The main economic driver of Lüderitz is the local commercial and subsistence fishing industry, which provides more than 80% of the employment[5]. The Port of Lüderitz, operated by Namport, caters for the fishing industry, offshore diamond and mining industries, and handling general cargo for Southern Namibia and the Northern Cape. Some tourism provides further opportunities.

Diamond mining, from the //Kharas Region and its offshore waters, provides a major contribution to Namibia's economy, providing N$7 billion in value addition and contributed to 3.9% of Gross Domestic Product (GDP) in 2019. Government gained N$1.255 billion in royalties and N$1.495 billion in tax revenue, amounting to 5% of all revenue collected (CoM, 2020).

Offshore diamond mining is dominated by large scale operators at depths from 30m – 120m, using highly sophisticated remote mining technology. Near-shore mining, in waters up to 12m deep, use divers working from small, converted fishing boats, during daylight hours, weather and swell permitting. LK Mining is intending to operate a purpose-built vessel for mining at a depth range of 10m – 30m, in a new niche depth-zone. A geological assessment of the amount of diamonds off Namibia's coast indicates that marine diamond mining can make a major

[5] https://www.luderitz-tc.com/?page_id=276 sourced on 15 May 2021.

contribution to Namibia's economic and social progress now and for many years to come (Schneider, 2020).

LK Mining will invest about $70 million in the offshore mining vessel and the initial implementation phase. It plans to employ 28 people to operate the vessel, plus run an office and store in Lüderitz. With that investment and its extensive knowledge of offshore diamond mining in Namibia, it anticipates operating costs of approximately N$14.5 million per annum and breaking even between one and five years. Government can expect revenue from royalties, company taxes and export levies.

The rock lobster industry is based in Lüderitz and operates seasonally from November to April, with highest fishing levels during January and February. The sector operates from boats in water depths of between 10m and 80m and the Rock Lobster Association was most concerned about their fishing not being disturbed in the Black Rock fishing area. In the 2020 and 2021 seasons, government set the Total Allowable Catch at 180 tons and this year 17 active vessels landed 190 tonnes. The vessels employ between 9 and 11 crew, which provides work for approximately 170 people during the season. The approximate income generated from the industry this year is N$60 million so it is regarded as a viable and important industry for Lüderitz.

From LK Mining's 2018 feasibility study, it will generate fewer jobs and contribute less to the local economy than the rock lobster industry. However, both industries are desirable as both will make an important contribution to the local and national economy. By and large, the two industries do not operate in exactly the same seabed area. With sensible mitigating measures, continuous monitoring and on-going dialogue between the parties involved, it would be socially and economically desirable for both industries to work together to ensure they both remain viable.

<u>Heritage of Hottentots Bay and surrounding</u>

In 2009 a total of 72 historical and archaeological sites were recorded in the course of a systematic ground survey of Hottentot Bay and the immediately surrounds. Pre-contact sites are relatively few in number, as are those relating to the early 19th century. A distinct peak occurs in the mid- to late 19th century, corresponding to the intense commercial activity at that time. This is followed by a trough in the early to mid-20th century, and a second peak in the mid- to late 20th century when the Table Mountain Cannery and Penguin Mining (Pty) Ltd were successively established and abandoned.

As no underwater survey has been carried out in Hottentot Bay, LK Mining will conduct further maritime archaeological studies.

PROTECTED AND CONSERVATION AREAS

<u>Marine Protected Areas</u>

ML 220 falls within the Namibian Islands Marine Protected Area (NIMPA). The NIMPA comprises a coastal strip extending roughly 400 km from Hollamsbird Island (24º38'S) in the north, to Chamais Bay (27º57'S) in the south, spanning approximately three degrees of latitude and an average width of 30 km, including 16 specified offshore islands, islets and rocks (Currie *et al.* 2008). The NIMPA spans an area of 9,555 km^2, and includes a line fish sanctuary near Meob Bay and a 478 km^2 rock lobster sanctuary between Prince of Wales Bay and Chameis Bay. The offshore islands, whose combined surface area amounts to only 2.35 km^2 have been given priority conservation and highest protection status (Currie *et al.* 2009). The area has been further zoned into four degrees of incremental protection.

Of particular significance in ML 220 is Neglectus Islet and the disused Jetty in Hottentots Bay. These provide important breeding sites for African Penguins, Bank, Cape, Crowned and White-breasted cormorants and are given special protection under NIMPA. In 2009, the jetty had the largest breeding colony of White-breasted cormorants along the southern Namibian coast. Access to Neglectus Islet is only allowed with a permit and the islet has a buffer zone extending from the low water mark to 120 m off the islet in which activities are restricted. Access to the jetty is not allowed at all and no approach is permitted to within 50 m of the jetty from the seaward side.

Ecologically or Biologically Significant Areas

Ecologically or Biologically Significant Areas (EBSAs) are marine areas that provide important services to an ecosystem or to one or more species / populations within an ecosystem. These areas require targeted conservation management actions to limit marine biodiversity declines. An inventory of EBSAs aids marine spatial planning by advising and providing a guideline to which activities would be (in)compatible with areas of high ecological value (Dunn et al. 2014).

EBSAs spanning the coastline between Angola and South Africa were proposed and successfully submitted for international recognition to the Convention of Biological Diversity (CBD) in March 2020. The principal objective of the EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures.

The **Namibian Islands** are located offshore of the central Namibian coastline and within the intensive Lüderitz upwelling cell. These islands and their surrounding waters are significant for life history stages of threatened seabird species as they serve as crucial seabird breeding sites within the existing Namibian Islands Marine Protected Area (NIMPA). The surrounding waters are also key foraging grounds for both seabirds and for 'Critically Endangered' leatherback turtles that nest along the northeastern coast of South Africa.

Although the proposed zonation of the EBSAs is still under discussion, and industry has not been approached for comments, the management objective in the zones marked for 'Conservation' is "*strict place-based biodiversity protection aimed at securing key biodiversity features in a natural or semi-natural state, or as near to this state as possible*". The management objective in the zones marked for 'Impact Management' is "*management of impacts on key biodiversity features in a mixed-use area to keep key biodiversity features in at least a functional state*".

The proposed mining area overlaps with the recommended, but not proclaimed, conservation zone proposed to offer biodiversity protection to Neglectus Islet and the disused jetty in Hottentots Bay.

ALTERNATIVES

The identification and consideration of alternatives is recognised as required practice in environmental assessment procedures globally and is a regulatory requirement in terms of the Namibian Environmental Management Act, 2007 (Act No. 7 of 2007).

However, no alternative, except the no-go option, can be given for off-shore diamond mining.

IDENTIFICATION AND DESCRIPTION OF POTENTIAL IMPACTS

The proposed mining activities in ML 220 have the potential to impact on the marine environment. Environmental aspects and potential impacts were identified during the scoping phase, in consultation with authorities, IAPs and the environmental team.

The following potential impacts have been identified and are assessed in Chapter (of the main report:

- Disturbance and loss of benthic marine fauna and rock lobster.
- Impact on the photosynthetic capability of phytoplankton; feeding success of pelagic predators; and egg and larval development. Benthic species inundation.
- Smothering of benthic communities
- Pollution and impact on marine ecology
- Damage to Heritage resources (shipwrecks etc.)
- Disruption of fisheries research surveys
- Disruption of marine transport routes
- Conflict with other mining/exploration activities.
- Hazard to other marine users
- Hydrocarbon spillage
- Impact on physiology and behaviour of marine organisms
- Adding sewage to waste water treatment plant in Lüderitz
- Adding to waste in Lüderitz landfill site
- Use of water from Lüderitz municipality
- Contribution to GDP
- Loss of income due to reduction of lobster fishery
- Job creation and skills development

ASSESSMENT OF RELEVANT ASPECTS & IMPACTS AND MANAGEMENT & MITIGATION MEASURES FOR ALL IDENTIFIED ASPECTS

The detailed assessment and mitigation measures of identified impacts are provided in Chapter 8 of the main report. The table below provides a summary of the assessment.

Impact	Probability	Significance (before mitigation)	Significance (after mitigation)
Multi-beam and sub-bottom profiling sonar on marine fauna	Unlikely (physiological injury) – Possible (behavioural disturbance)	Low negative	Low negative
Underwater noise from sampling and mining on marine fauna	Unlikely	Low negative	--
Multibeam, bottom profiling and side-scan sonar on fisheries catch	Possible	Low negative	Low negative
Disturbance and loss of benthic macrofauna	Definite	Moderate negative	Moderate negative
Disturbance and loss of rock lobster	Unlikely	Low negative	Low negative
Increased turbidity in suspended sediment plumes and at the seabed	Unlikely	Low negative	Low negative
Remobilisation of contaminants and nutrients	Unlikely	Low negative	Low negative
Redeposition of discarded sediments on soft-sediment macrofauna	Possible	Low negative	Low negative
Redeposition of discarded sediments: smothering effects on rocky outcrop communities	Unlikely	Low negative	Low negative
Loss of ferrosilicon	Unlikely	Low negative	Low negative
Equipment lost to the seabed or watercolumn	Unlikely/Possible	Low/Moderate negative	Low negative
Pollution of the marine environment through operational discharges to the sea from mining vessel	Most likely	Low negative	Low negative
Impacts on turtles and cetaceans due to ship strikes, collision and entanglement with towed or moored equipment	Unlikely	Low negative	Low negative

Impact	Probability	Significance (before mitigation)	Significance (after mitigation)
Operational Spills and vessel accidents	Possible (operational Spill)/ Unlikely (vessel accident)	Low/Moderate negative	Low negative
Impacts of exclusion of fisheries during survey and mining operations	Unlikely	Low negative	--
Impacts on the local and national economy	Most likely	High positive	Very High positive
Impacts on employment, at household, local and national levels	Most likely	High positive	Very High positive
Damage and Loss to archaeological heritage	Most likely	High negative	High positive

11 WAY FORWARD

The way forward for the EIA scoping phase is as follows:

- Distribute the scoping report and a summary thereof for review by the IAPs and authorities;
- receive comments from IAPs and authorities on 07 July 2021 (at the end of the review period);
- submit the scoping report (with comments) to MME and MEFT; and
- follow up on MEFT's decision.

ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSIONS

The environmental aspects associated with the proposed offshore diamond mining by LK Mining have been successfully identified and assessed as part of this EIA process. Relevant mitigation measures have been provided and are included in the EMP that accompanies this scoping report. ASEC believes that a thorough assessment of the proposed project has been achieved and that MEFT can make an informed decision regarding the application for an environmental clearance certificate.

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ACRONYMS, ABBREVIATIONS AND GLOSSARY

Acronyms / Abbreviations	Definition
BCLME	Benguela Current Large Marine Ecosystem
CAPEX	Capital Expenditure
CapMarine	Capricorn Marine Environmental (Pty) Ltd
CBA	Critical Biodiversity Area
CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
CoM	Chamber of Mines, Namibia
COSDEC	Community Skills Development Centre
COVID-19	*Coronavirus* disease of 2019
CPUE	Catch Per Unit Effort
CSIR	Council for Scientific and Industrial Research
dB	decibell
DEA	Department of Environmental Affairs
DebMarine	De Beers Marine Namibia
DMS	Dense Medium Separation
E	East
EAP	Environmental Assessment Practitioner
EBSA	Ecologically and Biologically Significant Area
ECC	Environmental Clearance Certificate
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPL	Exploration and Prospecting Licence
ESIA	Environmental and Social Impact Assessment
FAO	Food and Agricultural Organisation
FeSi	Ferrosilicon
GDP	Gross Domestic Product
GRT	Gross Registered Tonnage
HAB	Harmful Algal Blooms
IBA	Important Bird Area
ICCAT	International Convention for the Conservation of Atlantic Tunas
ICSEAF	International Commission for South East Atlantic Fisheries
IMDH	International Mining and Dredging Holdings Ltd
IPPR	Institute for Public Policy Research
IUCN	International Union for Conservation of Nature

Acronyms / Abbreviations	Definition
IUU	Illegal, Unreported and Unregulated fishing
IWC	International Whaling Commission
JNCC	Joint Nature Conservation Committee
kts	Knots as measure of wind speed
LKM	LK Mining (Pty) Ltd
MBES	Multibeam Echosounder
MPA	Marine Protected Area
MEFT	Ministry of Environment, Forestry and Tourism
MFMR	Ministry of Fisheries and Marine Resources (Namibia)
ML	Mining Licence
MLR	Ministry of Lands and Rehabilitation
MME	Ministry of Mine and Energy
MMOs	Marine Mammal Observers
MoHSS	Ministry of Health and Social Services
NACOMA	Namibian Coast Conservation and Management Project
Namport	Namibia Ports Authority
NatMIRC	National Marine Information and Research Centre
NEMA	Namibian Environmental Management Act
NHIES	Namibia Household Income and Expenditure Survey
NOAA	National Oceanic and Atmospheric Administration
NSA	Namibia Statistics Agency
NDTC	Namibia Diamond Trading Company
PIM	Particulate Inorganic Matter
POM	Particulate Organic Matter
PTS	Permanent Threshold Shift
Q2	Quarter 2
QMAs	Quota Management Areas
RBS	Risk Based Solutions
RFMO	Regional Fisheries Management Organisation
RPZC	Rosh Pinah Zinc Corporation
SACW	South Atlantic Central Water
TAC	Total Allowable catch
TAE	Total Allowable Effort
TSPM	Total Suspended Particulate Matter
TTS	Temporary Threshold Shift
UNCLOS	United Nations Convention of the Law of the Sea
UNEP	United Nations Environmental Programme
USD	United States Dollar

Acronyms / Abbreviations	Definition
VMS	Vessel monitoring system

Units used in the report

Units	Definition
µg/ℓ	micrograms per litre
µPa	micro Pascal
cm	centimetres
cm/s	centimetres per second
g C/ m^2/ day	grams Carbon per square metre per day
h	hours
Ha	hectar
HP	Horse power
kHz	kiloHerz
kg	kilogram
km	kilometres
km^2	square kilometres
m	metres
m/s	metres per second
mm	millimetres
m^2	square metres
m^3/day	cubic metres per day
m/s	metres per second
mg/ℓ	milligrams per litre
mg Chl a/ m^3	milligrams Chlorophyll a per cubic metre
ppm	parts per million
s	seconds
%	percentage
~	approximately
<	less than
>	greater than
°C	degrees centigrade

Glossary

Barotropic	a fluid whose density is a function of only pressure
Bathymetry	measurements of the depths of the ocean relative to mean sea level.
Benthic	Referring to organisms living in or on the sediments of aquatic habitats (lakes, rivers, ponds, etc.).
Benthos	The sum total of organisms living in, or on, the sediments of aquatic habitats.
Benthic organisms	Organisms living in or on sediments of aquatic habitats.

Biodiversity	The variety of life forms, including the plants, animals and micro-organisms, the genes they contain and the ecosystems and ecological processes of which they are a part.
Biomass	The living weight of a plant or animal population, usually expressed on a unit area basis.
Biota	The sum total of the living organisms of any designated area.
Bivalve	A mollusk with a hinged double shell.
Community structure	All the types of taxa present in a community and their relative abundance.
Community	An assemblage of organisms characterized by a distinctive combination of species occupying a common environment and interacting with one another.
Dissolved oxygen (DO)	Oxygen dissolved in a liquid, the solubility depending upon temperature, partial pressure and salinity, expressed in milligrams/litre or millilitres/litre.
Ecosystem	A community of plants, animals and organisms interacting with each other and with the non-living (physical and chemical) components of their environment.
Epifauna	Organisms, which live at or on the sediment surface being either attached (sessile) or capable of movement.
Environmental impact	A positive or negative environmental change (biophysical, social and/or economic) caused by human action.
Habitat	The place where a population (e.g. animal, plant, micro-organism) lives and its surroundings, both living and non-living.
Intertidal	the area of a seashore which is covered at high tide and uncovered at low tide
Macrofauna	Animals >1 mm.
Mariculture	Cultivation of marine plants and animals in natural and artificial environments.
Marine environment	Marine environment includes estuaries, coastal marine and near-shore zones, and open-ocean-deep-sea regions.
Pollution	The introduction of unwanted components into waters, air or soil, usually as result of human activity; e.g. hot water in rivers, sewage in the sea, oil on land.
Population	Population is defined as the total number of individuals of the species or taxon.
Recruitment	The replenishment or addition of individuals of an animal or plant population through reproduction, dispersion and migration.
Sediment	Unconsolidated mineral and organic particulate material that settles to the bottom of aquatic environment.

Species	A group of organisms that resemble each other to a greater degree than members of other groups and that form a reproductively isolated group that will not produce viable offspring if bred with members of another group.
Subtidal	The zone below the low-tide level, *i.e.* it is never exposed at low tide.
Supralittoral	The supralittoral zone is situated above the high water spring tide level.
Surf zone	Also referred to as the 'breaker zone' where water depths are less than half the wavelength of the incoming waves with the result that the orbital pattern of the waves collapses and breakers are formed.
Suspended material	Total mass of material suspended in a given volume of water, measured in mg/ℓ.
Suspended matter	Suspended material.
Suspended sediment	Unconsolidated mineral and organic particulate material that is suspended in a given volume of water, measured in mg/ℓ.
Taxon (Taxa)	Any group of organisms considered to be sufficiently distinct from other such groups to be treated as a separate unit (e.g. species, genera, families).
Turbidity	Measure of the light-scattering properties of a volume of water, usually measured in nephelometric turbidity units.
Vulnerable	A taxon is vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

A. Speiser Environmental Consultants cc
VAT Reg. No.: 3452708015 Reg. No.: cc 2003/0606
Alexandra Speiser
MSc MPhil
P.O. Box 40386 Windhoek Namibia Tel:+264 61 244 782 Cell: 081 124 5655 e-mail:amspeiser@yahoo.com

SCOPING REPORT INCLUDING ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML 220 OF LK MINING, REQUIRED FOR AN ENVIRONMENTAL CLEARANCE CERTIFICATE

1 INTRODUCTION

LK Mining (Pty) Ltd (LKM) applied for a Mining Licence (ML 220) over their existing EPL 5965 area. The ML is located in Hottentots Bay, approximately 60 km north of Lüderitz, and falls within the Namibian Islands Marine Protected Area (NIMPA) of the Namibian Coast (**Figure 1**). The ML covers an area of 4227 Ha. The Mining Licence application was filed by LKM with the Ministry of Mines and Energy (MME) in October 2019. The last outstanding document, before execution and grant of ML 220 is to apply and obtain an Environmental Clearance Certificate (ECC) from the Ministry of Environment, Forestry and Tourism (MEFT), subject to an approved Environmental Impacts Assessment (EIA) report and Environmental Management Plan (EMP).

Some of the ML area has been previously mined by Tidal Diamonds, who held a Mining License (ML 30) from 1993 to 2013. The area was also mined by other companies between 1965 and 1970.

1.2 Motivation for the proposed marine mining activities

The Directorate of Mines within the Ministry of Mines and Energy (MME) undertakes to exploit the country's mineral resources in a responsible manner which integrates mining into the various economic sectors for the socio-economic development of the country. In order to achieve this, MME issues mining licences to various entities for the mining of minerals within the country and its coastal waters.

LKM conducted exploration activities on EPL 5965 between 2016 to 2019 and delineated a viable diamond resource that could be mined. This provides social and economic development in the region and country.

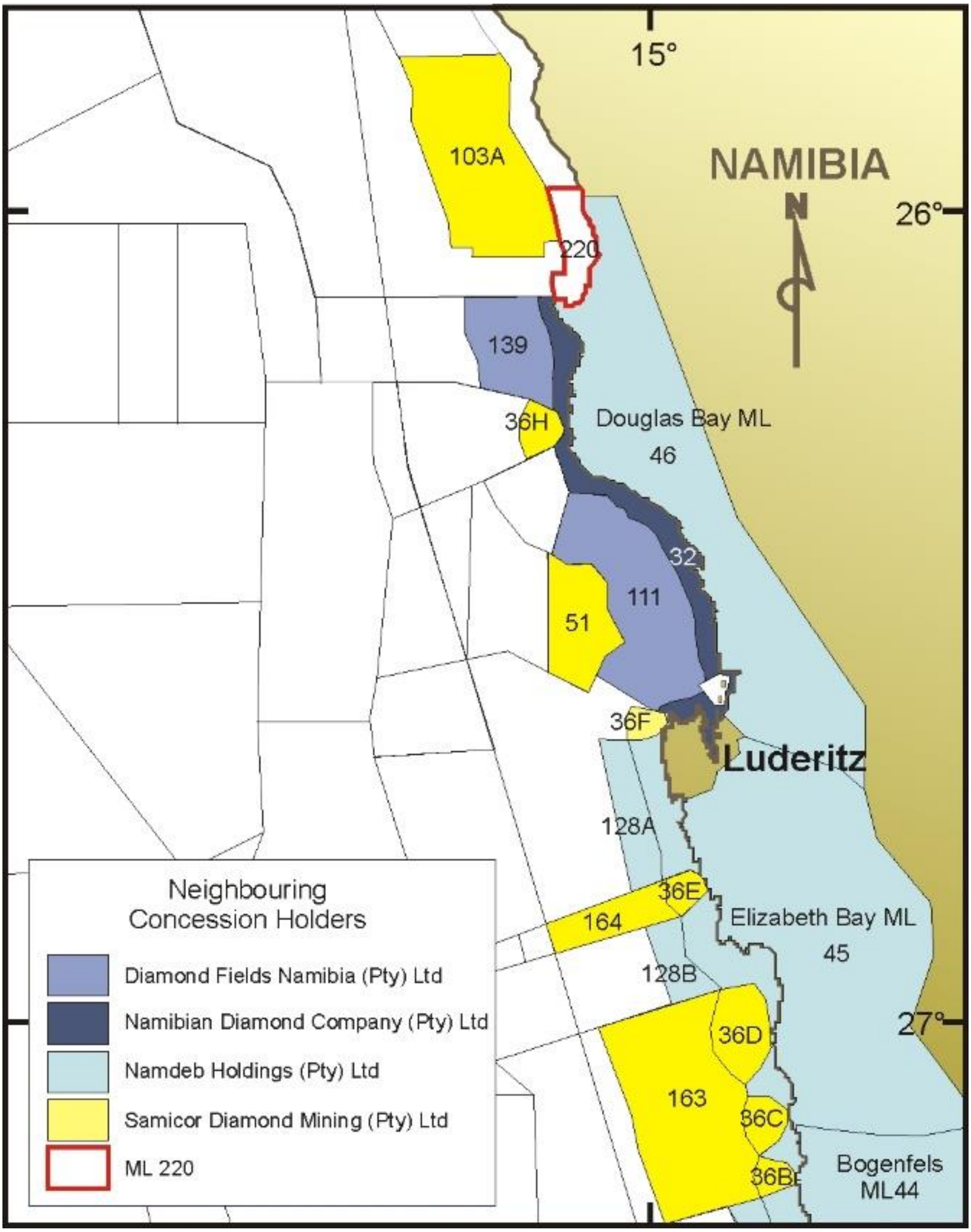


Figure 1: Location of the proposed ML 220 in relation to Lüderitz and other licence areas.

1.3 Introduction to the environmental impact assessment

EIAs are regulated by the Ministry of Environment, Forestry and Tourism (MEFT) in terms of the Environmental Management Act, 7 of 2007. This Act was gazetted on 27 December 2007 (Government Gazette No. 3966) and enacted on 6 February 2012. The EIA Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) were promulgated on 6 February 2012.

The list of activities that may not be undertaken without an Environmental Clearance Certificate: Environmental Management Act, 2007 was also promulgated through Government Gazette No. 4878. The following listed activities are triggered as a result of the proposed mining activities:

"MINING AND QUARRYING ACTIVITIES

Activity 3.1: The construction of facilities for any process or activities which requires a licence, right or other form of authorisation, and the renewal of a licence, right or other form of authorisation, in terms of the Minerals (Prospecting and Mining) Act, 1992.

Activity 3.2: Other forms of mining or extraction of any natural resources whether regulated by law or not.

Activity 3.3: Resource extraction, manipulation, conservation and related activities."

1.3.1 EIA process for the proposed offshore diamond mining activities

Prior to the commencement of the proposed diamond mining activities, an ECC is required from the MEFT: Department of Environmental Affairs (DEA) on the basis of an approved EIA Scoping Process.

This EIA process is conducted in terms of the Environmental Management Act, 7 of 2007 and the above-mentioned EIA regulations. This document provides the scoping report (including an assessment of potential impacts) and the production of an Environmental Management Plan (EMP). This report is the Scoping Report, with assessment included. The main purpose of this report is to provide information relating to the proposed mining project, to indicate which environmental aspects and potential impacts have been identified during the previous EIA process conducted for exploration activities in the same area (SLR, 2016) and this EIA Scoping phase and provide an assessment of the identified impacts. This Scoping Report has been compiled referring to the Scoping report conducted by SLR (Environmental Scoping Report (with assessment) and EMP for LK Mining's Offshore Diamond Exploration Activities on EPL 5965 (SLR, 2016)). LK Mining conducted exploration activities on EPL 5965 during 2016 – 2019.

The EIA process included the following specialist desktop studies in order to assess the identified impacts related to the proposed mining activities:

- Marine ecology specialist study (**Appendix G**);
- Fisheries specialist study (**Appendix H**);
- Archaeology specialist study (**Appendix I**); and
- Socio-economic specialist study (part of the EIA report).

ASEC is of the opinion that this Scoping Report (including an assessment of impacts), together with the attached EMP (**Section 10**), will provide sufficient information for the MEFT to make an informed decision regarding the proposed mining activities, and whether an ECC can be issued (or not).

1.3.2 EIA process

The EIA process and corresponding activities are outlined in **Table 1** below.

Table 1: EIA Process.

Objectives	Corresponding activities
Project initiation phase (March 2021)	
• Identify environmental aspects and potential impacts internally • Notify the decision-making authority of the proposed project • Initiate the EIA process.	• Project initiation meetings • Identify environmental and social issues and which specialist studies would be required. • Determine legal requirements.
Scoping phase (including assessment of impacts) (April – July 2021)	
• Identify interested and/or affected parties (IAP) and involve them in the EIA process through information sharing. • Further identify potential environmental issues associated with the proposed project. • Consider alternatives (where relevant). • Provide a description of the potentially affected environment. • Assessment of potential environmental impacts associated with the proposed mining activities. • Develop design requirements and management and mitigation measures.	• Notify government authorities IAPs of the project and EIA process (telephone calls, e-mails, distribution of background information document, newspaper advertisements and site notice). • Submit Application for Authorisation to MEFT. • IAP registration and comments. • Focus group meetings (physical and virtual) with key stakeholders in Walvis Bay, Swakopmund and Lüderitz. • Conduct specialist studies. • Compilation of Scoping Report (with assessment) and EMP. • Distribute Scoping Report (with assessment) and EMP to relevant authorities and IAPs for review. • Forward finalised Scoping Report (with assessment) and EMP and IAP comments to MME (as the Competent Authority) and MEFT for decision making.

1.3.3 EIA team

ASEC is the independent firm of consultants appointed by LK Mining to undertake the EIA process. Alexandra Speiser, the project manager, has more than 20 years of relevant experience in environmental management, conducting/managing EIAs, compiling EMPs and implementing EMPs and Environmental Management Systems. Alexandra has a Master Degree in Geology/Palaeontology and a Post-Master degree in Environmental Management. Alexandra is certified as a lead environmental practitioner and reviewer with the Environmental Assessment Professionals Association of Namibia (EAPAN). She is also member of the Chamber of Mines of Namibia and Chamber of Environment of Namibia.

Werner Petrick has more than twenty-two years of relevant experience in conducting/managing EIAs, compiling EMPs and implementing EMPs and Environmental Management Systems. Werner has a B. Eng (Civil) degree and a Master's degree in environmental management is certified as lead environmental practitioner and reviewer under the EAPAN.

The relevant curriculum vitae documentation is attached in **Appendix F**.

The environmental project team is outlined in **Table 2**.

Table 2: Environmental Project Team.

Team	Name	Designation	Tasks and roles	Company
LK Mining Project Team	Carel Neethling	Geologist / project proponent	Responsible for the interface between LK Mining and the environmental team, and for ensuring implementation of the EIA outcomes.	LK Mining
Project management	Alexandra Speiser	Project Manager	Management of the process, team members and other stakeholders. Report compilation. Review	ASEC
	Werner Petrick	Project Management Assistant	Management of the process, team members and other stakeholders. Report review	Namisun
Specialist investigations	Andrea Pulfrich	Marine Ecologist	Conduct marine biodiversity/ ecology study	Pisces
	Sarah Wilkinson, David Japp	Fisheries specialist	Conduct fisheries study	CapMarine
	John Kinahan	Archaeologist	Conduct desktop archaeological study	QRS
	Vanessa Maitland	Marine Archaeologist	Maritime and Underwater Heritage Survey of Hottentot Bay	Independent maritime archaeologist
	Auriol Ashby	Socio-economist	Socio-economy study	A. Ashby Associates

2 EIA PROCESS METHODOLOGY

2.2 Information collection

ASEC used various sources to identify the environmental issues associated with the proposed offshore mining activities. The main sources of information for the preparation of the Scoping Report (including assessment of impacts) include:

- Project information provided by LK Mining;
- Consultation with and input from specialists;
- Consultation with Ministry of Fisheries and Marine Resources (MFMR);
- Consultation with IAPs;
- Consultation with relevant authorities; and
- Environmental Scoping Report (with assessment) and EMP for LK Mining's Offshore Diamond Exploration Activities on EPL 5965 (SLR, 2016).

2.2 Scoping (including Impact Assessment) Report

The main purpose of this Scoping (including Impact Assessment) Report is to indicate which aspects relating to the proposed mining project might have an impact on the environment and to assess them. **Table 3** outlines the Scoping Report requirements contained in Section 8 of the Environmental Impact Assessment Regulations promulgated in February 2012 under the Environmental Management Act, 7 of 2007. The table includes reference to the relevant sections in the report.

Table 3: scoping report Requirements stipulated in the EIA regulations.

REQUIREMENTS FOR A SCOPING REPORT IN TERMS OF THE FEBRUARY 2012 REGULATIONS	REFERENCE IN REPORT
(a) the curriculum vitae of the EAP who prepared the report;	Appendix F
(b) a description of the proposed activity;	Section 4
(c) a description of the site on which the activity is to be undertaken and the location of the activity on the site	Section 4 and 5
(d) a description of the environment that may be affected by the proposed activity and the manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed listed activity;	Section 5 and 8
(e) an identification of laws and guidelines that have been considered in the preparation of the Scoping Report;	Section 3
(f) details of the public consultation process conducted in terms of regulation 7(1) in connection with the application, including - (i) the steps that were taken to notify potentially interested and affected parties of the proposed application; (ii) proof that notice boards, advertisements and notices notifying potentially interested and affected parties of the proposed application have been displayed, placed or given; (iii) a list of all persons, organisations and organs of state that were registered in terms of regulation 22 as interested and affected parties in relation to the application; and	Section 2.3 and Appendices A - E

REQUIREMENTS FOR A SCOPING REPORT IN TERMS OF THE FEBRUARY 2012 REGULATIONS	REFERENCE IN REPORT
(iv) a summary of the issues raised by interested and affected parties, the date of receipt of and the response of the EAP to those issues;	
(g) a description of the need and desirability of the proposed listed activity and any identified alternatives to the proposed activity that are feasible and reasonable, including the advantages and disadvantages that the proposed activity or alternatives have on the environment and on the community that may be affected by the activity;	Section 1.2 and 7
(h) a description and assessment the significance of any significant effects, including cumulative effects, that may occur as a result of the undertaking of the activity or identified alternatives or as a result of any construction, erection or decommissioning associated with the undertaking of the proposed listed activity;	Section 8 and 9
(i) terms of reference for the detailed assessment; and	Section 9
(j) a draft management plan, which includes - (i) information on any proposed management, mitigation, protection or remedial measures to be undertaken to address the effects on the environment that have been identified including objectives in respect of the rehabilitation of the environment and closure; (ii) as far as is reasonably practicable, measures to rehabilitate the environment affected by the undertaking of the activity or specified activity to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development; and (iii) a description of the manner in which the applicant intends to modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation remedy the cause of pollution or degradation and migration of pollutants.	Section 10 (Final EMP)

2.3 Public participation process

The public consultation process aimed to ensure that all persons or organisations that may be affected or interested in the proposed project (i.e. offshore mining and associated activities) were informed of the issues and were able to register their views and concerns. Building from there, the process provided opportunities to influence the project design so that its benefits can be maximised and potential negative impacts be minimised.

Included below is a summary of the interested and affected parties (IAP) consulted to date, the process that was followed, and the issues that were identified.

As part of the public scoping process a series of focus group and information-sharing meetings were held with key stakeholders in Walvis Bay, Swakopmund and Lüderitz at the end of March and beginning of April 2021. Advertisements announcing the proposed project and the availability of the BID were placed in Namibian newspapers as stipulated in the Environmental Management Act, 7 of 2007 and EIA Regulations.

2.3.1 Interested and Affected Parties

Table 4 provides a broad list of stakeholders that are relevant to the proposed project. They were informed about the proposed mining activities through newspaper advertisements and direct contact. IAPs were requested to register their views and concerns with ASEC.

Table 4: List of stakeholders.

Category	Stakeholders
Local and Regional Authorities	• Lüderitz Town Council • //Kharas Regional Council
Key Government Ministries	• Ministry of Mines and Energy • Ministry of Environment, Forestry and Tourism • Ministry of Fisheries and Marine Resources • Ministry of Works and Transport
Government Parastatals and Sate Owned Enterprises	• NamPort Walvis Bay and Lüderitz • National Heritage Council of Namibia • National Petroleum Corporation of Namibia (NAMCOR)
NGOs	• Namibian Coast Conservation and Management Project (NACOMA) • Benguela Current Commission • Coastal Environmental Trust of Namibia • Earthlife Namibia • Namibian Dolphin Project • Namibian Nature Foundation • Namibian Environment and Wildlife Project • Namibian Chamber of Mines • Namibian Maritime & Fisheries Institute
Associations	• Confederation of Namibian Fishing Association • Namibian Hake Association • Pelagic Fishing Association • Large Pelagic (Tuna and Swordfish) and Hake Longlining Association • Namibian Mariculture Association • Namibian Midwater Trawling Association • Namibian Monk and Sole Association • Namibian Rock Lobster Fishing Association
Other interested and affected parties	• Various Fishery Companies • Various Mining Companies • Marine Specialists • Any other people with an interest, or who may be affected by the proposed project

A full stakeholder database, of whom all got contacted by email, meetings, etc, is included in **Appendix B**.

2.3.2 Public consultation process

The public participation process adopted follows the guidelines in terms of the Environmental Management Act, No. 7 of 2007.

The steps undertaken are set out in **Table 5**.

Table 5: IAP Consultation Process.

<table>
<tr><th>TASK</th><th>DESCRIPTION</th><th>DATE</th></tr>
<tr><td colspan="3">Notification - regulatory authorities and IAPs</td></tr>
<tr><td>Notification to MEFT</td><td>The project was lodged on the MEFT EIA portal. Application APP002452</td><td>25 March 2021</td></tr>
<tr><td>IAP identification</td><td>ASEC developed an IAP database, taking previous relevant projects/EIAs in the area into consideration and further updated it, as and when required, throughout the EIA Scoping process. A copy of the IAP database is attached in Appendix B.</td><td>Throughout the process</td></tr>
<tr><td>Distribution of background information document (BID)</td><td>BIDs were distributed via email to relevant authorities and IAPs on the IAP database. Hard copies of the BID were also distributed during some focus group meetings.

The purpose of the BID was to inform IAPs and authorities about the proposed offshore mining project, the EIA process being followed, possible environmental impacts and means of providing input to the EIA (Scoping & assessment) process.

A copy of the BID and the presentation is attached in Appendix A.</td><td>March 2021</td></tr>
<tr><td>Notice boards and flyers</td><td>A Site notice were placed in Lüderitz at the Information Centre. The notice provided a short description of the proposed activities, the location of the mining area, information regarding the EIA process being followed and who to contact for further information.

Photos of the notices are attached in Appendix C.</td><td>April 2021</td></tr>
<tr><td>Newspaper Advertisements</td><td>Block advertisements providing information about the project and the public meeting were placed as follows:
Market Watch as part of the following newspaper:
The Namibian Sun (25 March and 1 April 2021)
Die Republikein (25 March and 1 April 2021)
Allgemeine Zeitung (25 March and 1 April 2021)
Copies of the advertisements are attached in Appendix C.</td><td>March/beginning April 2021</td></tr>
<tr><td colspan="3">Focus group meetings and submission of comments</td></tr>
<tr><td>IAP meetings</td><td>Focus Group meetings were held with the following entities:

<table><tr><th>Date</th><th>Organisation</th></tr><tr><td>31 March 2021</td><td>NamPort Walvis Bay</td></tr><tr><td>01 April 2021</td><td>Ministry of Fisheries and Marine Resources (MFMR) in Swakopmund</td></tr><tr><td>07 April 2021</td><td>Sperrgebiet Diamond Mining (Pty) Ltd</td></tr><tr><td>08 April 2021</td><td>NamPort in Lüderitz</td></tr><tr><td>08 April 2021</td><td>Lüderitz Town Council in Lüderitz</td></tr><tr><td>09 April 2021</td><td>MFMR and the Namibian Rock Lobster Fishing Association in Lüderitz</td></tr></table>The Presentation is provided in Appendix A.</td><td>March/beginning April 2021</td></tr>
</table>

TASK	DESCRIPTION	DATE
Comments and Responses	Minutes of the meeting and all comments received during the meetings or by email and telephone, are attached in **Appendix D**. The Issues and Responses Report is attached in **Appendix E**.	
Review of draft Scoping (including Impact Assessment) Report		
IAPs and authorities (excluding MET) review of Scoping Report and EMP	The main Scoping (with assessment) Report (excluding Appendices) was distributed to all authorities and IAPs that are registered on the IAP database via e-mail. Electronic copies of the full report (including Appendices) are available from ASEC on request Authorities and IAPs have 21 working days to review the Scoping Report and submit comments in writing to ASEC. The closing date for comments is 07 July 2021.	June/July 2021
MET review of Scoping Report and EMP	A copy of the final Scoping (with assessment) Report, including authority and IAP review comments, will be delivered to MME on completion of the public review process for their review and recommendations to MEFT. The Final documents will also be uploaded onto the MEFT online portal.	July 2021

2.3.3 Summary of issues raised

All issues that have been raised throughout the process by authorities and IAPs are provided in **Appendix D**. Issues raised relate to the following:

- Potential impact on the lobster fishery;
- Potential impact on the breeding bird colonies;
- Impact on Namibian Islands Marine Protected Area (NIMPA) and sensitive habitats;
- Impact of increased turbidity from discarded overburden; and
- Potential work opportunities.

These issues have been addressed in this report and the EMP.

The Issues and Responses Report is attached in **Appendix E**.

3 LEGAL FRAMEWORK

The Republic of Namibia has five tiers of law and a number of policies relevant to the project and these include:

- The Constitution
- Statutory law
- Common law
- Customary law
- International law

Key policies currently in force include:

- The EIA Policy (1995)
- Namibia's Environmental Assessment Policy for Sustainable Development and

Environmental Conservation (1994)

As the main source of legislation, the Constitution of the Republic of Namibia (1990) makes provision for the creation and enforcement of applicable legislation. In this context and in accordance with its constitution, Namibia has passed numerous laws intended to protect the natural environment and to mitigate adverse environmental impacts. One of the main aspects of the Constitution is the 'preservation of Namibia's ecosystems, essential ecological process and biological diversity', as well as 'sustainable use of natural resources'.

3.1 Applicable laws and policies

Namibia's environmental impact assessment (EIA) policy of 1995

This policy promotes accountability and informed decision making through the requirement of EIAs for listed programmes and projects.

Environmental Management Act, No. 7 of 2007

To enforce the policy on EIAs, the Environmental Management Act (EMA) (7 of 2007) has been compiled and is regulated by the Ministry of Environment and Tourism (MET). This Act was gazetted on 27 December 2007 (Government Gazette No. 3966) and the Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) were promulgated on 6 February 2012. In terms of this legal framework certain identified activities may not commence without an Environmental Clearance - a certificate that is issued by MEFT. This environmental clearance can only be granted after consideration of an EIA.

3.2 Applicable laws and policies

In the context of the proposed exploration activities, there are several laws and policies currently applicable. They are reflected in **Table 6**.

Table 6: Relevant Legislation and Policies for Mining Activities.

YEAR	NAME	Natural Resource Use (energy & water)	Emissions to air (fumes, dust & odours)	Emissions to land (non-hazardous & hazardous	Emissions to water (industrial & domestic)	Noise (remote only)	Visual	Vibrations	Impact on Land use	Impact on biodiversity	Impact on Archeology	Emergency situations	Socio-economic	Safety & Health
1990	The Constitution of the Republic of Namibia of 1990	X	X	X	X	X	X	X	X	X	X	X	X	X
1997	Namibian Water Corporation Act, 12 of 1997	X											X	
1992	The Minerals (Prospecting and Mining) Act 33 of 1992	X	X	X	X					X				
2001	The Forestry Act 12 of 2001	X							X	X				
2013	Water Resources Management Act 11 of 2013	X			X								X	
2004	National Heritage Act 27 of 2004										X		X	
2007	Environmental Management, Act 7 of 2007	X	X	X	X	X	X	X	X	X	X		X	X
2012														
1975	Nature Conservation Ordinance 14 of 1975	X			X					X	X			
1976	Atmospheric Pollution Prevention Ordinance 11 of 1976		X											
1995	Namibia's Environmental Assessment Policy for Sustainable Development	X	X	X	X	X	X	X	X	X	X	X		X

YEAR	NAME	Natural Resource Use (energy & water)	Emissions to air (fumes, dust & odours)	Emissions to land (non-hazardous & hazardous	Emissions to water (industrial & domestic)	Noise (remote only)	Visual	Vibrations	Impact on Land use	Impact on biodiversity	Impact on Archeology	Emergency situations	Socio-economic	Safety & Health
	and Environmental Conservation													
2000	Marine Living Resources Act No. 27	X			X					X				
2012	Namibian Islands' Marine Protected Area: Marine Resources Act (No. 316)	X			X					X				
1972	Convention on the International Regulations for Preventing Collisions at Sea (COLREGs). International Maritime Organisation			X								X		X
2002	Aquaculture Act 18	X			X					X				
1973	Sea Birds and Seals Protection Act 46									X				
2000	Marine Resources Act 27	X								X				
1990	Territorial Sea and Exclusive Economic Zone of Namibia Act 3	X			X					X				

4 DESCRIPTIONS OF THE PROPOSED OFF-SHORE DIAMOND MINING ACTIVITIES

The proposed ML 220 over Hottentots Bay lies approximately 60 km north of Lüderitz and covers an area of 42.3 km^2 (see **Figure 3**). The ML extends from the shore to 2 km off-shore (~45 m depth) and stretches along the coast over a distance of 6 km. The area falls within the Namibian Island Marine Protected Area (NIMPA) (see **Section 6**). LK Mining will use a small dredge-pump vessel with an on-board processing plant to mine in Target Area 1. Additionally, further detailed geophysical exploration activities will be conducted over 'sampling areas 2, 3 and 4' (see Figure 2) within the ML as well as ongoing sampling and resource development.

The survey and mining will be undertaken in water depths of between 14 m to 40 m and are described in more detail below. Information in the sections below was provided by LK Mining.

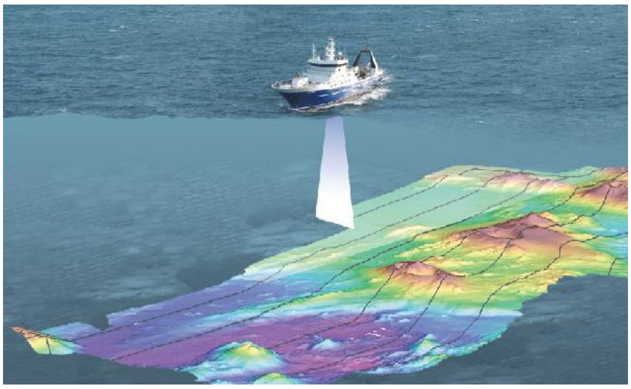
The mining activities and methodology will be the same as applied during the exploration activities, that were conducted between 2016 to 2019.

4.1 Geophysical remote sensing

The ongoing exploration and resource development programme will use a variety of geophysical remote sensing techniques to further delineate the resource in ML 220. These include multibeam bathymetry, high resolution side scan sonar, geophysical remote sensing techniques that will be employed are briefly described below.

4.1.2 Multibeam Echosounder

Multi-beam technology is a complex sonar array that provides depth-sounding information on either side of the vessel's track across a swath width of approximately two times the water depth (**Figure 2**), thereby allowing for highly accurate imaging and mapping of seafloor topography in the form of digital terrain models. The multi-beam echo sounder (MBES) emits a fan of acoustic beams from a hull-mounted transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1 µPa at 1 m. Most MBESs have soft-start capabilities where the sound can gradually be ramped up to that required for optimal operation.



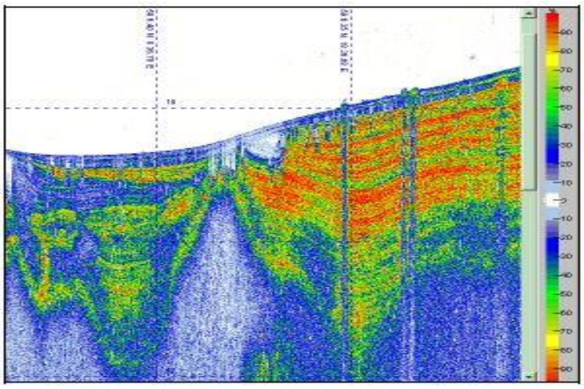


Figure 2: The geophysical survey techniques employed would include multibeam bathymetry (left) (http://www.gns.cri.nz/) and sub-bottom profiling (right).

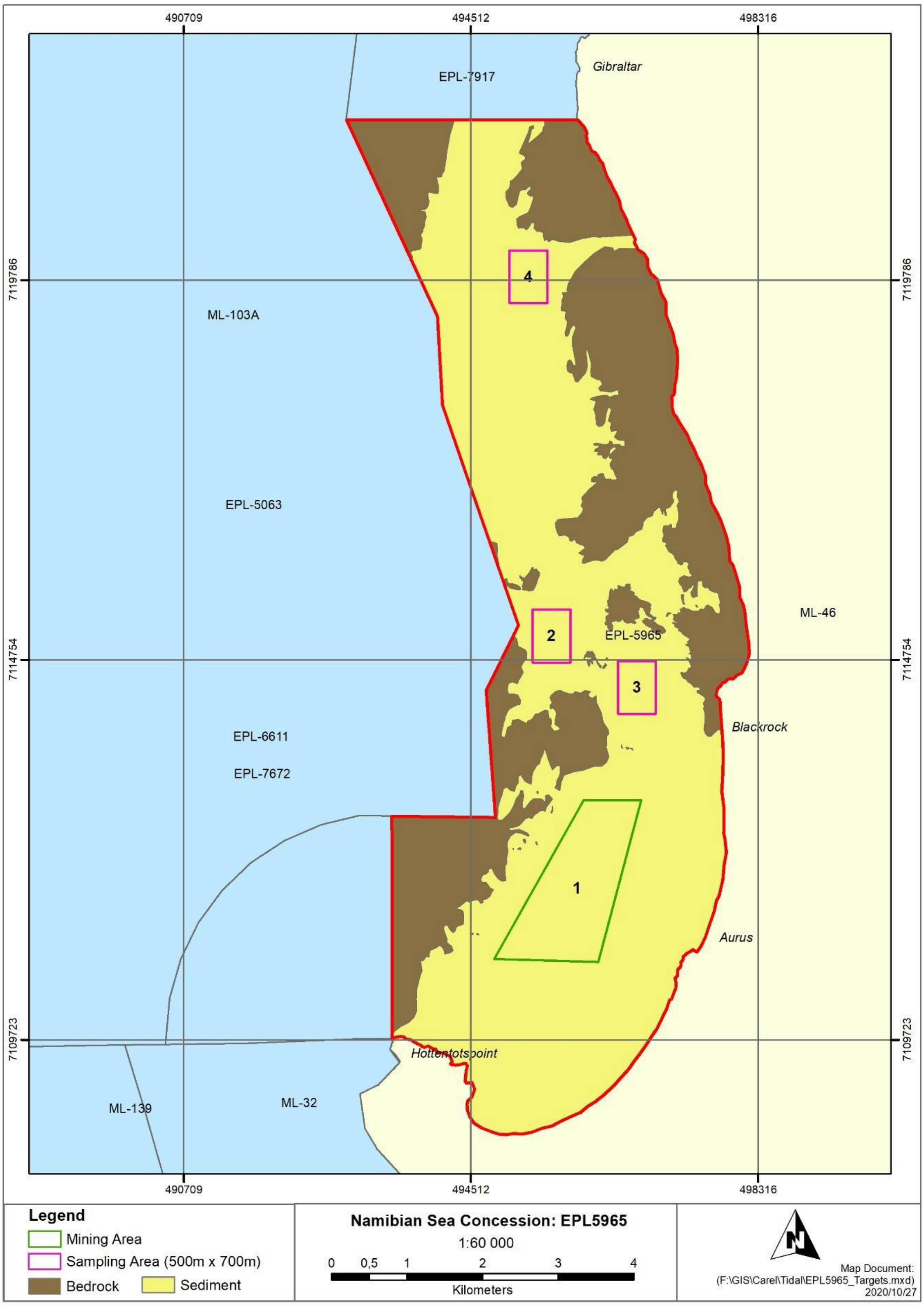


Figure 3: ML 220 showing the location of Mining Area 1 and the three resource development areas. The distribution of unconsolidated sediments and bedrock across the licence area is also shown.

4.1.3 Side-scan sonar

Side-scan sonar systems uses a sonar device, which can be towed from a vessel or mounted on the ship's hull. By ensonifying a swath of seabed and measuring the amplitude of the back-scattered return signals, an oblique image is built up of objects on the seabed, including information on the morphology and substrate content comprising the seabed. Sidescan sonars typically operate at frequencies of between 50 – 500 kHz and source levels of 220-230 dB re 1 µPa at 1m. High frequency sonar (e.g. 500 kHz) provides high-resolution images, but with a small width (50 – 100 m) of the seabed, whereas the lower frequency systems (e.g. 100 kHz) provide larger width coverage (e.g. 500 m) of the seabed but with lower resolution. Side-scan sonar systems typically do not have soft-start capabilities.

4.1.4 Dual Frequency Vertical Depth Sounding

Dual frequency echosounders transmit a low frequency pulse (typically around 24 kHz) at the same time as a high frequency pulse (typically around 200 kHz) directly below the vessel. Dual frequency echosounders enable the identification of a layer of soft mud over a layer of coarse and hard sediment, and/or rock. The pulse emitted would typically be for more than 0.025 seconds and produces sound levels in the order of 180+ dB re 1 µPa at 1 m.

4.1.5 Bottom profiler

There are various single-beam systems, operating at different frequencies, used for shallow seismic seabed profiling (www.ozcoasts.gov.au/geom_geol/toolkit). These include pingers, boomers, sparkers and chirp systems. The acoustic pulse travels through the water column (at a rate determined by water temperature, salinity and suspended material concentration), and penetrates the seafloor. Some of the acoustic signal is reflected from the seafloor, but the remainder penetrates the seafloor being reflected only when it encounters boundaries between layers that have different acoustic impedance. For ongoing exploration activities in ML 220, a hull-mounted 'pinger' chirp system will be used.

A typical sub-bottom chirp profiler emits an acoustic pulse from a transducer at frequencies ranging from 1.5 kHz to 12.5 kHz and typically produces sound levels in the order of 202 db re 1µPa at 1m. Longer chirp pulses can be used for deeper penetration. The chirp system can operate in water as shallow as 30 cm. Chirp sonars are wide-band, frequency modulated systems designed to replace pingers and boomers. By sweeping through a range of frequencies, usually between 1.5 to 15 kHz for shallow water applications, these systems achieve vertical resolutions down to ~5 cm, and can provide very high-resolution profiles in soft sediments, attenuating to 100 m depth.

Table 7 provides a comparison of the frequency ranges and source levels of the acoustic equipment typically used during geophysical surveys. Although some of the equipment used does not have soft-start capabilities, to mitigate this, one could commence the survey by turning on the equipment that has a soft start (e.g. Multibeam Echosounder) and then only once those are started, start the other equipment (such as the Chirp and Side Scan Sonar) that does not have a soft start. The operating frequencies of the equipment proposed for the exploration activities over ML 220 would fall into the high frequency kHz range, and therefore into the hearing range of most fish, turtles and marine mammals.

The information obtained by the multibeam and sub-bottom profiler systems would be used to produce high-resolution maps of the seabed geomorphology, sediment and bedrock distribution and morphology, bathymetry and sediment type and thickness profiles. From these maps, areas of unconsolidated sediment suitable for sampling would be identified, and a sampling grid positioned over the area. In order to develop geological models for further resource development, surveying activities would be ongoing

Table 7: Specifications of acoustic equipment typically utilised in the geophysical surveys.

Type	Frequency (kHz)	Source level (dB re 1 µPa at 1m)	Soft start capability
Chirp sub - bottom profiler	1.5 – 12.5	206	No
Side Scan Sonar	100 – 850 kHz	190 - 242	No
Multibeam echo sounder	200 - 455	190 - 220	Yes
IXSEA “Echos” medium frequency chirp system	0.6 – 2.4	211	No
10 inch Sleeve gun system	0.1 - 0.8	~ 220	Yes
Single beam Echosounders	10 - 200	180+	No
Pingers	2-15	130-150	Yes

4.2 Mining Activities

LK Mining plans to buy a supply vessel and convert it to a remote mining vessel. The mining vessel would use a suitable shallow/mid water with a gravel pump system for operating in the 14 – 40 m water depth range. The mining system would comprise a suspended steel mining tool fitted with a digging mining head, ~ 300 mm diameter suction hoses and an on-board mining pump. The opening of the mining tool would be fitted with grizzly cross-bars to allow sized gravel (nominally <100 mm) to pass through and prevent blockages in the suction system. The digging head will also be fitted with high pressure water jetting nozzles to agitate the gravel on the seabed and improve mining efficiency. Fixed-head remote exploration/mining systems (**Figure 4**), operating in the shallow and mid-water depth range, can efficiently extract gravel in areas of thicker overburden.

Mining would involve the removal of only the unconsolidated surficial sediments. The dredged sediment-slurry would be pumped to the surface and discharged onto a series of screens, which separate the oversize (>12 mm) and undersize (<1.2 mm) fractions. The tailings, which typically comprise ~99% of the dredged material, will be discharged overboard below the surface to the sea. The fine material forms turbid plumes that are carried away from the vessel by ambient currents, while the coarse material falls directly to the sea floor below the vessel. During the extraction process the operator generally attempts to deposit the coarse tailings in previously excavated areas to prevent re- mining of already processed material.

The fraction of interest (post-screened plant feed) is fed through a crusher to fragment the shell and clay components, mixed with ferrosilicon (FeSi) and pumped under pressure to an on-board Dense Media Separation (DMS) plant. Low density materials (floats) are separated from the concentrated plant feed and discarded overboard following magnetic recovery of the FeSi. The remaining high density fraction is dried and passed through a X-ray sorting process to separate the diamonds from the residual gravels. Non-fluorescent (gravel) material is discarded overboard with the float material, and the fluorescent fraction containing the diamonds is then hand sorted, within a confined glove box, for diamonds under strict control and monitoring on board the vessel. Plant feed rates for this technology at present average 8 tonnes per hour for the smaller vessels and up to 100 tonnes per hour for the deeper water vessels.

Mining would commence over Mining Area 1 (see **Figure 3**), which at 228 ha covers 5.4% of the total licence area. The current mine plan is for seven years, and through additional resource development over Target Areas 2, 3 and 4 the mine plan could be extended another 3 years at least.

Target areas 2, 3 and 4 each measure 500 x 700 m. It is proposed to take a total of 35 point samples over a 100 m sampling grid in each target area. Each sample will disturb an area of ~ 20 m^2, with a total area of 2,100 m^2 being disturbed. The point sampling will be followed by a bulk sampling phase during which a total of 12 block samples (50 x 50m) will be taken over another total area of 30,000 m^2. In total, sampling and resource development will thus be conducted over a total area of 32,100 m^2, which equates to <0.07% of the total licence area.

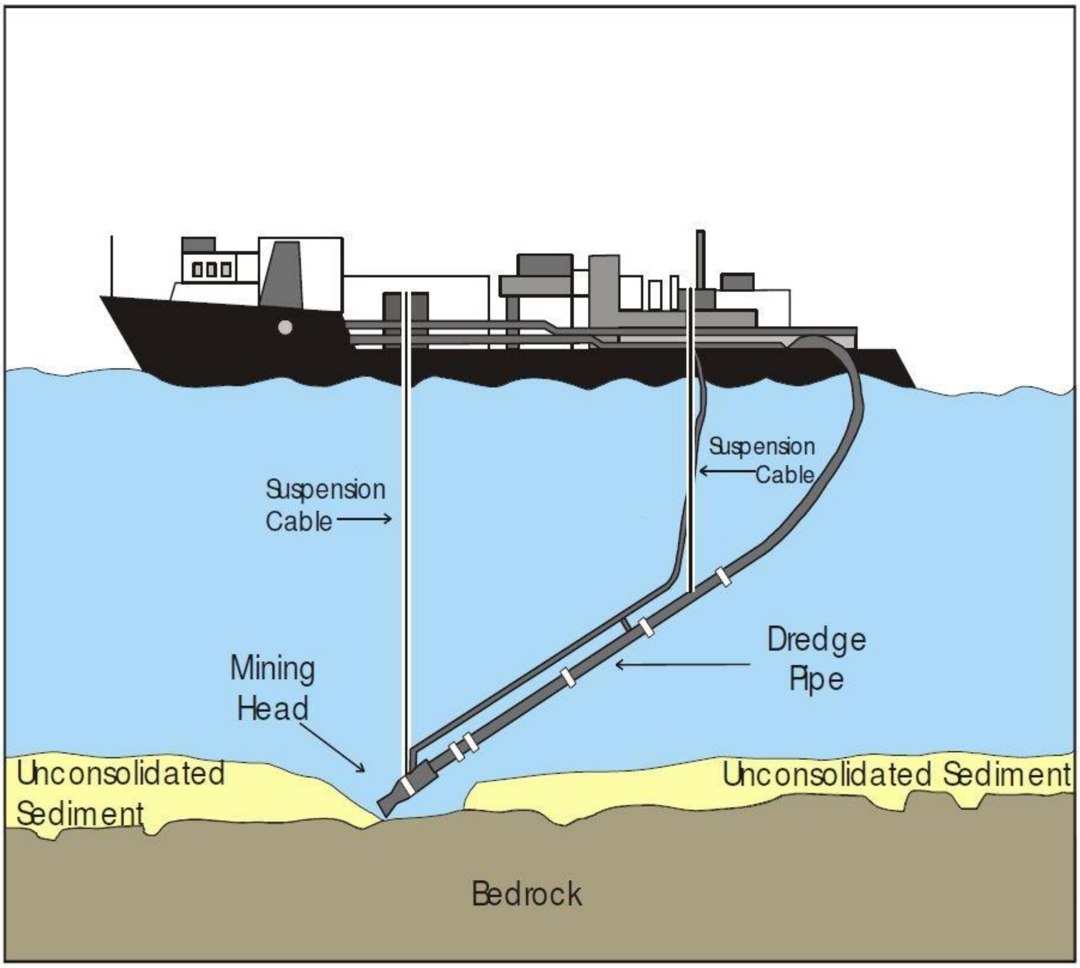


Figure 4: Schematic of the proposed mining system (Placer Resource Management (Pty) Ltd, January 2015).

Sampling and mining operations would be conducted to depths of between 14 m and 24 m from a fully self-contained mining vessel with an on-board processing plant. The vessel would operate as semi-mobile mining platform, anchored by a static positioning system, commonly on a four anchor spread. Positioning winches will enable the vessel to be locate precisely over the mining block where it would 'crab' across the target area removing overburden and ore down to bedrock. The mining vessel would thus have limited manoeuvrability and other vessels should remain at a safe distance.

4.3 Supporting infrastructure and other activities

The sampling/mining vessel would use the Port of Lüderitz to provide supporting infrastructure (e.g. specialist engineering services, refuelling, waste disposal, victualling). Crew changes would take place in the port and in emergencies small craft would be used for medical evacuations.

The vessel will take fresh water from the Lüderitz port, enough for each voyage. The vessel also has capacity, through reverse osmoses, to produce fresh water from sea water for consumption.

4.3.1 Sewage and Waste

MARPOL Annexure IV contains requirements to control pollution of the sea by sewage and Annexure V on waste. The discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; sewage which is not comminuted or disinfected has to be discharged at a distance of more than 12 nautical miles (nm) from the nearest land waste. Food wastes comminuted or ground must be discharged over 3 nm from the nearest land.

As ML 220 is within 3 nautical miles of the land LK Mining will dispose of their sewage at the waste water treatment plant and all waste at a certified land fill facility in Lüderitz.

4.3.2 Refuelling of vessels

The vessel will be refuelled at Lüderitz harbour under controlled conditions.

4.3.3 Employment

The majority of crew members will be Namibian, however, some of the specialists on board might need to be sourced from outside Namibia. The aim is to employee as many Namibians as possible. The crew will consist of 14 people, rotating 7 on duty for 12 hour shifts each on 28-day cycles with the other crew. After 28 days the shift will be changed in Lüderitz. It is anticipated that the vessel will operate for 11 months per year.

LK Mining will also have an office in Lüderitz.

5 DESCRIPTION OF THE CURRENT ENVIRONMENT

This section has been compiled extracting information from the *Atlas of Namibia* (Mendelsohn *et al*., 2009) and the LK Mining – Environmental Scoping Report (with assessment) and Environmental Management Plan of LK Mining's offshore diamond exploration activities on Exclusive Prospecting Licence 5965' (SLR, 2016) as well as the following specialist reports:

- Marine ecology specialist study (PISCES, 2021) included as **Appendix G**;
- Fisheries specialist study (CapMarine, 2021) included as **Appendix H**;
- Marine archaeology specialist study (QRS, 2021) included as **Appendix I**; and
- Socio-economic specialist study (A. Ashby Associates, 2021).

All further references can be found in the specialist reports attached in the various appendices and were therefore not referenced again in this Scoping Report.

The description below encompasses the coastal zone and shallow nearshore waters (< 100 m depth) extending from Elizabeth Bay north to Walvis Bay. Some of the data presented are, however, more regional in nature, e.g. the wave climate, nearshore currents, etc. The purpose of this environmental description is to provide the marine baseline environmental context within which the mining and further exploration activities would take place.

The Namibian coast covers the continental shelf and slope from one kilometre offshore with a depth of approximately 500 m. The coastal area is dominated by upwelling and associated high biological productivity which in turn supports a crucial fishing industry.

5.1 Physical Environment

5.1.1 Climate

The weather on the Namibian coast is significantly different from that of the inland. There is little rain at the coast, the average temperatures are much lower, radiation and sunshine are less and frost is absent. Yet, the winds are stronger and humidity is higher due to frequent fog. The climate of the area is mainly influenced by the Benguela Current and the South Atlantic Anticyclone (SAA). The SAA undergoes seasonal variations in that it is strongest in the austral summer when it also attains its southernmost extension lying southwest and south of the subcontinent. It weakens in winter and migrates north westwards.

ML 220 is situated within the Coastal Fog Zone. This zone forms a band along the coast of approximately 20 km in width. As a result of this, the climate is predominantly cool and humid with frequent fog occurring. The mean annual precipitation at the coast is very low, with much of the precipitation being associated with fog. According to the Atlas of Namibia the average number of fog days at Lüderitz is over 125 days with only occasional rainfall events (average of 0-50 mm per annum). The monthly evaporation for all months is significantly higher than the rainfall, indicating that the area is a water negative area. The average annual temperature is less than 16˚C.

Wind is a dominating feature of the coast. The presence of the subtropical SAA off the coast of Namibia strongly influences the wind pattern, generating gale force winds along the coast in all seasons, but most frequently during mid-summer and spring. Although wind strength decreases inland, the effect is noticeable for distances of up to 200 km from the coast. The strong coastal south-westerly winds carry sand inshore from the coast to the Namib Sand Sea and create upwelling cells which allow nutrient-rich water to be brought to the surface, therefore increasing fish resources.

5.1.2 Geology and Geomorphology

The geological history of the continental shelf dates back to the Late Jurassic - Early Cretaceous (125 to 130 MY. BP) when the fragmentation of West Gondwanaland and the subsequent separation of South America from Africa occurred. This process was accompanied by tensional down faulting of basement blocks and graben forming parallel to the present coastline.

As the subsidence of the basement blocks continued, the Orange and other associated rivers discharged their sediments onto the down faulted margin, filling the basin with Cretaceous and Tertiary deposits. Through these tectonic processes the continental margin evolved into a fully developed Atlantic Type, described as a tensional clean break crust, totally displaced by transverse marginal fracture zones.

North of the Orange River the variation in width of the shelf can be attributed to changes in the strike of the coastline, the shelf edge itself maintaining a fairly constant north-west trend. The middle to outer shelf usually lacks large fluctuations in relief and slopes gently seawards, reaching a water depth of approximately 500m at the shelf break.

The underlying coastal geological formations around Lüderitz are composed primarily of gneisses and schists of the Namaqua Metamorphic complex. Where not covered by Quaternary, wind-blown sands, they crop out to form an extensive harsh and rugged rocky coastline. In the coastal hinterland the Namaqua Metamorphic complex is interrupted by a corridor of Cainozoic sediments and aeolian sands, which stretch from Elizabeth Bay, northwards to beyond Hottentots Bay (Rogers 1977; Pallett 1995). This represents a drowned trough formed by powerful aeolian erosion of the north-south striking schist within the more resistant gneiss. Aeolian deflation of the Tertiary sandstones filling this trough caused the concentration of diamonds which are mined in the area.

5.1.3 Seabed Topography, Bathymetry and Sediments

The surficial sediments in the intertidal and shallow subtidal areas are generally dominated by moderately to well-sorted fine to medium sand with median particle sizes of 200- 400 μm. However, some of the beaches in Lüderitz bay were recently identified as having comparatively coarse sediments. Agate Beach for example has a mean particle size of 551 μm, whereas the beach at Angra Point has a mean particle size of 447 μm. Grossebucht in contrast has much finer sediments (118 μm) (BCC, unpublished data).

Further offshore, the seafloor is dominated by undulated rock or hard sediment with occasional rock outcrops or reefs running either parallel or at an angle to the coastline (**Figure 5**). Sandy areas are sparse, and generally occur in small isolated patches scattered over the area. Unconsolidated sediments comprise only 53% of the licence area. The sediment accumulations are thin, typically with an observed thickness of <1 m.

The typical sediment sequence in Hottentots Bay, and within the proposed mining area, extends over ~3 m and comprises an overlying layer of Holocene mud/silt (20-50 cm) over a shell or sandy-shell horizon. Lenses of Glauconitic mud occur at the base of this horizon.

Figure 5: Bathymetry ML 220 showing bedrock areas (shaded), historically mined areas and environmentally sensitive areas.

Locally derived rubble containing quartzschists, vein quartz and limestone of the Gariep Complex lie below the shell. This basal angular gravel, with ventifacts/grit and sparse small cobbles is evidence of a deflation basin. The footwall consists of weathered quartzschists and Biotite schist occasionally covered by calcrete horizons and compacted Glauconitic sandstone. Below the calcrete horizon, the quartzschist is weathered to saprolite.

5.1.4 Waves

The Southern Namibian Coast is classified as exposed, experiencing strong wave action rating between 13-17 on the 20 point exposure scale (McLachlan 1980). The coastline is influenced by major swells generated in the roaring forties, as well as significant sea waves generated locally by the persistent southerly winds. The dominant peak energy period for swells is ~13 seconds, whilst wind induced waves have shorter wave periods (~8 seconds). Data collected by Voluntary Observing Ships indicate that the largest waves recorded in the area offshore of Lüderitz originate from the S-SSW sectors and may attain 7-10 m. Storms occur frequently, particularly during winter and spring. Swells are concentrated in a fairly narrow directional band with 43% of waves moving in the S direction sector, whilst 19% are in the SW sector and 15% are in the SSW sector. Although much less common, swells attaining maximum heights of 4-5 m occur in the N sector ~2% of the time (CSIR 1996).

The wave pattern within the licence area is largely protected by the north facing embayment of Hottentots Bay, which provides shelter from the prominent southerly wave patterns and significantly reduces the wave height.

5.1.5 Tides

In common with the rest of the southern African coast, tides in the study area are regular and semi-diurnal. The maximum tidal variation is approximately 2 m, with a typical tidal variation of ~1 m. Variations of the absolute water level as a result of meteorological conditions such as wind and waves can however occur adjacent to the shoreline and differences of up to 0.5 m in level from the tidal predictions are not uncommon.

5.1.6 Coastal Currents

Current velocities in continental shelf areas of the Benguela region range generally between 10 – 30 cm/s (Boyd & Oberholster 1994). The flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington et al. 1990; Nelson & Hutchings 1983). Fluctuation periods of these flows are 3 - 10 days, although the long-term mean current residual is in an approximate NW (alongshore) direction. Currents in the nearshore environment along the coastline of the study area have not been well studied. Surface currents in the Lüderitz area appear to be quite variable, with flows primarily <30 cm/s and an average velocity of 14 cm/s. Near bottom shelf flow is mainly poleward (Nelson 1989) with low velocities of typically 5 cm/s.

In the nearshore zone, strong wave activity from the south and southwest (generated by winds and waves in the South Atlantic and Southern Ocean) drives a predominantly northward long-shore current (Shillington et al. 1990). Surface currents appear to be topographically steered, following the major topographic features (Nelson & Hutchings 1983). Current velocities vary accordingly (~0.10-0.35 m/s), with increased speeds in areas of steep topography and reduced velocities in areas of regular topography.

5.1.7 Surf zone Currents

Typically wave-driven flows dominate in the surf zone (characteristically 150 m to 250 m wide), with the influence of waves on currents extending out to the base of the wave effect (~40 m; Rogers 1979). The influence of wave-driven flows extends beyond the surf zone in the form of rip currents. Longshore currents are driven by the momentum flux of shoaling waves approaching the shoreline at an angle, while cross-shelf currents are driven by the shoaling waves. The magnitude of these currents is determined primarily by wave height, wave period, angle of incidence of the wave at the coast and bathymetry. Surf zone currents have the ability to transport unconsolidated sediments along the coast in the northward littoral drift.

Nearshore velocities in the study area have not been reported and are difficult to estimate because of acceleration features such as surf zone rips and sandbanks. However, computational model estimates using nearshore profiles and wave conditions representative of this coastal region suggest time-averaged northerly longshore flows which have a cross-shore mean of between 0.2 to 0.5 m/s. Instantaneous measurements of cross-shore averaged longshore velocities are often much larger. Surf zone-averaged longshore velocities in other exposed coastal regions commonly peak at between 1.0 m/s to 1.5 m/s, with extremes exceeding 2 m/s for high wave conditions (CSIR 2002). The southerly longshore flows are considered to remain below 0.5 m/s.

5.1.8 Water Masses and Temperature

South Atlantic Central Water (SACW) comprises the bulk of the seawater in the study area, either in its pure form in the deeper regions, or mixed with previously upwelled water of the same origin on the continental shelf (Nelson & Hutchings 1983). Temperatures range between 6°C and 16°C and salinities range between 34.5‰ and 35.5‰ (Shannon 1985). Data recorded over a 36-year period at the Ministry of Fisheries and Marine Resources (MFMR) jetty in Robert Harbour (1973 – 2009) show that average monthly seawater temperatures vary between a minimum of 12.2°C in September to a maximum of 14.5°C in February, averaging 13.3°C (Kolette Grobler, MFMR, pers com.). They show a strong seasonality with lowest temperatures occurring during early spring when upwelling is at a maximum.

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations, especially on the bottom. SACW itself has depressed oxygen concentrations (~80% saturation value), but lower oxygen concentrations (<40% saturation) frequently occur (Visser 1969; Bailey et al. 1985; Chapman & Shannon 1985; Pulfrich et al. 2006) and can persist for extended periods.

5.1.9 Upwelling

The major feature of the Benguela system is upwelling and the consequent high nutrient supply to surface waters leads to high biological production and large fish stocks. The prevailing longshore, equatorward winds move nearshore surface water northwards and offshore. To balance the displaced water, cold, deeper water wells up inshore. Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest. The largest and most intense upwelling cell is in the vicinity of Lüderitz, and upwelling can occur there throughout the year (**Figure 6**). Off northern and central Namibia, several secondary upwelling cells occur. Upwelling in these cells is perennial, with a late winter maximum (Shannon 1985).

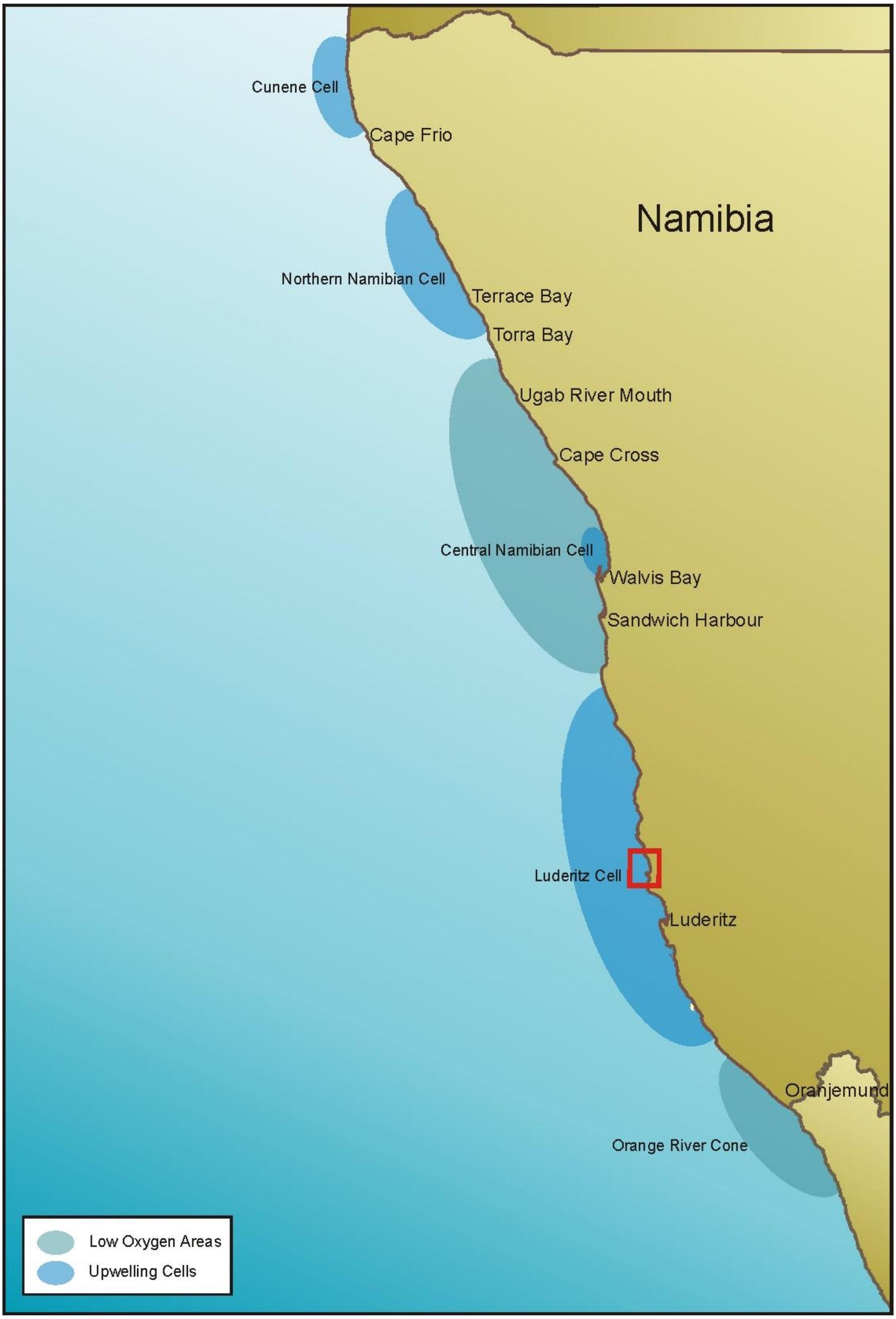


Figure 6: Map of the Namibian coastline showing the positions of the upwelling cells and the formation zones of low oxygen water in relation to the project area (red polygon).

5.1.10 Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) is typically divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. PIM loading in nearshore waters is strongly related to natural inputs from rivers or from 'berg' wind events, or through resuspension of material on the seabed.

The major source of turbidity in the swell-influenced nearshore areas off Namibia is the redistribution of fine inner shelf sediments by long-period Southern Ocean swells. The current velocities typical of the Benguela (10-30 cm/s) are capable of resuspending and transporting considerable quantities of sediment equatorwards. Under relatively calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow poleward undercurrent (Shillington *et al.* 1990; Rogers & Bremner 1991).

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This northward, nearshore transport is generated by the predominantly southwesterly swell and wind-induced waves. Longshore sediment transport, however, varies considerably in the shore-perpendicular dimension. Sediment transport in the surf zone is much higher than at depth, due to high turbulence and convective flows associated with breaking waves, which suspend and mobilise sediment (Smith & Mocke 2002).

In a shallow embayment such as Hottentots Bay and in the nearshore regions of the licence area, swell and wind-induced waves and currents result in the constant resuspension of sediments. Consequently, nearshore waters are naturally turbid, and underwater visibility seldom exceeds 1 m.

The powerful easterly 'berg' winds occurring along the Namibian coastline in autumn and winter also play a significant role in sediment input into the coastal marine environment (**Figure 7**), potentially contributing the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Zoutendyk 1992; Shannon & O'Toole 1998; Lane & Carter 1999). For example, for a single 'berg'-wind event it was estimated that 50 million tons of dust were blown into the sea by extensive sandstorms along much of the coast from Cape Frio, Namibia in the north to Kleinzee, South Africa in the south (Shannon & Anderson 1982) with transport of the sediments up to 150 km offshore.

5.1.11 Organic Inputs

The Benguela upwelling region is an area of particularly high natural productivity, with extremely high seasonal production of phytoplankton and zooplankton. These plankton blooms in turn serve as the basis for a rich food chain up through pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). All of these species are subject to natural mortality, and a proportion of the annual production of all these trophic levels, particularly the plankton communities, die naturally and sink to the seabed.

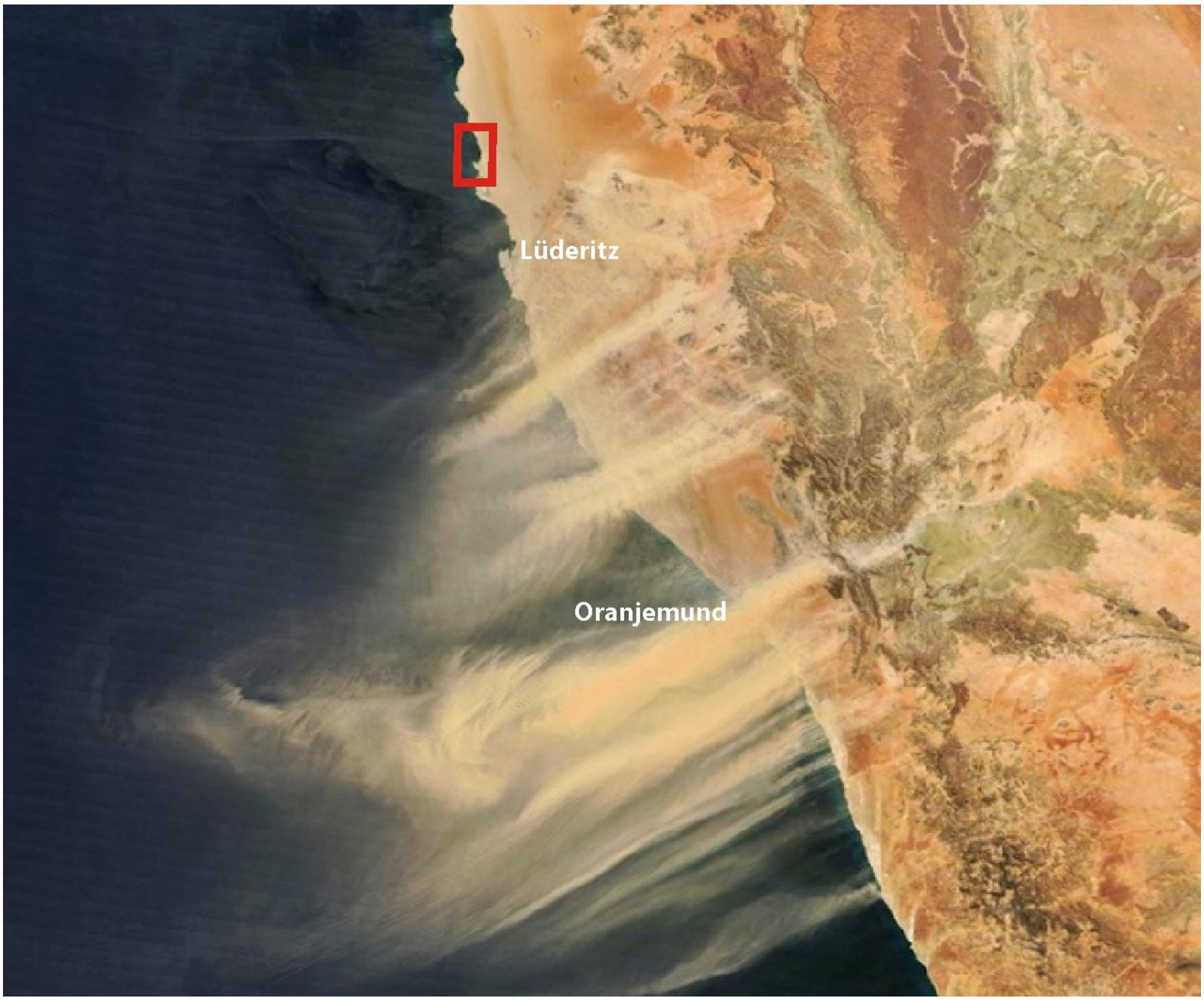


Figure 7: Satellite image showing aerosol plumes of sand and dust due to a 'berg' wind event on the southern African west coast in October 2019 (Image source: LandWaterSA). The project area is indicated by the red square.

Balanced multispecies ecosystem models have estimated that during the 1990s the Benguela region supported biomasses of 76.9 tons/km^2 of phytoplankton and 31.5 tons/km^2 of zooplankton alone (Shannon *et al*. 2003). Thirty six percent of the phytoplankton and 5% of the zooplankton are estimated to be lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the southern African west coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters overlying these muds and the generation of hydrogen sulphide and sulphur eruptions along the coast.

An associated phenomenon ubiquitous to the Benguela system are red tides (dinoflagellate and/or ciliate blooms) (see Shannon & Pillar 1985; Pitcher 1998). Also referred to as Harmful Algal Blooms (HABs), these red tides can reach very large proportions, with sometimes spectacular effects. Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water. Periodic low oxygen events associated with massive algal blooms in the nearshore can have catastrophic effects on the biota (see below).

5.1.12 Low Oxygen Events

The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman & Shannon 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches, there are corresponding preferential areas for the formation of oxygen-poor water, the main one being off central Namibia (Chapman & Shannon 1985) (see Figure 6). The distribution of oxygen-poor water is subject to short (daily) and medium term (seasonal) variability in the volumes of oxygen depleted water that develops (De Decker 1970; Bailey & Chapman 1991). Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

Oxygen deficient water can affect the marine biota at two levels. It can have sub-lethal effects, such as reduced growth and feeding, and increased intermoult period in the rock-lobster population (Beyers *et al.* 1994). The oxygen-depleted subsurface waters characteristic of the southern and central Namibian shelf are an important factor determining the distribution of rock lobster in the area. During the summer months of upwelling, lobsters show a seasonal inshore migration (Pollock & Shannon 1987), and during periods of low oxygen become concentrated in shallower, better-oxygenated nearshore waters.

On a larger scale, periodic low oxygen events in the nearshore region can have catastrophic effects on the marine communities. Low-oxygen events associated with massive algal blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of other marine biota and fish (Newman & Pollock 1974; Matthews & Pitcher 1996; Pitcher 1998; Cockroft *et al.* 2000). In March 2008 a series of red tide or algal blooms dominated by the (non-toxic) dinoflagellate *Ceratium furca* occurred along the central Namibian coast (MFMR 2008). These bloom formations ended in disaster for many coastal marine species and resulted in what was possibly the largest rock lobster walkout in recent memory. While such mass mortalities have been reported from the central Namibian coast (www.nacoma.org.na), they are uncommon in the area around Lüderitz.

5.1.13 Sulphur Eruptions

Closely associated with seafloor hypoxia is the generation of toxic hydrogen sulphide and methane within the organically-rich, anoxic muds following decay of expansive algal blooms. Under conditions of severe oxygen depletion, hydrogen sulphide (H_2S) gas is formed by anaerobic bacteria in anoxic seabed muds (Brüchert *et al.* 2003). This is periodically released from the muds as 'sulphur eruptions', causing upwelling of anoxic water and formation of surface slicks of sulphur discoloured water (Emeis *et al.* 2004). Such eruptions are accompanied by a characteristic pungent smell along the coast and the sea takes on a lime green colour. These eruptions strip dissolved oxygen from the surrounding water column. Such complex chemical and biological processes are often associated with the occurrence of harmful algal blooms, causing large-scale mortalities to fish and crustaceans (see section 5.1.12).

5.2 Biological Environment

Biogeographically the coastline of the study area falls on the boundary between the cold temperate Namaqua Province, which extends from Cape Point up to Lüderitz, and the warm-temperate Namib Province, which extends northwards from Lüderitz into southern Angola (Emanuel *et al.* 1992). The coastal, wind-induced upwelling characterising the Benguela ecosystem, is the principle physical process that shapes the marine ecology of the study area. Pallett (1995) has assigned the coastline of southern Namibia as an area of high sensitivity, as the entire coastal strip contains hummock vegetation which supports many endemic animals, offshore islands and reefs harbouring various breeding seabird and Cape fur seal colonies, as well as virtually undisturbed rocky shores and sandy beaches.

The benthic and coastal habitats of Namibia were mapped as part of the Benguela Current Commission's Spatial Biodiversity Assessment (BCC-SBA) (Holness *et al.* 2014) to develop assessments of their ecosystem threat status and ecosystem protection level (**Figure 8**). The benthic habitats were subsequently assigned an ecosystem threat status based on their level of protection.

ML 220 falls into the Lüderitz Inshore and Lüderitz Inner Shelf habitats. Habitats occurring along the shoreline of ML 220 include Lüderitz Intermediate Sandy Beach, Lüderitz Mixed Shore, Lüderitz Exposed Rocky Shore, Lüderitz Reflective Sandy Beach, and Lüderitz Sheltered Rocky Shore. The inshore and coastal habitats in the area have all been assigned a threat status of 'Least Concern', (Holness *et al.* 2014). The coastline of the study area predominantly comprises sandy beaches punctuated by numerous rocky shores. Consequently, marine ecosystems along the coast comprise a limited range of habitats that include:

- sandy intertidal and subtidal substrates,
- intertidal rocky shores, subtidal reefs and hard grounds,
- the water body.

The benthic communities within these habitats are generally ubiquitous throughout the southern African West Coast region, being particular only to substratum type, wave exposure and/or depth zone. They consist of many hundreds of species, often displaying considerable temporal and spatial variability. The biological communities 'typical' of each of these habitats are described in the specialist report (**Appendix G**).

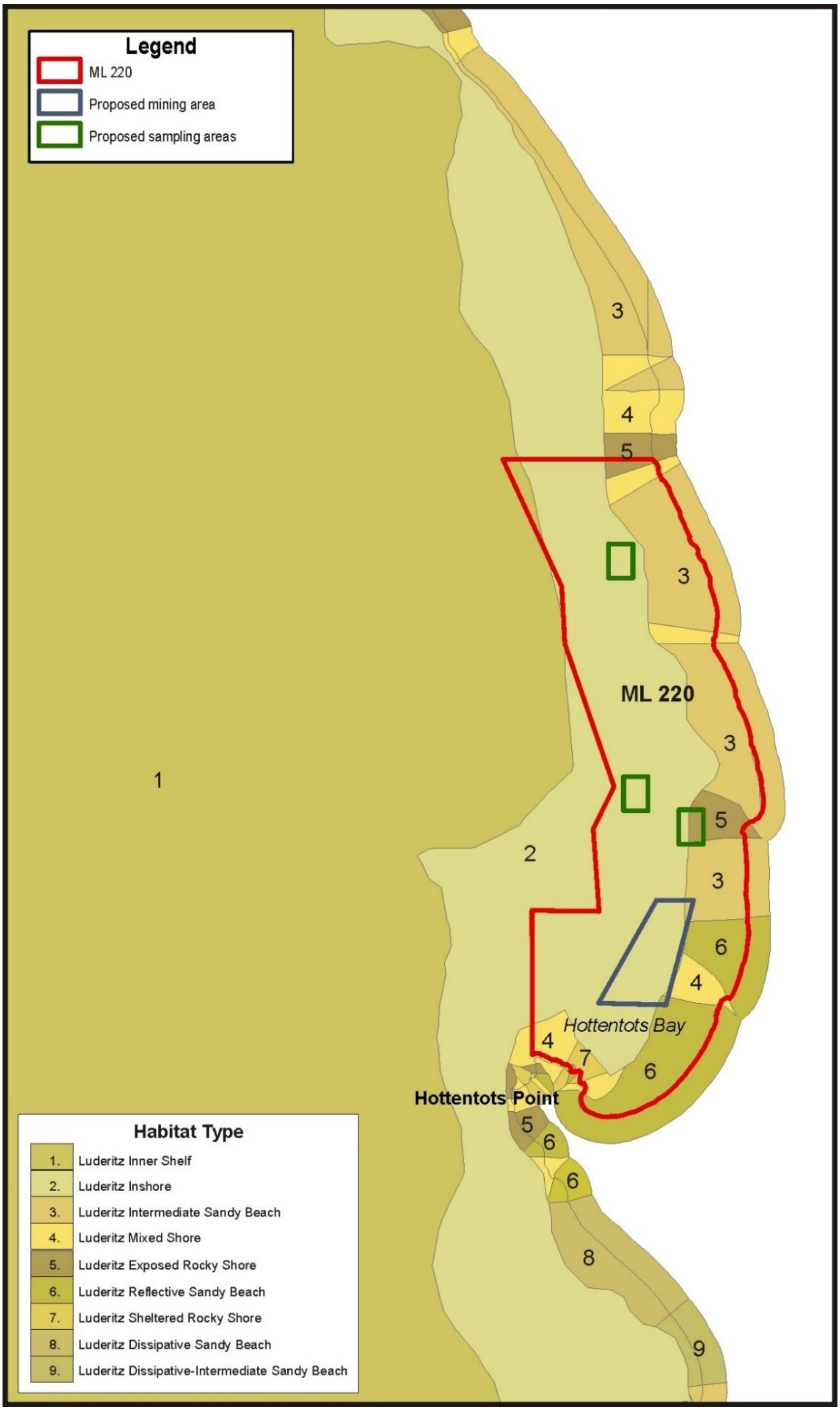


Figure 8: The proposed mining and sampling areas in relation to the Namibian benthic and coastal habitats (adapted from Holness et al. 2014).

5.2.1 Near- and Offshore Soft Sediments

Numerous studies have been conducted on southern Namibian inner shelf benthos, mostly focused on mining impacts (Goosen *et al.* 2000; Steffani & Pulfrich 2007; Steffani 2009a, 2009b, 2009c; Karenyi 2014; Steffani *et al.* 2015; Biccard & Clark 2016; Biccard *et al.* 2016; Duna *et al.* 2016; Karenyi *et al.* 2016; Biccard *et al.* 2017, 2018; Gihwala *et al.* 2018; Biccard *et al.*2019; Giwhala *et al.* 2019)). The description below is drawn from these. Generally, species richness increases from the inner-shelf across the mid-shelf and is influenced by sediment type. The highest total abundance and species diversity was measured in sandy sediments of the mid-shelf. Biomass is highest in the inshore (± 50 g/m^2 wet weight) and decreases across the mid-shelf averaging around 30 g/m^2 wet weight (Karenyi 2014; Karenyi *et al.* 2016).

Typical species occurring at depths of up to 60 m included the snail *Nassarius* spp., the polychaetes *Orbinia angrapequensis*, *Nepthys sphaerocirrata*, several members of the spionid genera *Prionospio*, and the amphipods *Urothoe grimaldi* and *Ampelisca brevicornis*. The bivalves *Tellina gilchristi* and *Dosinia lupinus orbignyi* are also common in certain areas. All these species are typical of the southern African West coast (Goosen *et al.* 2000; Steffani & Pulfrich 2007; Steffani, unpublished data).

Benthic communities are structured by the complex interplay of a large array of environmental factors. Water depth and sediment grain size are considered the two major factors that determine benthic community structure and distribution on the South African west coast (Steffani & Pulfrich 2007; Steffani 2007a; 2007b). However, studies have shown that shear bed stress - a measure of the impact of current velocity on sediment – oxygen concentration (Post *et al.* 2006; Currie *et al.* 2009; Zettler *et al.* 2009, 2013), productivity (Escaravage *et al.* 2009), organic carbon and seafloor temperature (Day *et al.* 1971) may also strongly influence the structure of benthic communities. There are clearly other natural processes operating in the deep water shelf areas of the West Coast that can over-ride the suitability of sediments in determining benthic community structure, and it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro & van der Plas 2006; Pulfrich *et al.* 2006). In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure.

5.2.2 Rocky Intertidal Shores

West Coast rocky intertidal shores can be divided into five zones on the basis of their characteristic biological communities: The Littorina, Upper Balanoid, Lower Balanoid, Argenvillei and the Infratidal Zones. These biological zones correspond roughly to zones based on tidal heights. Tolerance to the physical stresses associated with life on the intertidal, as well as biological interactions such as herbivory, competition and predation interact to produce these five zones. A detailed description of the associated fauna and flora can be found in **Appendix G**.

Some of the rocky shores in Lüderitz Bay more resemble mixed shores as they are strongly influenced by sand. Such shores will harbour more sand-tolerant and opportunistic foliose algal genera (e.g. *Ulva* spp*., Grateloupia belangeri, Nothogenia erinacea)* many of which have mechanisms of growth, reproduction and perennation that contribute to their persistence on sand-influenced shores (Daly & Matheison 1977; Airoldi *et al.* 1995; Anderson *et al.* 2008). Of the benthic fauna, the sand-tolerant anemone *Bunodactis reynaudi*, the Cape reef worm *Gunnarea gaimardi*, and the siphonarid *Siphonaria capensis* were prevalent, with the anemone in particular occupying much of the intertidal space.

5.2.3 Subtidal Reefs and Kelp Beds

The biological communities of the sublittoral habitat can be broadly grouped into an inshore zone (from the supralittoral fringe to a depth of ~10 m), and an offshore zone (below 10 m depth). The shift in communities from the flora-dominated inshore zone to the fauna-dominated offshore zone is not knife-edge, however, representing instead a continuum of species distributions, merely with changing abundances. As wave exposure is moderated with depth, wave action is less significant in structuring the communities than in the intertidal, with prevailing currents, and the vertical distribution of oxygen and nutrients playing more important roles.

Research on subtidal organisms along the Namibian coastline has been limited. Current knowledge is primarily restricted to macrobenthic reef communities in depths of less than 30 m in the area around Lüderitz (Tomalin 1993; Parkins & Branch 1995, 1996, 1997; Pulfrich & Penney 1998, 1999, 2001; Pulfrich 2019). A detailed description of the associated fauna and flora can be found in **Appendix G**.

The fish fauna of rocky reefs off the southern African West Coast has not been specifically studied, and it is necessary to refer to fish catches for a review. Shore- and boat-angling is extremely limited along the southern Namibian coastline due to restricted access by the public. Catches from the area around Lüderitz, however, cite the common and widespread hottentot (*Pachmetopon blochii*), the galjoen (*Dichistius capensis*), snoek (*Thrysites atun*), maned blennies (*Scartella emarginata*), and blacktail (*Diplodus sargus*) as being common reef-associated species (Sauer & Erasmus 1997; Brouwer *et al.* 1997; Sakko 1998).

5.2.4 Mixed Shores

Most semi-exposed to exposed shores on the Southern African West coast are strongly influenced by sediments, and may include considerable amounts of sand intermixed with the benthic biota. Mixed shores contribute only 6.3% to the total Namibian shoreline habitats (Holness *et al.* 2014).

Mixed shores incorporate elements of the trophic structures of both rocky and sandy shores. As fluctuations in the degree of sand coverage are common (often adopting a seasonal affect), the fauna and flora of mixed shores are generally impoverished when compared to more homogenous shores. The macrobenthos is characterized by sand tolerant species whose lower limits on the shore are determined by their abilities to withstand physical smothering by sand (Daly & Mathieson 1977; Dethier 1984; van Tamelen 1996).

On mixed shores, the composition of the intertidal and subtidal macrophytes is dominated by sand-tolerant and opportunistic filamentous genera, such as *Cladophora*, *Chaetomorpha*, and *Chondria* spp. Many of the psammophytic (sand-tolerant) algal species have mechanisms of growth, reproduction and perennation that contribute to their persistence on sand-influenced shores such as peak growth and reproduction just prior to seasonal burial, abbreviated life cycles, regeneration of fronds from basal parts, or rhizomatous growth (Daly & Matheison 1977; Airoldi *et al.* 1995; Anderson *et al.* 2008).

The mixed-shore habitat also provides important refuges for opportunistic species capable of sequestering, but susceptible to elimination by competition in more uniform intertidal environments.

5.2.5 Pelagic Communities

The pelagic communities are typically divided into plankton and fish, and their main predators, marine mammals (seals, dolphins and whales), seabirds and turtles.

Plankton

Plankton is abundant in the shelf waters off Namibia, being associated with the upwelling characteristic of the area. Plankton range from single-celled bacteria to jellyfish of 2-m diameter, and include bacterio-plankton, phytoplankton, zooplankton, and ichthyoplankton.

Off the Namibian coastline, phytoplankton are the principle primary producers with mean annual productivity being comparatively high at 2 g C/m^2/day. The phytoplankton is dominated by diatoms, which are adapted to the turbulent sea conditions. Diatom blooms occur after upwelling events, whereas dinoflagellates are more common in blooms that occur during quiescent periods, since they can grow rapidly at low nutrient concentrations (Barnard 1998). In the surf zone, diatoms and dinoflagellates are nearly equally important members of the phytoplankton, and some silicoflagellates are also present. Charateristic species belong to the genus *Gymnodinium*, *Peridinium*, *Navicula*, and *Thalassiosira* (McLachlan 1986).

Namibian zooplankton reaches maximum abundance in a belt parallel to the coastline and offshore of the maximum phytoplankton abundance. The mesozooplankton (<2 mm body width) community included egg, larval, juvenile and adult stages of copepods, cladocerans, euphausiids, decapods, chaetognaths, hydromedusae and salps, as well as protozoans and meroplankton larvae (Hansen *et al*. 2005). Copepods are the most dominant group making up 70–85% of the zooplankton. Seasonal patterns in copepod abundance, with low numbers during autumn (March–June) and increasing considerably during winter/early summer (July–December), appear to be linked to the period of strongest coastal upwelling in the northern Benguela (May–December), allowing a time lag of about 3–8 weeks, which is required for copepods to respond and build up large populations (Hansen *et al*. 2005). This suggests close coupling between hydrography, phytoplankton and zooplankton. Timonin *et al*. (1992) described three phases of the upwelling cycle (quiescent, active and relaxed upwelling) in the northern Benguela, each one characterised by specific patterns of zooplankton abundance, taxonomic composition and inshore-offshore distribution. It seems that zooplankton biomass closely follows the changes in upwelling intensity and phytoplankton standing crop.

Ichthyoplankton constitutes the eggs and larvae of fish. The preferred spawning grounds of numerous commercially exploited fish species are located to the north of the study area off central and northern Namibia (**Figure 9**), where their eggs and larvae form an important contribution to the ichthyoplankton. South of the Lüderitz upwelling cell, between approximately 29°S – 31°S, lies the Lüderitz Upwelling Cell Orange River Cone (LUCORC) area, which is considered to be an environmental barrier to the transport of ichthyoplankton from the southern to the northern Benguela upwelling ecosystems. Areas of powerful upwelling are considered unfavourable fish spawning habitats, with pelagic fish species, such as anchovy, redeye round herring, horse mackerel and shallow-water hake, reported as spawning on either side of the Lüderitz upwelling cell, but not within it (Lett *et al*. 2007). Ichthyoplankton abundance off the study area is thus expected to be low.

Small pelagic species include the sardine/pilchard (*Sadinops ocellatus*), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes (Crawford *et al.* 1987), and generally occur within the 200 m contour, although they may often be found very close inshore, just beyond the surf zone. They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried up the coast in northward flowing waters. The Namibian pelagic stock is currently considered to be in a critical condition due to a combination of over-fishing and unfavourable environmental conditions as a result of Benguela Niños. Abundance of small pelagics in the study area is expected to be low due to its location within the Lüderitz upwelling cell.

Since the collapse of the pelagic fisheries, jellyfish biomass has increased and the structure of the Benguelan fish community has shifted, making the bearded goby (*Sufflogobius bibarbatus*) the new predominant prey species. However, despite increased predation pressure, the gobies are thriving. Recent research has shown that gobies have a very high tolerance of low oxygen and high H_2S levels, which enables them to feed on benthic fauna within hypoxic waters during the day, and then move to oxygen-richer pelagic waters at night, when predation pressure is lower, to feed on live jellyfish (Utne-Palm *et al.* 2010; van der Bank *et al.* 2011).

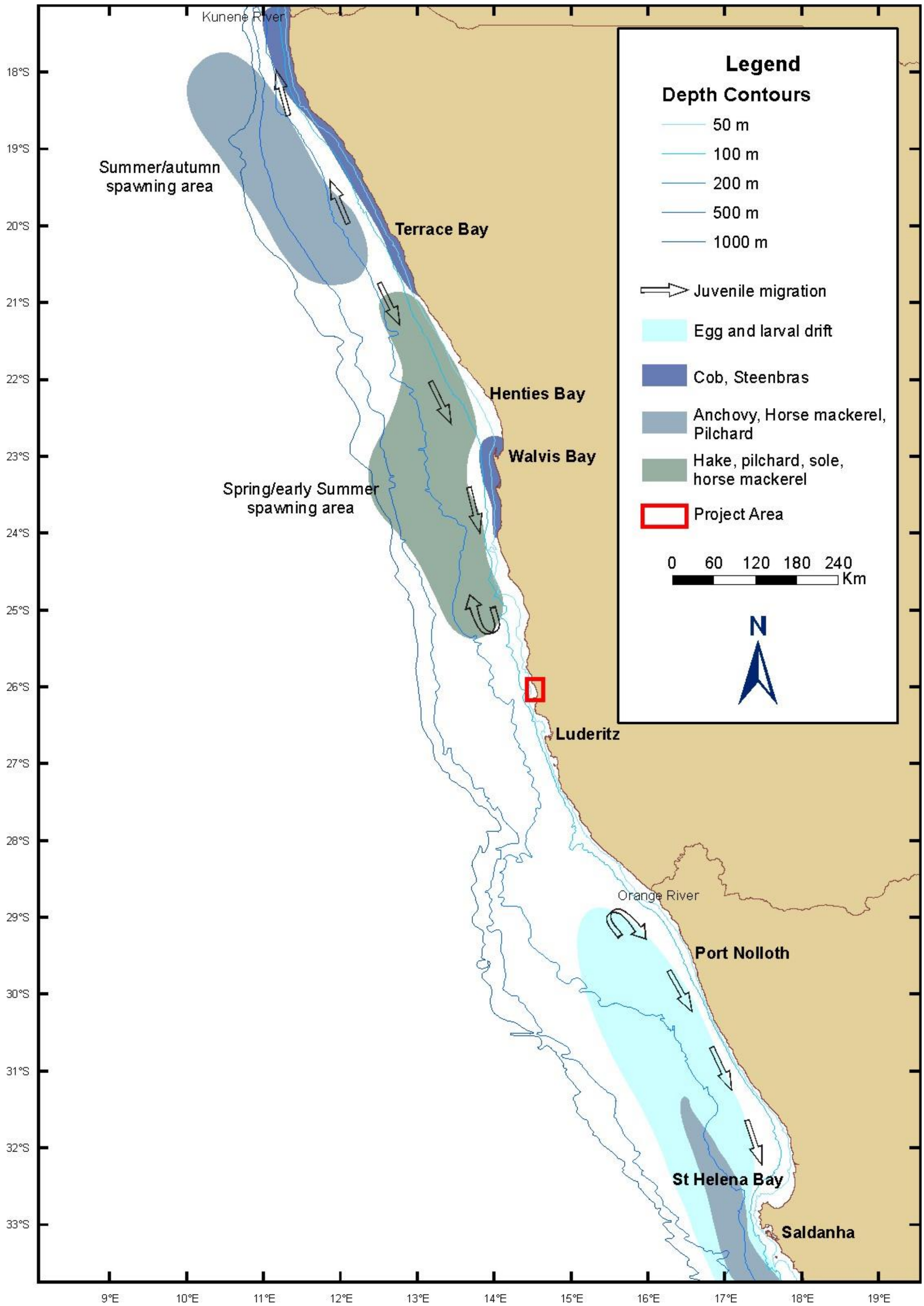


Figure 9: Major spawning areas in the central Benguela region (adapted from Cruikshank 1990) in relation to the study area (red rectangle – not to scale).

Turtles

Five of the eight species of turtle worldwide occur off Namibia (Bianchi *et al.* 1999). Limited information is available on marine turtles in Namibian waters, although the leatherback turtle (*Dermochelys coriacea*), which are known to frequent the cold southern ocean, are the most commonly-sighted turtle species in the region. Observations of Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*), Hawksbill (*Eretmochelys imbricata*) and Olive Ridley (*Lepidochelys olivacea*) turtles in the area are rare. Only one species, the Green turtle, breeds on the Namibian shores, in the far north of the Skeleton Coast. **Table 8** details their conservation status.

Table 8: Marine turtles known from Namibian waters with their overall species conservation status. *The Leatherback turtle species is divided into seven subpopulations worldwide, and turtles found in Namibian waters are known from three of these subpopulations.

English name	Scientific name	IUCN status
Loggerhead turtle	*Caretta caretta*	Vulnerable
Green turtle	*Chelonia mydas*	Endangered
Hawkbill turtle	*Eretmochelys imbricata*	Critically Endangered
Olive ridley turtle	*Lepidochelys olivacea*	Vulnerable
Leatherback turtle*	*Dermochelys coriacea*	Vulnerable (Critically Endangered)

The South Atlantic population of leatherback turtles is the largest in the world, with as many as 40,000 females thought to nest in an area centred on Gabon, yet the trajectory of this population is currently unknown (Witt *et al.* 2011). Namibia is gaining recognition as a feeding area for leatherback turtles that are either migrating through the area or undertaking feeding excursions into Namibian waters. The turtles are thought to be attracted by the large amount of gelatinous plankton in the in central and southern Namibian waters (Lynam *et al.* 2006, Roux *et al.* 2013). These turtles are from three different subpopulations, two of which (Southwest Indian Ocean and Southwest Atlantic Ocean) are ranked as 'critically endangered' (Wallace *et al.* 2013). Satellite tracking of Leatherback turtles from Gabon and Mozambique/KwaZulu-Natal in South Africa has shown animals of these regions migrating to Namibian waters while tagged animals from Brazil and Gabon have also been sighted or recovered dead after entanglement in the Lüderitz area.

Leatherback turtles are listed as "Vulnerable" worldwide by the IUCN (Red List 2013), with the regional population considered "Endangered" (Hughes & Nel 2014) and are in need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species).

Seabirds

The Namibian coastline sustains large populations of breeding and foraging seabird and shorebird species, which require suitable foraging and breeding habitats for their survival. In total, 12 species of seabirds are known to breed along the southern Namibian coast, mainly on islands. Six of these species are considered globally threatened or near-threatened; nine are considered threatened or near-threatened in Namibia (**Table 9**).

Most seabirds breeding in Namibia are restricted to areas where they are safe from land predators, with the islands and islets along the southern Namibian coast from Meob Bay in the north to Baker's Bay in the south therefore providing vital breeding habitats. Although some species are able to breed on the mainland coast in inaccessible places, in general most breed on islands. However, the number of successfully breeding birds at the particular breeding sites varies with food abundance (J. Kemper, MFMR Lüderitz, pers. comm.). Within the licence area, Neglectus Islet and the disused jetty in Hottentots Bay provide important breeding areas. The jetty presently has the largest breeding colony of White-breasted cormorants along the southern Namibian coast (Currie *et al*. 2009).

A number of shorebird species are found along Namibia's coast, both on rocky shores and sandy beaches. These include the common breeding resident White-fronted Plovers *Charadrius marginatus,* as well as various migratory shorebirds, some of which may overwinter. They mostly feed on a range of small invertebrates, from polychaete worms to small crustaceans, mussels and kelp flies, often searching through washed-up kelp for food.

Most of the seabird species breeding in Namibia generally feed relatively close inshore (10-30 km). Some species may forage further offshore, such as Cape Cormorants (Roux 2007), Cape Gannets, which may forage up to 140 km offshore (Dundee 2006; Grémillet *et al.* 2008; Ludynia *et al.* 2012), and African Penguins, which have been recorded more than 60 km offshore (Ludynia *et al.* 2012). Gulls are largely opportunistic surface-feeders or feed along the shore or scavenge on land, while oystercatchers feed on mussels, limpets and other invertebrates along the shore and in the intertidal zone.

In addition to these coastal seabirds that breed in Namibia, about 50 species of non-breeding seabird species are found off the southern coast of Namibia. These consist of a number of albatrosses, petrels, giant petrels, storm-petrels, shearwaters skuas and prions, and include several globally and/or nationally threatened species (Simmons *et al.* 2015; IUCN 2020). Information on their exact seasonal distributions and abundances in Namibian waters is generally limited (Roux 2007; Simmons *et al.* 2015). Highest densities of pelagic seabirds occur in winter on the shelf-break, but some species may venture closer inshore and some can even be observed occasionally from the shore, including Giant Petrels and White-Chinned Petrels (J-P Roux, J Kemper pers. obs.). These seabirds forage in open waters, covering vast distances, and feed on a range of fish, krill and squid.

Table 9: Seabird species breeding along the Namibian coastline with their Namibian and global IUCN Red-listing classification* (from Simmons et al. 2015; IUCN 2020).

SPECIES	Namibian	Global IUCN
African Penguin *Spheniscus demersus*	Endangered	Endangered
Bank Cormorant *Phalacrocorax neglectus*	Endangered	Endangered
Cape Cormorant *Phalacrocorax capensis*	Endangered	Endangered
Cape Gannet *Morus capensis*	Critically Endangered	Endangered
Crowned Cormorant *Phalacrocorax coronatus*	Near Threatened	Near Threatened
White-breasted cormorant *Phalacrocorax carbo*	Least Concern	Least Concern
African Black Oystercatcher *Haematopus moquini*	Near Threatened	Least Concern
Kelp Gull *Larus dominicanus*	Least Concern	Least Concern
Hartlaub's Gull *Larus hartlaubii*	Vulnerable	Least Concern
Caspian Tern *Hydroprogne caspia*	Vulnerable	Least Concern
Swift Tern *Sterna bergii bergii*	Least Concern	Least Concern
Damara Tern *Sterna balaenarum*	Near Threatened	Vulnerable

*In the IUCN scheme Endangered is a more extinction-prone class than Vulnerable, and differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

[1]. May move to Critically Endangered if mortality from long-lining does not decrease.

Pinnipeds (Seals and Fur seals)

Two species of true seals are known to occur (as rare vagrants) in Namibian waters, the Southern elephant seal (*Mirounga leonina*), and the Leopard seal (*Hydrurga leptonyx*). The sub-Antarctic fur seal (*Arctocephalus tropicalis*) is also a rare vagrant to our shores. All three species are ranked as "Least concern" for their conservation status by the IUCN and have a marginal distribution in the region.

The Cape fur seal (*Arctocephalus pusillus pusillus*) is the only species of seal resident along the west coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs. The species as a whole is ranked "Least concern" as a conservation status by the IUCN (Hofmeyr 2015). Cape fur seals are endemic to the Benguela Current region and are opportunistic predators with a diet composed mostly of epi- and meso-pelagic preys dominated by fish and squid species caught in the water column over the inner and mid continental shelf. The diet composition varies regionally, seasonally and interannually according to local prey abundance and availability (De Bruyn *et al.* 2003, De Bruyn *et al.* 2005, Mecenero *et al.* 2006a, 2006b; MFMR unpubl. data).

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles (~220 km) offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991). Namibian populations declined precipitously during the warm events of 1993/94 (Wickens 1995), as a consequence of the impacts of these events on pelagic fish populations. Population estimates fluctuate widely between years in terms of pup production, particularly since the mid-1990s (MFMR unpubl. Data; Kirkman *et al.* 2007).

In the Lüderitz region fur seal colonies are found at Dolphin Head (Spencer Bay), Little Ichaboe, Marshall Reef, Staple, Boat Bay and Dumfudgeon Rocks, Seal Island (Lüderitz Bay), Wolf Bay, Atlas Bay, Long Island, North Reef (Possession Island). Off those, a complex of three colonies (Wolf Bay, Atlas Bay and Long Island) about 18 km south of Lüderitz comprise the bulk of the population of southern Namibian fur seal population. It consists of about 300,000 seals, producing roughly 100,000 pups per year. Further colonies are located at van Reenen Bay and Bakers Bay, with a further ~9,600 individuals existing on Hollamsbird Island south of Sandwich Harbour. All colonies have important conservation value since they are largely undisturbed at present, as public access to the southern Namibian coast is restricted.

The Cape fur seal population in the Benguela is regularly monitored by the South African and Namibian governments (e.g. Kirkman *et al*. 2012). Surveys of the full species range done every three years providing data on seal pup production (which can be translated to adult population size), thereby allowing for the generation of high quality data on the population dynamics of this species. While the Namibian fur seal population as a whole seems to have remained relatively stable in the last three decades, the southern Namibian part has declined by about 50% since 1993 (Kirkman *et al.* 2007, Kirkman *et al.* 2013, MFMR unpublished data). The cause of this long-term regional decline is probably linked to changes in the regional prey abundance, prey quality and diet composition (e.g. Roux *et al.* 2013).

Cetaceans (Whales and Dolphins)

The southern African region (including Namibian waters) has a very high diversity of whales and dolphins (Best 2007). The cetacean fauna of southern Namibia comprises at least 33 species of whales and dolphins known (from historical sightings or strandings and recent surveys) or likely (habitat projections based on known species parameters) to occur here (3-5) (Findlay *et al.* 1992; Findlay 1996; Bianchi *et al.* 1999; Best 2007). The majority of these occur in offshore waters, near the shelf edge and are highly unlikely to be present on the inner shelf and the project area.

The most abundant of the migratory mysticete (baleen) whales frequenting the inner shelf habitat are the humpback whales and southern right whales. In the last decade, both species have been increasingly observed to remain along the west coast of southern Africa well after the 'traditional' southern African whale season (June - November) into spring and summer (October - February) where they have been observed feeding in upwelling zones, especially off Saldanha and St Helena Bays in South Africa (Barendse *et al.* 2011; Mate *et al.* 2011). Increasing numbers of summer records of both species in Namibia, suggest that animals may also be feeding in the southern half of the country near the Lüderitz upwelling cell and may therefore occur in or pass through the Lüderitz Bay area throughout the year.

The southern African population of southern right whales historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baia dos Tigres) and is considered to be a single population within this range (Roux *et al.* 2015). The most recent abundance estimate for this population is available for 2017 which estimated the population at ~6,100 individuals including all age and sex classes, and still growing at ~6.5% per annum (Brandaõ *et al.* 2017). Due to historical overexploitation the local population crashed nearly two centuries ago and the range contracted down to just the south coast of South Africa. Internationally protected since the early 20th century the population has been slowly recovering and repopulating its historical distribution including Namibia (Roux *et al.* 2001, 2015; de Rock *et al.* 2019) and Mozambique (Banks *et al.* 2011). Southern right whales are seen regularly in Namibian coastal waters (<3 km from shore), especially in the southern half of the Namibian coastline (Roux *et al.* 2001, 2011). Right whales have been recorded in Namibian waters in all months of the year (J-P. Roux pers. obs.), with numbers peaking in winter and spring (June - October). Notably, all available records have been very close to shore with only a few out to 100 m depth. While globally ranked in the “Least concern” category by the IUCN (due to the growing population and adequate conservation measures) it should be noted that the global population is still only ~10% of the estimated original pre-whaling levels.

The majority of humpback whales passing through the region are migrating to breeding grounds off tropical west Africa, between Angola and the Gulf of Guinea (Rosenbaum *et al.* 2009; Barendse *et al.* 2010). A recent synthesis of available humpback whale data from Namibia (Elwen *et al.* 2014) shows that in coastal waters, the northward migration stream is larger than the southward peak supporting earlier observations from whale catches (Best & Allison 2010). This supports suggestions that animals migrating north strike the coast at varying places mostly north of St Helena Bay (South Africa) resulting in increasing whale density in shelf waters as one moves northward towards Angola, but with no clear migration ‘corridor’. On the southward migration, there is evidence from satellite tagged animals and a smaller secondary peak in numbers in Walvis Bay, that many humpback whales follow the Walvis Ridge offshore then head directly to high latitude feeding grounds, while others follow a more coastal route (including the majority of mother-calf pairs), possibly lingering in the feeding grounds off west South Africa in summer (Elwen *et al.* 2014, Rosenbaum *et al.* 2014).

Regular sightings of humpback whales in spring and summer in Namibia, especially in the Lüderitz area, suggest that summer feeding is occurring in Namibian waters as well (or at least that animals foraging off West South Africa range up into southern Namibia). The most recent abundance estimates available put the number of animals in the west African breeding population to be in excess of 9,000 individuals in 2005 (IWC 2012) and it is likely to have increased since this time at about 5% per annum (IWC 2012). Humpback whales are thus likely to be the most frequently encountered baleen whale in the project area, ranging from the coast to beyond the shelf, with year round presence but numbers peaking in June – July (northern migration) and a smaller peak with the southern breeding migration around September – October but with regular encounters until February associated with subsequent feeding in the Benguela ecosystem.

Fin whales have been sighted several times in recent years off the coast and in inshore waters near Lüderitz. While uncommon visitors in the project area they are the longest whale species likely to be encountered with a total length reaching close to 25 m (Best 2007).

The Odontoceti (toothed whales) are a varied group of animals that includes the dolphins, porpoises, beaked whales and sperm whales. Species occurring within Namibian waters display a diversity of features, for example their habitats vary from extremely coastal and highly site specific to oceanic and wide ranging. Those in the region can range in size from 1.6 m long (Heaviside’s dolphin) to 17 m (bull sperm whale).

Dusky dolphins (*Lagenorhynchus obscurus*) are likely to be the most frequently encountered small cetacean in the project area. The species is very boat friendly and will often approach boats to bowride. This species is resident year round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay *et al.* 1992). Although no information is available on the size of the population, they are regularly encountered in the inner and mid shelf waters, with most records coming from beyond 5 nautical miles from the coast (Elwen *et al.* 2010; De Rock *et al.* 2019). In recent surveys of the Namibian Islands' Marine Protected Area (between latitudes of 24˚29' S and 27˚57' S and depths of 30-200 m) dusky dolphin were the most commonly detected cetacean species with group sizes ranging from 1 to 70 individuals (Martin *et al.* submitted), although group sizes up to 800 have been reported in southern African waters (Findlay *et al.* 1992).

Heaviside's dolphins are relatively abundant in both the southern and northern Benguela ecosystem with several hundred animals living in the areas around Walvis Bay and Lüderitz. Heaviside's dolphins are resident year-round. This species occupies waters from the coast to at least 200 m depth (Elwen *et al.* 2006, 2010; Best 2007), and may show a diurnal onshore-offshore movement pattern feeding offshore at night, although this varies throughout the range (Elwen *et al.* 2009b). In the Lüderitz area the species is present in the inshore area from the breakers in less than 2 m depth as well as bays and coves along the coast. Some pods specialize in feeding on the edge and within established natural kelp beds (J-P. Roux, pers. obs).Heaviside's dolphins (together with African Penguins) are particularly important economically near Lüderitz as they constitute the highlight of the growing local marine tourism sector.

Common bottlenose dolphins (*Tursiop struncatus*) are widely distributed in tropical and temperate waters throughout the world, but frequently occur in small (10s to low 100s) isolated coastal populations. Within Nambian waters two populations of bottlenose dolphins occur. A small population inhabits the very near shore coastal waters (mostly <15 m deep) of the central Namibian coastline from approximately Lüderitz in the south to at least Cape Cross in the north, and is considered a conservation concern. The population is thought to number less than 100 individuals (Elwen *et al.* 2011). An offshore 'form' of common bottlenose dolphins occurs around the coast of southern Africa including Namibia and Angola (Best 2007) with sightings restricted to the continental shelf edge and deeper. Members of the small Namibian coastal population visit Lüderitz Bay on a regular basis.

The cold waters of the central region of the Benguela current associated with the Lüderitz upwelling cell allow a northwards extension of the normally sub Antarctic habitat of Southern right whale dolphins (*Lissodelphis peronii*) (Best 2007). Most records in the region originate in a relatively restricted region between 26°S and 30°S (Rose & Payne 1991; Best 2007; MFMR unpubl. data). They are often seen in mixed species groups with dusky dolphins in the region. There was a live stranding of two individuals in Lüderitz Bay in December 2013 (J-P. Roux pers. obs.). It is possible that the Namibian sightings represent a regionally unique and resident population (Findlay *et al.* 1992).

All whales and dolphins are given protection under the South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished. No vessel or aircraft may approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.

5.3 Biological Resources

5.3.1 Rock Lobster Sanctuaries

Two rock lobster sanctuaries exist in the vicinity of the project area (**Figure 52**, left in Section 6). The Ichaboe lobster sanctuary, which lies about 20 kms south of ML 220, was proclaimed in 1951 and extends from Danger Point to Douglas Point in Douglas Bay. No western boarder has been defined making it extend to the outer boundary of the Exclusive Economic Zone (EEZ). The sanctuary has been effective in preserving the natural size structure of the rock lobster population, which in the sanctuary has resulted in a significantly higher abundance of large-sized lobsters compared with commercially fished areas (Currie *et al.* 2009).

The whole of the Lüderitz Bay, which lies 60 kms south of the licence area, was proclaimed a rock lobster sanctuary in 1939. The bay serves primarily as a recruitment settlement area and high numbers of lobster puerulus larvae and juvenile lobsters are reported to occur there, due to the protective environment provided by various bays, small fjords, two islands and a lagoon area (Keulder 2005; Currie *et al.* 2009). Neither commercial nor recreational fisheries are permitted in either of these sanctuaries.

5.4 Human Utilization of Marine Resources

Namibian commercial fisheries catch and effort data were sourced from the Ministry of Fisheries and Marine Resources (MFMR) for the period 2005 to 2019, where available. Data on fishing rights holdings and industrial bodies was sourced from the 2019 edition of the Fishing Industry Handbook[6]. Information on species distribution was taken from the Benguela Current Large Marine Ecosystem (BCLME) Annual State of the Stocks Report 2011[7].

Table 10: Date range of data used for each fishery sector assessed.

Sector	Date Range		Comment
	Catch	Effort	
Small pelagic purse-seine	2005 – 2017	2005 – 2017	Fishery was closed for a three-year period commencing 01 January 2018
Midwater trawl	2005 – 2018	2005 – 2018	
Demersal trawl	2005 – 2018	2005 – 2018	
Demersal longline	2005 – 2018	2005 – 2018	
Large pelagic long-line	2004 – 2019	2004 – 2019	
Tuna pole	2004 – 2019	2004 – 2019	
Line-fish	2000 – 2019	2000 – 2019	
Deep-sea crab	2013 – 2018	2013 – 2018	
Deep-water trawl	1994 – 2007	N/A	Fishery has been closed since 2007
Rock lobster	2005 – 2016	2005 – 2016	

[6] Fishing Industry Handbook South Africa, Namibia and Moçambique (2019) 47th edition George Warman Publications, Cape Town, South Africa

[7] Benguela Current Large Marine Ecosystem State of Stocks Review 2011 (2nd Edition; Ed C. Kirchner). Benguela Current Commission.

The study is based on a number of assumptions and is subject to certain limitations listed below. The outcome of the impact assessment is, however, not expected to be affected by these assumptions and limitations:

- The official governmental record of Namibian commercial fisheries data was used to show fishing catch and effort relative to the licence area. These data are derived from logbooks that are completed by skippers whilst at sea and then transcribed into electronic format by the Ministry of Fisheries and Marine Resources (MFMR). It is assumed that there would be a proportion of erroneous data due to inaccurate reporting and recording, but that this is likely to be minimal in comparison to the total volume of the dataset. Where obvious errors in the reporting of fishing positions were identified these were excluded from the analysis.
- Fishing positions are reported by the skippers as the start latitude and longitude of each fishing event and the accuracy of the reported positions is assumed to be to the nearest nautical minute.
- The dataset used to map the spatial distribution for each fishery covers at least a ten-year period and includes the most recent available data. The time span for each sector is listed in **Table 10**.
- The effects of sound on the CPUE of fish and invertebrates have been drawn from the findings of international studies. To date there have been no studies focused directly on the species found locally. Although the results from international studies are likely also to be representative for local species, current gaps in knowledge on the topic lead to uncertainty when attempting to accurately quantify the potential loss of catch for each type of fishery. Research into the effects of sound on marine fauna is ongoing.

5.4.1 Description of Receiving Environment

Background

Namibia has one of the most productive fishing grounds in the world, based on the Benguela Current System (FAO, August 2015). Namibia is Africa's fourth largest capture fisheries nation behind Morocco, South Africa and Mauritania, and 36th worldwide.[8] Namibia's 200 nautical mile Exclusive Economic Zone (EEZ) supports some 20 different commercially exploited marine species. The three main Namibian commercial species (hake, sardine and horse mackerel) comprise the primary species of historical importance in Namibia. Other species of more recent importance include orange roughy, the deepwater crab trap fishery, monk, rock lobster and the large pelagic fisheries for tuna. The majority of sectors are considered by MFMR to be sustainably utilised.

Prior to Namibian independence in 1990, fisheries in Namibian water were managed under a Regional Fisheries Management Organisation (RFMO) known as the International Commission for South East Atlantic Fisheries (ICSEAF). During this time fish resources were heavily exploited by foreign fishing fleets operating under ICSEAF as well as Illegal, Unreported and Unregulated fishing (IUU). The ICSEAF RFMO was disbanded in 1989, critically however, during the period of tenure of this organisation, several international measures were introduced under the United Nations Convention of the Law of the Sea (UNCLOS). This included the United Nations Fish Stocks Agreement for Highly Migratory

[8] Wikipedia, February 2017. https://en.wikipedia.org/wiki/Fishing_industry_by_country

Species, and the declaration of the 200 nm EEZ. Since independence, the Namibian government has taken over the management of its fisheries and drastically cut Total Allowable Catch (TAC) levels for key commercial species, which has allowed most fish stocks to recover to maximum sustainable levels (MFMR, August 2004). Namibia has gained international repute for its well-managed fishery and has become an exporter of quality fish products to countries including South Africa, Democratic Republic of the Congo, Mozambique, Spain, Italy and Portugal (MFMR, 2013).

The fishing industry is a cornerstone of the Namibian economy, generating approximately N$10 billion in export revenue (2016) - the second most important forex earner after mining, while it sustains some 16 800 direct jobs (Ministry of Fisheries and Marine Resources, 17 February 2017) - 70% of which are in the hake sector.

Each of these fisheries sectors are covered in the following overview of the current status of Namibian fisheries. Note also, because of the poor data records of these fisheries associated with irregular management, it is only since Namibian independence that attempts have been made to reconstruct the historical catches of these fisheries.

5.4.2 Overview of the Status of Namibian Fisheries since 1990s

The Namibian fishing industry is the country's second largest export earner of foreign currency and the third largest economic sector in terms of contribution to the Gross Domestic Product (GDP). In terms of the value of production, Namibia ranks among the top ten fishing countries globally (Food and Agricultural Organization (FAO): http//www.fao.com.na). Supported by the high productivity of the Benguela upwelling ecosystem, abundant fish stocks have historically typified Namibian waters[9].

Fish resources in upwelling systems are typically high in biomass and relatively low in diversity (relative to non-upwelling environments). Commercial fish stocks, as found in the Benguela system typically support intensive commercial fisheries. Although varying in importance at different times in history, Namibian fisheries have focused on demersal species, small pelagic species, large migratory pelagic fish, linefish (caught both commercially and recreationally) and crustacean resources (e.g. lobster and crabs).

Mariculture production is a developing industry based predominantly in Walvis Bay and Lüderitz Bay and surrounds. The main commercial fisheries, targeted species and gear types are shown in **Table 11** and recent TACs are presented in **Table 12** below.

The allocation of TACs and management of each fishing sector is the responsibility of MFMR.

Table 11: List of fisheries that operate within Namibian waters, targeted species and gear types used.

Fishery	Gear Type	Targeted Species
Mariculture	Long-lines, rafts	Pacific oysters, European oysters, Black mussel, Seaweed (Gracilaria sp.)
Small pelagic	Purse-seine	Sardine (*Sardinops sagax*), Horse mackerel (*Trachurus capensis*)
Mid-water trawl	Mid-water trawl	Horse mackerel (*Trachurus capensis)*

[9] Noting that in the ICSEAF period these resources were over-exploited. The northern Benguela (Namibian waters) however remains a highly productive upwelling system resulting in proportionately (to many other countries) abundant commercial fish resources

Fishery	Gear Type	Targeted Species
Demersal trawl	Demersal trawl	Cape hakes (*Merluccius paradoxus, M. capensis*), Monkfish (*Lophius vomerinus)*
Demersal longline	Demersal longline	Cape hakes (*Merluccius paradoxus, M. capensis*)
Large pelagic longline	Pelagic longline	Albacore tuna (*Thunnus alalunga*), Yellowfin tuna (*T. albacares*), Bigeye tuna (*T. obesus*), Swordfish (*Xiphias gladius*), shark spp.
Tuna pole	Pole and line	Albacore tuna
Line-fish	Hand line	Silver kob (*Argyrosomus inodorus*), Dusky kob (*A. coronus*)
Deep-sea crab	Demersal long-line trap	Red crab (*Chaceon maritae*)
Deep-water trawl	Demersal trawl	Orange roughy (*Hoplostethus atlanticus),* Alfonsino (*Beryx splendens*)
Rock Lobster	Demersal trap	Rock lobster (*Jasus lalandii*)

Table 12: Total Allowable Catches (tons) from 2009/10 to 2020/21 (supplied by Ministry of Fisheries and Marine Resources, Namibia).

Year	Sardine / Pilchard	Hake	Horse Mackerel	Crab	Rock Lobster	Monk
2009/10	17 000	149 000	230 000	2700	350	8 500
2010/11	25 000	140 000	247 000	2700	275	9 000
2011/12	25 000	180 000	310 000	2850	350	13 000
2012/13	31 000	170 000	310 000	3100	350	14 000
2013/14	25 000	140 000	350 000	3100	350	10 000
2014/15	25 000	210 000	350 000	3150	300	12 000
2015/16	15 000	140 000	335 000	3446	250	10 000
2016/17	14 000	154 000	340 000	3400	240	9800
2017/18	0	154 000	340 000	3400	230	9600
2018/19	0	154 000	349 000	3900	200	9600
2020/21*	0	154 000	349 000	3900	180	9600

Note: Deepwater trawl TAC is currently not applied for Alfonsino and Orange roughy. There is no TAC (output control) for albacore tuna – this is an effort (input) controlled sector with no restriction on catch.

“ *Provisional” noting that fishing rights not yet allocated and current rights and allowable catches subject to extension of 2018/19 allocations

Namibia has only two major fishing ports from which all the main commercial fishing operations are based namely, Walvis Bay and Lüderitz. In central Namibia, the major port is Walvis Bay and it is from this port that the majority of fishing vessels operate. Most of the fishing conducted from this port is, for economic and logistical reasons, directed at fishing grounds in the central and northern part of Namibia and to a lesser extent the southerly fishing grounds towards the South African border. A significant amount of fishing activity also takes place from Lüderitz, from where hake trawlers and longliners operate, as well as a small rock lobster fishery based in southern Namibian waters.

There are currently 116 Namibian-registered commercial fishing vessels. The dominant fleet comprises demersal trawlers that include both large freezer vessels (up to 70 m in length), as well as a smaller fleet of monk trawlers. These vessels fish year round, with the exception of a one month closed season in October, and range the length of the Namibian EEZ. There is a 200 m fishing depth restriction (i.e. no bottom trawling permitted shallower than 200 m).

Prior to Namibian independence in 1990, a much larger fleet of trawlers existed, however Namibia now exercises strict effort control and vessel size limits. The only other fleets of significance are the mid-water trawlers that target horse mackerel and the large pelagic tuna long-line vessels. The mid-water fleet was historically uncontrolled and comprised of many large industrial vessels mostly of eastern origin (Ukranian and Russian). Currently these large midwater trawl vessels (mostly >100 m in length) operate in the northern waters of Namibia and are restricted to fewer than 20 vessels.

The large pelagic (tunas and shark) long-line vessels operate broadly in Namibian waters, but unlike the mid-water vessels, concentrate in the south near the South African border targeting the migrations of albacore and yellowfin tuna. The numbers of these vessels vary and is dependent on the seasonal availability of tuna and tuna-like species. The tuna pole (baitboat) vessels are a small fleet[10] and also increase in numbers depending on the number of licenses issued to South African boats. The tuna long-liners are also variable with the number of licenses issued to both Namibian flags and others (mostly Asian) fluctuating annually. The extent and number of these vessels is difficult to ascertain (as they are unpublished), although the actual numbers are limited and are less than the numbers of licensed Namibian boats.

There are few known foreign fishing vessels licensed to fish in Namibian waters, although the majority of the current mid-water fleet have permits to fish under foreign flag registration, but as a rule all licensed fishers must reflag under Namibia. There is a possibility that licenses may have been issued to foreign tuna boats, although these would be few in number and they would be closely monitored by the Namibian compliance units and their Vessel Monitoring System (VMS).

5.4.3 Fisheries Management and Research

The commercial exploitation of fish stocks is managed by MFMR, which is advised by the Ministry's National Marine Information and Research Centre (NatMIRC) in Swakopmund. TACs are set annually by the Minister on recommendation by an advisory council. Commercial fisheries are represented at industry level by the Confederation of Namibian Fishing Industries, and at fish species sector-specific level by the Midwater Trawling Association of Namibia, the Namibian Hake Association, Namibian Monk and Sole Association, Namibian Tuna and Hake Longlining Association and the Pelagic Fishing Association of Namibia.

MFMR conducts regular research (biomass) surveys for demersal, mid-water and small pelagic species. These surveys are normally fixed at specific times of the year and cover the entire continental shelf from the Angolan to the South African maritime borders. For example, the demersal trawl surveys take place in January and/or February over the period of one month. MFMR surveys normally follow fixed transects from inshore to offshore. Surveys have a systematic transect design, with a semi-random distribution of stations along transects designed to statistically optimise the number of stations according to the area of every 100 m depth zone out to 500 m. Transects normally run perpendicular to the coastline are 20-80 nm long and are spaced between 20 and 25 nm apart. Most of the sampling stations (trawls) take place during daylight hours.

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[10] The baitboat fleet consists of up to 20 Namibian vessels. This is a small number of vessels compared to South Africa. However, because of the variable and migratory nature of tuna, the number of vessels participating in the fishery varies depending on the seasonal and inter-annual availability of tuna. Namibia also licenses South African vessels to optimise the exploitation of these resources when they are available.

Swept-area biomass surveys for hake are conducted annually to obtain an index of abundance, determine the geographical distribution and collect biological information of the stock. From 1990 to 1999, these surveys were conducted with the Norwegian R/V *Dr Fridtjof Nansen* (Sætersdal *et al* 1999). Since 2000, Namibian commercial trawlers (using the same trawl gears as that of the *Dr Fridtjof Nansen*) were used for the surveys. Since 2002, the commercial trawler *F/V Blue Sea 1*[11] has been used to conduct these surveys. These surveys are normally carried out over the period of one month during January and February and cover the entire continental shelf from the Angolan to the South African maritime border. The method of abundance estimation from these surveys is based on depth stratification and trawls range in depth from 100 m to 600 m. During trawling the vessel tows the net for a period of 30 minutes at a speed of approximately 3 knots.

Scientific acoustic surveys are carried out between February and March each year to estimate the biomass of small pelagic species (using the survey vessel F/V *Welwitchia*). These surveys cover the Namibian shelf from the coastline to the 500 m depth contour (and up to the 2000 m contour northwards of 18°30´S). The vessel surveys along pre-determined transects that run perpendicular to depth contours (East-West / West-East direction).

5.4.4 Stock Distribution, Spawning and Recruitment

The distribution patterns for the Namibian commercial stocks are summarised as follows:

- **The sardine stock** ranges along the entire Namibian coast, but in recent years predominantly from 25°S northwards to southern Angola, inshore of the 200 m bathymetric contour. The southern border of this range is demarcated by the Lüderitz upwelling front, a region of cold, upwelled water located off the port of Lüderitz. Historically, spawning occurred continuously from September to April with two seasonal peaks evident – the first from October to December in an inshore area between Walvis Bay and Palgrave Point and the second from February to March near the 200 m isobath between Palgrave Point and Cape Frio (King, 1977). The fishery collapsed in the 1960’s and currently the status remains overexploited with a low biomass estimate and a significantly contracted distribution pattern compared to historical levels. The fishery is currently closed after a three-year moratorium was implemented on 01 January 2018 due to a significant population reduction. Scientific studies are underway to ascertain the causes (MFMR 2015 and 15 February 2019).

- **Cape horse mackerel** occurs predominantly north of 25°S with juveniles present in the inshore regions up to the 200 m isobath and adult horse mackerel populations extending into waters up to 500 m deep. Biomass estimates in this region are mostly low in summer and higher in winter and early spring. Abundance of horse mackerel is, therefore, higher at these times and increases availability of the species to the fisheries exploiting them. Spawning is heaviest in the north between October and March (O’Toole 1977).

- **Albacore tuna, yellowfin tuna, bigeye tuna, shark and swordfish** are large pelagic species with an extensive offshore distribution ranging along the entire Namibian coastline. The abundance of these species has a strong seasonal signal resulting in increased availability to the fisheries targeting them at different periods. For albacore tuna, availability increases from the last trimester (summer) and peaks in the first trimester (late summer to early autumn). Baitboats using pole and line target albacore tuna primarily in southern Namibia in the first trimester (January to March). For the

[11] Namibia now also has new research vessel, the *FV Mirabalis* undertaking routine fishery surveys

pelagic longline sector targeting yellowfin tuna, bigeye tuna and swordfish, the availability of these target species is highest in the second and third trimesters. It is important to note that weather conditions play an important role in operations within the tuna fisheries (pole and line and long-line). With the onset of summer there is cold water upwelling as a result of increasing south-easterly winds. The availability of longfin tuna is associated with this increased biological activity and bait fish (sardine and anchovy) abundance. The longline tuna fishing season peaks two to three months later than the fishery for albacore tuna.

- **Hake** is the most commercially important Namibian fishery. Within the Namibian EEZ the hake stock extends along the entire shelf and slope approximately between the 100 m and 1000 m isobaths. Hake spawn and recruit throughout the year with peaks in spawning thought to occur in early summer (Botha 1980, Olivar *et al*. 1988) along the shelf break off central Namibia.
- **Monkfish** is found along the entire extent of the Namibian coast, with the fishery concentrated between 17°15'S and 29°30'S at depths of 200 m to 500 m. Spawning is irregular and variable and is thought to occur throughout the year (Macpherson 1985) with two separate areas of recruitment recorded between the 100 m and 300 m isobaths off Walvis Bay and Lüderitz (Leslie and Grant 1990).
- **Deep-sea red crab stocks** are distributed predominantly from 23°35'S northwards into Angola within a depth range of approximately 300 m to 1000 m. Spawning takes place throughout the year (Le Roux 1997) on the shallower waters of the continental slope with adult females generally occurring at shallower depths to that of males.
- **Orange roughy** has a discontinuous pattern of distribution along the continental slope with concentrations of fish within four known spawning grounds (within designated Quota Management Areas) within the Namibian EEZ. The species has a short, intense spawning period of about a month from July to August (Boyer and Hampton 2001) during which period individuals aggregate. As a result of overexploitation of the stock(s), the fishery has been closed since 2007; however, the stock is currently being assessed with a view to considering the viability of re-opening the fishery.
- **Rock lobster** is found from 25°S to 28°30'S at depths shallower than 100 m. The depth distribution of adults varies seasonally in response to changes in the concentration of dissolved oxygen in the water. Adults moult during spring (males) and late autumn/early winter (females), with egg hatching peaking in October/November. Fishing activity is greatest over January and February with the number of active vessels declining towards the end of the fishing season in May.

The principle commercial fish species in Namibia undergo a critical migration pattern which is central to the sustainability of the small pelagic and hake fisheries. In Namibian waters, hake spawning commences north of the powerful Lüderitz upwelling centre (27°S) and continues up to the Angola–Benguela Front (16–19°S). Sardines and horse mackerel also spawn in the region between Lüderitz and the Angola–Benguela front. Circulation patterns at depth reveal complex eddying and considerable southward and onshore transport beneath the general surface drift to the north-west (Sundby *et al.* 2001).

As eggs drift, hatching takes place followed by larval development. Settlement of larvae occurs in the inshore areas. Sardine spawning peaks 30–80 km offshore during September–October off the central Namibian shelf, with larvae occurring slightly further offshore and recruits appearing close inshore, so there appears to be a simple inshore–offshore movement over the Namibian shelf. Spawning also occurs in mid-summer in the vicinity of the Angola–Benguela

Front (Crawford *et al.* 1987). During late summer (December – March) warm water from the Angolan Current pushes southwards into central Namibian waters, allowing pelagic spawning products to be brought into the nursery grounds off central Namibia. There is a high likelihood of substantial offshore transport associated with this convergent frontal region (Shannon 1985).

5.4.5 Description of Commercial Fishing Sectors and Fisheries Research Surveys

Small Pelagic Purse-Seine

The pelagic purse-seine fishery is based on the Namibian stock of Benguela sardine (*Sardinops sagax*) (also regionally referred to as pilchard), and small quantities of juvenile horse mackerel. The purse-seine fishery in Namibia commenced in 1947 following World War II and an increased demand for canned fish. The fishery was the largest by volume of fish landings in the Benguela ecosystem and grew rapidly until 1968, at which time the stock collapsed. Over the period 1960 to 1977, landings of pilchard averaged 580 000 tons per year and fell to a mere 46 000 tons in 1978 (see **Figure 10**). Following peak catches of 1.4 million tons recorded in 1968 (Cochrane et al., 2009; refer to **Figure 11**), there was a sharp decrease attributed to stock collapse due primarily to overfishing and environmental perturbations (Boyer et al. 2001).

Since independence, Namibia has issued a small TAC of pilchard to sustain the small pelagic sector and to allow land-based factory turnover and in addition, they allow part of this catch to target juvenile horse mackerel (Kirchner et al., 2014). In recent years the resource base has been unable to sustain even these minimal TACs and the fishery has been closed and reopened on an ad hoc basis depending on resource availability. A three-year moratorium was implemented on 01 January 2018 due to a significant population reduction, and extensive scientific studies are underway to ascertain the causes (MFMR 2015 and 15 February 2019). This fishery is currently closed.

Recent landings (2005 to 2017) are shown in **Figure 11** and monthly trends in landings and catch composition are shown in **Figure 12** (source MFMR, 2019).

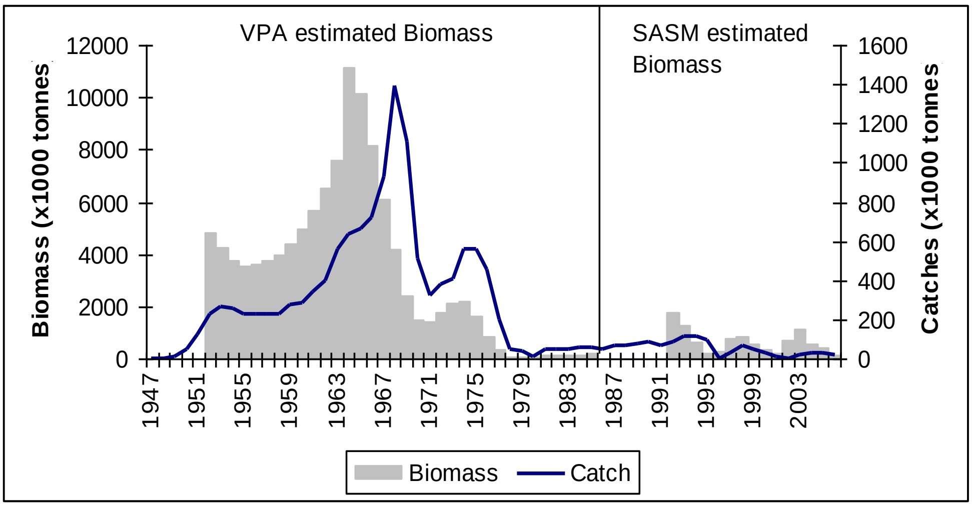


Figure 10: Biomass estimates from 1952-1985 of Namibian sardine (Virtual Population Analysis) from 1991-2006 as well as catches taken throughout this period (after Cochrane et al. 2009).

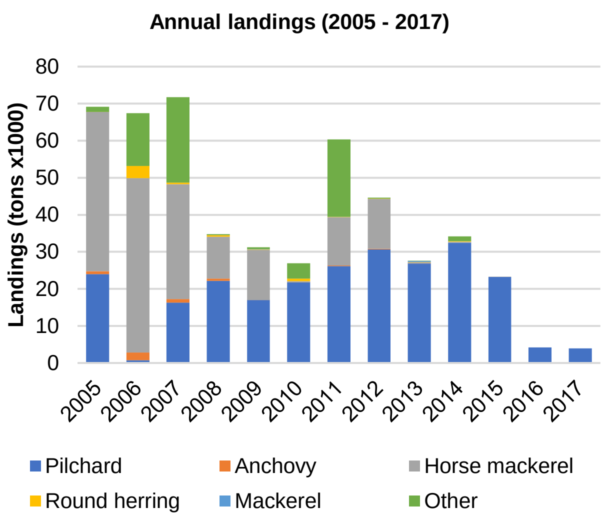


Figure 11: Annual Landings (tons) of small pelagic species by the purse-seine sector from 2005 to 2017 (source: MFMR).

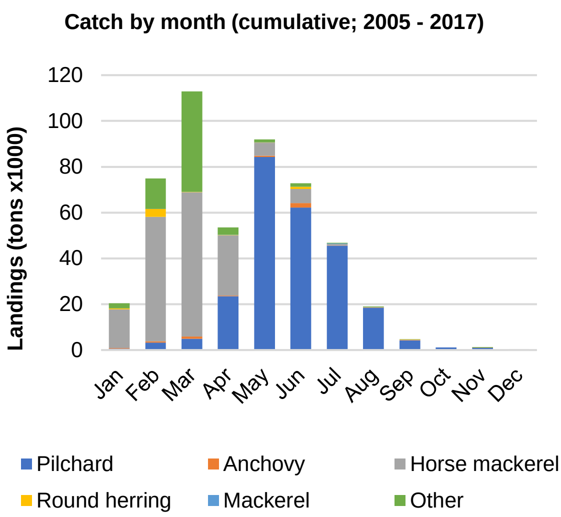


Figure 12: Monthly cumulative landings of small pelagic species by the purse-seine sector from 2005 to 2017 (source: MFMR).

The industry operates from the harbour at Walvis Bay, except for the period 1964-1974 when Lüderitz was used as well. The small pelagic fleet consists of 36 wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 21 m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel will steam around it and encircle it with a large net, extending to a depth of 60 to 90 m (see **Figure 13** and **Figure 14**). Netting walls surround aggregated fish, preventing them from escaping by diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped on board into the hold of the vessel. It is important to note that after the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered on board and this may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

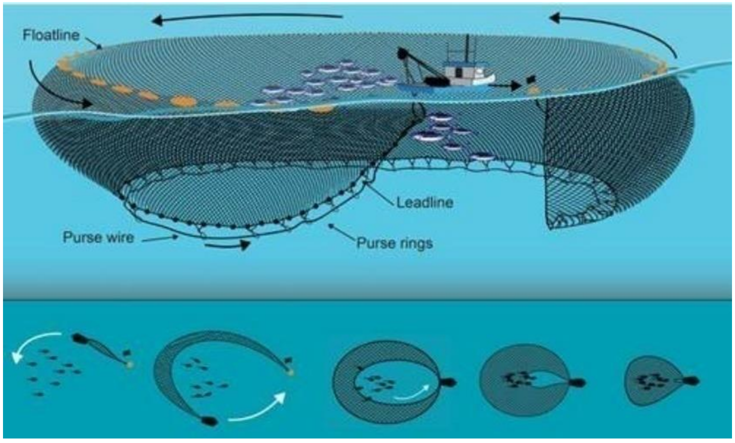


Figure 13: Schematic of typical purse-seine gear deployed in the small pelagic fishery (http://www.afma.gov.au/ portfolio-item/purse-seine).

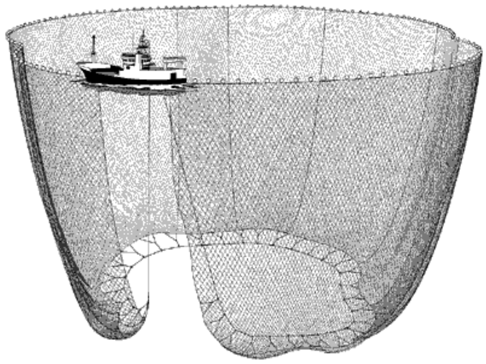


Figure 14: Typical configuration of purse-seine gear used to target small pelagic species (http://www.fao.org).

The extent of the stock distribution has effectively contracted since stock collapse, prior to which the historical distribution was throughout the Benguela system. Recent biomass surveys have shown small aggregations of the stock mostly located inshore of the 200 m isobath. The distribution of commercial fishing activity within the Namibian EEZ and in relation to ML 220 is shown in **Figure 15**. The fishery operates northwards of 25°S to the Angolan border primarily inshore of the 200 m depth contour and there is no overlap of fishing grounds with ML 220. The fishery has been closed since 2018.

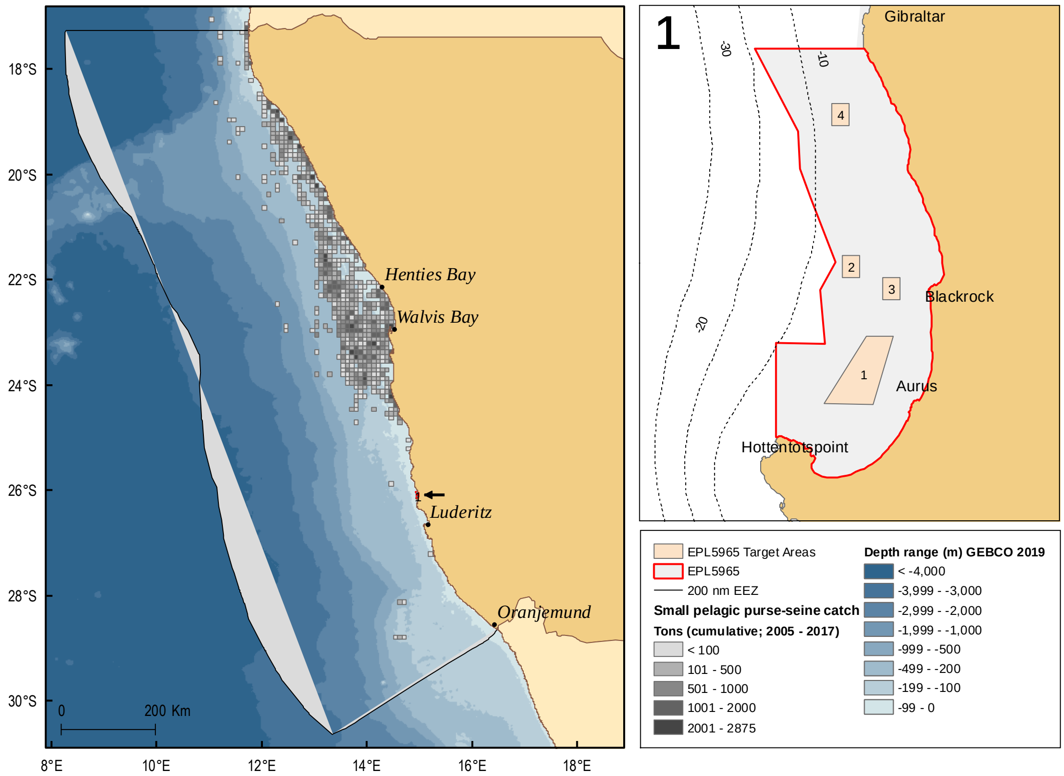


Figure 15: Spatial distribution of small pelagic purse-seine catch (2005 – 2017) within the Namibian EEZ and in the vicinity of ML 220.

Midwater Trawl

The fishery for Cape horse mackerel (*Trachurus capensis*) is the largest contributor by volume and second highest contributor by value to the Namibian fishing industry. The stock is caught by the mid-water trawl fishery (targeting adult horse mackerel) and pelagic purse-seine fishery (smaller quantities of juvenile horse mackerel). The midwater fishery operates using trawls within the water column to catch schools of adult horse mackerel. The catch is either converted to fishmeal or sold as frozen, whole product with landings for the year 2006 valued at N$800 million (MFMR unpublished data in Kirchner *et al.*, 2010). The processing of horse mackerel is an emerging employment creator, as value addition through on-shore fish processing is a key strategy for revenue and job creation under Government's National Development Plan, NDP 5, together with development of mariculture (National Planning Commission, 2016).

The history of the sector in Namibian waters shows initial low catches reported in the early 1960s and a fluctuating but overall increase to a maximum of 600 000 tons in the early 1980s. Since the 1990s landings were on average 300 000 tons per year and the current TAC for horse mackerel is 349 000 tons (2020/21). **Figure 16** shows the TACs set from 1997 to 2018 for the pelagic and mid-water fisheries targeting the Namibian stock of horse mackerel.

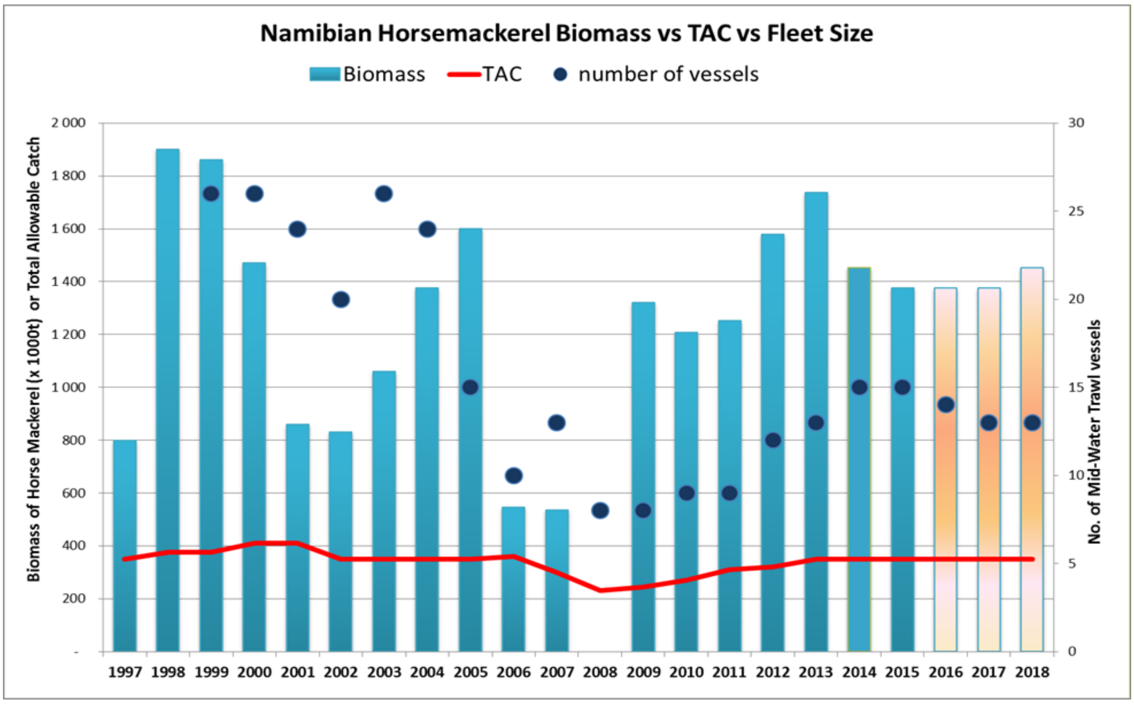


Figure 16: Estimated biomass of horse mackerel, TACs set for the mid-water fishery and number of licenced vessels (1997 to 2018).

Prior to independence, the fleet was dominated by various eastern block countries. After independence, the fishery underwent structural changes and it is currently mainly composed of the Russian fleet registered in Namibia but still operated by a foreign crew[12]. The fleet size has decreased since independence from 57 to 22 at present. Of these, only one is Namibian-flagged, although a further eight are based permanently in Namibia. Vessels range in length

[12] These are large industrial vessels, primarily of Russian origin, that are flagged as Namibian and must carry a proportion of Namibian crew. The right to fish horse mackerel is only permitted to Namibian nationals who charter these vessels to catch their fish allocations.

between 60 m and 120 m. In 2013, 67 rights-holders were registered within the mid-water trawl fishery, with the duration of rights ranging from seven to 15 years. Fishing rights are in the process of being reallocated and have as of yet not been finalised.

The target catch species is meso-pelagic (i.e. found at depths between 200 m and 1000 m above the sea floor (Crawford *et al*. 1987)) and shoals migrate vertically upwards through the water column between dusk and dawn. Mid-water trawlers exploit this behaviour (diurnal vertical migration) by adjusting the depth at which the net is towed (this typically varies from 400 m to just below the water surface). The net itself does not come into contact with the seafloor (unlike demersal trawl gear) and towing speed is greater than that of demersal trawlers (between 4.8 and 6.8 knots). Trawl warps are heavy, ranging from 32 mm to 38 mm in diameter. Net openings range from 40 m to 80 m in height and up to 120 m in width. Weights in front of, and along the ground-rope assist in maintaining the vertical opening of the trawl. To reduce the resistance of the gear and achieve a large opening, the front part of the trawl net is usually made from very large rhombic or hexagonal meshes. The use of nearly parallel ropes instead of meshes in the front part is also a common design. On modern, large mid-water trawls, approximately three quarters of the length of the trawl is made with mesh sizes above 400 mm. A schematic diagram showing the configuration of midwater trawling gear is shown in **Figure 17**.

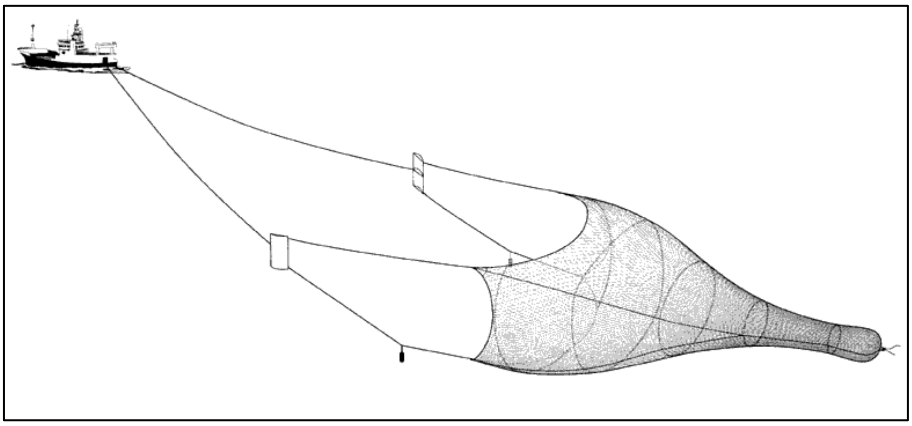


Figure 17 Typical gear configuration used during mid-water trawling operations.

The fishery operates year-round with relatively constant catch and effort values by month. The mid-water trawl fleet operates exclusively out of the port of Walvis Bay and fishing grounds extend north of 25ºS to the border of Angola. Juvenile Cape horse mackerel move into deeper water when mature and are fished mostly between the 200 m and 500 m isobaths towards the shelf break. The distribution of horse mackerel-directed fishing grounds in relation to the Namibian EEZ is shown in **Figure 18**. The southern extent of fishing activity is situated 108 km north-west of the ML and there is no overlap.

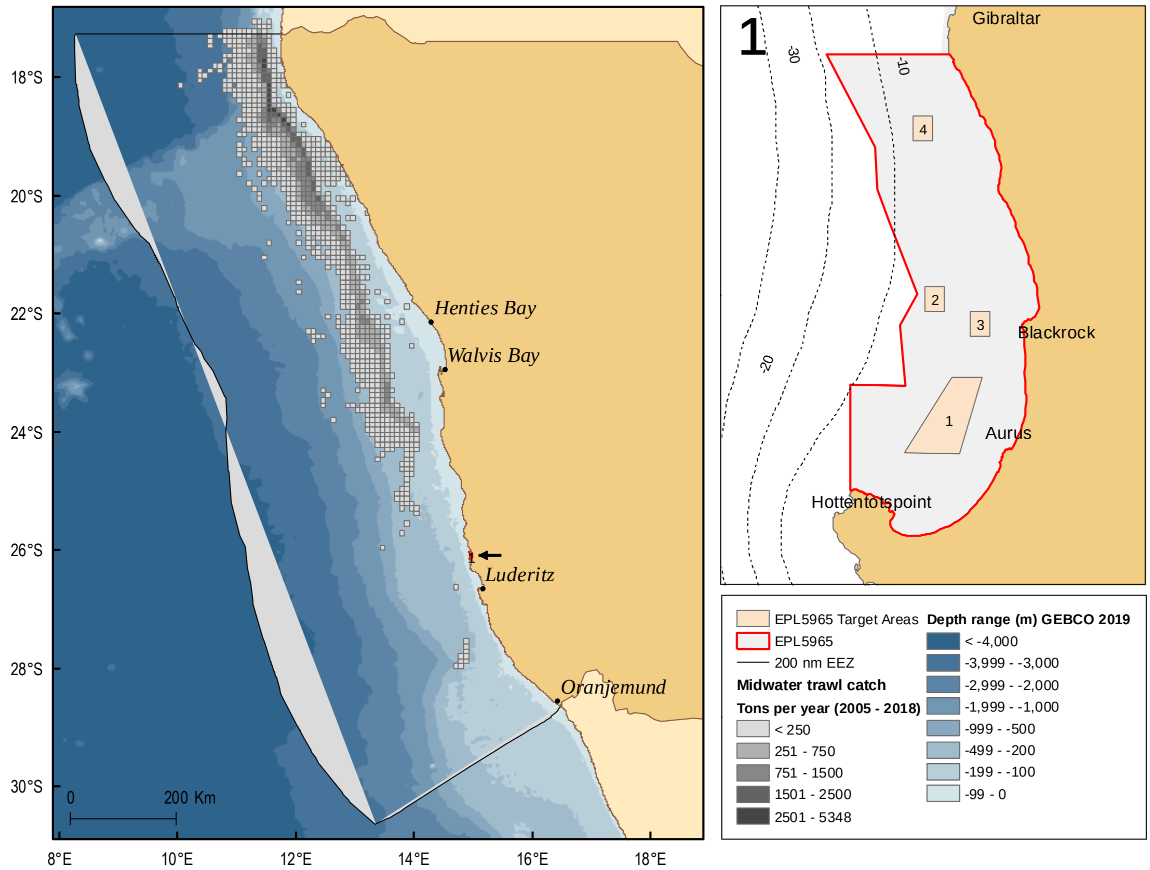


Figure 18: Spatial Distribution of Midwater Trawl Catch (2005 – 2018) within the Namibian EEZ and in relation to ML 220.

Demersal Trawl

The most economically important species in Namibia are shallow-water hake (*Merluccius capensis*) and deepwater hake (*Merluccius paradoxus*). Shallow-water hake is the predominant species, but, because they look very similar, it is difficult to record data separately and the two species are managed as one stock. A proportion of the smaller vessels in demersal trawl fleet target monkfish (*Lophius* spp.), sole and kingklip.

Catches of hake in Namibian waters reached almost 1 million tons in the mid-1970s at the peak of their exploitation (some believe this was a gross underestimated) and was fished by many nations including eastern-block countries, South Africa and Spain (which remains significantly involved in Namibian fisheries). The fishery is currently managed through a TAC, which varies from year to year with a current annual hake TAC of 154 000 tons (2020/21). TACs for hake and monkfish over the period 1991 to 2018 are shown in **Figure 19**. The fishery is active year-round except for a closed period during October each year (see **Figure 20**).

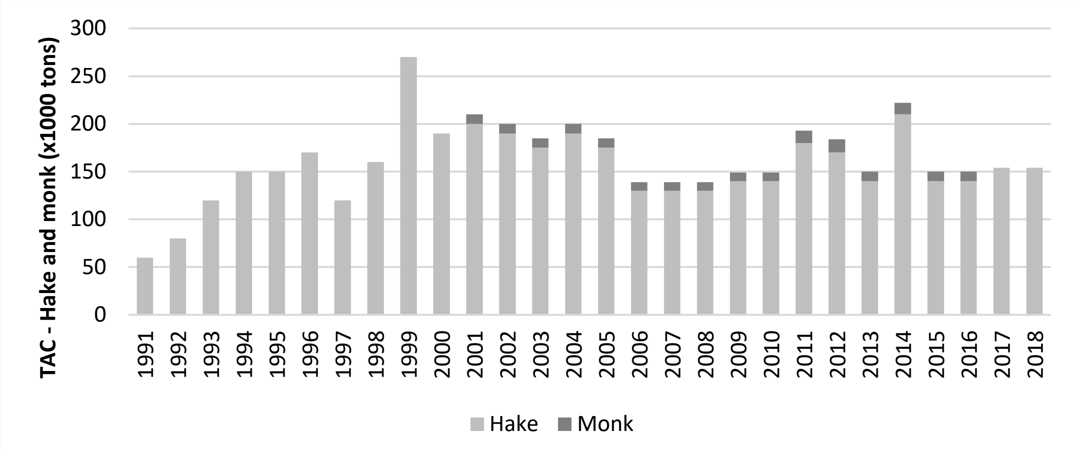


Figure 19: Total Allowable Catch set for Hake and Monkfish from 1991 to 2018.

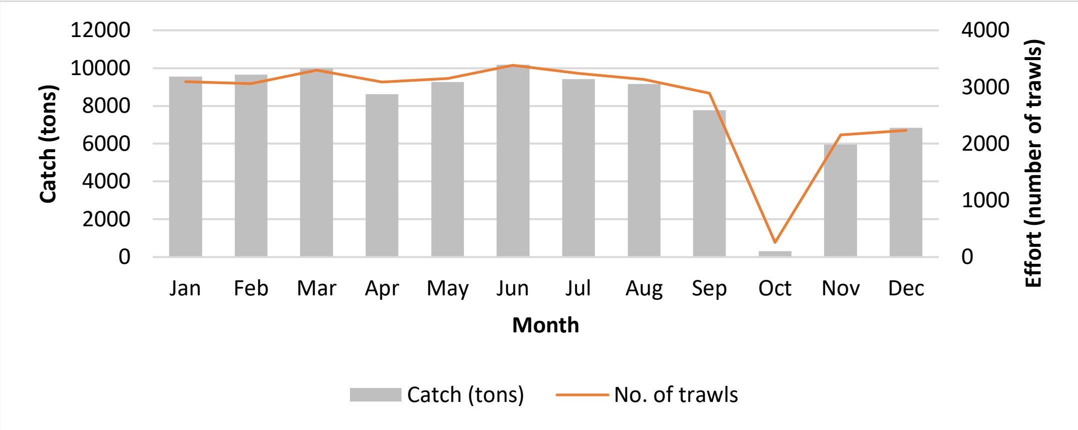


Figure 20: Average landings by month reported for wetfish trawlers from 2005 to 2017.

A fleet of 71 demersal trawlers are currently licensed to operate within the fishery. The deep-sea fleet is divided into wetfish and freezer vessels (70:30 ratio is prescribed) which differ in terms of the capacity for the processing of fish offshore (freezers process at sea and wetfish vessel land fish at factories ashore for processing) and in terms of vessel size and capacity (shaft power of 750 – 3 000 kW). Wetfish vessels have an average length of 45 m, are generally smaller than freezer vessels which may be up to 90 m in length. Whilst freezer vessels may work in an area for up to a month at a time, wetfish vessels may only remain in an area for about a week before returning to port (catch is retained on ice). The majority of trawlers operate from the port of Walvis Bay, with fewer vessel operating from Lüderitz.

Trawl gear is towed astern of the vessel and configurations are similar for both freezer and wetfish vessels (refer to **Figure 21**). Typical demersal trawl gear configuration consists of:

- Steel warps up to 32 mm diameter - in pairs up to 3 km long when towed;
- A pair of trawl doors/otter boards (500 kg to 3 tons each);
- Net footropes which may have heavy steel bobbins attached (up to 24" diameter) as well as large rubber rollers (“rock-hoppers”); and
- Net mesh (diamond or square shape) is normally wide at the net opening whereas the bottom end of the net (or cod-end) has a 130 mm stretched mesh.

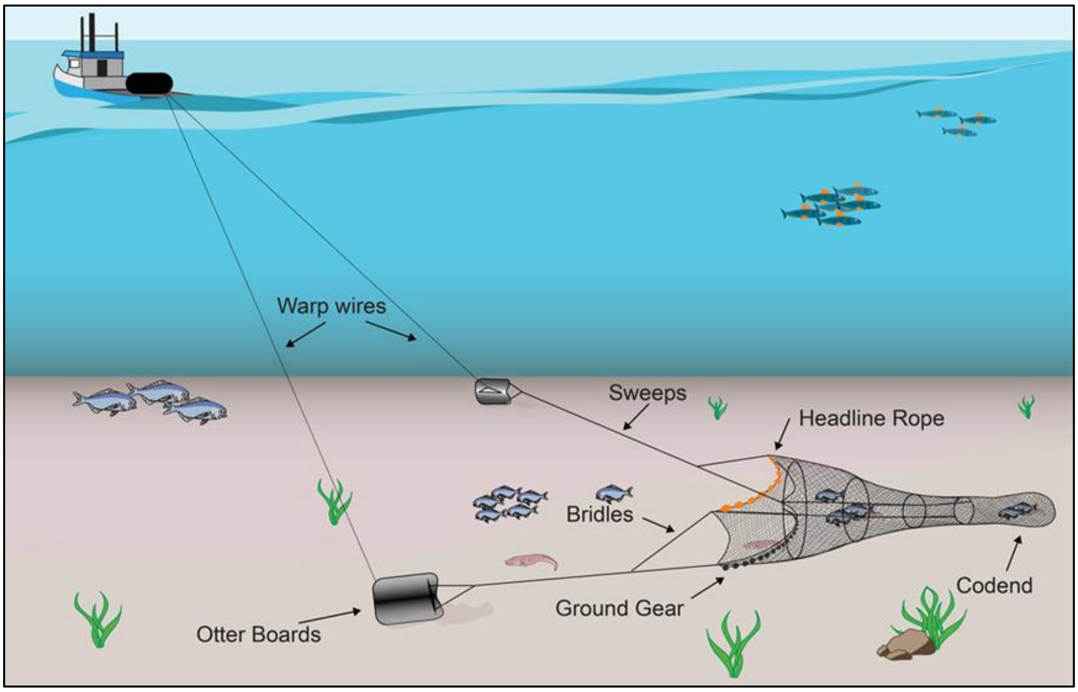


Figure 21: Schematic diagram of trawl gear typically used by deep-sea demersal trawlers targeting hake (Source: http://www.afma.gov.au/portfolio-item/trawling.

Otter trawling is the main trawling method used in the Namibian hake and monk-directed fisheries. This method of trawling makes use of trawl doors (also known as otter boards) that are dragged along the seafloor ahead of the net, maintaining the horizontal net opening. Bottom contact is made by the footrope and by long cables and bridles between the doors and the footrope. Behind the trawl doors are bridles connecting the doors to the wings of the net (to the ends of the footrope and headrope). A headline, bearing floats and the weighted footrope (that may include rope, steel wire, chains, rubber discs, spacers, bobbins or weights) maintain the vertical net opening. The “belly”, “wings” and the “cod-end” (the part of the net that retains the catch) may contact the seabed.

Generally, trawlers tow their gear at 3.5 knots for two to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net opening may be up to 50 m in width and 10 m in height and the swept area on the seabed between the doors may be up to 150 m. The opening of the net is maintained by the vertical spread of the trawl doors, which are in contact with the seafloor. There is a wide range of ground gear configurations used with different companies, vessels and skippers using different combinations that have varied over time, in different grounds and with different fishing strategies relating to market demands. The intention in demersal hake trawling is to have the ground gear in close contact with the seafloor surface and to skim over it rather than to dig into the ground although trawl doors often penetrate up to 150 mm into the seafloor on soft grounds. Footrope protection such as the use of wire in the footrope, bound ropes along the footrope, the addition of rubber disks or rollers (large rollers are considered rock hoper gear or rubber or steel bobbins at regular intervals along the footrope is required, particularly for fishing in hard or irregular ground.

Fishing grounds extend along the entire coastline following the distribution of hake and monkfish along the continental shelf at a depth range of 200 m[13] to approximately 850 m. The total extent of fishing grounds used by the demersal trawl fleet is approximately 78,895 km^2.

Figure 22 shows these fishing grounds in relation to the Namibian EEZ and ML 220. The closest fishing activity is situated at least 50 km from ML220 at the 300 m depth contour and there is no overlap of grounds with the ML.

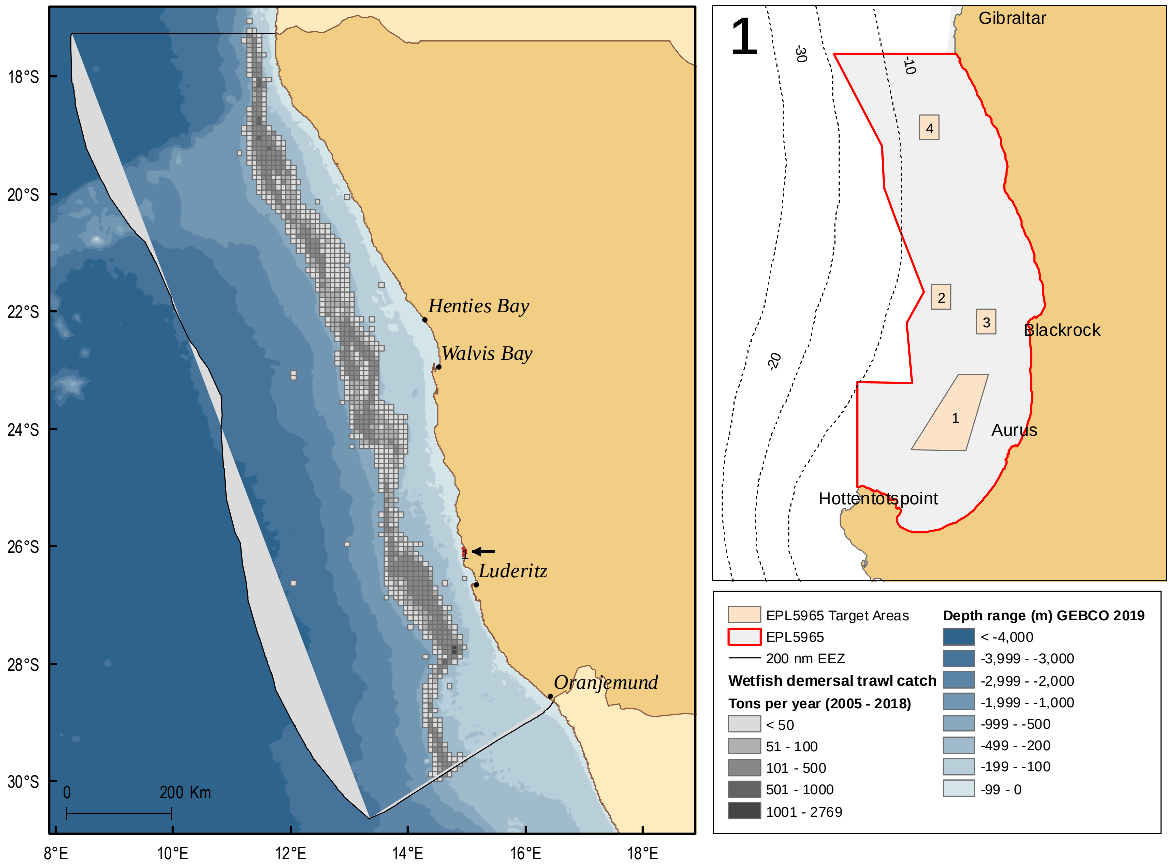


Figure 22: Spatial distribution of the catch of hake (2005 – 2018) by demersal trawl vessels in the Namibian EEZ and in relation to ML 220.

Demersal Longline

Similar to the demersal trawl fishery the target species of this fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. The catch packed unfrozen, on ice, and is landed as either prime quality (PQ) or headed and gutted. A total hake TAC of 154 000 tons was set for 2020/21 but less than 10 000 tons of this is caught by longline vessels. **Figure 23** shows annual landings recorded by the sector from 2005 to 2018. Vessels operate year-round but operations are particularly low in October (see **Figure 24**).

[13] Namibia has a designated area closed to most "offshore" fishing activities under 200 m water depth i.e. to protect potential spawning areas as well as areas of high juvenile abundance for most demersal species, including hake. Demersal trawling is prohibited in waters shallower than 200 m.

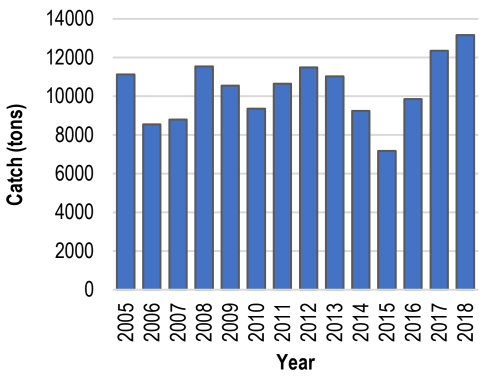


Figure 23: Landings recorded for the Namibian demersal long-line sector from 2005 to 2018.

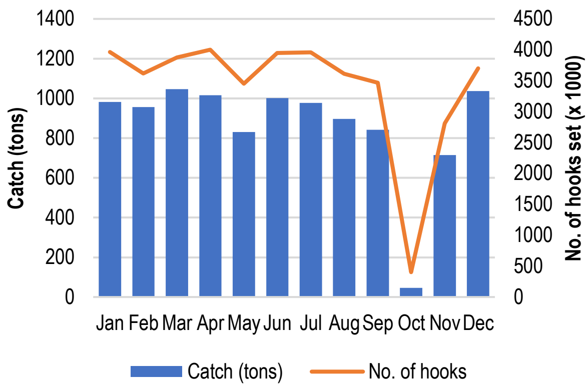


Figure 24: Average monthly catch (tons) recorded by the Namibian demersal longline sector between 2005 and 2018.

A demersal longline vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor (see **Figure 25**).

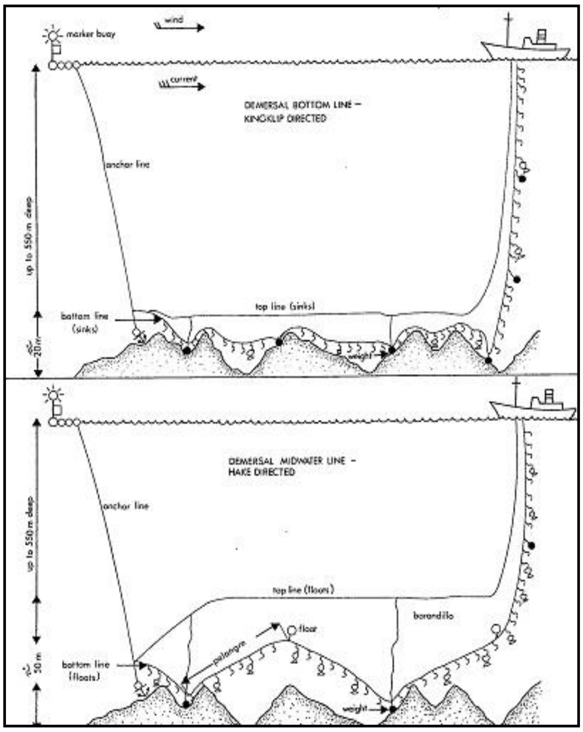


Figure 25: Typical configuration of demersal (bottom-set) gear used within the demersal longline fishery (Source: Japp, 1989).

Steel anchors, of 40 to 60 kg are placed at the ends of each line to anchor it. These anchor positions are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16 mm diameter) is more buoyant than the bottom line, it is raised off the seafloor and minimizes the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically 20 – 30 nautical miles in length. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of 5 – 9 knots. Once deployed the line is left to soak for up to eight hours before retrieval commences. A line hauler is used to retrieve gear (at a speed of approximately 1 knot) and can take six to ten hours to complete.

Long-line vessels are similar in size and power to wet-fish trawlers and may vary in length from 18 m to 50 m and remain at sea for four to seven days at a time.

Namibia has a designated area closed to most “offshore” fishing activities under 200 m water depth i.e. to protect potential spawning areas as well as areas of high juvenile abundance for most demersal species, including hake. Long-line vessels fish in similar areas targeted by the hake-directed trawling fleet, in a broad area extending from the 200 m to 650 m contour along the full length of the Namibian coastline. Some 18 vessels operate within the sector. Those based in Lüderitz mostly work South of 26°S towards the South Africa border while those based in Walvis Bay operate between 23°S and 26°S and North of 23°S. **Figure 26** shows the distribution of catch reported within the Namibian EEZ and in relation to ML 220. The closest fishing activity is situated at least 50 km from ML220 roughly at the 300 m depth contour and there is no overlap of grounds with the ML.

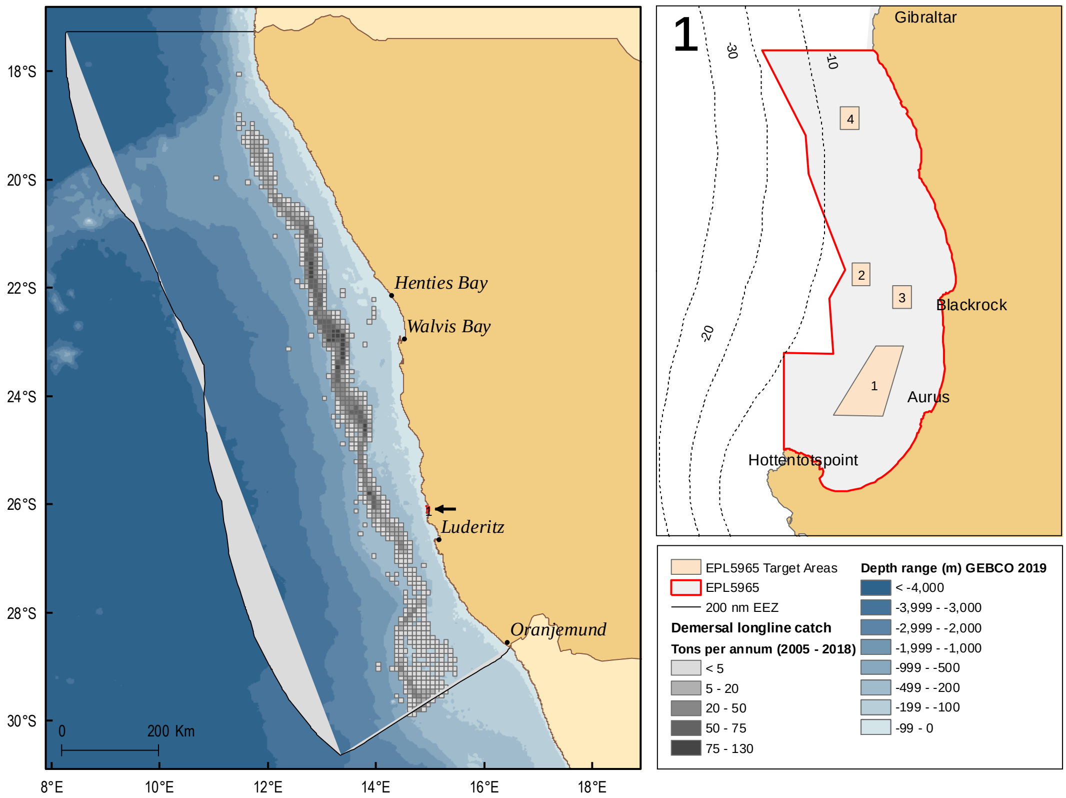


Figure 26: Spatial distribution of catch (2005 – 2018) reported by the demersal longline fishery targeting Cape hakes (M. capensis; M. paradoxus) within the Namibian EEZ and in relation to ML 220.

Large Pelagic Longline

This sector makes use of surface long-lines to target migratory pelagic species including yellowfin tuna (*T. albacares*), bigeye tuna (*T. obesus*), swordfish (*Xiphias gladius*) and various pelagic shark species. Commercial landings of these species by the fishery are variable and Namibian-reported catch from 1992 to 2018 is shown in **Figure 27** (ICCAT, 2020). There is provision for up to 26 fishing rights and 40 vessels (http://www.mfmr.gov.na/).

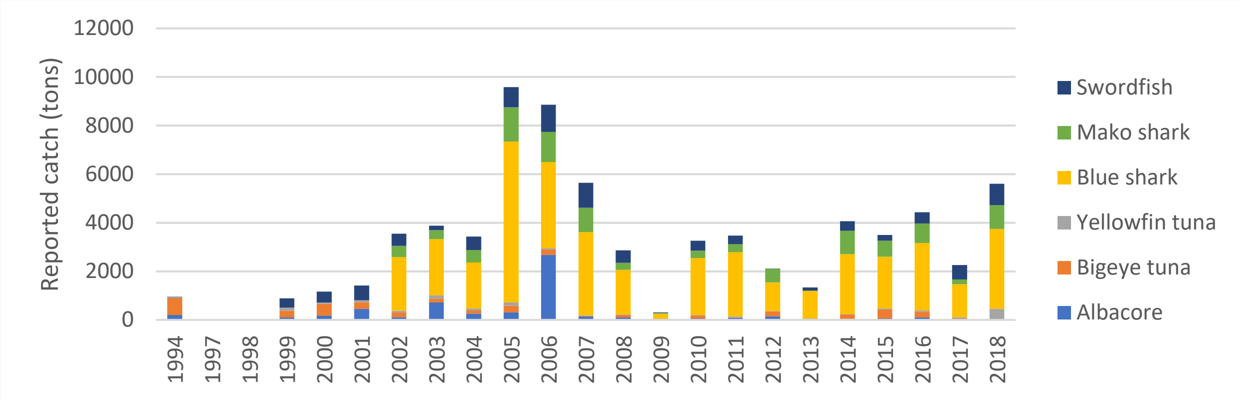


Figure 27: Total nominal longline catch (tons) of blue shark, shortfin mako shark, Atlantic swordfish, bigeye tuna and yellowfin tuna reported by Namibia between 1992 and 2018. Source: ICCAT statistical bulletin, 2020.

Yellowfin tuna are distributed between 10°S and 40°S in the south Atlantic, and spawn in the central Atlantic off Brazil in the austral summer (Penney *et al.* 1992). According to Crawford *et al.* (1987) juvenile and immature yellowfin tuna occur throughout the year in the Benguela system. After reaching sexual maturity they migrate (in summer) from feeding grounds off the West Coast of southern Africa to the spawning grounds in the central Atlantic. Bigeye tuna occurs in the Atlantic between 45°N and 45°S. Spawning takes place in the Gulf of Guinea and in the eastern central Atlantic north of 5°N and it is thought that bigeye tuna migrate to the Benguela system to feed. Swordfish spawn in warm tropical and subtropical waters and migrate to colder temperate waters during summer and autumn months. Tuna are targeted at thermocline fronts, predominantly along and offshore of the shelf break. Pelagic longline vessels set a drifting mainline, up to 50-100 km in length, and are marked at intervals along its length with radio buoys (Dahn) and floats to facilitate later retrieval (see **Figure 28**).

Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Between radio buoys the mainline is kept near the surface or at a certain depth by means of ridged hard-plastic buoys, (connected via a "buoy-lines" of approximately 20 m to 30 m). The buoys are spaced approximately 500 m apart along the length of the mainline. Hooks are attached to the mainline on branch lines, (droppers), which are clipped to the mainline at intervals of 20 m to 30 m between the ridged buoys. The main line can consist of twisted tarred rope (6 mm to 8 mm diameter), nylon monofilament (5 mm to 7.5 mm diameter) or braided monofilament (~6 mm in diameter).

A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. Refer to **Figure 28** for a schematic diagram of pelagic longline gear and **Figure 29** for photographs of an example of vessel, marker buoys and lines. Effort occurs year-round with a slight peak over the period March to May (see **Figure 30**).

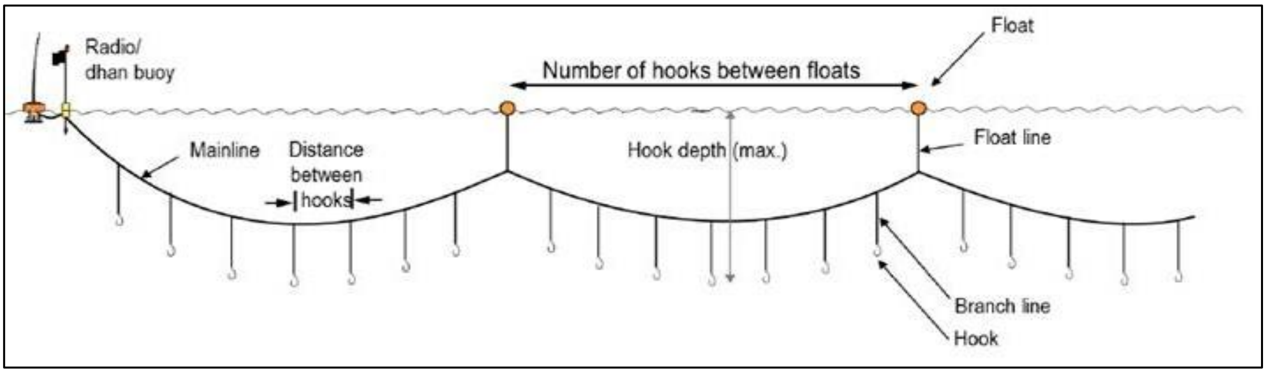


Figure 28: Schematic diagram of gear typically used by the pelagic long-line fishery (Source: IOTC ROSS Observer Training Manual, 2015).

Figure 29: Photographs showing marker buoys (left), radio buoys (centre) and monofilament branch lines (right) (Source: CapMarine, 2015).

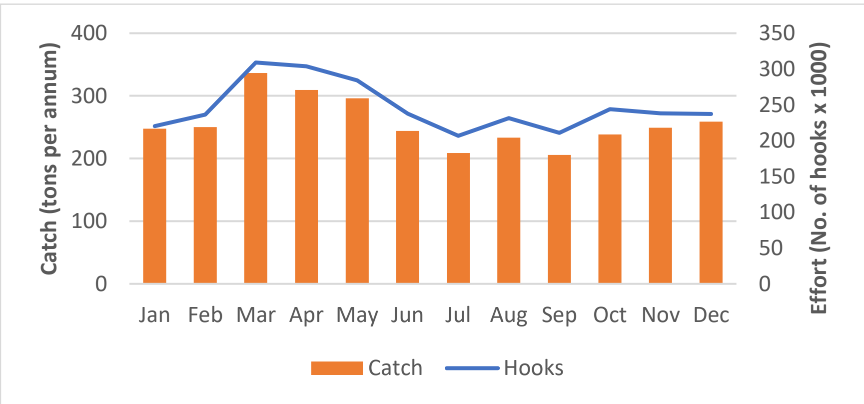


Figure 30: Monthly average catch and effort recorded within the large pelagic longline sector within Namibian waters (2003 – 2019).

Longline vessels targeting pelagic tuna species and swordfish operate extensively around the entire coast along the shelf-break and into deeper waters. The spatial distribution of fishing effort is widespread and may be expected predominantly along the shelf break (approximately along the 500 m isobath) and into deeper waters (2 000 m). Because the gear used by this fishery drifts along with surface currents, lines cover a large area during the time that they are deployed. The spatial mapping of the catch and effort used in this assessment is based on the position recorded at the start of line setting and does not take into account the large area covered by the mobile gear before it is retrieved.

Figure 31 shows the spatial distribution of commercial catches within the Namibian EEZ and in relation to ML 220. The closest fishing activity is situated at least 100 km from ML220 and there is no overlap.

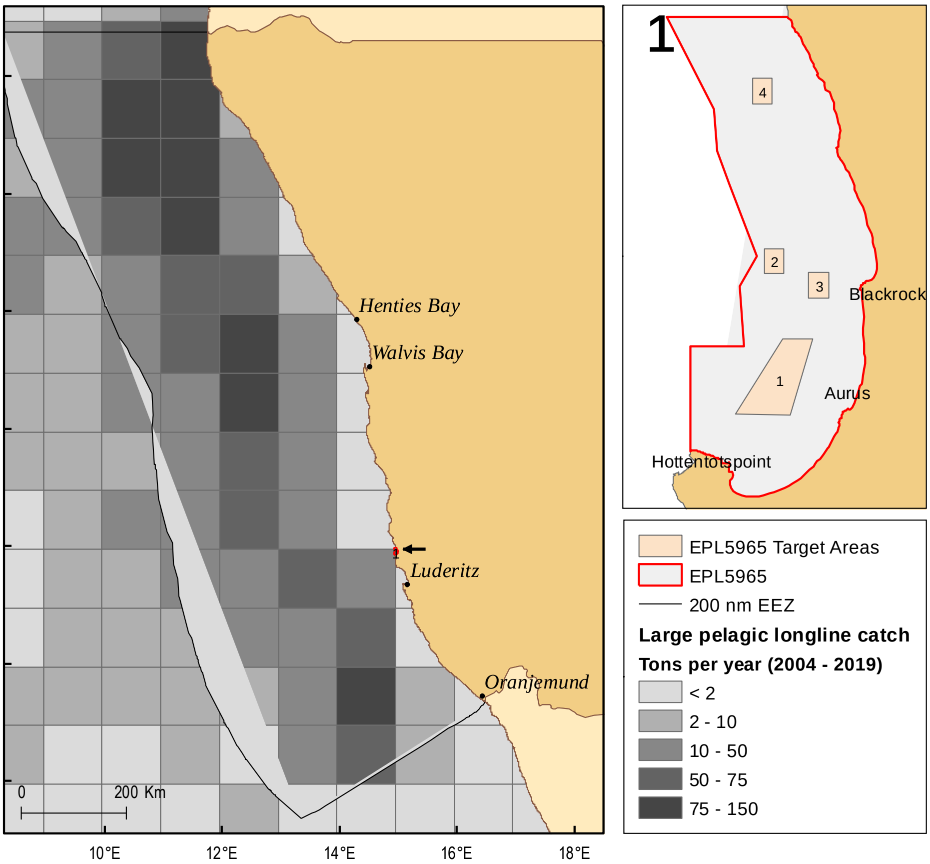


Figure 31: Spatial distribution of catch recorded by the pelagic longline fishery within the Namibian EEZ and in relation to ML 220. Catch is displayed on a 60 x 60 minute grid (average catch per year over the period 2003 to 2019).

Tuna Pole-and-Line

Poling for tuna is predominantly based on the southern Atlantic albacore (longfin tuna) stock (*T. alalunga*) and a very small amount of skipjack tuna (*Katsumonus pelamis*), yellowfin tuna and bigeye tuna. Namibia's quota for tuna and swordfish is allocated by the International Commission for Conservation of Atlantic Tunas (ICCAT), of which Namibia is a member. Catches of albacore tuna for Namibia and South Africa apply to what is referred to as the Atlantic "southern stock" (ICCAT Statistical Bulletin 2012).

Albacore are a temperate species of tuna, favouring subtropical ocean waters of 16° to 20°C (Penney et al 1998). Albacore found in the waters off the coast of southern Africa are proposed to originate from the south Atlantic stock (Penrith 1963, Yeh et al 1996, Penney et al 1998), with some degree of mixing of individuals between the Atlantic and Indian Oceans (Morita 1978, ICCAT Report 2011). Southern albacore migrate annually through their Atlantic distribution range between 10°S and 40°S. Nepgen (1971) noted that juvenile and sub-adult albacore are present in the Benguela region throughout the year. They migrate locally along the west coast feeding at upwelling and topographically induced fronts (Penney et al 1992).

The pole-and-line (also referred to as baitboat) and long-line fisheries target albacore that occur in four main areas of the Benguela region: the Vema Seamount off Namibia, Tripp Seamount south of Lüderitz, South Bank south of Hondeklip Bay and the Cape Canyon (Penney et al 1992). Adults of the population occur mostly off Brazil, Argentina and Namibia (Penney et al 1992).

Because of the irregular data availability and dependence on reporting of both South African and Namibian catches to the Regional Fishery Management Organisation (RFMO) (ICCAT) interpretation of catching performance is split between the South African and Namibian data. Overall baitboat catch rate trends exhibit large fluctuations, with a somewhat declining overall trend (ICCAT, 2012). Catch records start from 1960 and climbed steeply in the 1970's and peaked in the late 1990s. Thereafter, catches tapered off to between 6000 tons and 8000 tons per year but have steadily declined since 2009, to below 6000 tons in 2015. In 2016, the estimated Namibian and South African catches were below that of the previous five year (ICCAT, 2018) and in 2018, Namibian catches declined to approximately 874 tons (ICCAT, 2020).

Figure 32 shows the total catches of albacore and yellowfin tuna by the South African and Namibian tuna pole ("baitboat") sectors, combined, as well as the relative proportion of the Namibian component of the catch which approximates 20% of the total reported for the two target species.

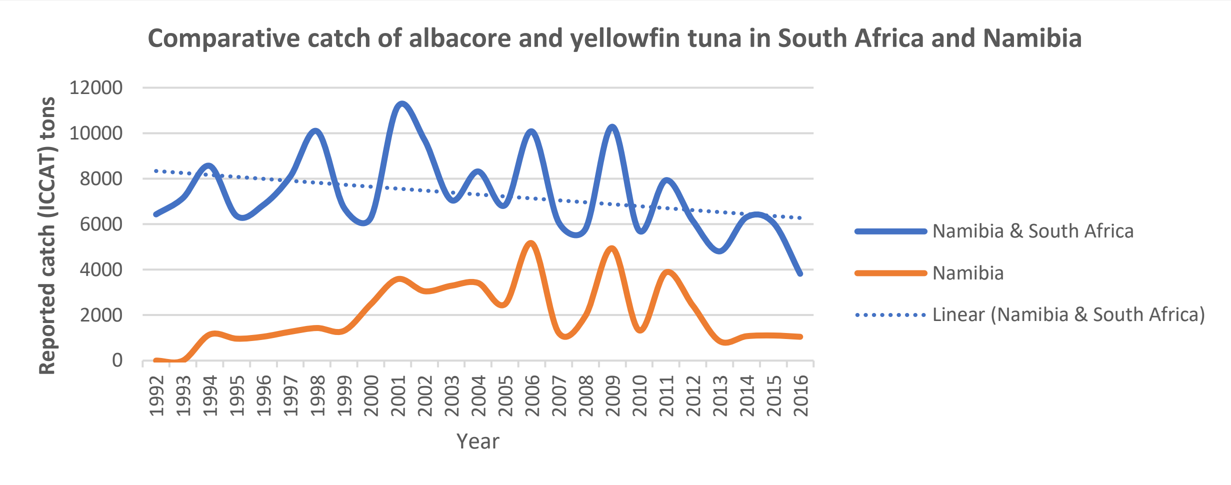


Figure 32: Total nominal baitboat and longline catch (tons) of longfin (albacore) and yellowfin tuna reported by South Africa and Namibia between 1992 and 2016. Source: ICCAT statistical bulletin, 2018.

Vessels operating within the fishery are typically small (< 25 m in length). Catch is stored on ice, chilled sea water or frozen and the storage method often determines the range of the vessel. Trip durations average between four and five days, depending on the distance of the fishing grounds from port. Vessels drift whilst attracting and catching pelagic tuna species. Whilst at sea, the majority of time is spent searching for fish with actual fishing events taking place over a relatively short period of time. Sonars and echo sounders are used to locate schools of tuna. At the start of fishing, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface, thereby attracting tuna to the surface. Live bait is flung out to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the 2 to 3 m poles are fitted with a short length of fishing line leading to a hook. Hooked fish are pulled from the water and many tons can be landed in a short period of time. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (see **Figure**

33). The nature of the fishery and communication between vessels often results in a large number of these vessels operating in close proximity to each other at a time. The vessels fish predominantly during daylight hours and as they do not anchor or have any fixed gear in the water, these vessels remain manoeuvrable.

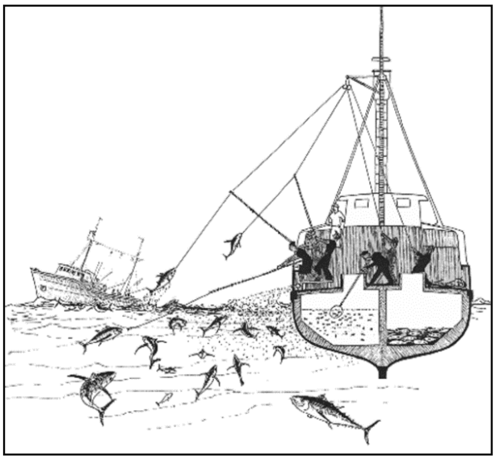


Figure 33: Schematic diagram of pole and line operation (www.fao.org/fishery).

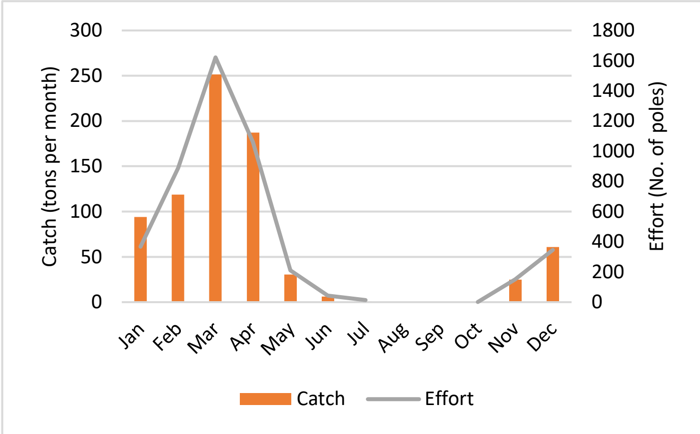


Figure 34: Average monthly catch and effort recorded by the tuna pole and line fleet in Namibian waters (2003 – 2019). Source: MFMR, 2020.

Approximately 36 South African pole and line vessels operate under arrangements with Namibian right holders each year, however, the number of active vessels and landed catch have recently shown a decline. As already discussed, the fishery is seasonal with vessel activity mostly between December and May and peak catches in March and April (see **Figure 34**). Effort fluctuates according to the availability of fish in the area, but once a shoal of tuna is located a number of vessels will move into the area and target a single shoal which may remain in the area for days at a time. As such the fishery is dependent on window periods of favourable conditions relating to catch availability.

Aggregations of albacore tuna occur in specific areas, in particular Tripp Seamount which is situated just north of the South Africa/ Namibia maritime border. Catches in this area are variable from year to year, although boats will frequent the area knowing that albacore aggregate around the seamount after migrating through South African waters. The movement of albacore between South Africa and Namibia is not clear although it is believed that the fish move northwards following bathymetric features and generally stay beyond the 200 m depth contour.

Figure 35 shows the spatial distribution of fishing effort within the Namibian EEZ and in relation to ML 220. There is evidence of albacore catch in the vicinity of the ML during 2005; however, the fishing locations lie offshore of ML220 and fishing activity in the area is considered improbable.

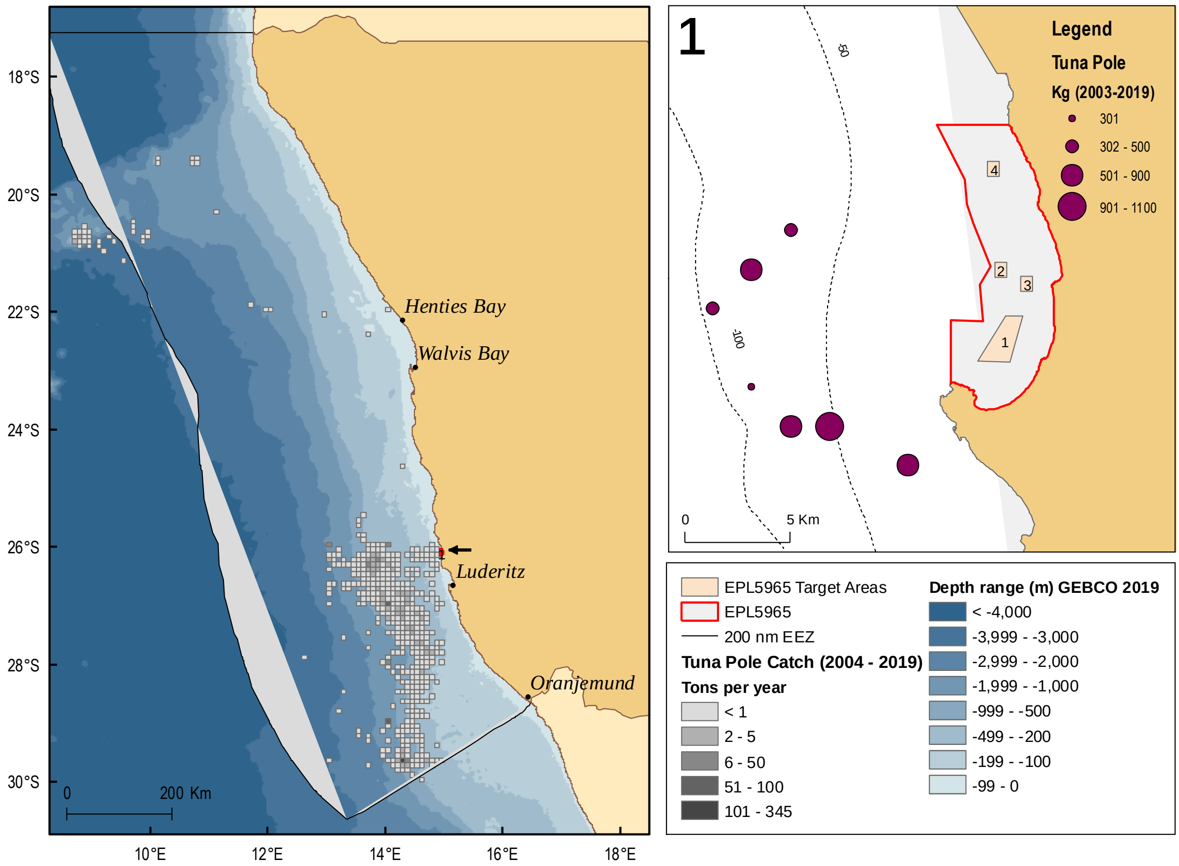


Figure 35: Spatial distribution of fishing effort expended by the tuna pole and line fleet (2003 – 2019) within the Namibian EEZ and in relation to ML 220.

Linefish

The traditional line fishery primarily targets snoek (*Thyrsites atun*) with bycatch of yellowtail, silver kob (*Argyrosomus inodorus*), dusky kob (*A. coronus*), and shark, which are sold on the local market. Snoek availability to the fishery is seasonal. Catches peak in late summer whereafter the fish migrate south into South African waters. The other species caught, such as kob and shark occurs year round, but is in relatively small amounts. Operationally the fishery is limited in extent to Walvis Bay, Swakopmund and Henties Bay and also due to the small size of the boats does not operate much further than 12 nm offshore (i.e. 22 km). There is also a small component of the fishery operating out of Lüderitz in the South. The two commercial components of the linefish sector comprise a fleet of up to 26 small deck boats. Commercial operators sell linefish on the local market as well as exporting regionally to South Africa and Zimbabwe.

Average monthly landings are shown in **Figure 36** with catches dropping in the mid-winter period with catches increase from spring into summer. This trend is associated with both the availability of snoek and also with weather and sea conditions which make it difficult for the fishery to operate during this time due to the small size of the boats used. The sector operates inshore of the 200 m depth contour and into coastal waters. The spatial distribution of linefish catch within the Namibian EEZ and in relation to ML 220 is shown in **Figure 37**.

Fishing activity is reported to the nearest minute (approximately equivalent to one nautical mile) and has been redisplayed at a gridded resolution of 5 nautical miles. Data provided on the fishery show that very small amounts of snoek are occasionally caught either within ML220 or in the proximity of the area. Snoek availability is highly seasonal and the catches, which average 1.97 tonnes a year or 0.06% of the total snoek landings in Namibian waters, is considered negligible. Fishing effort expended within the area amounted to an average of 24 hours, or 40 lines. This is equivalent to 0.06% of the overall snoek landings by the sector.

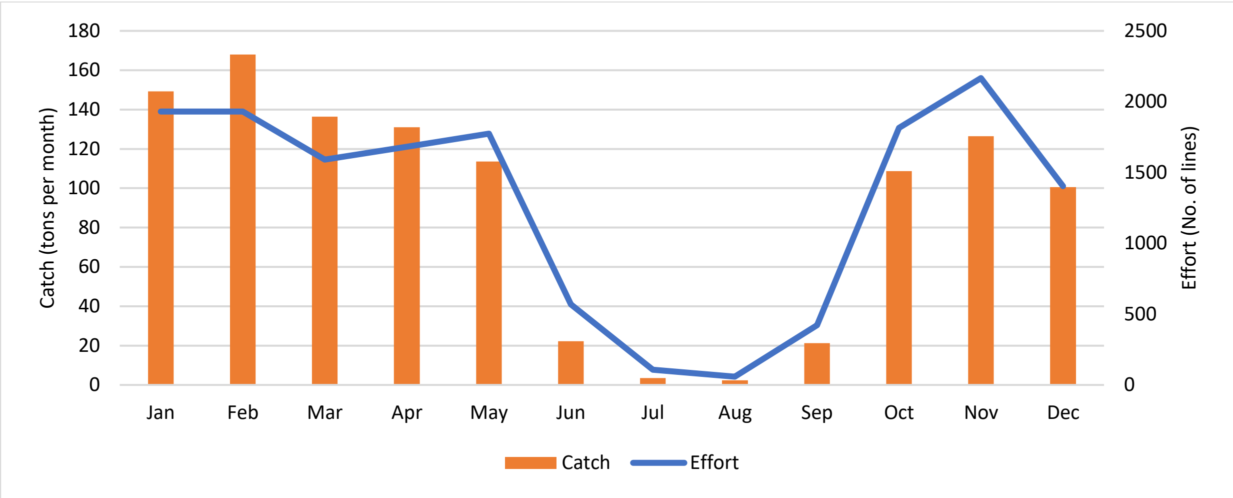


Figure 36: Average monthly catch and effort recorded by linefish vessels in Namibian waters (2000 – 2019). Source: MFMR, 2020.

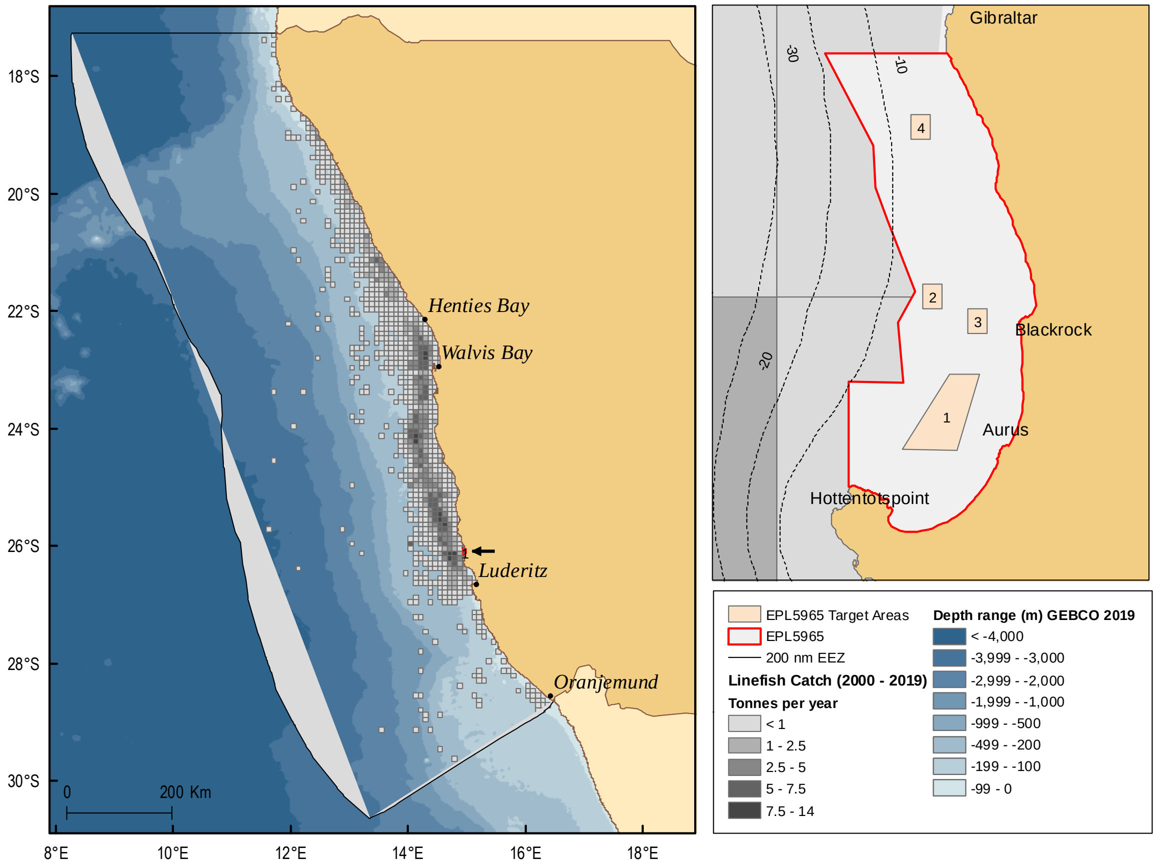


Figure 37: Spatial distribution of catch taken between 2000 and 2019 by ski-boats operating within the linefish sector within the Namibian EEZ and in relation to ML 220.

Deep-sea Crab

The Namibian deep-sea crab fishery is based on two species of crab namely spider crab (*Lithodes ferox*) and red crab (*Chaceon maritae*). The fishery commenced in 1973 with a peak in catches of 10 000 tons in 1983. Catches remained high during the 1980s between 5000 tons and 7000 tons. Following heavy exploitation by foreign fleets during this period, catch rates dropped significantly and have averaged at approximately 2000 tons in 1997 and have been steadily increasing since then. The TAC for 2020/21 has been set at 3900 tons (see **Figure 38**).

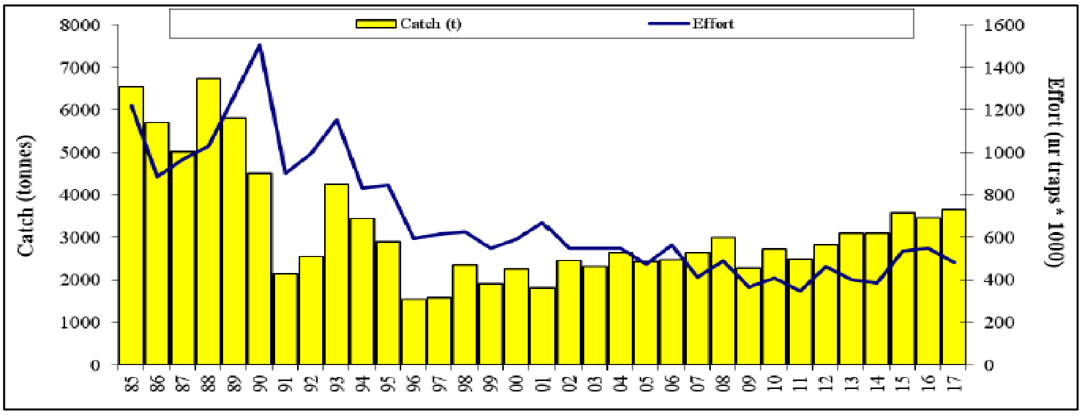


Figure 38: TACs set for red crab (C. maritae) from 1985 to 2017[14]

The distribution of red crab extends from ~5°S to just South of Walvis Bay and the commercial fishery operates in grounds extending northwards of 23°S and into Angolan waters (**Figure 40**). There is a minimum operational depth of 400 m set for the fishery, which sets traps at depths of up to 1200 m. The fishery is small, with only two vessels currently operating from the port of Walvis Bay. Vessels are active year-round but with relatively low fishing effort from November to February.

Method of capture involves the setting of a demersal longline with a string of approximately 400 Japanese-style traps (otherwise known as "pots") attached to each line (**Figure 39**). Traps are made of plastic and dimensions are approximately 1.5 m width at the base and 0.7 m in height. They are spaced 15 m apart and typically baited with horse mackerel or skipjack. The line is typically 6000 m in length and weighted at each end by a steel anchor. A surface buoy and radar reflector mark each end of the line via a connecting dropper line that allows retrieval of the gear. Up to 1200 traps may be set each day (or two to three lines) and are left to soak for between 24 and 120 hours before being retrieved.

Fishing grounds within the Namibian EEZ and in relation to ML 220 are shown in **Figure 40**. Grounds are situated at least 450 km from ML220 and there is no overlap.

[14] Benguela Current Commission (2018) : Report of the Regional Demersal Working Group meeting 10-14 Dec. 2018.

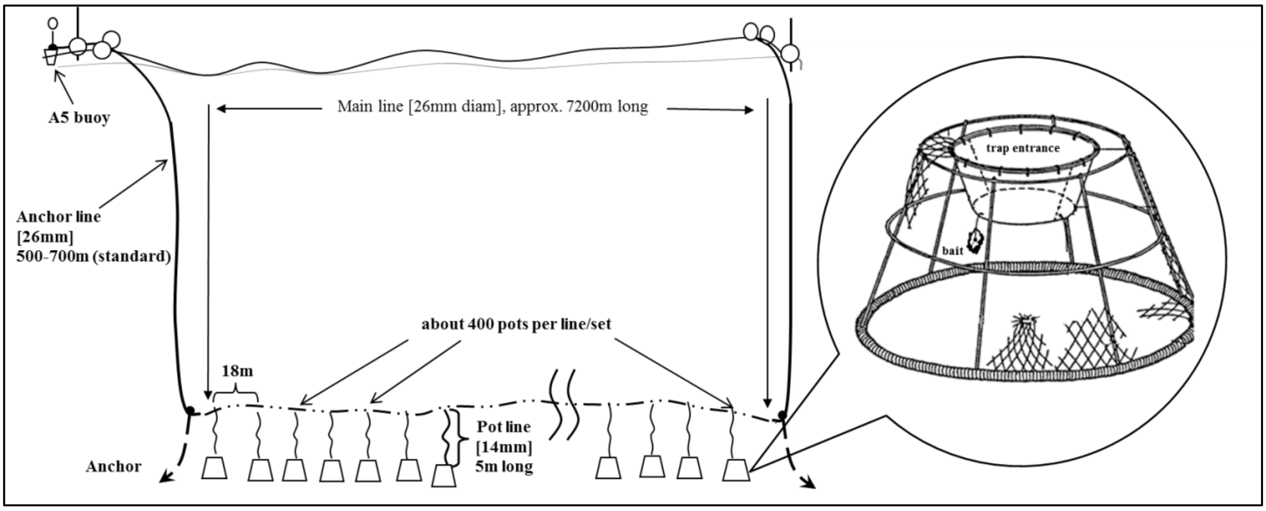


Figure 39: Schematic diagram of the gear configuration used by the deep-sea crab fishery (SEAFO, 2018).

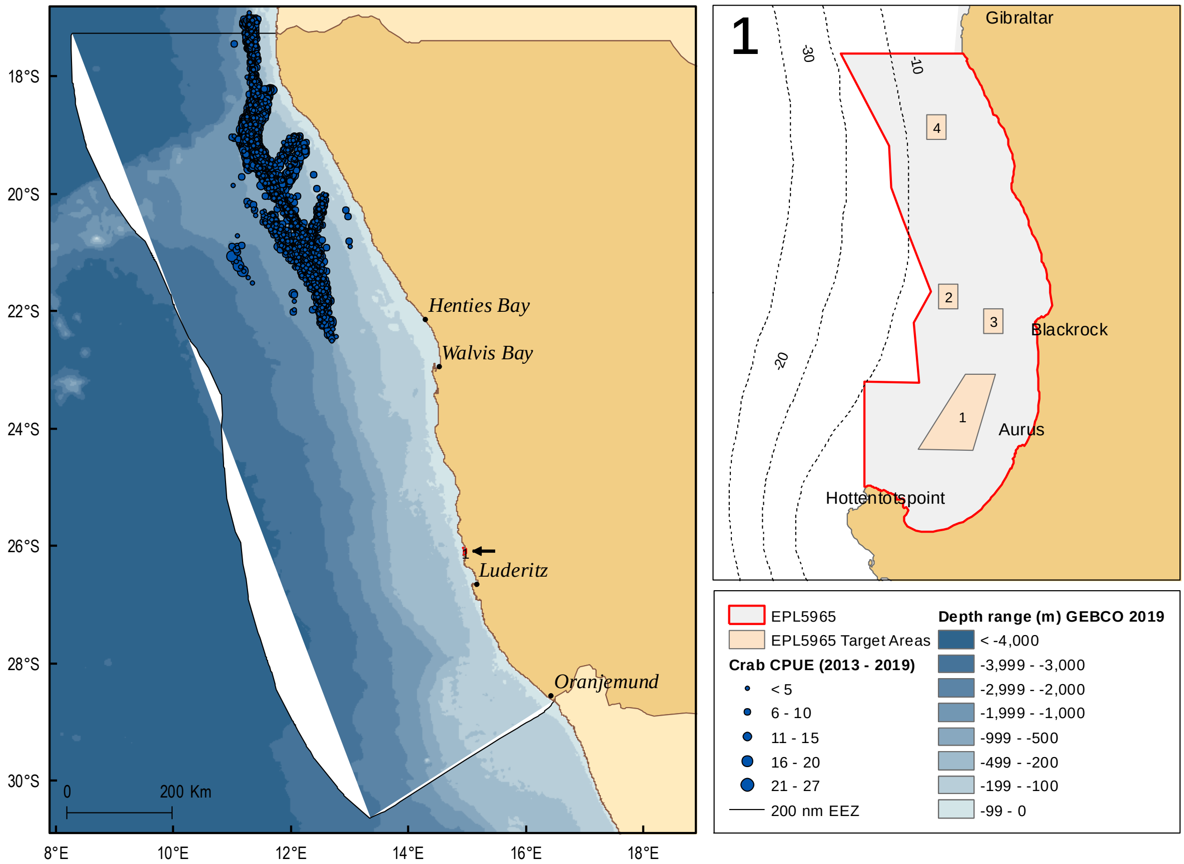


Figure 40: Spatial Distribution of catch taken by the Deep-Sea Crab Fishery (2013 – 2018) within the Namibian EEZ and in relation to the ML 220.

Deep-Water Trawl

The deep-water trawl fishery is a small but lucrative fishing sector directed at the outer Namibian shelf from 400 m to 1500 m water depth targeting orange roughy (*Hoplostethus atlanticus*) and alfonsino (*Beryx splendens*). Both species are extremely long-lived and aggregate densely, leading to high catch rates.

General aggregations of the stock occur between June and August. Fishable aggregations are usually found on hard grounds on features such as seamounts, drop-off features or canyons (Branch, 2001). Off Namibia orange roughy has a restricted spawning period of less than a month in late July, when spawning takes place in dense aggregations close to the bottom in small areas typically between 10 and 100 km^2 in extent (Boyer and Hampton 2001b).

The fishery uses a similar gear configuration to that used by the demersal hake-directed trawl fishery. Alfonsino is taken primarily as a bycatch in the orange roughy fishery, although after the collapse of the orange roughy stock, the deep-water trawl boats continued to fish for alfonsino (which is a species more widely distributed than orange roughy and also are not as closely associated with bottom substrate). However, with the demise of the orange roughy, the economic incentives to fish in deep-water was lost and as a result alfonsino catches also effectively stopped.

The fishery is split into four Quota Management Areas (QMA's) referred to as "Hotspot", "Rix", "Frankies" and "Johnies" and TACs are set for each specific QMA. Fishing grounds were discovered in 1995/1996 and total catches reached 15500 tons in 1997. At this point catch limits were set (see **Figure 41**) and effort was limited to five vessels. Following a steep decline in biomass levels, the TAC was decreased from 12 000 tons in 1998 to 1875 tons in 2000.

By 2007 the number of vessels had dropped to one and total catches declined to 270 tons. The fishery has ceased commercial operations due to stock collapse however, the stock is currently being assessed with a view to considering the viability of re-opening the fishery. Research surveys are undertaken in July each year by MFMR to assess the status of the resource.

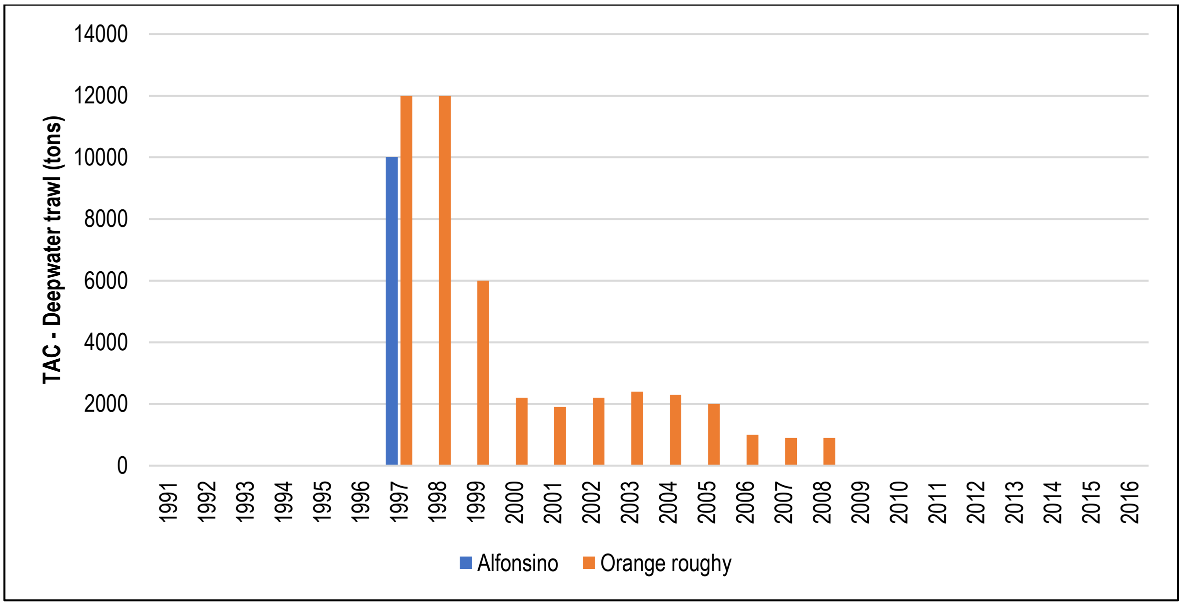


Figure 41: TACs issued for Orange Roughy (H. atlanticus) and Alfonsino (B. splendens), Targeted by the Namibian Deep-Water Trawl Fishery.

MFMR conducts annual acoustic and swept-area surveys on all indicated orange roughy grounds. These scientific surveys are aimed at determining the biomass of the stock which enables advice on possible re-opening of the fishery.

During these surveys, trawl gear is towed at a speed of approximately 3.5 knots along the depth contour. The default is to trawl in a northern direction, but if the stratum border is crossed during the towing by doing this, the towing course is selected to the south. The duration of each trawl is targeted for maximum 30 minutes on the seabed. Recent orange roughy biomass surveys have been undertaken using the MV *Pemba Bay* which is a commercial vessel operated by a Spanish company through the National Fishing Corporation (FISHCOR). The vessel is a 48 m factory stern trawler, with 907 GRT and 1496 HP. The trawl net is based on the standard New Zealand ‘Arrow’ rough bottom trawl, with cut-away lower wings. Sweep and bridle lengths of 100 m and 50 m, respectively. A ‘rock-hopper’ footrope was used with 21“rock-hoppers. The net had a 5-6 m headline height when towed at an average speed of about 3.5 knots. Wingspread is estimated at 15 m.

Table 13 shows the stock biomass estimates within all four management areas.

Table 13: Biomass estimates of orange roughy from acoustic and swept-area surveys conducted within all three QMAs (adapted from MFMR, 2019[15])

QMA	Biomass estimate (tons)							
	2004	2005	2006	2007	No data	2016	2017	2018
QMAs: All Total Biomass	9 874	9 710	7 395	11 370	ANS	26 221	17 713	26 928

ANS Area not surveyed *Behaviour of orange roughy did not permit acoustic assessment

The location of the QMAs within the Namibian EEZ and in relation to ML 220 are shown in **Figure 42**. The closest QMA, Johnies, is situated at least 97 km from the ML and there is no overlap.

[15] MFMR (2019): Survey of the Orange Roughy Stock: Cruise Report No 1/2018 (Survey No. 201801: 10 – 27 July 2018). Orange Roughy Research, Demersal Subdivision. National Marine Information and Research Centre (NatMIRC), Swakopmund.

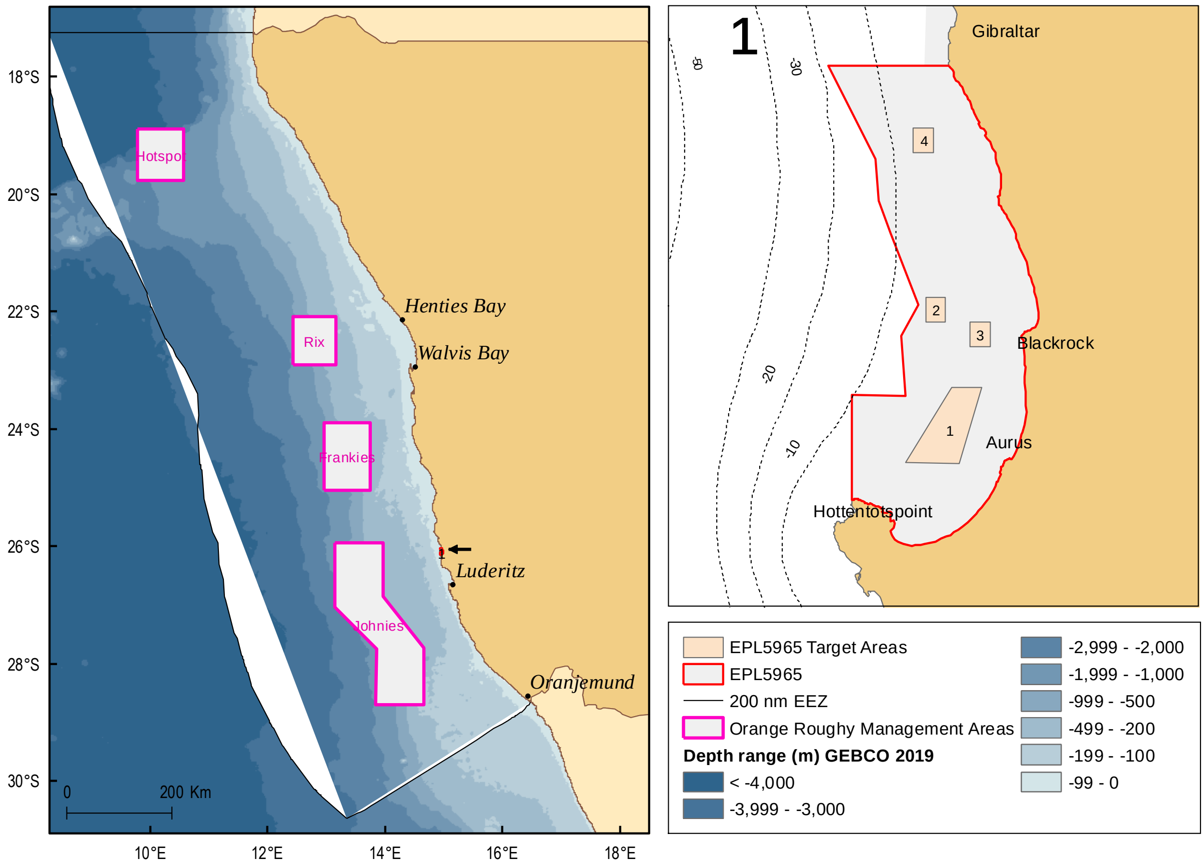


Figure 42: Management Areas Used by the Deep-Water Trawl Fishery (1994–2007) within the Namibian EEZ and in relation to ML 220.

Rock Lobster

The small but valuable fishery of rock lobster (*Jasus lalandii*) is based exclusively in the port of Lüderitz. Within Namibian waters, the lobster stock is commercially exploited between 28°30'S and 25°S from the Orange River border in the south to Easter Cliffs/Sylvia Hill north of Mercury Island. Catch is landed whole and is managed using a TAC. Historically, the fishery sustained relatively constant catches of up to 9000 tonnes per year until a decline in the late 1960s. **Figure 43** shows the commercial rock lobster catches from 1986 to 2019. The TAC for the 2020/21 was set at 180 tonnes, remaining unchanged from the previous season and a reduction from 200 tonnes TAC set during 2018/19. The TACs have not been filled in recent years with poor catch rates and generally adverse environmental and weather conditions impacting operations. The industry lands between 50% and 80% of the total TAC each season.

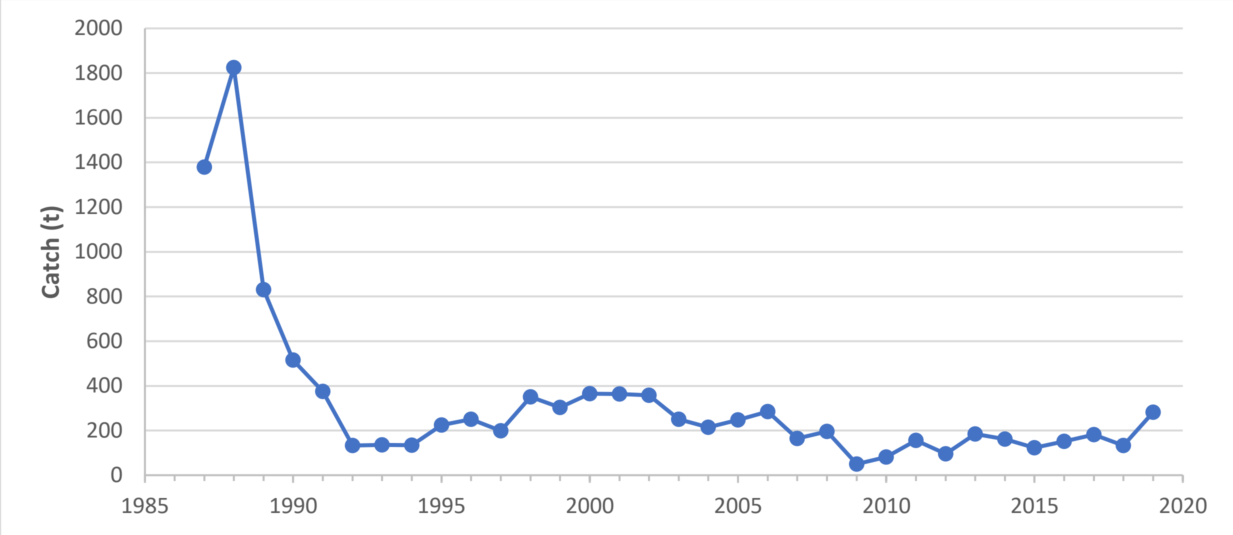


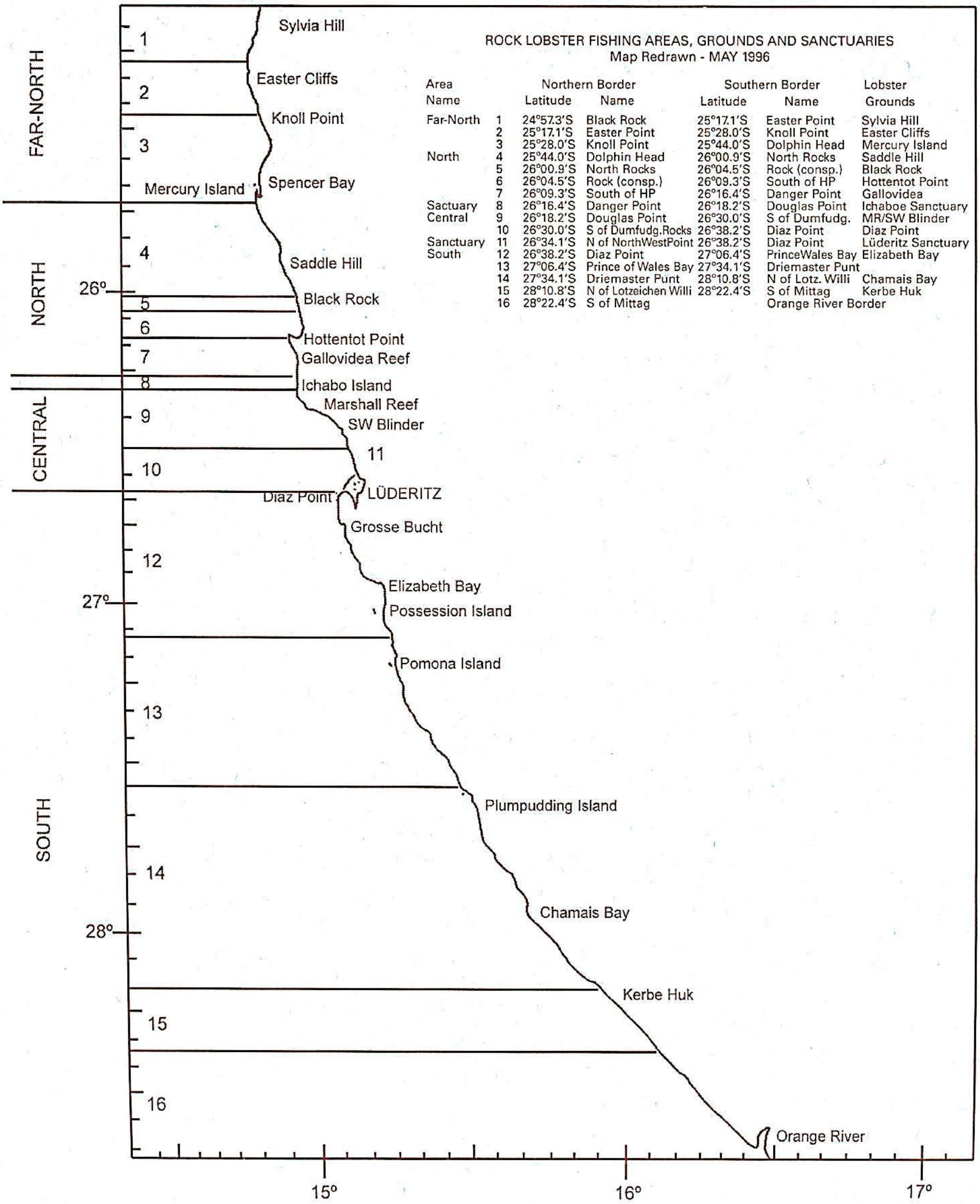
Figure 43: Management Catches of rock lobster in Namibia from 1986 to 2019 (Source: FAO catch statistics).

The Namibian Rock Lobster fishery is a seasonal fishery that conventionally occurs from the start of November to the end of April the following year. There is a closed period extending from 01 May to 31 October each year. The fishery is delineated by a commercial fishing zone starting just north of Sylvia Hill all the way to the Orange River Mouth along the southern coast of Namibia. The fishery is spatially managed through the demarcation of catch grounds by management area (refer to **Figure 44** for map of management areas). Fishing locations from this fishery are not referenced by GPS data, but by the easily recognized features along the coastline. Fishing operations occur at various depths but are mainly limited to the 2-40m depths, and rarely exceed 50m. Effort is reported by management zone an as the number of traps deployed per 24-hour period (termed a "trap day"). Catch reported in kilograms.

Figure 45 shows the Far North, North, Central and South fishing areas which are further separated into 16 management zones including two sanctuary areas. **Figure 44** shows the aggregated rock lobster catch by zone. ML 220 coincides with the Black Rock (Zone 5) and Hottentot Point (Zone 6) management zones situated within the North Fishing Area. Mining Area 1, Target Areas 2 and 3 are situated within Management Zone 6 (Hottentot Point) which yielded an average of 17.2 tonnes of lobster per year over the period 2005 to 2016. Target Area 4 is situated within Management Zone 5 (Black Rock) which yielded an average of 18.8 tonnes of lobster per year. Rock lobster catch within the ML amounts to 22.2% of the overall national rock lobster catch landed by the sector. Fishing in the Hottentot Point and Black Rock areas takes place from January to April.

Fishing is directed over reef areas or within a limited distance (several metres) from these hard grounds. Baited traps consisting of rectangular metal frames covered by netting, are deployed from small dinghy's and delivered to larger catcher reefers to take to shore for processing. The number of active vessels correlates to the allocated quota each season with between 16-29 vessels active. The fleet consists of vessels ranging in length from 7 m to 21 m, setting traps usually in the late morning and allowed to soak overnight before being retrieved the following morning.

Although the proposed mining and areas targeted for resource development are located within the depth range targeted for rock lobster, the planned mining area is situated in areas of unconsolidated sediment which are therefore unlikely to coincide with grounds targeted by the fishery. While the proposed areas inside the bay are unlikely to overlap with the fishery or operations, these areas may have impacts associated with lobster juvenile settlement and future recruitment.



Area Name		Northern Border Latitude	Northern Border Name	Southern Border Latitude	Southern Border Name	Lobster Grounds
Far-North	1	24°57.3'S	Black Rock	25°17.1'S	Easter Point	Sylvia Hill
	2	25°17.1'S	Easter Point	25°28.0'S	Knoll Point	Easter Cliffs
	3	25°28.0'S	Knoll Point	25°44.0'S	Dolphin Head	Mercury Island
North	4	25°44.0'S	Dolphin Head	26°00.9'S	North Rocks	Saddle Hill
	5	26°00.9'S	North Rocks	26°04.5'S	Rock (consp.)	Black Rock
	6	26°04.5'S	Rock (consp.)	26°09.3'S	South of HP	Hottentot Point
	7	26°09.3'S	South of HP	26°16.4'S	Danger Point	Gallovidea
Sactuary	8	26°16.4'S	Danger Point	26°18.2'S	Douglas Point	Ichaboe Sanctuary
Central	9	26°18.2'S	Douglas Point	26°30.0'S	S of Dumfudg.	MR/SW Blinder
	10	26°30.0'S	S of Dumfudg.Rocks	26°38.2'S	Diaz Point	Diaz Point
Sanctuary	11	26°34.1'S	N of NorthWestPoint	26°38.2'S	Diaz Point	Lüderitz Sanctuary
South	12	26°38.2'S	Diaz Point	27°06.4'S	PrinceWales Bay	Elizabeth Bay
	13	27°06.4'S	Prince of Wales Bay	27°34.1'S	Driemaster Punt	
	14	27°34.1'S	Driemaster Punt	28°10.8'S	N of Lotz. Willi	Chamais Bay
	15	28°10.8'S	N of Lotzeichen Willi	28°22.4'S	S of Mittag	Kerbe Huk
	16	28°22.4'S	S of Mittag		Orange River Border	

Figure 44: Fishing areas and management zones demarcated for the Namibian rock lobster fishery.

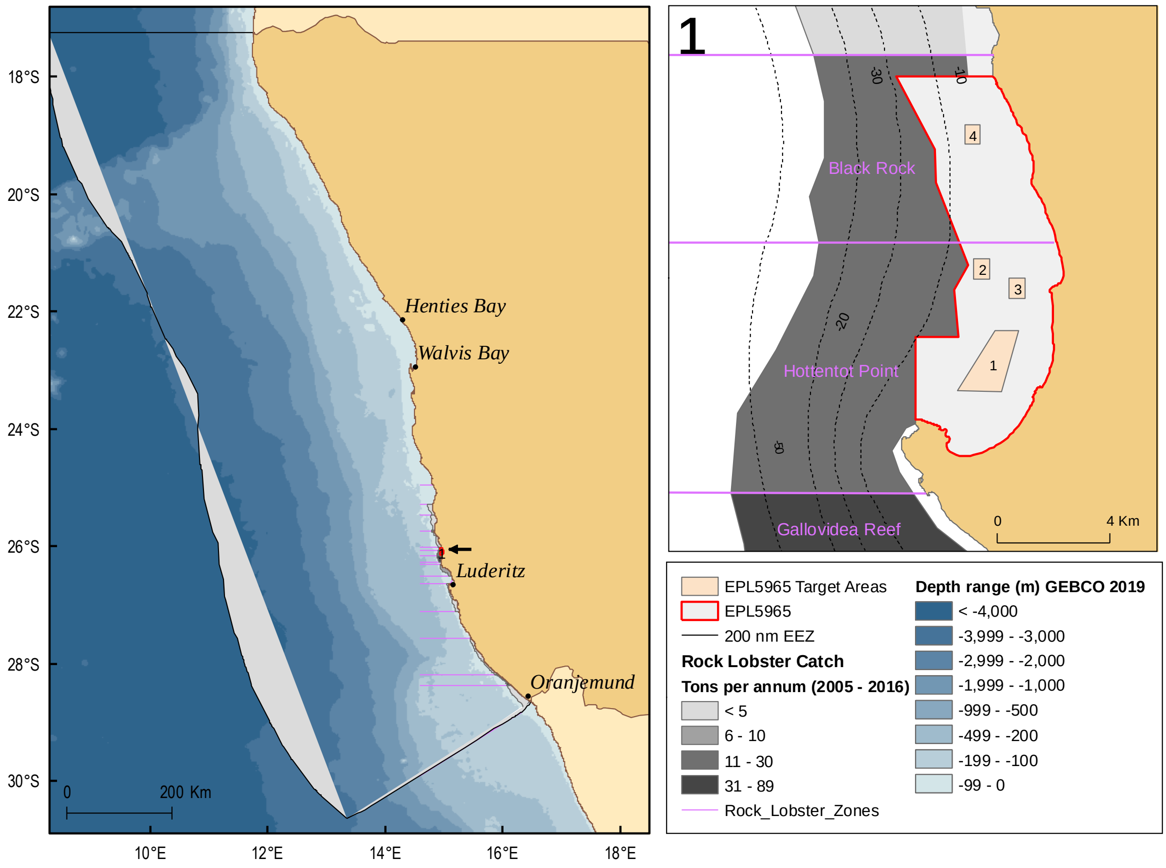


Figure 45: Spatial Distribution of Rock Lobster Catch (2005 – 2016) within the Namibian EEZ and in relation to ML 220.

5.5 Socio-economic Aspects

5.5.1 The //Kharas Region Overview

Demographics

The project hub will be located in Lüderitz, a major port in the //Kharas Region, which is the largest of Namibia's regions (161,086 km^2). It is Namibia's most arid region and has the lowest population density of 0.5 people per square kilometre. The region's population is estimated to be 89,000 (about 3.7% of the national population) of which just under one third (31%) is under the age of 15 years (NSA, 2019). In 2011, the three main languages spoken in the //Kharas Region were: Afrikaans (36%), Oshiwambo (27%), and Nama/Damara (23%) (NSA, 2013).

The population is considerably more urban 59% than rural at 41%, and urbanization is increasing in all regions (NSA, 2017). The region has an estimated 23 500 households, and the average household size has decreased to 3.6 in 2015/16 from 4.2 in 2011. Although the population is fairly balanced regarding gender, two thirds of households (66%) are headed by males (NSA, 2017). 48% of households own their house outright or with a mortgage while 23% are renting their accommodation (NSA, 2017).

Economic Drivers in //Kharas Region

The economy of the //Kharas Region is essentially driven by the mining industry (diamonds at Oranjemund and northwards along the coast, as well as zinc and lead at Rosh Pinah and Aukam Graphite southeast of Aus), commercial agriculture (livestock farming predominantly to the east, as well as irrigation farming at Naute Dam and along the Orange River), a large non-tradable sector (government services) and by tourism (MLR, 2011). The region has much to offer tourism such as the Tsau //Khaeb National Park (formally the Sperrgebiet), the Fish River Canyon and the Namib-Naukluft Park. These economic developments over decades explain why only about 13% of the population was born in the region at the last census in 2011 (NSA, 2013).

Rosh Pinah Zinc Corporation (RPZC) has a huge impact on the regional economy, providing nearly 630 direct permanent jobs, a further 47 temporary jobs (CoM, 2020) further positive impacts with the import of chemicals for ore processing and the export of zinc and lead through the expanded Port of Lüderitz. At the national level, the value-added processing at the mines and export-oriented production contributes significantly to the country's foreign currency earnings, as well as direct and indirect taxes paid by the mines and their employees.

Employment and Unemployment in //Kharas Region

Results from the 2018 Namibia Labour Force Survey indicate that the Labour Force Participation Rate (the number of persons in the labour force given as a percentage of the working age population in that population group) for the //Kharas Region is 74% (which is a slightly higher percentage than the national rate of 71%). Males have a significantly higher employment absorption rate of 55% compared to women (45%) (NSA, 2019). About 58% of all employed persons work in the private sector while the government and parastatals employ about 29%, and a small proportion work in other sectors (NSA, 2014).

The 2018 broad unemployment rate (i.e. people being without work, or who are available for work, irrespective of whether they are actively seeking work) for the //Kharas Region was 32% which is significantly higher than 24% recorded in 2012 (NSA, 2013). Women in //Kharas suffer a higher unemployment rate at 35% compared to men at 29% (NSA, 2019). Youth aged 15-34 years who are not in employment and not in education or training are in a worse situation affecting 46% of women and 35% of young men (NSA, 2019).

Income and Poverty Levels in //Kharas Region

Households' main source of income in the //Kharas Region in 2015/16 was: salaries and wages (79%), pensions (9%) and remittances/grants (5%), while less than 2% of households relied on either subsistence and commercial farming or business (NSA, 2017).

As detailed in **Table 14**, according to the 2015/16 Namibia Household Income and Expenditure Survey (NHIES), the //Kharas Region has an average annual household income of N$116, 875 and an average annual income per capita of N$32,760 (which is slightly below the national average of N$119,000 per household and above the national per capita level of N$28,400) (NSA, 2017). There were large differences between the urban and rural areas with the average consumption of urban households (N$125 449) being significantly higher than those of rural households at N$104,800 (NSA, 2017).

Table 14: Annual consumption by urban/rural areas and region.

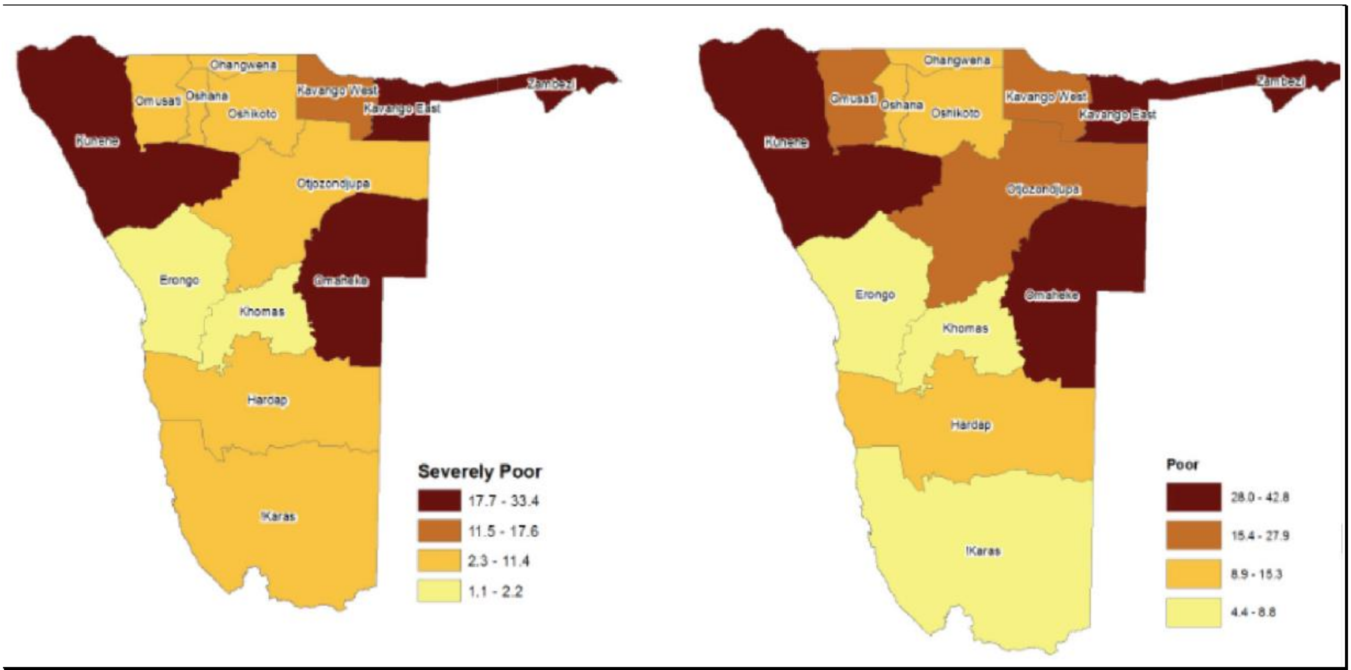
Region	Households	Population	Average Household size	Total Consumption		Average household consumption	Consumption per capita
	%	%		Million N$	%	N$	N$
National	100	`100	`4.2	64 849	100	119 065	28 434
//Kharas							
Urban	58.5	68.5	4.2	1 729	62.8	125 449	30 014
Rural	41.5	31.5	2.7	1 026	37.3	104 801	38 735
Total	100	100	3.6	2 754	100	116 875	32 760

Source: (NSA, 2017)

The number of poor and severely poor people[16] in all regions has been dropping significantly since independence in 1990. Nationally, the NHIES 2015/16 survey found that overall poverty levels have reduced significantly from 37.7% in 2003/4 to 17.4% in 2015/16. However, the inequality in income distribution (Gini Co-efficient) remains high at 0.56, which shows Namibia is one of the most unequal societies in the world[17]. People in //Kharas Region experience lower levels of poverty or severe poverty compared to many other regions in Namibia (**Figure 46**).

[16] Severely poor is defined as spending N$389.3 per adult per month on basic necessities (N$4,672 per annum), whilst an adult classified as poor spends N$520.80 per month (N$6,250 per annum) on basic necessities (NSA, 2017).

[17] The Gini coefficient can take any values between 0 to 1 (or 0% to 100%). A coefficient of zero indicates a perfectly equal distribution of income or wealth within a population. The data shows that the coefficient generally ranges from 0.24 to 0.63.



Source: (NSA, 2017)

Figure 46: Regional comparison of the distribution of poverty in 2015/16.

Health and Education in //Kharas

//Kharas residents are generally healthy with over 86% of the population reporting they have no chronic illnesses. The most common disease was high blood pressure suffered by about 8% of the population, while other chronic illnesses worth mentioning were diabetes and respiratory or asthma related conditions (NSA, 2017).

Literacy rates among all men and women over the age of 15 years are similar at 95% while this increases to over 98% among the age group 15 – 24 years (NSA, 2017).

Over the last five years, the government has increased the number of schools, classrooms and qualified teachers in response to the growing number of learners. There were 22,600 learners from Grade 0 to Grade 12 in schools in the region at the beginning of 2019, of which 25% were in secondary school (Grade 8-12). However, there is a disturbing trend that teachers with teaching qualifications have dropped from 93% in 2012 to 85% in 2019 (MoEAC, 2020).

5.5.2 Lüderitz

Lüderitz is the only major settlement near to the project area and is located about 60km to the south. The population of the Lüderitz Constituency has been stagnating around 14,000 since 2001. By 2011, the numbers of males and females had nearly equalized and approximately 66% of the population were in the economically active age group of 15 – 59 years of age.

Economic Drivers

The main economic driver of Lüderitz is the local commercial and subsistence fishing industry, which provides more than 80% of the employment[18].

[18] https://www.luderitz-tc.com/?page_id=276 sourced on 15 May 2021.

The commercial fisheries target mostly the deep-sea species (hake, orange roughly, monkfish and some tuna), and species associated with the coastline, notably rock lobster (crayfish), seals and guano. Small boats that characterise subsistence fisheries elsewhere in southern Africa are not used in Lüderitz because of the hazardous, high energy coastline (NACOMA, 2009). There are two fish processing plants in Lüderitz (one is currently closed) which preserve and package fish products mainly for export to Europe. This, and the servicing of fishing fleets are the main economic activities in the town. For most of the last two decades there have been diminishing stocks of important species such as hake and rock lobster, and thus the fisheries sector is in steady decline.

Mariculture, the growing and harvesting of marine products such as kelp seaweed, abalone and oysters show economic potential. While their development is promoted, their vulnerability to occasional natural marine events such as red tides and low oxygen water are risks. Big pollution events have not occurred in Namibian waters; an oil-spill or equivalent accidental spill could be disastrous for this sector (SLR, 2016).

The Town Council, and other stakeholders, are actively seeking new investments to reduce the dependency on fishing as variable fish stocks and quota allocations have caused unpredicted job losses.

The Port of Lüderitz, operated by Namport, caters for the fishing industry, offshore diamond and mining industries, and handling general cargo for Southern Namibia and the Northern Cape. The RPZC mine uses the port to export zinc and lead and import bulk sulphur and other chemicals. The port has a new 500m quay, two recently acquired 60-tonne haulers and one 45-tonne reach stacker, so it can provide efficient and safe cargo handling facilities for importers and exporters[19].

In 2018/19, Namport handled over 362,000 tonnes of cargo, 5,355 containers and received over 700 vessel visits during that year[20] (**Table 15**).

Table 15 Cargo Handled at the Port of Lüderitz 2018/19.

Cargo	Freight Tonnes	% of total freight
Cargo Landed:		
Sulphur	75 097	48%
Fuel	49 473	32%
Fish	30 010	19%
Other	1 072	1%
Total Landed	155 652	**100%**
Cargo Shipped		
Zinc/zinc concentrates	157 309	76%
Ice	34 446	17%
Lead & Lead concentrate	12 372	6%
Other	2 597	1%
Fish	119	0%
Total Shipped	**206 843**	**100%**

[19] https://www.namport.com.na/ports/welcome-to-the-port-of-luderitz/523/

[20] https://www.namport.com.na/files/files/Stats%20ended%20March%202019.pdf

Cargo	Freight Tonnes	% of total freight
Total Breakbulk handed	**362 495**	

Source: https://www.namport.com.na/files/files/Stats%20ended%20March%202019.pdf

The first consignment of 30,000 tonnes of manganese from the Northern Cape through the Port of Lüderitz was shipped in Q2 of 2019/20 and this brings a welcome economic boost to the port (Namport, 2020).

Lüderitz is the only port in the world that has no rail connection with the interior. The port is also hampered by being only 8.75 metres deep for 300m from the northern end of the quay, which is relatively shallow. This water depth cannot be used to accommodate average sized, economic bulk carriers that are used to transport bulk ore and other cargoes.

During the tuna season, fishing boats sometimes wait outside for a berth to become available, and 4 or 5 vessels might have to moor next to each other as space is limited. However, Namport has guaranteed the fishing industry that berths will be provided to any fishing boats wanting to discharge / load fish or load ice (fishing apparatus) for their operations for emergencies or repairs. Namport is investigating plans to develop a deep-water port at Angra Point, north of Lüderitz, which could increase volumes substantially. This new port would consist predominantly of facilities for bulk handling (dry and liquid bulk), as well as storage. It would increase fuel storage capacity in Lüderitz, which could in turn ease the high cost of doing business in the southern parts of Namibia, enabling Lüderitz to become a fuel pricing centre.

Prior to the global COVID-19, tourism had been increasing, as Lüderitz offers various attractions such as the Kolmanskop deserted diamond town, quaint old German architecture, the Waterfront development, a port for smaller passenger liners, the annual Crayfish Festival and other events. The Tsau //Khaeb National Park (formally known as the Sperrgebiet National Park) is a protected area of high biodiversity. There are strict restrictions regarding entering the Park, but these are in the process of being reduced and monitored, making this area an important potential resource to the Lüderitz tourism market. Tourism concessions from the MEFT include a day tour concession to Pomona Ghost Town and Bogenfels Rock arch from Lüderitz[21] and guided 4x4 off-road driving adventures from Lüderitz to Walvis Bay. The majority of visitors to the town are international tourists, of which Germans make up about 80%. Tourism will always be a challenge as Lüderitz is far from Namibia's other main southern attractions of the Fish River Canyon and Sossusvlei.

Education and skills-training in Lüderitz

Lüderitz provides a range of government schools, offering pre-primary to senior secondary school education, and has a Christian private school.

The Benguela Community Skills Development Centre (COSDEC) offers basic technical skills courses to approximately 135 trainees. Courses offered include Hospitality and Tourism (Level 3), Business Services (Office Administration and Computing) (Level 1-2), Plumbing and Pipefitting (Level 1-2), and Welding and Fabrication (Level 1-2). It also offers short courses in Information & Communication Technology, Leather work, Entrepreneurship and Building and Maintenance. It provides SME business training courses and counselling to small business owners and entrepreneurs in the town.

[21] https://www.met.gov.na/national-parks/tsau-khaeb-sperrgebiet-national-park/229/ accessed on 19/5/2021.

Health in Lüderitz

There is a state district hospital in Lüderitz, as well as a clinic, but they suffer from staff shortages. In 2015, the hospital had only 30% of its staff compliment, with 2 doctors out of an assessed need for 12 (MoHSS, 2016). The town also has a private doctors' surgery with medical facilities, and PathCare operates testing facilities.

The latest available government statistics on HIV prevalence is for 2016, when Lüderitz reported an impressive decline in the number of cases in pregnant women between the ages of 25 to 49 years, declining from 31% to 19% placing it below the national average for the first time **Table 16**.

Table 16: Change in HIV prevalence among pregnant women in Lüderitz.

	15-24 year age group				25-49 year age group			
	2010	2012	2014	**2016**	2010	2012	2014	**2016**
Lüderitz	4.0	14.1	6.1	**8.5**	27.3	27.4	31.3	**19.3**
National	10.3	8.9	8.3	**8.5**	26.4	26.3	24.1	**24.0**

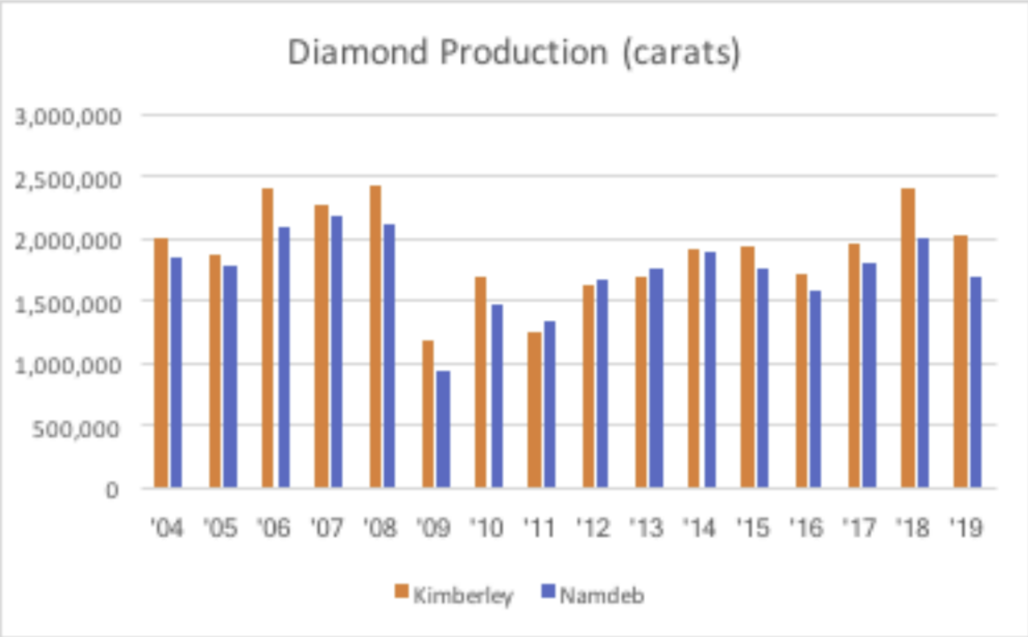
Source: (MoHSS, 2016)

5.5.3 Diamond Mining in Namibia

Namibia is renowned for producing high quality, high value diamonds for use in the jewellery industry. 95% of Namibia's diamond production is of gem quality, compared to a gemstone grade of 25-35% in an average kimberlite pipe (Schneider, 2020).

As a member of the Kimberley Process[22] (www.kimberleyprocess.com) Namibia has reported the volume and value of its production, export and import of rough diamonds since 2004 (IPPR, 2020). **Figure 47** shows that Namdeb Holdings has been the dominant producer of rough diamonds since 2004, but the totals reported to the Kimberley Process include diamonds produced by other companies, such as Samicor (and its predecessors) and Diamond Fields Namibia (IPPR, 2020).

[22] The Kimberley Process (KP) is a commitment to remove conflict diamonds (rough diamonds used to finance wars against governments) from the global supply chain.



Source: (IPPR, 2020)

Figure 47: Trends in Diamond production reported through Namdeb and the Kimberley Process.

Diamond mining provides a major contribution to Namibia's economy, providing N$7 billion in value addition and contributed to 3.9% of Gross Domestic Product (GDP) in 2019. Government gained N$1.255 billion in royalties and N$1.495 billion in tax revenue, amounting to 5% of all revenue collected (CoM, 2020). Namdeb Holdings pays corporate income tax at 55% plus a 10% tax on the export of rough diamonds plus an export levy of up to 2% on pure unsorted rough diamonds (IPPR, 2020).

The Namibia Diamond Trading Company (NDTC) was created in 2007 and is a 50:50 partnership between the Government of Namibia and De Beers. The NDTC is mandated to carry out the sorting, valuation and sales of all rough diamonds mined by Namdeb Holdings. The NDTC exclusively sells Namdeb's entire production of rough diamonds:

1. to Namdia, a 100% Namibian State-owned enterprise (since 2016), sells to international clients outside the De Beers network and it owns NamGem, a diamond cutting and polishing company
2. to local cutting and polishing factories (of between 1.0 and 14.8 carats) that have been selected as NDTC sightholders, who are contracted to cut and polish these domestically sourced diamonds along with rough diamonds they import from other sources; and
3. to De Beers Global Sightholder Sales in Botswana (IPPR, 2020).

Value addition from diamond cutting and polishing has grown impressively since 2013 and the value of processed stone exports has risen from 16% in 2007 to 61% in 2019. Together, diamond mining, cutting and polishing contributed 5.2% of Namibia's total GDP (IPPR, 2020).

Offshore diamond mining is dominated by large scale operators at depths from 30m – 120m, using highly sophisticated remote mining technology. Near-shore mining, in waters up to 12m deep, use divers working from small, converted fishing boats, during daylight hours and working 3 – 10 days per month, weather and swell permitting (Marvin Consultants, 2020). LK Mining is intending to operate a purpose-built vessel for mining at a depth range of 10m – 30m.

Large scale operators are dominated by a few major companies. Namdeb Holdings (Pty) Ltd is 50% owned by the government and 50% by De Beers. It is the holding company for the Namdeb Diamond Corporation (Namdeb) which is the exploration and mining operator for its onshore diamond mining licence areas and for De Beers Marine Namibia (Pty) Ltd (Debmarine) which operates the offshore licences. In 2019, DebMarine mined 1,292,000 carats of diamonds, employing nearly 1000 permanent staff at the end of 2019 (CoM, 2020). Its local procurement bill was over N$1.4 billion, out of a total of N$4 billion. It provided bursaries to six Namibians in the marine diamond mining fields of Mechanical Engineering, Electrical Engineering, Navigational Studies, Mechatronics and Medicine (Medicine being awarded under the Diamond Award) (CoM, 2020). Debmarine is constructing a diamond recovery vessel with an investment of USD 468million, increasing its fleet to seven and providing the capacity to add 500,000 carats of diamonds per annum, increasing production by 35% from the current levels[23].

By comparison, Namdeb's diamond land-based operations have reduced due to diminishing resources and an unsustainable cost profile of running these mines. In 2019, Namdeb mined 407,986 carats of diamonds and employed 1,339 permanent and 37 temporary employees. Its total procurement spend was N$2,1 billion of which N$1.68 billion was locally procured (CoM, 2020). It sold its Elizabeth Bay mine to Lewcor - Sperrgebiet Diamond Mining (Pty) Ltd in 2019.

An EIA Amendment process is being conducted for the 'Amendment to Namdeb's Environmental Management Programme Report for ML 43'. Namdeb has developed a potential new Long Term Business Plan to extend this LOM to allow for a sustainable and economic future (Namisun, 2019)

Namdeb Holdings realized an annual turnover of N$12 billion in 2019 (combining Namdeb and DebMarine), from which it paid wages of N$1.998 billion. It is the single largest contributor to the government, paying N$1.2 billion in royalties and N$1.33 billion in corporate tax in 2019. However, due to the planned maintenance operation of the mining vessel Mafuta and the drop in commodity prices, the mining sector's contribution to government accounts decreased by 11.1% from 2018 to 2019 (CoM, 2020).

Sakawe Diamond Mining, through its company Samicor, mined 113,520 carats in 2019 from mining licence areas: ML36A-J, ML103A, ML163, ML164 and ML51. (These mining licence areas were previously held by Namco and before that by Ocean Diamond Mining[24]). Samicor employs a contractor to conduct its exploration and mining so operational financials were not provided to the Chamber of Mines Namibia (CoM). Samicor paid N$8.8 million in royalties and N$1.3 million in export levies; it paid no corporate tax in 2019 (CoM, 2020).

Namibia Diamond Company, and its sister company Diamond Fields Namibia, mines and explores for offshore diamonds in ML 32, ML 111, ML138 and ML139 which covers over 312,000Ha in waters from 30m - 100m deep. Through its international technical partner, International Mining and Dredging Holdings Ltd (IMDH), they own the mining vessel mv Ya Toivo, as well as sampling and exploration vessels: The Explorer and DP Stars. The Ya Toivo

[23] Vella, Heidi. 2020 in Marine Mining: Lessons from Namibia, in Mining Technology, accessed on https://www.mining-technology.com/features/marine-mining-lessons-from-namibia

[24] (Schneider, 2020) gives an interesting insight into the history and productivity of marine diamond mining.

uses a 245-ton subsea crawler, operated and controlled via fibre optics, sensors and plc system, with a net width of 22m, to pump sediment at an average rate of ~2,500m^3/hour in sediments of 2m thickness. The Ya Toivo can be operated with a crew of 40 people (RBS, 2019).

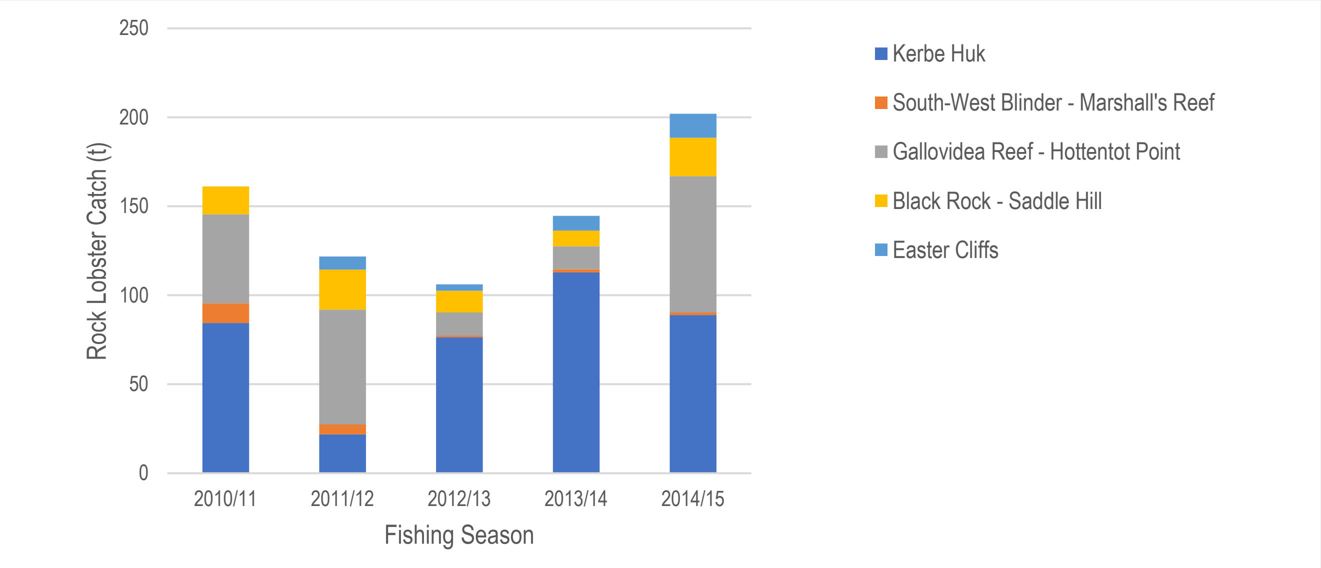
There is a convincing case that marine diamond mining can play a major contribution to Namibia's economic and social progress, to the African Blue Economy Strategy and it can positively contribute to all 17 of the UN Sustainable Development Goals (Schneider, 2020).

5.5.4 The Rock Lobster Industry in Lüderitz

The Rock Lobster Association of Namibia is based in Lüderitz and is concerned that the proposed project will affect their seasonal but valuable business which contributes to the local economy in a variety of ways and to government revenue.

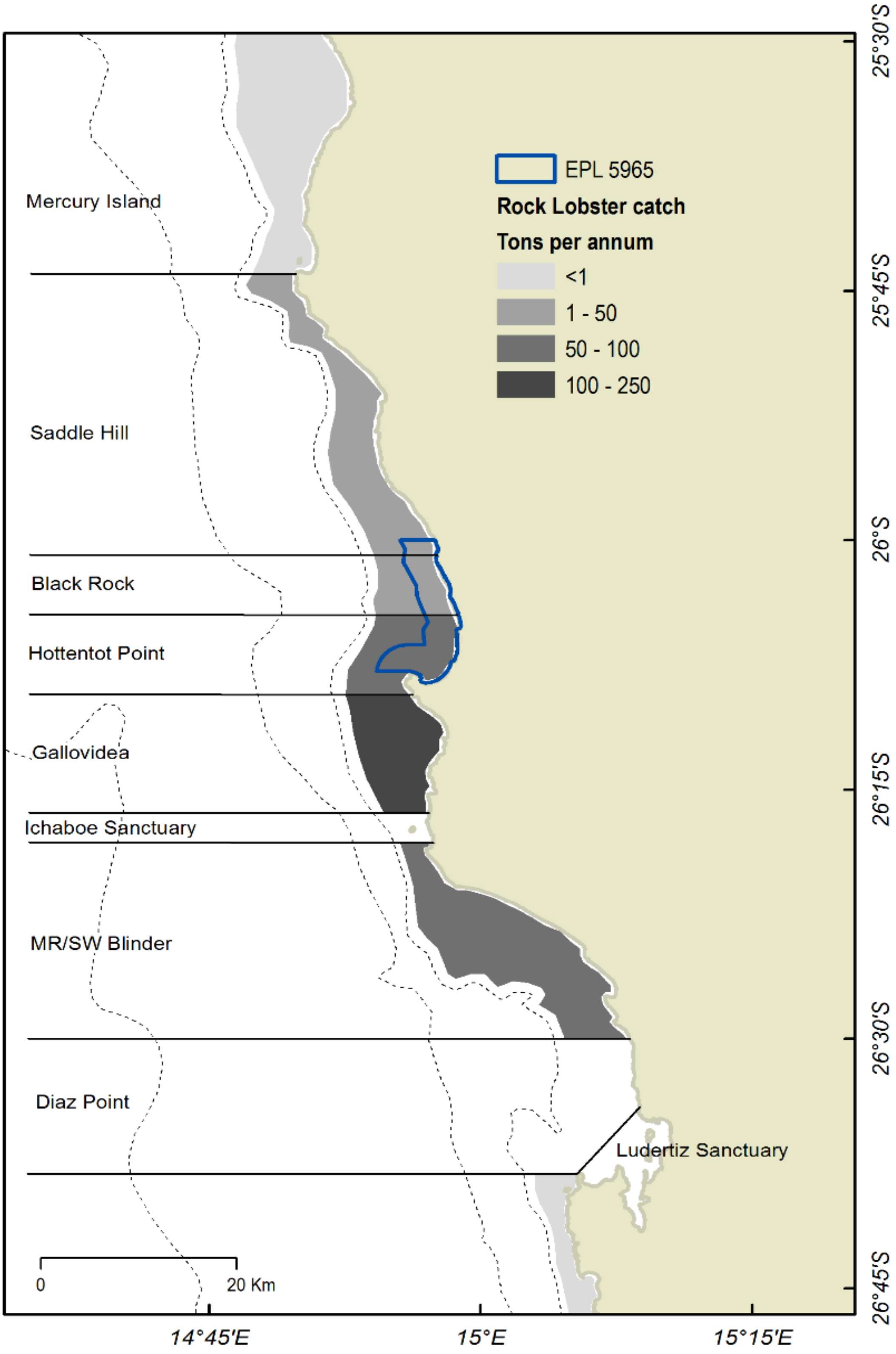
The Association was most concerned about their fishing not being disturbed at Black Rock, although the data below suggests that other areas are more productive (**Figure 48** and **Figure 49**).

The sector operates in water depths of between 10m and 80m. Baited traps consisting of rectangular metal frames covered by netting, are deployed from small dinghy's and delivered to larger catcher reefers to take to shore for processing. The rock lobster fishing fleet consists of vessels that range in length from 7 m to 21 m. Traps are usually set in the late morning and allowed to soak overnight before being retrieved by winch early the following morning. The catch season is a six-month period from 1st November to 30 April, with the highest fishing levels occur in January and February (SLR, 2016).



Source: (SLR, 2016)

Figure 48: Namibian rock lobster catch (tons) by season and fishing ground.



Source: (SLR, 2016)

Figure 49: Distribution of commercial catches of rock lobster in fishing grounds in the vicinity of ML220 (previously EPL 5965).

Historically, the fishery sustained relatively constant catches of up to 9000 tonnes per year until a decline in the late 1960s. **Figure 50** shows the commercial rock lobster catches from 1986 to 2019. The TAC for the 2020/21 was set at 180 tonnes, remaining unchanged from the previous season and a reduction from 200 tonnes TAC set during 2018/19. The TACs have not been filled in recent years with poor catch rates and generally adverse environmental conditions impacting operations. The industry lands between 50% and 80% of the total TAC each season.

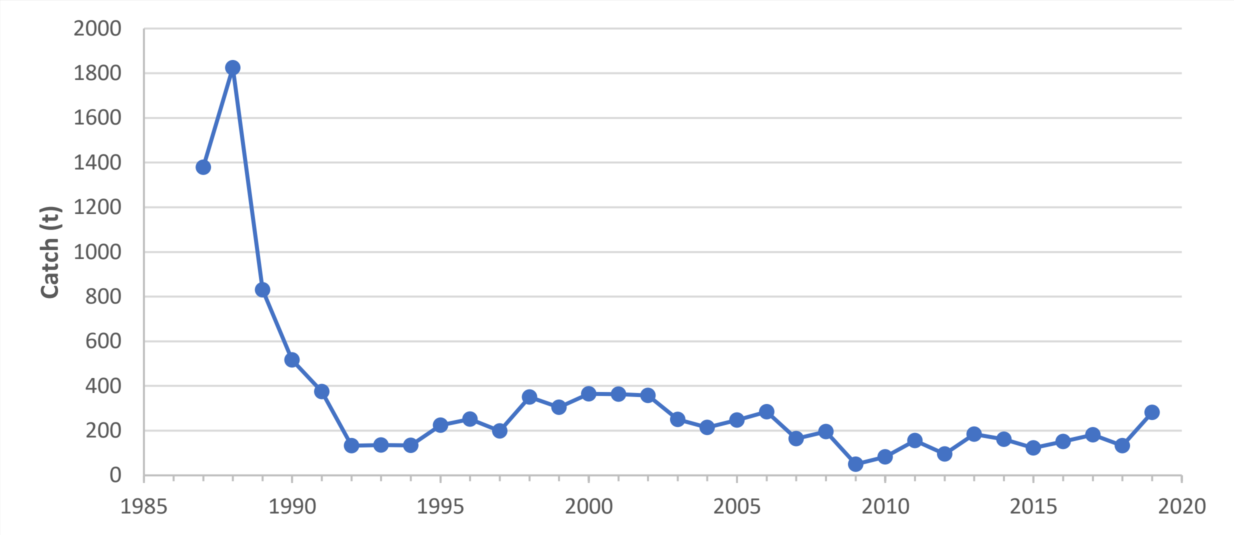


Figure 50: Management Catches of rock lobster in Namibia from 1986 to 2019 (Source: FAO catch statistics).

In the 2020 and 2021 seasons, the TAC was 180 tons and this year 17 active vessels landed 190 tonnes. The vessels employ between 9 and 11 crew, which provides work for approximately 170 people during the season.

The lobsters are kept without food for a few days to ensure their stomachs are empty and then taken to the Seaflower or the Pomona factory, in Luderitz, where they are frozen completely whole and intact, boxed and freighted to Japan. As the TAC was relatively low, only the Seaflower factory was operating in 2021 and it employed 5 permanent staff and 40 seasonal staff[25].

The fishermen market their catch through NamRock, a non-profit marketing agent for the Japanese market. They receive 2,600 yen (N$335) per kilo on arrival in Japan and they pay the factory N$42/kg for the freezing, packaging and storage[26]. In 2021, they exported approximately 160 tonnes valued at over N$50 million. The balance of 30 tonnes is sold to the local market at approximately N$220 per kilo, valued at a further N$6 million.

As this is a viable and important local industry, it is recommended that LK Mining meets the Rock Lobster Association before and at the end of each fishing season, so both parties can air their concerns and co-exist with mutual respect.

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[25] Pers Comm Mr Klein, Manager of Seaflower Rock Lobster factory on 19/5/2021

[26] Pers Comm: Mr José Calaḉa, Rock Lobster Association on 20/5/2021

5.6 Heritage of Hottentots Bay and surrounding

5.6.1 Setting

With reference to the Hottentot Bay environment, the headland was an offshore island until as recently as 11 000 years ago. This explains not only the nature of the terrain lying between the headland and the main coastline, but also the fact that in the first half of the 19th century guano deposits on the headland were systematically exploited. No seabirds nested on the headland at that time, and the guano, apparently a sub-fossil deposit, was excavated from beneath a sandy overburden up to 2m in depth.

Lying about 6 km south of Hottentot Bay, Ichabo Island was a major focus of the mid-nineteenth century “guano rage” during which up to 300 vessels were simultaneously anchored off the island. The island yielded more substantial guano deposits than the headland at Hottentot Bay.

However, Hottentot Bay provided a more sheltered anchorage than Douglas Bay adjacent to Ichabo and it appears that shipping and on-shore activities during this period encompassed the whole area. The intensity of these activities and their restricted focus on the landscape has resulted in a unique historical and archaeological record of mid-nineteenth century commercial activity on the Namib coast.

5.6.2 Archaeological observations

In 2009 a total of 72 historical and archaeological sites were recorded in the course of a systematic ground survey of Hottentot Bay and the immediately surrounds. Pre-contact sites are relatively few in number, as are those relating to the early 19th century. A distinct peak occurs in the mid- to late 19th century, corresponding to the intense commercial activity at that time. This is followed by a trough in the early to mid-20th century, and a second peak in the mid- to late 20th century when the Table Mountain Cannery and Penguin Mining (Pty) Ltd were successively established and abandoned.

5.6.3 Shipwrecks and other heritage resources

Although almost all of the historical evidence is from on-shore contexts it should be emphasized that access to both Hottentot Bay and Ichabo was exclusively by sea and that the seabed north of Ichabo and for some distance beyond the Hottentot Bay headland is likely to have significant amounts of wreckage. The large number of vessels involved at Ichabo (more than 1 000 in total) would have resulted in some losses of equipment, whaleboats and perhaps entire vessels, although the situation was not well regulated and detailed records are lacking. Northward drift due to the Benguela Current and the resulting cell circulation in the vicinity of Hottentot Bay may have concentrated important historical debris within the bay itself. **Table 17** lists the known vessels in the vicinity of Ichabo Island and Hottentot Bay.

Table 17: List of vessels lost in vicinity of Ichabo Island and Hottentot Bay.

(Based on information furnished by Mr Gunter von Schumann, Windhoek.)

Vessel	Date lost	Notes
unnamed	1488	Burned and sank Hottentot Bay
Guernsey Lily	17/05/1844	Guano carrier, lost Ichabo Island
Orion	1845	Guano carrier, lost Ichabo Island
Ann Mondell	28/02/1845	Guano carrier, lost Ichabo Island
Kate	27/10/1845	Ran aground north of Ichabo Island
Daphne	23/11/1845	Guano carrier, lost Ichabo Island
Sverige	5/05/1873	Ran aground, Ichabo Island
Byron	1/08/1893	Lost at Ichabo Island

Vessel	Date lost	Notes
Eurus	13/03/1896	Guano carrier, lost Ichabo Island
Kent	5/07/1850	Ran aground in Hottentot Bay
Canute	03/1861	Lost at Ichabo Island
Clara & Florence	7/08/1873	Lost in storm, Hottentot Bay
Solingen	4/11/1904	Ran aground, possibly Hottentot Bay
Heraclides	26/10/1907	Lost in Hottentot Bay
Sea Spray	1950	Ran aground in Hottentot Bay
St. John	15/06/1956	Wrecked at Hottentot Bay
Malagas	2009	Ran aground in Hottentot Bay

5.6.4 Archaeological sensitivity

There is valuable palaeo-environmental evidence from Hottentot Bay relating to late Pleistocene and mid-Holocene sea level changes. The evidence from Hottentot Bay has been studied in detail and the most important results have been published, although it is possible that some follow-up investigations will be carried out. Detailed archaeological surveys of the coastline north of Douglas Bay and in the vicinity of Hottentot Bay have located and documented all the major sites, including those relating to 19th century guano mining activities. On-shore surveys and archival searches have been carried out to determine the likely extent of shipping losses in and around Hottentot Bay. However, no underwater surveys have yet been carried out. The coastline around Hottentot Bay has a known potential for palaeoenvironmental and archaeological research, while there is unconfirmed evidence that the in-shore seabed within the bay would have important marine archaeological remains.

5.6.5 Further archaeological studies

As no underwater survey has been carried out in Hottentot Bay, LK Mining will conduct further maritime archaeological studies. This will be carried out by Ms V. Maitland, who is a qualified maritime archaeologist under a permit issued by the National Heritage Council.

A comprehensive maritime heritage survey in Hottentot Bay is important, as this bay offers some protection from the weather. Although there are a few small bays along the coast (**Figure 51**), according to modern sailors it is the only place offering protection between Walvis Bay and Lüderitz. This protection would have been sought by sailors through time.

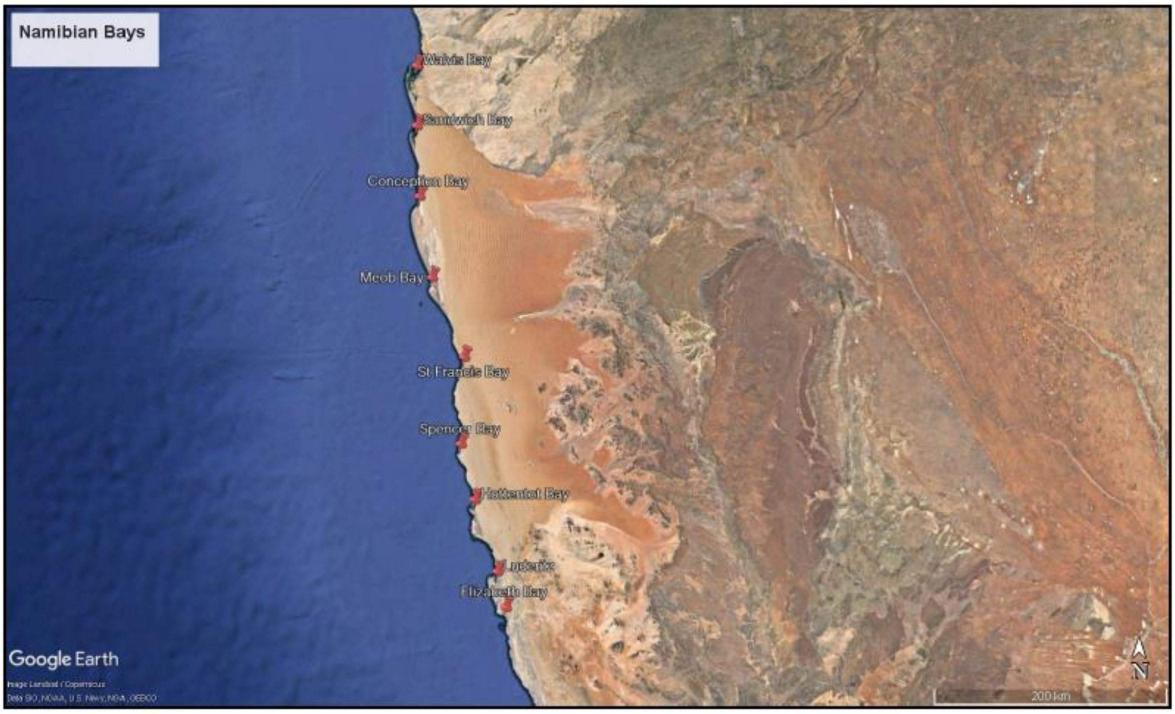

Figure 51: Namibian Bays (Google Earth 2021).

<u>Scope of Work and Methodology</u>

- Desktop survey of potential underwater heritage sites, especially shipwrecks in the area through study of available databases and historical records and newspapers. Databases include published as well as unpublished sources of information.
- Due to the lack of early historical records for Namibian shipwrecks and the high possibility of early wrecks being located here, a magnetometer survey is necessary. A magnetometer survey records the background magnetic variation, any shipwrecks, even old wooden ships have a large amount of ferrous metal in them, these are picked up as anomalies against the earth's magnetic field. The magnetic data can also be used by geologist to better understand the underlying geology of the area.
- If magnetic anomalies are noted, diver searches will need to be undertaken to ascertain if they are maritime underwater cultural heritage.
- The magnetometer survey will coincide with the benthic sampling program pre-mining

6 PROTECTED AND CONSERVATION AREAS

6.1.1 Marine Protected Areas

ML 220 falls within the Namibian Islands Marine Protected Area (NIMPA) (Figure 52, left). The NIMPA comprises a coastal strip extending roughly 400 km from Hollamsbird Island (24º38'S) in the north, to Chamais Bay (27º57'S) in the south, spanning approximately three degrees of latitude and an average width of 30 km, including 16 specified offshore islands, islets and rocks (Currie *et al.* 2008). The NIMPA spans an area of 9,555 km^2, and includes a line fish sanctuary near Meob Bay and a 478 km^2 rock lobster sanctuary between Prince of Wales Bay and Chameis Bay. The offshore islands, whose combined surface area amounts to only 2.35 km^2 have been given priority conservation and highest protection status (Currie *et al.* 2009). The area has been further zoned into four degrees of incremental protection. The regulations pertaining to the NIMPA (Government Gazette 5111, of 31 December 2012) detail which activities are permitted in each of the zones. The NIMPA was launched on 2 July 2009 under the Namibian Marine Resources Act (No. 29 of 1992 and No. 27 of 2000), with the purpose of protecting sensitive ecosystems and breeding and foraging areas for seabirds and marine mammals, as well as protecting important spawning and nursery grounds for fish and other marine resources (such as rock lobster).

Of particular significance in ML 220 is Neglectus Islet and the disused Jetty in Hottentots Bay. These provide important breeding sites for African Penguins, Bank, Cape, Crowned and White-breasted cormorants and are given special protection under NIMPA. In 2009, the jetty had the largest breeding colony of White-breasted cormorants along the southern Namibian coast. Access to Neglectus Islet is only allowed with a permit and the islet has a buffer zone extending from the low water mark to 120 m off the islet in which activities are restricted. Access to the jetty is not allowed at all and no approach is permitted to within 50 m of the jetty from the seaward side.

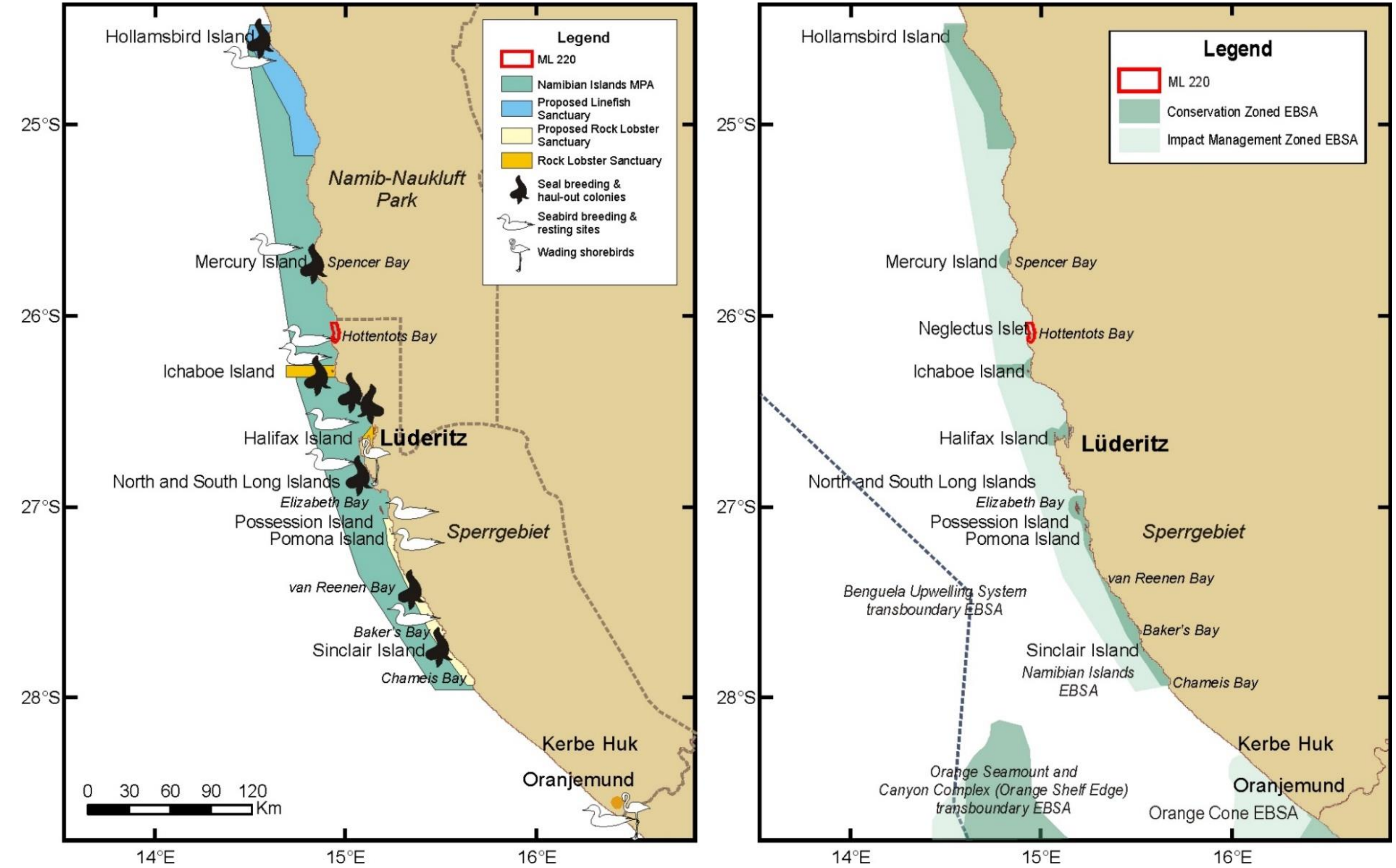

Figure 52: Mining Licence 220 (red polygons) in relation to the Namibian Islands Marine Protected Area and other project-environment interaction points (left) and Ecologically and Biologically Significant Areas (EBSAs) and the biodiversity conservations zones within these (right).

6.1.2 *Ecologically or Biologically Significant Areas*

Ecologically or Biologically Significant Areas (EBSAs) are marine areas that provide important services to an ecosystem or to one or more species / populations within an ecosystem. These areas require targeted conservation management actions to limit marine biodiversity declines. An inventory of EBSAs aids marine spatial planning by advising and providing a guideline to which activities would be (in)compatible with areas of high ecological value (Dunn et al. 2014).

In the spatial marine biodiversity assessment undertaken for Namibia (Holness et al. 2014), a number of offshore and coastal area were identified as being of high priority for place-based conservation measures. To this end, EBSAs spanning the coastline between Angola and South Africa were proposed and successfully submitted for international recognition to the Convention of Biological Diversity (CBD) in March 2020. The principal objective of the EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. The EBSAs are delineated to minimise conflict and avoid negative impacts with industries. In line with Namibia's National Development Plan 5, the EBSAs will in future potentially be used to inform and enhance Marine Spatial Planning in the country's EEZ.

Of the eight identified EBSAs off Namibia, two fall solely within Namibian national jurisdiction (Namib Flyway and Namibian Islands), while one is shared with Angola (Namibe) and two are shared with South Africa (Orange Shelf Edge and Orange Cone) (**Figure 52**, right). The Benguela Upwelling System transboundary EBSA extends along the entire southern African West Coast from Cape Point to the Kunene River and includes a portion of the high seas beyond the Angolan EEZ. The following summary was adapted from http://cmr.mandela.ac.za/EBSA-Portal/Namibia/.

The **Namibian Islands** are located offshore of the central Namibian coastline and within the intensive Lüderitz upwelling cell. These islands and their surrounding waters are significant for life history stages of threatened seabird species as they serve as crucial seabird breeding sites within the existing Namibian Islands Marine Protected Area (NIMPA). The surrounding waters are also key foraging grounds for both seabirds and for 'Critically Endangered' leatherback turtles that nest along the northeastern coast of South Africa.

Although at this stage no specific management actions have as yet been formulated for the EBSAs and they carry <u>no</u> legal status, two biodiversity zones have recently been defined within each EBSA as part of the marine spatial planning process (**Figure 52**, right) (https://cmr.mandela.ac.za/EBSA-Portal/Namibia/Namibian-EBSA-Status-Assessment-Management; accessed 16 March 2021).

Although the proposed zonation of the EBSAs is still under discussion, and industry has not been approached for comments, the management objective in the zones marked for 'Conservation' is "*strict place-based biodiversity protection aimed at securing key biodiversity features in a natural or semi-natural state, or as near to this state as possible*". The management objective in the zones marked for 'Impact Management' is "*management of impacts on key biodiversity features in a mixed-use area to keep key biodiversity features in at least a functional state*".

In the list of sea-use activities provided for this EBSA, the marine spatial planning zone for mining recommends that <u>mining be prohibited</u> in the Biodiversity Conservation zone (or Critical Biodiversity Area, CBA) and be conditionally permissible within the Impact Management zone. Conditional activities are defined as activities that "*are recommended to be managed as Consent activities, which are those that can continue in the zone subject to specific regulations and controls, e.g. to avoid unacceptable impacts on biodiversity features, or to avoid* *intensification or expansion of impact footprints of uses that are already occurring and where there are no realistic prospects of excluding these activities*" (MARISMA Project 2019).

The proposed mining area overlaps with the recommended, but not proclaimed, conservation zone proposed to offer biodiversity protection to Neglectus Islet and the disused jetty in Hottentots Bay (**Figure 53**).

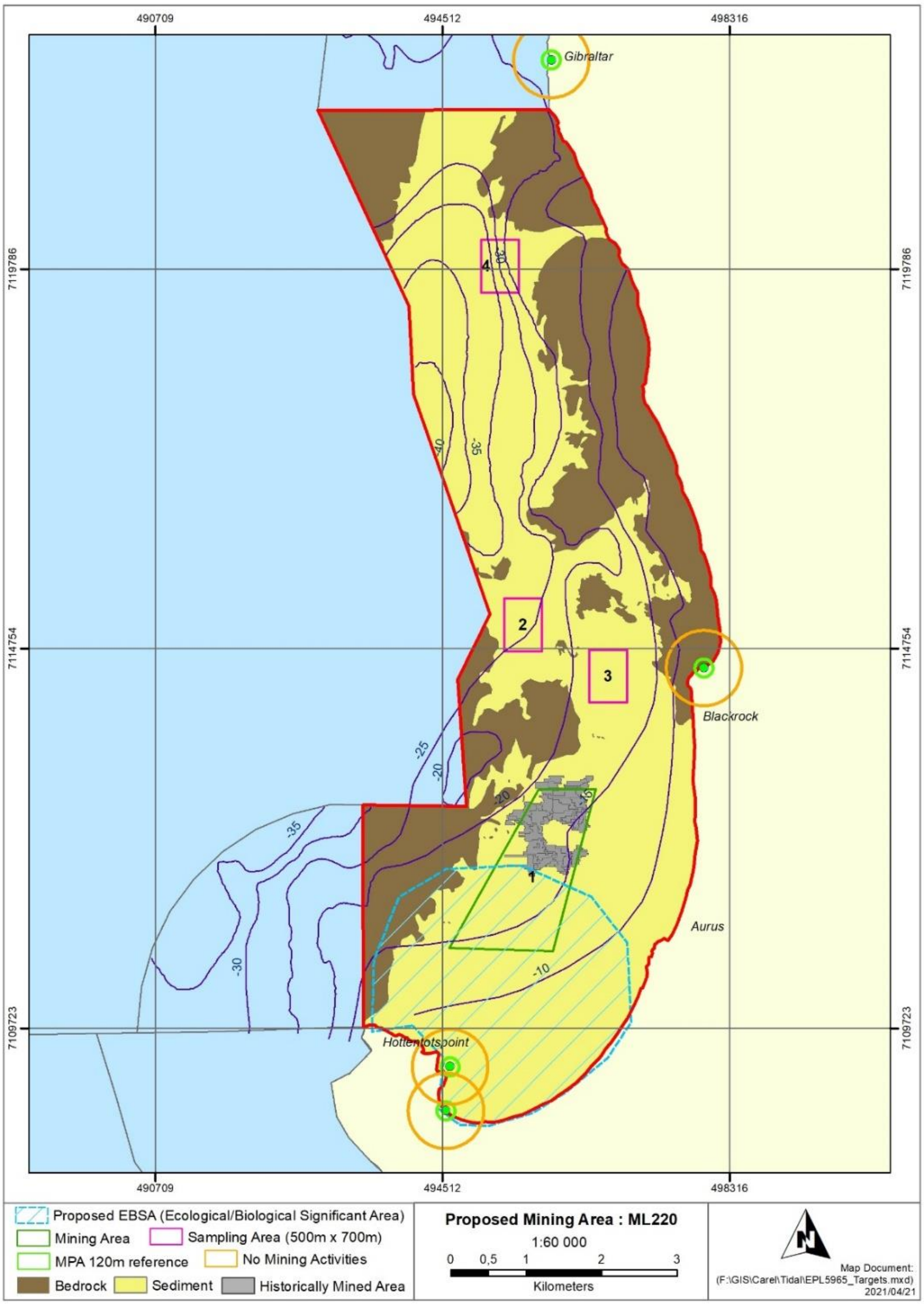

Figure 53: Details of Mining Licence 220 (red polygon) and the mining target area (green polygon) in relation to the marine spatial planning conservation zone (blue polygon) in Hottentots Bay within the Namibian Islands EBSA. The 500 m 'no activity' buffers around sensitive habitats are also shown.

6.1.3 Important Bird Areas (IBAs)

Important Bird and Biodiversity Areas (IBAs) are areas that are considered critical for birds at a global or regional scale. Although they do not carry any legal obligations as such, they provide decision-makers with a catalogue of areas of high bird conservation importance.

The Namib-Naukluft Park and Sperrgebiet IBAs are largely terrestrial but extend to the coastline and are therefore of relevance for shorebirds. The Lüderitz Bay Islands IBA consists of Flamingo, Seal, Penguin and Halifax islands and includes Lüderitz Harbour and the adjacent rocky shore to just south of Guano Bay. These islands, as well as Mercury, Ichaboe and Possession Islands are listed as global IBAs as they regularly support significant numbers of seabirds or waterbirds. More recently, an additional set of marine IBAs have been proposed by BirdLife (see https://maps.birdlife.org/marineIBAs/default.html). ML 220 falls within the proposed Sperrgebiet Marine IBA (**Figure 54**).

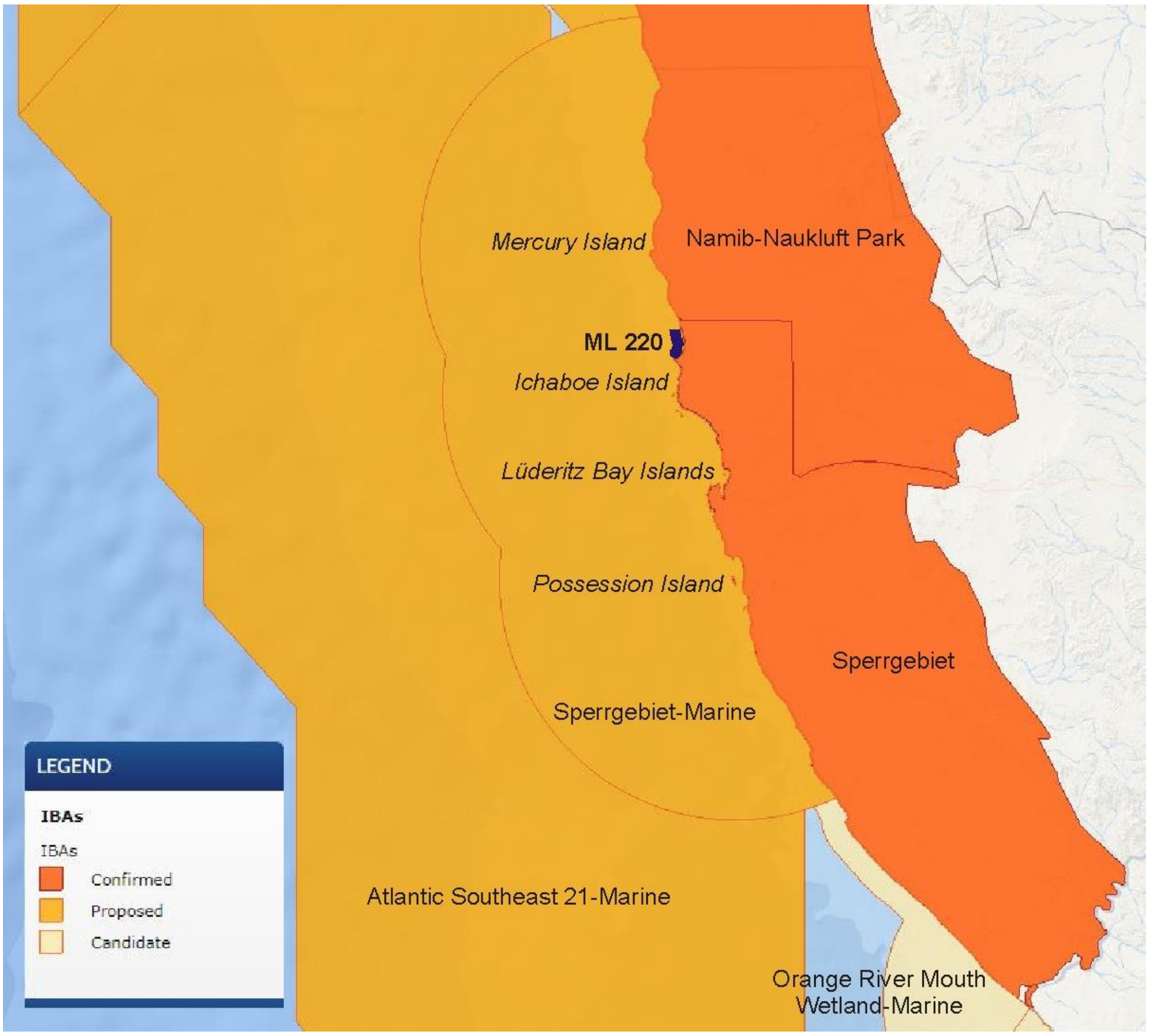

Figure 54: ML 220 (blue polygon) in relation to confirmed, proposed and candidate coastal and marine IBAs in Namibia (Source: https://maps.birdlife.org/marineIBAs).

6.1.4 Unique Biodiversity Resources

The marine benthic communities in the study area are generally typical for the West Coast, are not unique to the licence area and cannot be classified as locally, regionally or internationally important biodiversity resources. Consequently, the inshore and coastal benthic habitats in the area have all been assigned a threat status of 'Least Concern' (Holness *et al.* 2014). This rationale also applies to the pelagic and demersal fish, and marine mammals occurring in the exploration area as these are widespread on the Southern African west coast, and do not rely on the area as a critically important foraging or breeding area.

In contrast, the resident seabird community can be considered important biodiversity resources, especially the Cape, Crowned, White-breasted and Bank Cormorants (Kemper 2008). The total breeding population of Cape Cormorants in Namibia has declined by 57% during the last three generations (Crawford et al. 2007) warranting it being listed as 'Endangered'. The Namibian breeding population of Bank Cormorants declined by 86% from 5,182 to 732 in the five years between 1992/93 and 1887/97. Due to their population size, endemism and conservation classification these species represent internationally significant biodiversity resources. The main threats include a lack of prey, human disturbance at breeding sites, oil and plastic pollution, and lack of suitable breeding habitat.

7 ALTERNATIVES

The identification and consideration of alternatives is recognised as required practice in environmental assessment procedures globally and is a regulatory requirement in terms of the Namibian Environmental Management Act, 2007 (Act No. 7 of 2007).

However, no alternative, except the no-go option, can be given for off-shore diamond mining.

7.2 No-go Option

This option entails that no further activities are undertaken on the proposed ML220 area by LK Mining. After exploration during 2016 – 2019 LK Mining proved the presence of diamonds of the area and the Ministry of Mines and Energy is prepared to grant the mining licence once the ECC has been obtained.

The potential advantage of this option would be that no mining activities would take place in the MPA and will then limit the impact on the marine environment and/or the other users.

However, it needs to be taken into account that most of the area along the Namibian coast, on-land and in the marine area, has been granted for diamond exploration and mining. The positive impacts are revenue for the Namibian Government and employment for at least 30 people (mainly Namibians) and supply purchase at Lüderitz.

8 IDENTIFICATION AND DESCRIPTION OF POTENTIAL IMPACTS

The proposed mining activities in ML 220 have the potential to impact on the marine environment. Environmental aspects and potential impacts were identified during the scoping phase, in consultation with authorities, IAPs and the environmental team.

Table 18 below provides a summary of the activities associated with the mining activities, the associated environmental aspects and potential impacts on the environment and an initial screening of the potential impacts.

Table 18: potential environmental aspects and impacts associated with the proposed offshore Mining activities.

ACTIVITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (INITIAL SCREENING) OF POTENTIAL IMPACT
1. Mining			
Sediment removal	Sucking by remote mining tool/dragheads	Disturbance and loss of benthic marine fauna and rock lobster.	The proposed mining activities are expected to result in the disturbance and loss of benthic macrofauna through removal of sediments by the sampling/mining vessel. For the marine biodiversity impact assessments see Section 9. The Marine Ecology Assessment Report can be found in Appendix G.. There are also particular concerns that rock lobsters migrating between reefs or into deeper water during their seasonal inshore/offshore migrations may be physically sucked up by the remote mining tools and/or dragheads employed by mid water exploration operations. A fisheries assessment has been carried out and fisheries related impacts are dealt with in more detail in Section 9. The Fishery Assessment Report can be found in Appendix H..
	Movement of the mining head across seabed	Damage of Heritage resources (shipwrecks etc.)	Potentially some shipwrecks and other heritage resources may lie within the ML and could be affected by seabed prospecting. An archaeological study has been carried out and archaeological related impacts are dealt with in more detail in Section 9. The Archaeological study Report can be found in Appendix I.. Prior to commencement of mining activities, a magnetometer survey will be carried out by a marine archaeologist. Should any anomalies show, the area will be investigated by a diver survey.
	Turbidity from sediment plumes	Impact on the photosynthetic	Distribution and re-deposition of suspended sediments are the result of a complex interaction between oceanographic processes, sediment

ACTIVITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (INITIAL SCREENING) OF POTENTIAL IMPACT
Discharge of unwanted sediment		capability of phytoplankton; feeding success of pelagic predators; and egg and larval development. Benthic species inundation.	characteristics and engineering variables that ultimately dictate the distribution and dissipation of the plumes in the water column and the effects thereof on marine species. A marine ecology assessment has been carried out and marine biodiversity related impacts are dealt with in more detail in Section 9. The Marine Ecology Assessment Report can be found in **Appendix G**.
	Redepositing Tailings	Smothering of benthic communities	The oversize tailings are discarded overboard and settle back onto the seabed beneath the vessel. Following discharge overboard of the fine and coarse tailings, these settle back onto the seabed where they can result in smothering of benthic communities adjacent to the sampled areas. Smothering of benthic communities involves physical crushing, a reduction in nutrients and oxygen, clogging of feeding apparatus, as well as affecting choice of settlement site, and post-settlement survival. See Section 9 and Appendix G for more detail.
	Loss of Ferrosilicon	Pollution and impact on marine ecology	Ferrosilicon is made up of sand (silicon) and iron oxides, with small amounts of trace elements. It therefore oxidises rapidly in seawater and has no detrimental effect on marine life. No further assessment required.
2. Survey/sampling (Target Area 2 – 4)			
Survey/Sampling	Presence and use of stationary and moving vessel and equipment	Conflict with fishing sector	Geophysical surveying could impact on the commercial rock lobster fishing industry during the fishing season as a result of the presence of the survey vessel and equipment being towed along pre-selected survey lines. Similarly, during sampling/mining the vessel would be on an anchor-spread and an exclusion zone around the vessel would be maintained, potentially excluding the lobster fishing vessels from the fishing grounds temporarily.

ACTIVITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (INITIAL SCREENING) OF POTENTIAL IMPACT
			For the marine biodiversity related impact assessments see Section 9. The Marine Ecology Assessment Report can be found in Appendix G.. Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Rule 18), survey vessels that are engaged in surveying or towing operations are defined as a "vessel restricted in its ability to manoeuvre" which requires that power-driven and sailing vessels give way to a restricted vessel. Vessels engaged in fishing shall, so far as possible, keep out of the way of survey operations. The contractor undertaking the work is likely to request a safe operational limit that it would like other vessels to stay beyond. During mining and seismic surveying, at least a 500 m safety zone would therefore need to be enforced around the survey vessel at all times. No further assessment is therefore required; however the relevant requirements are stipulated in the EMP (see section 10).
		Damage to Heritage resources (shipwrecks etc.)	Potentially a few shipwrecks and archaeological remains may lie within the ML and could be damaged by the vessel e.g. the anchor. An archaeological study has been carried out and archaeological related impacts are dealt with in more detail in Section 9. The Archaeological study can be found in **Appendix I**. Prior to commencement of mining activities, a magnetometer survey will be carried out by a marine archaeologist. Should any anomalies show, the area will be investigated by a diver survey. This commitment is included in the EMP.
		Disruption of fisheries research surveys	The exclusion of vessels from entering the safety zone around a vessel engaged either in survey or mining activities poses a direct impact to fishing operations in the form of loss of access to fishing grounds. This is addressed in the EMP.

ACTIVITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (INITIAL SCREENING) OF POTENTIAL IMPACT
		Disruption of marine transport routes	Due to the inshore location of the ML, it is not located within major shipping routes and therefore was not further assessed.
		Conflict with other mining/exploration activities.	The presence of the vessel could interfere with other marine mining or prospecting operations in the neighbouring concession areas. However, other mining/exploration is conducted to a very limited extend if at all. Therefore, this issue was not further assessed.
		Air Pollution	Air pollution through emissions from the vessels is expected to be negligible. Vessel must comply with MARPOL standards. Therefore, this issue was not further assessed.
	Loss of equipment	Hazard to other marine users	Equipment such as anchors and sampling tools are occasionally, but seldom lost on the seabed. A marine ecology assessment has been carried out and marine biodiversity related impacts are dealt with in more detail in Section 9. The Marine Ecology Study can be found in **Appendix G**.
		Damage to heritage resources (shipwrecks etc.)	Potentially a few shipwrecks may lie within the ML and could be damaged by equipment dropped from the vessel. An archaeological study has been carried out and archaeological related impacts are dealt with in more detail in Section 8. The Archaeological study can be found in Appendix I. Prior to commencement of mining activities, a magnetometer survey will be carried out by a marine archaeologist. Should any anomalies show, the area will be investigated by a diver survey
	Accidents and emergencies	Hydrocarbon spillage	Grounding or sinking of the survey vessel, accidental and/or operational oil spills from the vessel may impact on marine mammals, seabirds and other

ACTIVITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (INITIAL SCREENING) OF POTENTIAL IMPACT
			marine organisms. Oil pollution poses a serious risk for many marine organisms, specifically the African penguin. For the marine biodiversity impact assessments see Section 9. The Marine Ecology Assessment Report can be found in **Appendix G**..
3. Geophysical Remote Sensing			
Multi-beam Bathymetry, Side Scan Sonar, Depth Sounding, Bottom Profiling	Acoustics	Impact on physiology and behaviour of marine organisms	Acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean can thus be expected to interfere directly or indirectly with such activities thereby potentially affecting the physiology and behaviour of marine organisms. For marine biodiversity related impacts see Section 9. The Marine Ecology Assessment Report can be found in **Appendix G**.
4. Socio-economic			
Employment	Socio-economic (positive)	Job creation	Where possible, Namibians will be involved in the mining activities. This would be a positive impact. See Section 9 and section 5.5.
Vessel Servicing	Sewage and Waste	Adding sewage to waste water treatment plant in Lüderitz. Adding to waste in Lüderitz landfill site.	The sewage will be disposed of at a waste water treatment plant in Lüderitz. The solid (domestic) waste produced by the vessel and its crew would be minimal. This material will be stored properly in the vessel until safe disposal on land (licensed Lüderitz landfill facility). Through the effective implementation of the management and mitigation measures, as described in the EMP (Section 10) the potential impacts relating to waste management can be avoided/mitigated.

ACTIVITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (INITIAL SCREENING) OF POTENTIAL IMPACT
	Water	Use of water from Lüderitz municipality.	Water could be sourced from Lüderitz, which is located in a water scarce area. The mining related activities will, however, use minimal water and therefore, this potential impact is not considered significant and was not assessed further.
	Economic contribution	Contribution to GDP	The purchase, operation and servicing of the vessel will create a number of jobs and tax income. At least 28 new jobs will be created in Lüderitz. The aspect if discussed in detail in Section 9.
Mining, survey and sampling activities	Socio-economic	Loss of income due to reduction of lobster fishery	The rock lobster fishery focusses its efforts in depths <30 m along the entire length of the ML, but with increased effort around Gallovidea Reefs and Marshall Rocks to the south of Hottentots Bay. As mining activities and geophysical surveys and sampling activities will be conducted at depths between 14 - 40 m, there will be a potential overlap with the commercial fishery, particularly during the fishing season from November to April. A fisheries assessment has been carried out and fisheries related impacts are dealt with in more detail in Section 9. The Fishery Assessment Report can be found in **Appendix G** and **H**.

9 ASSESSMENT OF RELEVANT ASPECTS & IMPACTS AND MANAGEMENT & MITIGATION MEASURES FOR ALL IDENTIFIED ASPECTS

9.1 Methodology

The environmental aspects that require further assessment (as identified in Section 8 of this Scoping Report) relate to marine ecology, fisheries, socio-economic and archaeological heritage.

The activities that are summarised in this chapter, link to the description provided in Sections 4 (project description), section 5 (biophysical description and section 8 (**Table 18**).

The specialist studies carried out in order to adequately assess these impacts can be found in:

- **Appendix G** - Marine Ecology Specialist Study;
- **Appendix H**- Fisheries Specialist Study; and
- **Appendix I** - Archaeological Specialist Study.

Management and mitigation measures to address the identified impacts are discussed (at a high level) in this section and are included in more detail in the EMP in section 10.

Both the criteria used to assess the impacts and the method of determining the significance of the impacts are outlined below. This method complies with the Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) EIA regulations. The methodology followed to assess the potential impacts are provided below.

IMPACT assessment criteria	
SIGNIFICANCE determination	Significance = consequence x probability
CONSEQUENCE	Consequence is a function of: • Nature and Intensity of the potential impact • Geographical extent should the impact occur • Duration of the impact

Ranking the NATURE and INTENSITY of the potential impact	
Negative impacts	
Low (L)	The impact has no / minor effect/deterioration on natural, cultural and social functions and processes. No measurable change. Recommended standard / level will not be violated. (Limited nuisance related complaints).
Moderate (M)	Natural, cultural and social functions and processes can continue, but in a modified way. Moderate discomfort that can be measured. Recommended standard / level will occasionally be violated. Various third party complaints expected.

High (H)	Natural, cultural or social functions and processes are altered in such a way that they temporarily or permanently cease. Substantial deterioration of the impacted environment. Widespread third party complaints expected.
Very high (VH)	Substantial deterioration (death, illness or injury). Recommended standard / level will often be violated. Vigorous action expected by third parties.
Positive impacts	
Low (L) +	Slight positive effect on natural, cultural and social functions and processes Minor improvement. No measurable change.
Moderate (M) +	Natural, cultural and social functions and processes continue but in a noticeably enhanced way. Moderate improvement. Little positive reaction from third parties.
High (H) +	Natural, cultural or social functions and processes are altered in such a way that the impacted environment is considerably enhanced /improved. Widespread, noticeable positive reaction from third parties.
Very high (VH) +	Substantial improvement. Will be within or better than the recommended level. Favourable publicity from third parties.

Ranking the EXTENT	
Low (L)	Local: confined to within the project concession area and its nearby surroundings
Moderate (M)	Regional: confined to the region, e.g. coast, basin, catchment, municipal region, district, etc.
High (H)	National; extends beyond district or regional boundaries with national implications
Very high (VH)	International: Impact extends beyond the national scale or may be transboundary

Ranking the DURATION	
Low (L)	Temporary/short term. Quickly reversible. (Less than the life of the project).
Moderate (M)	Medium Term. Impact can be reversed over time. (Life of the project).
High (H)	Long Term. Impact will only cease after the life of the project.
Very high (VH)	Permanent

Ranking the PROBABILITY	
Low (L)	Unlikely
Moderate (M)	Possibly

High (H)	Most likely
Very high (VH)	Definitely

These criteria are used to determine the CONSEQUENCE of the impact, which is a function of severity, spatial extent and duration.

INTENSITY	DURATION	EXTENT			
		Local (L)	**Regional (M)**	**National (H)**	**International (VH)**
LOW	**Permanent**	**Moderate**	**Moderate**	**High**	**High**
	Long-term	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Medium-term	**Low**	**Low**	**Low**	**Moderate**
	Short-term	**Low**	**Low**	**Low**	**Moderate**

INTENSITY	DURATION	EXTENT			
		Local (L)	**Regional (M)**	**National (H)**	**International (VH)**
MODERATE	**Permanent**	**Moderate**	**High**	**High**	**High**
	Long-term	**Moderate**	**Moderate**	**High**	**High**
	Medium-term	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Short-term	**Low**	**Moderate**	**Moderate**	**Moderate**

INTENSITY	DURATION	EXTENT			
		Local (L)	**Regional (M)**	**National (H)**	**International (VH)**
HIGH	**Permanent**	**High**	**High**	**Very High**	**Very high**
	Long-term	**High**	**High**	**High**	**Very High**
	Medium-term	**Moderate**	**Moderate**	**High**	**High**
	Short-term	**Moderate**	**Moderate**	**High**	**High**

INTENSITY	DURATION	EXTENT Local (L)	Regional (M)	National (H)	International (VH)
VERY HIGH	Permanent	Very high	Very High	Very High	Very high
	Long-term	High	High	Very High	Very high
	Medium-term	High	High	High	Very High
	Short-term	Moderate	High	High	Very High

The SIGNIFICANCE of an impact is then determined by multiplying the consequence of the impact by the probability of the impact occurring, with interpretation of the impact significance outlined below.

PROBABILITY		CONSEQUENCE L	M	H	VH
Definite	VH	Moderate	High	High	Very high
Most Likely	H	Moderate	Moderate	High	Very high
Possibly	M	Low	Moderate	High	High
Unlikely	L	Low	Low	Moderate	High

SIGNIFICANCE Description		
	Positive	**Negative**
Low (L)	Supports the implementation of the project	No influence on the decision.
Moderate (M)	Supports the implementation of the project	It should have an influence on the decision and the impact will not be avoided unless it is mitigated.
High (H)	Supports the implementation of the project	It should influence the decision to not proceed with the project or require significant modification(s) of the project design/location, etc. (where relevant).
Very high (VH)	Supports the implementation of the project	It would influence the decision to not proceed with the project.

9.2 Impact Assessment

The impact assessment follows the identified impacts from marine biology, fisheries, socio-economic and archaeological specialist studies.

9.2.1 Acoustic Impacts of Geophysical Surveying

Description of Impact

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation (see references in McCauley 1994). Such acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean may thus interfere directly or indirectly with such activities. Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 dB re 1 µPa at 1 m (NRC 2003). Especially at low frequencies between 5 to 100 Hz, vessel traffic is a major contributor to noise in the world's oceans, and under the right conditions, these sounds can propagate 100s of kilometres thereby affecting very large geographic areas (Coley 1994, 1995; NRC 2003; Pidcock *et al.* 2003). Other forms of anthropogenic noise include 1) aircraft flyovers, 2) multi-beam sonar systems, 3) seismic acquisition, 4) hydrocarbon and mineral exploration and recovery, and 5) noise associated with underwater blasting, pile driving, and construction (**Figure 55**).

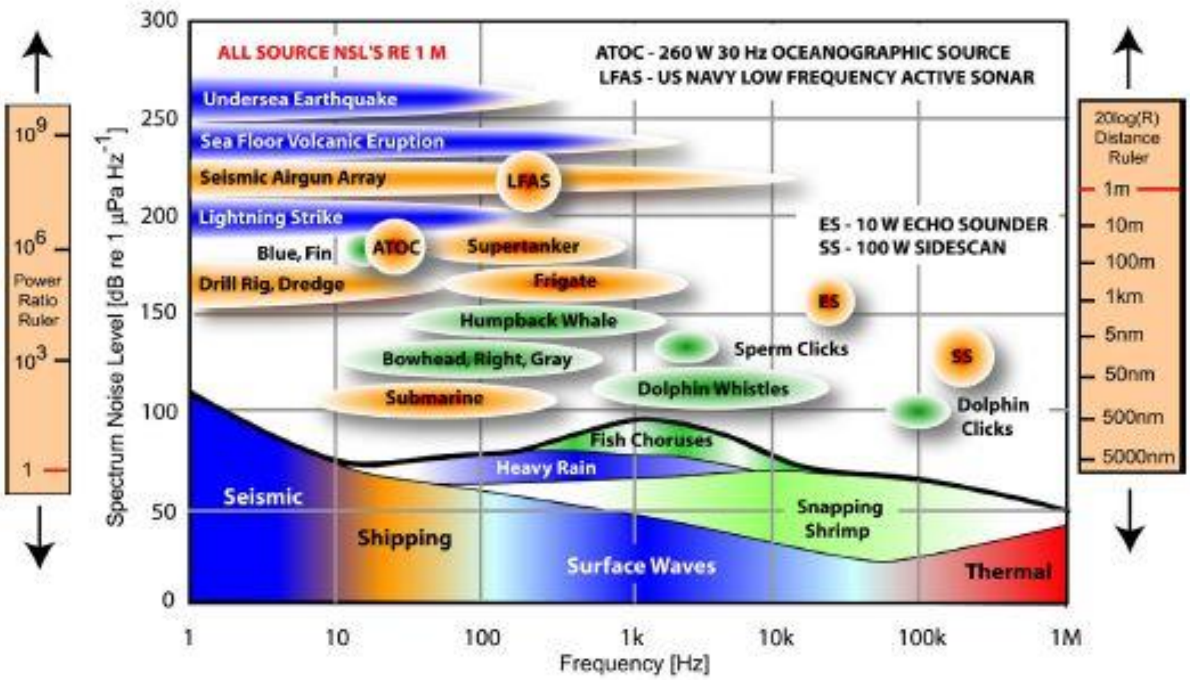

Figure 55: Comparison of noise sources in the ocean (Goold & Coates 2001).

Typical natural ambient noise levels in the study area are estimated to have overall root-mean-square sound pressure levels (RMS SPLs) in the range of 80 – 120 dB re 1 µPa, with a median level around 100 dB re 1µPa upon calm to strong sea state conditions (Li & Lewis 2020). The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern (Koper & Plön 2012), as such sound sources interfere directly or indirectly with the animals' biological activities. Reactions of marine mammals to anthropogenic sounds have been reviewed by McCauley (1994), Richardson *et al*. (1995), Gordon & Moscrop (1996) and Perry (1998), who concluded that anthropogenic sounds could affect marine animals in the surrounding area in the following ways:

- Physiological injury and/or disorientation;
- Behavioural disturbance and subsequent displacement from key habitats;
- Masking of important environmental sounds and communication;
- Indirect effects due to effects on prey.

It is the received level of the sound, however, that has the potential to traumatise or cause physiological injury to marine animals. As sound attenuates with distance, the received level depends on the animal's proximity to the sound source and the attenuation characteristics of the sound.

The noise generated by the acoustic equipment utilized during geophysical surveys falls within the hearing range of most fish, turtles and marine mammals (Table 3-6), and at sound levels of between 140 to 230 dB re 1 μPa at 1 m, will be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels (Findlay 2005). High frequency active sonar sources, in particular, have energy profiles that clearly overlap with cetacean's hearing sensitivity frequency range, particularly for cetaceans of High Frequency (e.g. odontocetes: dolphins, toothed whales (e.g. sperm), beaked whales, bottle-nose whales) and Very High Frequency (e.g. Heavisides dolphins, pygmy sperm and dwarf sperm whales) hearing groups. However, unlike the noise generated by airguns during seismic surveys, the emission of underwater noise from geophysical surveying and vessel activity is not considered to be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals in the region. The noise emissions are highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction, and only directly below or adjacent to the systems (within 10 m of the source) would sound levels be in the 230 dB range where exposure would result in permanent threshold shifts (PTS[27]). In the case of very-high-frequency cetaceans the maximum zones of PTS effect were predicted to occur within 70 m from the source along the cross-track direction. Temporary threshold shifts (TTS[28]) for marine mammals of all hearing groups except very-high-frequency cetaceans were predicted to be within approximately 25 m from the sonar source, extending to within 140 m from the source along the cross-track direction for very-high frequency cetaceans (Li & Lewis 2020b). Therefore, only directly below or within the sonar beam would received sound levels be in the range where exposure result in trauma or physiological injury. As most pelagic species likely to be encountered within the concessions are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur. Furthermore, the statistical

[27] A permanent threshold shift is a shift in the auditory threshold, which results in permanent hearing loss.

[28] A temporary threshold shift is a shift in the auditory threshold, which results in temporary hearing loss.

probability of crossing a cetacean or pinniped with the narrow multi-beam fan several times, or even once, is very small.

The underwater noise from the survey systems may, however, induce localised behavioural changes (e.g. avoidance of the source) in some marine mammal, but there is no evidence of significant behavioural changes that may impact on the wider ecosystem (Perry 2005) and no evidence of physical damage (i.e. PTS and TTS) (Childerhouse & Douglas 2016). The maximum impact distance for behavioural disturbance caused by the immediate exposure to individual sonar pulses was predicted to be within 1.8 km from the source for marine mammals of all hearing groups, at cross-track directions (Li & Lewis 2020b).

Similarly, the sound level generated by sampling or mining operations fall within the 120-190 dB re 1 µPa range at the sampling/mining unit, with main frequencies between 3 – 10 Hz. The noise generated by sampling operations thus falls within the hearing range of most fish and marine mammals, and depending on sea state would be audible for up to 20 km around the vessel before attenuating to below threshold levels (**Table 19**). In a study evaluating the potential effects of vessel-based diamond mining on the marine mammal community off the southern African West Coast, Findlay (1996) concluded that the significance of the impact is likely to be minimal based on the assumption that the radius of elevated noise level would be restricted to ~20 km around the mining vessel. Whereas the underwater noise from sampling operations may induce localised behavioural changes in some marine mammal, it is unlikely that such behavioural changes would impact on the wider ecosystem (see for example Perry 2005). The responses of cetaceans to noise sources are often also dependent on the perceived motion of the sound source as well as the nature of the sound itself. For example, many whales are more likely to tolerate a stationary source than one that is approaching them (Watkins 1986; Leung-Ng & Leung 2003), or are more likely to respond to a stimulus with a sudden onset than to one that is continuously present (Malme *et al.* 1985).

Table 19: Known hearing frequency and sound production ranges of various marine taxa (adapted from Koper & Plön 2012).

Taxa	Order	Hearing frequency (kHz)	Sound production (kHz)
Shellfish	Crustaceans	0.1 – 3	
Snapping shrimp	*Alpheus/ Synalpheus* spp.		0.1 - >200
Ghost crabs	*Ocypode* spp.		0.15 – 0.8
Fish	Teleosts		0.4 – 4
Hearing specialists		0.03 - >3	
Hearing generalists		0.03 – 1	
Sharks and skates	Elasmobranchs	0.1 – 1.5	Unknown
African penguins	Sphenisciformes	0.6 - 15	Unknown
Sea turtles	Chelonia	0.1 – 1	Unknown
Seals	Pinnipeds	0.25 – 10	1 – 4

Taxa	Order	Hearing frequency (kHz)	Sound production (kHz)
Northern elephant seal	*Mirounga agurostris*	0.075 – 10	
Manatees and dugongs	Sirenians	0.4 – 46	4 – 25
Toothed whales	Odontocetes	0.1 – 180	0.05 – 200
Baleen whales	Mysticetes	0.005 – 30	0.01 – 28

Sensitive Receptors

The taxa most vulnerable to disturbance by high-frequency underwater sonar noise are marine mammals, particularly the very-high frequency (e.g. Heaviside's dolphin, pygmy sperm and dwarf sperm whales) and high-frequency species (e.g. odontocetes: dolphins, toothed whales (e.g. sperm), beaked whales, bottle-nose whales). Some of the species potentially occurring in the project area, are considered regionally or globally 'Endangered' (e.g. fin and sei whales). Although species listed as 'Endangered' may potentially occur in the project area, due to their extensive distributions their numbers are expected to be low.

Assessment

The effects of high frequency sonars on marine fauna are considered to be localised, short-term (for duration of survey i.e. weeks) and of medium intensity. The sounds generated during acoustic surveys are unlikely to result in physiological damage to marine fauna, although behavioural disturbance is possible. The significant of the impact is thus considered of **LOW** significance both without and with mitigation.

The impact of underwater noise generated during sampling operations is considered to be of low intensity in the target area and for the duration of the sampling campaign (short-term). During mining operations, however, the underwater noise will continue over the medium term. For both sampling and mining operations, it is unlikely that underwater noise would cause damage or discomfort to marine fauna. The impact of underwater noise is thus considered of **LOW** significance without mitigation.

Mitigation

No mitigation measures are possible, or considered necessary for the generation of noise by the sampling/mining tools and vessels.

Despite the low significance of impacts for geophysical surveys, the Joint Nature Conservation Committee (JNCC) provides a list of guidelines to be followed by anyone planning marine sonar operations that could cause acoustic or physical disturbance to marine mammals (JNCC 2017). These have been revised to be more applicable to the southern African situation.

Recommendations for mitigation include:

- Onboard Marine Mammal Observers (MMOs) should conduct visual scans for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses.
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.

- "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- Avoid planning geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of **June to end of November**), and ensure that migration paths are not blocked by sonar operations. As no seasonal patterns of abundance are known for odontocetes occupying the licence area, a precautionary approach to avoiding impacts throughout the year is recommended.
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place between June and November.
- A MMO should be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.

Impacts of multi-beam and sub-bottom profiling sonar on marine fauna		
	Without Mitigation	**Assuming Mitigation**
Intensity	Medium	Low
Duration	Short-term; for the duration of the survey	Short-term
Extent	Local: limited to survey area	Local
Consequence	Low	Low
Probability	Unlikely (physiological injury) – Possible (behavioural disturbance)	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High
Nature of cumulative impact	No cumulative impacts as a result of the high frequency sonars are anticipated, although cumulative impacts of general anthropogenic ocean noise is likely	
Degree to which impact can be reversed	Fully reversible - any disturbance of behaviour, auditory "masking" or reductions in hearing sensitivity that may occur as a result of survey noise below 220 dB would be temporary	

Degree to which impact can be mitigated	High

Impacts of underwater noise from sampling and mining on marine fauna		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	No mitigation is proposed
Duration	Short-term (sampling) to Medium term (mining)	
Extent	Local: limited to survey area	
Consequence	Low	
Probability	Unlikely	
Significance	Low	
Status	Negative	
Confidence	High	

Nature of cumulative impact	No cumulative impacts as a result of the sampling or mining noise are anticipated, although cumulative impacts of general anthropogenic ocean noise is likely
Degree to which impact can be reversed	Fully Reversible - any disturbance of behaviour, auditory "masking" or reductions in hearing sensitivity that may occur would be temporary.
Degree to which impact can be mitigated	None

9.2.2 Impact of Survey Noise on Catch Rates

<u>Description of Impact</u>

The presence and operation of the survey vessel will introduce a range of underwater noises into the surrounding water column that may potentially contribute to and/or exceed ambient noise levels in the area. The survey vessel would be equipped with a medium- to high-frequency multi-beam echo sounder (MBES), low- to high-frequency sub-bottom profiler and medium- to high-frequency side scan sonar.

The likely geophysical survey equipment and its source frequencies and source noise levels are provided in the project description (section 2.1).

A description of the acoustic impacts on marine fauna of the current project activities is provided by Pulfrich (2021).

Sources of anthropogenic noise in the ocean include vessel traffic, multi-beam sonar systems, seismic acquisition, underwater blasting, pile driving, and construction. Elevated noise levels could impact marine fauna by:

- Causing direct physical injury to hearing or other organs, including permanent (PTS) or temporary threshold shifts (TTS) in hearing;
- Masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals and sounds produced by predators or prey); and
- Causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding areas.

A review of the literature and guidance on appropriate thresholds for assessment of underwater noise impacts are provided in the 2014 Acoustical Society of America (ASA) Technical Report *Sound Exposure Guidelines for Fishes and Sea Turtles* (ASA, 2014)[29]*.* The ASA Technical Report includes noise thresholds for mortality (or potentially mortal injury) as well as degrees of impairment such as TTS or PTS. Separate thresholds are defined for peak noise and cumulative impacts (due to continuous or repeated noise events) and for different noise sources (e.g. explosives, seismic airguns, pile driving, low- and mid-frequency sonar). As surveys using the MBES, sub-bottom profiling and side scan sonar sources have much lower noise emissions compared with seismic airgun sources, no specific considerations have been put in place in developing assessment criteria for these.

Whereas experiments have been carried out to define the levels of sound that cause mortality, injury or hearing damage; it is more difficult to determine the threshold levels that cause behavioural effects, which are likely to take place over wider areas. Reactions of fish to different types of anthropogenic sounds have been reviewed by Hawkins et al. (2015), who concluded that more information is required on the effects of man-made sounds on the distribution of fishes and their capture by different fishing gears as effects differ across species, fishing ground and habitat type.

Due to the more deleterious effects of loud, low frequency sounds such as those emitted in seismic surveys, research has focused on these effects. Due to the paucity of research into the effects of geophysical survey tools on fish and crustaceans and their related fisheries, effects are inferred by comparing the sounds that these organisms produce and are capable of detecting, and evidence of noise thresholds that can cause them harm or disturbance such that their fishery might be affected.

In general terms, sound sources that have high sound pressure and low frequency will travel the greatest distances in the marine environment. Conversely, sources that have high frequency will tend to have greater attenuation over distance due to interference and scattering effects (Anon 2007). It is for this reason that the acoustic footprint of sonar survey tools is considered to be much lower than that of deeper penetration low frequency seismic surveys that are used for petroleum exploration and in addition have lower sound pressure levels. The proposed multibeam survey produces frequencies between 10 kHz and 200 kHz (ultrasonic), with source sound levels in the order of 221dB re 1 μPa at 1m. Research into the effects of these multibeam swath bathymetry on fish and other fisheries-relevant organisms is lacking. However, as the frequencies produced fall well outside of the range of hearing of most marine fish, it is assumed to have little impact on fisheries. Furthermore, the intensity of such high-

[29] See also: Hawkins, A.D., Pembroke, A.E. and A.N. Popper. 2014. Information gaps in understanding the effects of noise on fishes and invertebrates. Rev Fish Biol Fisheries (2015) 25:39-64

frequency sound attenuates rapidly, meaning that any potential effects of the sound will be localised to near their source. The soft start capacity of this technology may encourage animals capable of detecting high frequencies to move out of the range of the sound.

Urchins exposed to three hours of one-second sweeps of 100 – 200kHz at 145 and 160 dB re 1µPa (within the range of multibeam echosounders) showed signs of physiological stress (Vazzana et al 2020.) This suggests that invertebrates may be sensitive to high frequency sound, which might cause ecosystem effects on fisheries. However, urchins are less mobile than fish and crustaceans, which may be able to avoid noise disturbance, especially if soft-starts are used.

Sub-bottom profilers include a variety of survey techniques that produce sound ranging from low frequencies (boomer, sparker and sleeve-gun systems) to medium frequencies (chirp and IXSEA) and ultrasonic frequencies (Innomar and Parametric systems). The low frequency techniques are capable of soft starts. Lower frequencies have the potential to travel large distances underwater and may interfere directly with fish and crustacean sound detection.

Marine organisms tend to be able to detect sounds that fall within the range produced by their species, prey or predators. High frequency, ultrasonic sound (>20kHz) sound is less commonly produced by marine animals. Some cetaceans and mantis shrimps produce ultrasonic sound and there is evidence that some fish species are capable of detecting it.

Bottom profiling has been proposed – this type of equipment would emit an acoustic pulse at frequencies ranging from 0.4 to 30 kHz and typically produces sound levels in the order of 200-230 db re 1µPa at 1m. This frequency range coincides with the hearing range of fish and crustaceans (refer to **Table 20**). The proposed multibeam survey produces frequencies between 10 kHz and 200 kHz (ultrasonic), with source sound levels in the order of 221dB re 1 µPa at 1m. Similarly, a typical side scan sonar emits a an ultrasonic pulse with frequencies ranging from 50 to 500 kHz and sound levels in the order of 220-230 db re 1µPa at 1m. These frequencies fall well outside of the range of hearing of most marine fish; however, members of the genera *Alosa* and *Brevoortia* (shads and menhadens) have shown specialisations that enable them to detect ultrasound. The American shad (*Alosa sapidissima*) is an example of a clupeoid species that shows a behavioural response to ultrasonic frequencies. American shad have been reported to respond with changes in schooling behaviour at 200-800Hz and 25-150 kHz (Velez, 2015). Behavioural responses have also been shown by blueback herring (*Alosa aestivalis*) at a sonar frequency range of 110 kHz to 140 kHz at sound levels above 180 dB re 1 Pa (peak) (Nestler *et al*. 1992, in Popper *et al*., 2014).

Table 20: Known hearing frequency and sound production ranges of various fish taxa (Pulfrich 2020 adapted from Koper & Plön 2012; Southall et al. 2019).

Taxa	Order	Hearing frequency (kHz)	Sound production (kHz)
Shellfish	Crustaceans	0.1 – 3	
Snapping shrimp	*Alpheus/ Synalpheus* spp.		0.1 - >200
Ghost crabs	*Ocypode* spp.		0.15 – 0.8
Fish	Teleosts		0.4 – 4
Hearing specialists		0.03 - >3	
Hearing generalists		0.03 – 1	
Sharks and skates	Elasmobranchs	0.1 – 1.5	Unknown

Assessment

The noise generated by the acoustic equipment utilized during bottom profiling falls within the hearing range of most fish, and at sound levels of between 200 to 230 dB re 1 μPa at 1 m, will be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels (Findlay 2005). Similarly, the sound level generated by mining operations fall within the 120-190 dB re 1 μPa range, with main frequencies between 3 – 10 Hz. The noise generated by mining operations thus falls within the hearing range of most fish, and depending on sea state would be audible for several kilometres around the vessel before attenuating to below threshold levels.

The noise emissions from the geophysical sources are highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction. Based on the rapid attenuation of high-frequency sound in the ocean, the spatial extent of the impact of noise on catch rates is expected to be localised.

Based on the location of fishing grounds of the various fisheries sectors in respect to ML 220, the sound generated during mining and survey activities would be expected to attenuate to below threshold levels before reaching fishing grounds. However, in the case of the linefish and rock lobster fisheries, the spread of sound into fishing grounds may affect catch rates. The impact on these sectors is assessed to be of low consequence and overall low significance. No mitigation measures are possible, or considered necessary for the generation of noise by the geophysical survey methods proposed in the current project. The impact is considered to be highly reversible – any disturbance of behaviour that may occur as a result of survey noise would be temporary.

Impacts of multibeam, bottom profiling and side-scan sonar on fisheries catch		
	Without Mitigation	**Assuming Mitigation**
Intensity	Moderate	Moderate
Duration	Short-term	Short-term
Extent	Local	Local
Consequence	Low	Low
Probability	Possibly	Possibly
Significance	Low - linefish, rock lobster	Low - linefish, rock lobster
Status	Negative	Negative
Confidence	High	High
Nature of Cumulative impact	some cumulative impacts can be anticipated. However, any direct impact is likely to be at individual level rather than at species level.	
Degree to which impact can be reversed	Fully reversible - Any disturbance of behaviour, auditory "masking" or reductions in hearing sensitivity that may	

	occur as a result of survey noise below 220 dB would be temporary.
Degree to which impact can be mitigated	Low

9.2.3 Disturbance and loss of benthic fauna during sampling and mining operations

Description of Impact

Sampling

The proposed sampling activities are expected to result in the disturbance and loss of benthic macrofauna through removal of sediments by the mining vessel. It is proposed to take in the order of 35 point samples from each of three sampling target areas thereby disturbing a total area of 2,100 m^2. Later bulk sampling in specific target areas would affect a further 30,000 m^2. The total cumulative area impacted by sampling activities would thus amount to 32,100 m^2, which equates to less than 0.07% of the total licence area.

Mining

The proposed mining activities would be undertaken in an area of 2,280,000 m^2 (228 ha), which amounts to 5.4% of the total licence area. Mining operations would totally remove the sediments and the associated benthic invertebrate communities.

As benthic fauna typically inhabits the top 20 - 30 cm of sediment, the sample operations would result in the elimination of the benthic infaunal and epifaunal biota in the sample and mining footprints. As many of the macrofaunal species serve as a food source for demersal and epibenthic fish, cascade effects on higher order consumers may result. However, considering the available area of similar habitat on the continental shelf off the Namibian coast, this reduction in benthic biodiversity can be considered negligible and impacts on higher order consumers are thus unlikely. The Lüderitz Inshore habitat type covers a total area of 356.2 km^2. This mining and sampling operations would directly disturb 0.65% of the available habitat.

The ecological recovery of the disturbed seafloor is generally defined as the establishment of a successional community of species that achieves a community similar in species composition, population density and biomass to that previously present (Ellis 1996). The rate of recovery (recolonisation) depends largely on the magnitude of the disturbance, the type of community that inhabits the sediments in the sampling area, the extent to which the community is naturally adapted to high levels of sediment disturbances, the sediment character (grain size) that remains following the disturbance, and physical factors such as depth and exposure (waves, currents) (Newell *et al.* 1998). Generally, recolonisation starts rapidly after a sampling/mining disturbance, and the number of individuals (*i.e.* species density) may recover within short periods (weeks). Opportunistic species may recover their previous densities within months. Long-lived species like molluscs and echinoderms, however, need longer to re-establish the natural age and size structure of the population. Biomass therefore often remains reduced for several years (Kenny & Rees 1994, 1996; Kenny *et al*. 1998).

The structure of the recovering communities is typically also highly spatially and temporally variable reflecting the high natural variability in benthic communities at depth. The community developing after an impact depends on (1) the nature of the impacted substrate, (2) differential re-settlement of larvae in different areas, (3) the rate of sediment movement back into the disturbed areas and (4) environmental factors such as near-bottom dissolved oxygen concentrations etc. For the current project, the proposed sampling would be undertaken in depths within the wave base (14-40 m). In shallower waters affected by swell (such as in ML 220), near-bottom sediment transport is comparatively high and excavations are not expected to persist for more than a few weeks or months. Beyond the wave base, however, near-bottom sediment transport is reduced and excavations are therefore expected to have slow infill rates and may persist for extended periods (years). In deeper waters, long-term or permanent changes in grain size characteristics of sediments may thus occur, potentially resulting in a shift in community structure if the original community is unable to adapt to the new conditions. Depending on the texture of the sediments at the sampling target sites, slumping of adjacent unconsolidated sediments into the excavations can, however, be expected over the very short-term. Although this may result in localised disturbance of macrofauna associated with these sediments and alteration of sediment structure, it also serves as a means of natural recovery of the excavations.

Natural rehabilitation of the seabed following sampling operations, through a process involving influx of sediments and recruitment of invertebrates, has been demonstrated on the southern African continental shelf (Penney & Pulfrich 2004; Steffani 2007a, 2009b, 2010, 2012; Biccard et al. 2018, 2019; Gihwala et al. 2018, 2019) in much deeper waters than those of the ML 220. Recovery rates of impacted communities were variable and dependent on the sampling /mining approach, sediment influx rates and the influence of natural disturbances on succession communities. Results of on-going research on the southern African West Coast suggest that differences in biomass, biodiversity or community composition following mining with drill ships or crawlers below the wave base may endure beyond the medium term (6-15 years) (Parkins & Field 1998; Pulfrich & Penney 1999a; Steffani 2012). Savage *et al*. (2001), however, noted similarities in apparent levels of disturbance between mined and unmined areas off the southern African west coast, and areas of the Oslofjord in the NE Atlantic Ocean, which is known to be subject to periodic low oxygen events. Similarly, Pulfrich & Penney (1999a) provided evidence of significant recruitments and natural disturbances in recovering succession communities off southern Namibia. These authors concluded that the lack of clear separation of impacted from reference samples suggests that physical disturbance resulting from sampling or mining may be no more stressful than the regular naturally occurring anoxic events typical of the West Coast continental shelf area.

Sensitive Receptors

The sampling activities would be undertaken in the nearshore marine environment where the Lüderitz Inshore habitat type has been assigned a threat status of 'Least Threatened'. Being located within the wave-base, the unconsolidated sediments will be extremely dynamic. The benthic fauna inhabiting unconsolidated sediments at the depths of the proposed sampling and mining operations are thus expected to be relatively robust. The benthic communities will be ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the unconsolidated sediments in ML 220. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered LOW.

Assessment

During sampling and mining operations the negative impact of sediment removal and its effects on the associated communities will definitely occur and is unavoidable. In the case of sampling, the intensity of the impact is considered LOW, whereas for mining the intensity of the impact is MODERATE. In both cases, the impacts will be extremely localised, constitute only about 0.07% and 5.4% of the licence area, respectively. As the licence area is located within the wave base and all sampling and mining targets are located shallower than 25 m, recovery will occur over the short-term. For both sampling and mining, the impact by definition is therefore rated as being of **MODERATE** significance. However, considering the highly localise nature of the impact, and that the disturbance will only affect 0.65% of the Lüderitz Inshore habitat type, the impact may be downscaled to being of **MODERATE** significance.

Mitigation

No mitigation measures are possible, or considered necessary for the direct loss of macrobenthos due to sampling, bulk sampling and mining. However, sampling/mining activities of any kind should avoid rocky outcrop areas or other identified sensitive habitats in the licence area.

A recommended management measure for the mining phase of the project would be to develop a robust and defensible benthic sampling programme, the objective of which would be to determine pre- and post-mining benthic community composition and demonstrate natural post-mining recovery of impacted communities.

Disturbance and loss of benthic fauna through sampling and mining		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low (sampling) to Moderate (mining)	Low (sampling) to Moderate (mining)
Duration	Short-term	Short-term
Extent	Local: limited to sampling/mining area	Local
Consequence	Low	Low
Probability	Definite	Definite
Significance	Moderate	Moderate
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	The highly localised disturbance and loss of benthic macrofauna during sampling operations is not expected to result in cumulative impacts
Degree to which impact can be reversed	The impact is partially reversible as natural recovery over the short- to medium-term will occur
Degree to which impact can be mitigated	Low

9.2.4 Disturbance to and loss of rock lobsters during sampling/mining operations

Description of Impact

Sampling

The proposed sampling activities are expected to result in the disturbance and removal of sediments by the mining vessel. The total area disturbed during sampling will amount to 2,100 m^2, with later bulk sampling in specific target areas affecting a further 30,000 m^2.

Mining

The proposed mining activities would be undertaken in an area of 2,280,000 m^2 (228 ha). Mining operations would totally remove the sediments and the associated benthic invertebrate communities. Following on-board treatment, all oversized and undersized tailings are discharged back to the sea on site.

There are concerns that the remote mining heads used during sampling and mining operations may physically suck up rock lobsters migrating between reefs or into deeper water during their seasonal inshore/offshore migrations. However, during a 26-day bulk sampling operation covering an area of ~3,100 m^2 of unconsolidated seabed, Tarras-Wahlberg (1999) recorded only 21 rock-lobster and 6 fish on the sorting screens. Existing data therefore suggest that numbers captured are insignificant compared to the annual quota landed by the commercial rock lobster industry. Records kept during sampling operations undertaken by LK Mining in February 2017 indicate that in the week-long sampling campaign, only one rock lobster was caught in the trommel before being returned to sea.

The damage to, and survival of rock-lobsters through mining activities was assessed by Barkai & Bergh (1992) in a manipulated lobster pumping experiment using a small shore-based ‘walpomp’. Of the 85 animals sucked up the hose and fed through the screening unit, a total of 61 survived. Most of these were below 60 mm carapace length, and it was found that greater limb and antennae loss resulted in far higher mortality of larger lobsters. In general, however, rock-lobsters are easily able to avoid the pump nozzle and are seldom sucked up during regular diver-assisted mining operations. In the case of remote mining, where suction pressures are greater, lobsters may not be able to actively avoid the mining head. However, the digging mining head would create substantial underwater noise and vibrations during operation, and it is expected that lobsters would be able to detect this from some distance away and therefore avoid the active mine site. Only in cases where animals are forced to leave an area due to the onset of hypoxia, would the natural flight response to the mining head be overrun by physiological responses.

The West Coast rock lobster exhibits a strong association with creviced habitats, and avoidance of gravel and sand areas (Beyers & Wilke 1990; Pulfrich & Penney 2001; Pulfrich *et al.* 2006; see also Cobb 1971; Spanier 1994). Depth distribution and availability of rock lobsters is strongly influenced by environmental conditions (Newman & Pollock 1971; Pollock 1978; Beyers 1979; Pollock & Beyers 1981; Bailey *et al*. 1985; Pollock & Shannon 1987; Tomalin 1993, amongst others). During winter lobsters occur in deep waters, possibly seeking shelter from winter swells, or to feed and release larvae (Pollock & Shannon 1987; Noli & Grobler 1998). During summer (January to April) the lobster migrate inshore again in response to intrusion off near-bottom low-oxygen water brought inshore by upwelling and seawards movement of nearshore waters. This inshore migration and concentration of lobsters in shallower, better-oxygenated water coincides with the commercial fishing season (Noli & Grobler 1998). During such migrations lobsters will leave the shelter of their preferred reef habitats and move across unconsolidated sediments, often in large numbers. This would make them vulnerable both to predation as well as mining operations targeting areas of unconsolidated sediments in their migration path.

Lobsters found on mud or sand are therefore unlikely to be there by preference, but are moving across such areas in response to imposition or relaxation of the near-bottom hypoxia.

By its nature, marine mining removes unconsolidated sediments with the larger boulders that have been screened out by the mining tools, remaining on the seabed. Studies investigating the impacts of shallow-water mining operations on rock lobsters concluded that removal of sediment from gullies resulted in temporary creation of areas of suitable habitat for lobsters with resultant localised increases in lobster abundance (Pulfrich & Penney 1998, 1999b, 2001). The abundance, mean sizes or catch rates of lobsters were not negatively affected by the mining operations (Barkai & Bergh 1992; Tomalin 1995, 1996; Parkins & Branch 1996, 1997; Pulfrich 1998a; Pulfrich et al. 2003; Pulfrich & Branch 2014), and benthic communities within metres of the mined gulley remained unaffected by the mining-induced disturbance. Disturbance of rock lobsters as a result of shallow-water mining operations were thus considered negligible, particularly when seen in context with responses to natural disturbances such as low oxygen events. The use of remote mining systems will obviously have effects on a larger scale, but if mining operations move progressively from one side of the mining block to another, there is no reason why mined-out areas dominated by boulders would not provide high-profiled habitat for rock lobsters. This habitat creation would, however, be temporary only as sediments from adjacent unmined areas, as well as tailings released from the mining vessel, would be redistributed into the mined-out areas by wave action and the long-shore littoral drift.

The principle impacts of mining activities on rock lobsters relate to alteration of suitable lobster habitat through discharge of tailings. This is discussed further in Section 9.2.5 below.

Sensitive Receptors

The West Coast rock lobster *Jasus lalandii* is a key predator in kelp beds and on nearshore reefs along the southern African West Coast. It is the target of a small but valuable fishery based exclusively in the port of Lüderitz. The lobster stock is commercially exploited between Kerbe Huk in the south to Easter Cliffs/Sylvia Hill north of Mercury Island, with the fishery operates in water depths of between 10 m and 80 m.

Assessment

Reductions in rock lobster populations through large numbers of animals being sucked up by the mining tool is highly unlikely, and should it occur would persist only over the very short term (hours), be highly localised and result in only a limited loss of resources. The impact would be of low intensity and is consequently deemed to be of **LOW** significance.

Mitigation

The following mitigation measures are recommended:

- Monitor sorting screens and terminate operations should large numbers of lobsters appear on the screens over a short period of time.
- Avoid sampling and mining in the immediate vicinity of rocky outcrop areas or other identified sensitive habitats in the licence area.

Disturbance to and loss of rock lobsters		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to sampling/mining area	Local
Consequence	Low	Low
Probability	Unlikely	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	The highly localised disturbance and loss of rock lobsters during sampling operations is not expected to result in cumulative impacts
Degree to which impact can be reversed	The impact is partially reversible as natural recovery of injured lobsters and the rock lobster populations will occur
Degree to which impact can be mitigated	Low

9.2.5 Increased turbidity due to generation of suspended sediment plumes

Description of Impact

The sampled/mined seabed sediments are pumped to the surface and discharged onto sorting screens on the sampling/mining vessel. The screens separate the fine sandy silt and large gravel, cobbles and boulders from the size fraction of interest, the 'plantfeed' (>1.2 to <12 mm). The fine tailings are immediately discarded overboard where they form a suspended sediment plume in the water column, which is advected away from the mining vessel by wind and ambient currents and is rapidly diluted. The 'plantfeed' is mixed with a high density ferrosilicon (FeSi) slurry and pumped under pressure into a Dense Medium Separation (DMS) plant resulting in a high density concentrate. The majority of the ferrosilicon is magnetically recovered for re-use in the DMS plant and the fine tailings (-2 mm) from the DMS process are similarly deposited over board. Furthermore, fine sediment re-suspension by the sampling tools will generate suspended sediment plumes near the seabed.

After discharge, the tailings material typically forms a negatively-buoyant sediment plume that either mixes directly with the receiving waters as it sinks (surface plume) or sinks as a density-driven current (dynamic plume). The dynamic plume undergoes convective descent through the water column until it either reaches the seabed or achieves neutral buoyancy, at which point it collapses and spreads laterally. As the dynamic plume sinks, some fine sediment may be entrained due to wind-generated turbulence; this is mixed through the water column and can contribute to the formation of a surface plume. Surface plumes are visible on the surface and thus likely to have a greater effect on organisms in the upper water column than dynamic plumes. In many cases, both types of plumes develop simultaneously, resulting in a composite plume which possess characteristics of surface and dynamic plumes. These are classified as transitional plumes.

Various factors influence which types of plume form: outflow velocity of tailings discharged from the vessel; water density and movement; and density of the plume (sand and silt composition of the mined sediments can vary greatly). The mining method also influences the sediment plume, with air-lift systems, which entrain air in the sediment, making the plume more buoyant and persistent in the upper water column, whereas dredge-pumped sediments have little or no air entrained, enabling the plume to sink much faster. Dredge-pumping is the proposed mining method for ML220.

Potential impacts on the water column associated with sediment plumes from mining vessels are primarily linked with increased turbidity and its effects on light penetration through the water column, remobilisation of dissolved constituents from seafloor sediments (see section 9.2.5), and reduction in oxygen levels in the water column resulting from high levels of primary production.

Sensitive Receptors

The taxa most vulnerable to increased turbidity and reduced light penetration are phytoplankton. Due to the location of the mining licence within the Lüderitz upwelling cell, the abundance of phytoplankton can be expected to be seasonally high. Being dependent on nutrient supply, plankton abundance is typically spatially and temporally highly variable and is thus considered to have a low sensitivity. Fish likely to be encountered in the water column are highly mobile and would be expected to avoid elevated suspended sediment plumes in the water column. Likewise, demersal fish would be expected to avoid elevated suspended sediment plumes near the seabed. These fauna are thus considered to have a low sensitivity.

Assessment

The formation, extent and dynamics of turbidity plumes generated by deepwater mining vessels have been comprehensively investigated in numerous studies (Environmental Evaluation Unit 1996; O'Toole 1997; Carter & Midgley 2000; CSIR 2006; Carter 2008). During continuous discharge of tailings from remote mining vessels, the major source of water column turbidity results from the dynamic collapse of the sediment-laden jet and the subsequent dilution, spreading and settling of the particulate constituents. In all cases, the suspended sediment concentrations generated at the point of discharge, the extent and area over which plumes disperse, and their duration, depend largely on the proportions of silts, muds and clays (<63 µm) in the mined sediments, as well as the sea-surface conditions during disposal. The higher the proportion of silts and clays in the target sediments, the larger and more persistent the suspended sediment plume is likely to be (Newell *et al.* 1998; Johnson & Parchure 1999; Posford Duvivier Environment 2001). Modelling studies, field measurements and aerial observations of tailings plumes from mining vessels found that concentrations reduce rapidly with distance from the vessel, indicating fairly fast settlement and dilution of even the fine fractions (Shillington & Probyn 1996; CSIR 1998b; Carter & Midgley 2000). In their study of tailings plumes from a deepwater mining vessel using an air-lift Wirth drill off Lüderitz, Carter & Midgley (2000) found that local tailings plumes ranged from 700 - 5,500 m in length and 700 - 3,500 m in width. Maximum plume sediment concentrations near the discharge point were found to be 60 mg/l, compared to background levels of <5 mg/l. These reduce rapidly with distance to a mean of <7 mg/l (maximum of 11 mg/l) 2 km downstream of the mining vessel, confirming fairly rapid settlement and dilution. Similarly, Holton *et al*. (2015) reported on measurements of suspended solids in the plume that extended downstream of the MV Mafuta, which operates a dredge-pump subsea crawler, in the Atlantic 1 MLA. Elevated turbidity (compared to <2 mg/l background levels) was detected in the upper water column extending to a maximum depth of ~70 m in the immediate vicinity of the mining vessel. The depth of the elevated turbidity signal decreased with distance away from the vessel, and the surface and deeper water expression of the signal dissipated almost entirely within ~500 m from the mining vessel. Beyond this point, little to no evidence of a turbidity signal throughout the water column could be detected.

Distribution and re-deposition of suspended sediments are the result of a complex interaction between oceanographic processes, sediment characteristics and engineering variables that ultimately dictate the distribution and dissipation of the plumes in the water column. Ocean currents, both as part of the meso-scale circulation and due to local wind forcing, are important in distribution of suspended sediments. Turbulence generated by surface waves can also increase plume dispersion by maintaining the suspended sediments in the upper water column.

One of the more apparent effects of increased concentrations of suspended sediments and consequent increase in turbidity, is a reduction in light penetration through the water column with potential adverse effects on the photosynthetic capability of phytoplankton (Poopetch 1982; Kirk 1985; Parsons *et al.* 1986a, 1986b; Monteiro 1998; O'Toole 1997) and the foraging efficiency of visual predators (e.g. pelagic fish, seabirds and marine mammals) (Simmons 2005; Braby 2009; Peterson *et al.* 2001). However, due to the rapid dilution and widespread dispersion of settling particles, any adverse effects in the water column would be ephemeral and highly localised. Any biological effects on nectonic and planktonic communities would be negligible (Aldredge *et al.* 1986). Turbid water is a natural occurrence along the Southern African coast, resulting from aeolian and riverine inputs, resuspension of seabed sediments in the wave-influenced nearshore areas and seasonal phytoplankton production in the upwelling zones.

High sediment loading can also impair the egg and/or larval development of fish and invertebrates may be impaired through. Bivalves and crustaceans in particular may be impacted by near-bottom plumes include. Suspended sediment effects on juvenile and adult bivalves occur mainly at the sublethal level with the predominant response being reduced filter-feeding efficiencies at concentrations above about 100 mg/l. Lethal effects are seen at much higher concentrations (>7,000 mg/l) and at exposures of several weeks.

Due to the naturally turbid nearshore waters, kelp is restricted to the immediate subtidal regions to a maximum depth of ~10 m. Those fringing kelp beds occurring around Black Rock and the rocky shoreline to the north are unlikely to be affected by the turbidity plumes generated as a result of tailings discharges. Similarly, the depths of the proposed sampling areas lie beyond those at which kelp is likely to occur on adjacent reefs and no shading of these canopy forming macrophytes by mining-related turbidity plumes is expected.

As the unconsolidated sediments in the mining target area in ML220 comprise primarily medium to fine sands, with a minimal silt and clay fraction, the suspended sediment plumes generated through discharge of tailings during sampling and mining operations in ML220 are expected to remain far more localised than those reported from previous studies of deepwater mining vessels. Furthermore, the sediments will be dredge-pumped at a mining rate orders of magnitude lower than the mining vessels for which the previous studies have been undertaken. As Hottentots Bay is relatively protected, the spreading of the plume by winds and currents will be minimal and any plumes generated during the sampling and mining process will thus remain highly localised. The low-intensity, negative impact of suspended sediments generated during sampling and onboard processing operations and its effects on the associated communities will therefore be extremely localised and very short-term. The plumes will be ephemeral and negative effects of increased suspended sediment concentrations on marine communities are highly unlikely as biota would be well adapted to naturally high suspended sediment concentrations. Even the highest concentrations in the immediate discharge are unlikely to reach concentrations that would have lethal effects on marine fauna. The impacts from suspended sediment plumes can confidently be rated as being of **LOW** significance.

<u>Mitigation</u>

No mitigation measures are possible, or considered necessary for the discharge of fine tailings from the sampling vessel.

A recommended management measure would be to monitor pelagic seabird and small mammal occurrence and activity around the sampling/mining vessel while in operation to determine if these are in any way affected by the suspended sediment plumes.

Increased turbidity in suspended sediment plumes and at the seabed		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Low
Duration	Short-term	Short-term

Extent	Local: limited to around the sampling/mining vessel and mining tool	Local
Consequence	Low	Low
Probability	Unlikely: lethal or sublethal effects on biota are highly improbable	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Increased turbidity in suspended sediment plumes would not result in cumulative impacts
Degree to which impact can be reversed	Suspended sediment plumes are short-lived and any effects will be fully reversible
Degree to which impact can be mitigated	Low

9.2.6 Remobilisation of contaminants and nutrients

Description of Impact

Recently deposited sediments in specific areas on the Namibian shelf may be characterised by high levels of heavy metals of marine and/or terrestrial origin (Calvert & Price 1970; Chapman & Shannon 1985; Bremner & Willis 1990). In the Atlantic 1 Mining Licence Area off Oranjemund, high metal concentrations have been measured in samples of surficial sediments (Environmental Evaluation Unit 1996; Biccard *et al.* 2020), some of which exceeded the Recommended Guideline Values (RGV) and in some cases Probable Effects Concentrations (PEC) published by the Benguela Current Commission (BCC). Geographic variation in the levels of trace metals tested in that area was considerable, and while it is considered likely that inputs from terrestrial sources (principally the Orange River) are responsible for elevated trace metal levels in proximity to the river mouth, in the northern portion of the Atlantic 1 MLA elevated levels of trace metals were consistent with similarly elevated levels observed in the the mudbelt between Lüderitz and Walvis Bay (Borchers *et al*. 2005; Carter 2010). Indeed, on the Namibian shelf, there appears to be a consistent relationship between trace metal concentrations and elevated organic carbon concentrations in the sediments. From this it can be inferred that the distribution of trace metal concentrations will follow that of the high Particulate Organic Carbon (POC) mud belts and that concentrations outside of these will be relatively low. This is consistent with general and widespread observations on sediment trace metals in that they are largely associated with silt and clay sized particles and generally have lower concentrations in coarser sediments (e.g. ANZECC 2000).

Changes in nutrient concentrations off the coast of Namibia are strongly driven by large-scale wind induced upwelling, which brings nutrient-rich waters to the surface. The shelf waters off Namibia are characterised by elevated concentrations of nutrients in comparison with those in the surface mixed layer of adjacent oceanic waters, and with concentrations in the SACW source waters. Local nutrient regeneration processes within the sediments and water column are thus important throughout the Benguela, but particularly off Namibia (Shannon & O'Toole 1998).

The re-suspension of sediments during mining can release these trace metals and nutrients into the water column. Metal bio-availability and eco-toxicology is complex and depends on the partitioning of metals between dissolved and particulate phases and the speciation of the dissolved phase into bound or free forms (Rainbow 1995; Galvin 1996). Although dissolved forms are regarded as the most bio-available, many of these are not readily utilisable by aquatic organisms. Consequently those forms that are ultimately bio-available and potentially toxic to marine organisms usually constitute only a fraction of the total concentration. Trace metal uptake by organisms may occur through direct absorption from solution, by uptake of suspended matter and/or *via* their food source. Toxic effects on organisms may be exerted over the short term (acute toxicity), or through bioaccumulation.

Sensitive Receptors

The benthic fauna inhabiting unconsolidated sediments in ML220 are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the continental slope unconsolidated sediments.

The taxa in the water column most vulnerable to bio-available contaminants are phytoplankton, which will be seasonally abundant during upwelling periods. Being dependent on nutrient supply, plankton abundance is typically spatially and temporally highly variable and is thus considered to have a low sensitivity. These fauna are thus considered to have a low sensitivity.

Assessment

Chemical analyses of tailings samples from mining vessels in the Atlantic 1 MLA found that heavy metal concentrations did not exceed the SA chronic water-quality guidelines or the "prohibition limit" as imposed by the London Convention, for any of the measured contaminants (Steffani & Pulfrich 2004; CSIR 2006). In some cases, however, concentrations were in the category which requires some form of "action or special care" (CSIR 2006). Despite concentrations within surficial sediments in the Atlantic 1 MLA being high (Biccard et al. 2020), it appears that those contaminants released during the mining process are rapidly diluted and their concentrations in the water column following discharge of tailings is very low. Furthermore, as plumes generated during mining are highly dynamic, neither acute effects nor bioaccumulation are likely to be of concern. In ML220, in particular, organic carbon concentrations in the sediments is expected to be low due to the low contribution by silts and muds. Trace metal concentrations are thus likely to be negligible and potential chemical contamination of the water column and bio-accumulation in the sediments or in biological receptors is highly unlikely. The impacts associated with the potential release of contaminants from disturbed sediments is therefore considered of **LOW** significance.

Similarly, the introduction of nutrients into the upper layers of the water column as a result of tailing discharge is considered negligible given the highly localised area affected by the suspended sediment plumes generated during sampling and mining operations, relative to that influenced by upwelling (Schloemann 1996).

Mitigation

No mitigation measures are possible, or considered necessary for the possible remobilisation of contaminants and nutrients in the sediments.

Remobilisation of Contaminants and Nutrients		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to around the sampling/mining vessel and mining tool	Local
Consequence	Low	Low
Probability	Unlikely: lethal or sublethal effects on biota are highly improbable	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Remobilised contaminants and nutrients in discharged tailings would not result in cumulative impacts
Degree to which impact can be reversed	Suspended sediment plumes are short-lived and any effects will be fully reversible
Degree to which impact can be mitigated	Low

9.2.7 Smothering of benthos in redepositing tailings

Description of Impact

The sampled seabed sediments are pumped to the surface and discharged onto sorting screens, which separate the large gravel, cobbles and boulders and fine silts from the 'plantfeed'. The oversize tailings are discarded overboard and settle back onto the seabed beneath the vessel where they can result in a localised smothering of benthic communities adjacent to the sampled areas. Smothering involves physical crushing, a reduction in nutrients and oxygen, clogging of feeding apparatus, as well as affecting choice of settlement site, and post-settlement survival.

In general terms, the rapid deposition of the coarser fraction from the water column is likely to have more of an impact on the soft-bottom benthic community than gradual sedimentation of fine sediments to which benthic organisms are adapted and able to respond. However, this response depends to a large extent on the nature of the receiving community. Studies have shown that some mobile benthic animals are capable of actively migrating vertically through overlying sediment thereby significantly affecting the recolonization of impacted areas and the subsequent recovery of disturbed areas of seabed (Maurer *et al*. 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger *et al*. 2000; but see Harvey *et al.* 1998; Blanchard & Feder 2003). In contrast, sedentary communities may be adversely affected by both rapid and gradual deposition of sediment. Filter-feeders are generally more sensitive to suspended solids than deposit-feeders, since heavy sedimentation may clog the gills. Impacts on highly mobile invertebrates and fish are likely to be negligible since they can move away from areas subject to redeposition.

Of greater concern is that sediments discarded during sampling operations may impact rocky-outcrop communities adjacent to sampling target areas hosting sensitive reef communities and rock lobsters. Studies investigating the discard of the oversize tailings during diver-assisted mining found that benthic communities characterising tailings dump sites were significantly different from those of unaffected reef areas as a result of the change in seabed type, being dominated by detritus feeders. However, the effects remained highly localised and persisted over the short-term only as tailings were rapidly redistributed by wave action (Barkai & Bergh 1992; Parkins & Branch 1995, 1996, 1997; Pulfrich 1998b; Pulfrich & Penney 1998, 1999b, 2001). Excessive and repetitive dumping on the same area may, however, preclude dispersion and thus induce persistent change by reducing biodiversity, changing community structure, potentially altering preferred rock lobster habitat and smothering of benthic organisms, thereby reducing food availability for lobsters.

The abundance of lobsters within a habitat, however, also depends on the availability and suitability of food (Parrish & Polovina 1994; Hudon 1987; Branch & Griffiths 1988; Wahle & Steneck 1991, 1992). In the Lüderitz area, rock lobsters feed primarily on mussels and algae (Tomalin 1993). Smothering of reef areas and their associated benthic communities adjacent to mining targets through the discharge of oversize tailings may therefore indirectly affect rock lobster abundance in an area as well as reducing growth and reproductive rates of the animals.

Sensitive Receptors

The mining and sampling activities would be undertaken in the offshore marine environment where the Lüderitz Nearshore benthic habitat types have been rated as of 'Least Concern'. The benthic fauna inhabiting unconsolidated sediments at the depths of the proposed sampling are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the unconsolidated sediments in ML 220. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered LOW.

Assessment

The impacts of redepositing tailings onto seabed of unconsolidated sediments would be of low intensity but highly localised, and short-term as recolonization from adjacent areas or upward migration through deposited sediments would occur rapidly. Considering the available area of unconsolidated seabed habitat on the continental shelf off southern Namibia, the reduction in biodiversity of macrofauna associated with unconsolidated sediments through smothering can be considered negligible. The potential impact of smothering on communities in unconsolidated habitats is consequently deemed to be of **LOW** significance. In the case of rocky outcrop communities, however, impacts could be of medium intensity and highly localised, but potentially enduring over the medium-term due to their slower recovery rates. As the mining target is far removed from reef habitats, there is a very low likelihood of the impact occurring. Also, as the sampling and mining target areas are located within the wave base, any fine sediments settling on adjacent reefs would be periodically resuspended and redistributed by near-bottom currents. Smothering effects would therefore likely be ephemeral. The potential impact of smothering on rocky outcrop communities is consequently deemed to be of **LOW** significance.

Mitigation

No mitigation measures are possible, or considered necessary for the loss of macrobenthos due to smothering by redepositing sediments. However, sampling activities of any kind should avoid rocky outcrop areas or other identified sensitive habitats in the exploration area.

Redeposition of discarded sediments on soft-sediment macrofauna		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to around the sampling/mining vessel	Local
Consequence	Low	Low
Probability	Possible	Possible
Significance	Low*	Low
Status	Negative	Negative

Confidence	High	High

Nature of Cumulative impact	Redeposition of tailings on unconsolidated seabed would not result in cumulative impacts
Degree to which impact can be reversed	The impact is fully reversible as natural recovery of affected communities will occur from adjacent areas and deposited sediments will be rapidly redistributed by swell action
Degree to which impact can be mitigated	Low

*although by definition this should be rated as MEDIUM, when seen in the context of similar available habitat on the continental shelf, it is reduced to LOW.

Redeposition of discarded sediments: smothering effects on rocky outcrop communities		
	Without Mitigation	**Assuming Mitigation**
Intensity	Medium	Low
Duration	Medium-term	Short-term
Extent	Site specific: limited to isolated reef areas	Local
Consequence	Medium	Low
Probability	Unlikely	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Redeposition of tailings on reefs is unlikely to lead to cumulative impacts as sampling activities will focus on targets over the very short-term only
Degree to which impact can be reversed	The impact is fully reversible as natural recovery of affected communities will occur over the medium-term
Degree to which impact can be mitigated	Low

9.2.8 Loss of Ferrosilicon

Description of Impact

The only additive used in the diamond extraction process onboard the mining vessels is Ferrosilicon (FeSi). Although most of the FeSi is magnetically recovered for re-use, recovery is lower when mining sediments with a high shell content, as the FeSi becomes trapped in the shells. On average ~6-8 tons are lost annually per vessel of this magnitude during full-scale mining operations.

Sensitive Receptors

The benthic fauna inhabiting unconsolidated sediments at the depths of the proposed sampling are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the unconsolidated sediments in the licence area. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered low.

Assessment

Ferrosilicon is made up of sand (silicon) and iron oxides, with small amounts of trace elements. It therefore oxidises rapidly in seawater and has no detrimental effect of marine life. There is, however, a risk of exceeding established water quality guidelines by the heavy metal constituents of the FeSi. Dilution of these trace elements would be rapid, and any effects are likely to be brief. The potential impact would thus be of low intensity, persisting only locally over the short-term and can confidently be considered of **LOW** significance.

Mitigation

The following mitigation measures are recommended:

- Reduce FeSi loss through the implementation of shell crushers or ball mills.
- Maintain accurate records of all FeSi used and discarded overboard with tailings.

Loss of Ferrosilicon		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Site specific: limited to around the vessel	Local
Consequence	Low	Low
Probability	Unlikely	Unlikely

Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Loss of FeSi would not result in cumulative impacts
Degree to which impact can be reversed	Fully Reversible
Degree to which impact can be mitigated	Medium

9.2.9 Potential loss of Equipment

Description of Impact

Equipment such as anchors and sampling tools are occasionally lost on the seabed, although every effort is usually made to retrieve them. Equipment that sinks to the seabed, would crush benthic fauna in its footprint and potentially disturb or damage seabed habitats, but ultimately provide a hard surface for colonisation. If lost anchor cables float to the surface, they would pose a shipping hazard, and an entanglement risk to turtles and marine mammals, potentially leading to physiological injury or death.

Sensitive Receptors

The benthic fauna inhabiting unconsolidated sediments at the depths of the proposed sampling are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the unconsolidated sediments in the licence area. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered low.

In contrast, the benthos of hard substrata, are typically vulnerable to disturbance due to their longer generation times. The closest reefs and hard grounds lie ~500 m to the west of the mining target and these amy harbour more sensitive biota such as sponges, gorgonians and soft corals. The sensitivity of such reef communities is considered moderate.

Assessment

If left on the seabed, large items such as anchors and sampling tools would form a hazard to other users. If not retrieved, the loss of equipment would be considered of low intensity, resulting in only highly localised damage to or loss of biota and would thus be rated as being of **LOW** significance. Although they would eventually be colonised by benthic organisms typical of hard seabeds, every effort should be made to remove such foreign objects.

In the case of anchor cables or ropes, the loss of such equipment would be of moderate intensity due to the entanglement risks posed to seals, turtles and cetaceans. The moderate-intensity negative impact of lost cables and ropes would be extremely localised but if not retrieved could result in mortality of the entangled animal. Entanglement by small cetaceans and seals in ropes and cables is considered possible and the impact is thus rated as being of **MODERATE** significance.

Mitigation

The positions of all lost equipment must be accurately recorded in a hazards database, and reported to maritime authorities. Every effort should be made to remove lost equipment, especially anchor ropes and cables.

Equipment lost to the seabed or watercolumn		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low to Moderate (cables and ropes)	Low
Duration	Permanent	Short-term
Extent	Local: limited to mining area	Local
Consequence	Moderate	Low
Probability	Unlikely to Possible (cables and ropes)	Unlikely
Significance	Low to Moderate (cables and ropes)	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	No cumulative impacts are anticipated
Degree to which impact can be reversed	Fully Reversible – any lost equipment is likely to be recovered
Degree to which impact can be mitigated	High

9.2.10 Pollution of the marine environment through Operational Discharges from Vessel

Description of Impact

During the geophysical surveying and sampling and mining operations, normal discharges to the sea can come from a variety of sources (from survey and sampling/mining vessel) potentially leading to reduced water quality in the receiving environment. These discharges are regulated by onboard waste management plans and shall be MARPOL compliant. For the sake of completeness, they are listed and briefly discussed below:

- **Deck drainage**: all deck drainage from work spaces is collected and piped into a sump tank on board the vessel to ensure MARPOL compliance (15 ppm oil in water). The fluid would be analysed and any hydrocarbons skimmed off the top prior to discharge. The oily substances would be added to the waste (oil) lubricants and disposed of on land.
- **Sewage**: sewage discharges would be comminuted and disinfected. In accordance with MARPOL Annex IV, the effluent must not produce visible floating solids in, nor causes discolouration of, the surrounding water. The treatment system must provide primary settling, chlorination and dechlorination before the treated effluent can be discharged into the sea. The discharge depth is variable, depending upon the draught of the vessel / support vessel at the time, but would not be less than 3 m below the surface.
- **Vessel machinery spaces and ballast water**: the concentration of oil in discharge water from vessel machinery space or ballast tanks may not exceed 15 ppm oil in water. If the vessel intends to discharge bilge or ballast water at sea, this is achieved through use of an oily-water separation system. Oily waste substances must be shipped to land for treatment and disposal.
- **Food (galley) wastes**: food wastes may be discharged after they have been passed through a comminuter or grinder, and when the vessel is located more than 12 nautical miles from land. For vessels outside of special areas, discharge of comminuted food wastes is permitted when >3 nautical miles from land and en route. Discharge of food wastes not comminuted may be discharged from vessels en route when >12 nautical miles from shore. The ground wastes must be capable of passing through a screen with openings <25 mm. The daily volume of discharge from a standard mining/survey vessel is expected to be <0.5 m^3.
- **Detergents**: detergents used for washing exposed marine deck spaces are discharged overboard. The toxicity of detergents varies greatly depending on their composition, but low-toxicity, biodegradable detergents are preferentially used. Those used on work deck spaces would be collected with the deck drainage and treated as described for deck drainage above.
- **Cooling Water**: electrical generation on sampling vessels is typically provided by large diesel-fired engines and generators, which are cooled by pumping water through a set of heat exchangers. The cooling water is then discharged overboard. Other equipment is cooled through a closed loop system, which may use chlorine as a disinfectant. Such water would be tested prior to discharge and would comply with relevant Water Quality Guidelines.

<u>Sensitive Receptors</u>

The operational waste discharges would primarily take place in the licence area and along the route taken by the support vessels between the ML 220 and Lüderitz. The licence area extends offshore from the shore and is located within the NIMPA and Namibian Islands EBSA and therefore in close proximity to sensitive coastal receptors (e.g. key faunal breeding/feeding areas, bird or seal colonies). Vessel discharges *en route* to the onshore supply base in Lüderitz could similarly result in discharges closer to shore, thereby potentially having an environmental effect on the sensitive coastal environment.

The taxa most vulnerable to routine operational discharges are pelagic seabirds, turtles, and pelagic fish and marine mammals. Some of the species potentially occurring in the licence area, are considered regionally or globally 'Critically Endangered' (e.g. leatherback turtles, Cape Gannet), 'Endangered' (e.g. African Penguins, Bank and Cape Cormorant), 'Vulnerable' (e.g. loggerhead turtles, Hartlaub's Gull, Caspian Tern and humpback whales) or 'Near Threatened' (e.g. Crowned cormorant, African Black Oystercatcher). Although species listed as 'Critically Endangered' or 'Endangered' may potentially occur in ML 220, compliance with MARPOL will ensure reduced discharges and reduced sensitivity of marine fauna to these discharges. Thus, the overall sensitivity is considered to be medium.

Assessment

The potential impact on the marine environment of such operational discharges from the survey, sampling and mining vessel would be limited to the licence area over the short-term. As volumes discharged would be low, they would be of low intensity, and are therefore considered to be of **LOW** significance, both without or with mitigation.

Mitigation

The following mitigation measures are recommended:

- Ensure compliance with MARPOL 73/78 standards,
- Develop a waste management plan using waste hierarchy.

Impacts of operational discharges to the sea from vessels		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to immediate area around exploration vessel	Local
Consequence	Low	Low
Probability	Most likely	Most likely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	None
Reversibility	Fully Reversible
Loss of resources	N/A

Mitigation potential	High

9.2.11 Collision of Vessels with Marine Fauna and Entanglement in Gear

Description of Impact

The potential effects of vessel presence and towed equipment on turtles and cetaceans include physiological injury or mortality due to the survey/sampling/mining vessel, or support vessels colliding with animals basking or resting at the sea surface. Entanglement of cetaceans in towed equipment lines is also possible if tension is lost.

Sensitive Receptors

The leatherback turtles that occur in offshore waters around southern Africa, and likely to be encountered in ML 220 is considered regionally 'Critically Endangered'. However, due to their extensive distributions and feeding ranges, the numbers of individuals encountered are likely to be low.

Thirty-three species or sub species/populations of cetaceans (whales and dolphins) are known or likely to occur off the Namibian coast. The majority of migratory cetaceans in Namibian waters are baleen whales (mysticetes), while toothed whales (odontocetes) may be resident or migratory. Of the 33 species, the blue whale is listed as 'Critically Endangered', the fin and sei whales are 'Endangered' and the sperm, Bryde's (inshore) and humpback whales are considered 'Vulnerable' (South African Red Data list Categories). Due to the extensive distributions of the various species concerned and their unlikely occurrence within the Hottentots Bay inshore areas (with the possible exception of Humpback whales), and mobility of these animals to avoid project vessels, the numbers of individuals encountered during operations are likely to be low.

The overall sensitivity is considered to be **MEDIUM**.

Assessment

Collisions between turtles or cetaceans and vessels are not limited to survey and mining vessels. Given the slow speed (about 2 - 3 kts) of the survey vessel while towing the sonar sources, ship strikes and entanglement whilst surveying are unlikely, but may occur during the transit of the survey/sampling/mining vessel to or from the area of interest. Ship strikes by the support vessels may also occur. As the mining vessel is largely stationary, collisions would occur only while in transit to and from the support base in Lüderitz.

Ship strikes have been reported to result in medium-term effects such as evasive behaviour by animals experiencing stress, or longer-term effects such as decreased fitness or habitual avoidance of areas where disturbance is common and in the worst case death (see for example Constantine 2001; Hastie et al. 2003; Lusseau 2004, 2005; Bejder et al. 2006; Lusseau et al. 2009). Ship strikes have been documented from many regions and for numerous species of whales (Panigada et al. 2006; Douglas et al. 2008; Elvin & Taggart 2008) and dolphins (Bloom & Jager 1994; Elwen & Leeney 2010), with large baleen whales being particularly susceptible to collision. Any increase in vessel traffic through areas used as calving grounds or through which these species migrate will increase the risk of collision between a whale and a vessel. The chances of collisions would increase between May and December when humpback and fin whales are known to migrate through the area.

The sidescan sonar towfish and MBES towed astern of the survey vessel also increases the potential for collision with or entrapped in equipment and towed streamers when these are being lowered from the vessel into the water. Entanglement of cetaceans in gear is possible in situations where tension is lost on the towed array. The major cause of large whale entanglements (mainly southern right and humpback whales) in South Africa are static fishing gear, anchor, mooring and buoy lines and the large-mesh shark nets set off KwaZulu-Natal to reduce shark attacks (Meÿer et al. 2011).

Basking turtles are particularly slow to react to approaching objects and may not be able to move rapidly away from approaching equipment. Entrapment occurs either as a result of 'startle diving' in front of towed equipment. Depending on the equipment design, once stuck inside or in front of the sonar source, the water pressure generated by the 2–3 knot towing speed, would hold the animal against the source with little chance of escape.

Due to their extensive distributions and feeding ranges, and the extended distance (over 1 000 km) from their nesting sites, the number of turtles encountered during the proposed geophysical survey is expected to be low. Should collisions or entanglements occur, the impacts would be of high intensity for individuals but of LOW intensity for the population as a whole. Furthermore, as the duration of the impact would be limited to the short-term and be restricted to the survey area (LOCAL), the potential for collision and entanglement in equipment is therefore considered to be unlikely and therefore of **LOW** significance.

The potential for ship strikes and entanglement of cetaceans in the towed equipment, is similarly highly dependent on the abundance and behaviour of cetaceans in the survey area at the time of the survey and vessel speed. Due to their extensive distributions and feeding ranges, the number of cetaceans encountered is expected to be low. In the unlikely event of an entanglement occurring, the impacts would be of high intensity for individuals but of LOW intensity for the population as a whole. Furthermore, as the duration of the impact would be limited to the short-term, and be restricted to ML 220, the potential for entanglement in towed equipment is therefore considered to be of **LOW** significance.

Mitigation

The following mitigation measures are recommended:

- All vessel operators should keep a constant watch for marine mammals and turtles in the path of the vessel.
- Ensure vessel transit speed between the survey area and port is a maximum of 12 knots (22 km/hr), except within 25 km of the coast where it is reduced further to 10 knots (18 km/hr) as well as when sensitive marine fauna are present in the vicinity.
- A non-dedicated marine mammal observer (MMO) must keep watch for marine mammals behind the vessel when tension is lost on the towed equipment. Either retrieve or regain tension on towed gear as rapidly as possible.
- Should a cetacean become entangled in towed gear, contact the Ministry of Fisheries and Marine Reources to provide specialist assistance in releasing entangled animals.

Impacts on turtles and cetaceans due to ship strikes, collision and entanglement with towed or moored equipment		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to immediate area around exploration vessel	Local
Consequence	Low	Low
Probability	Unlikely	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	None
Reversibility	Fully Reversible
Loss of resources	N/A
Mitigation potential	High

9.2.12 Operational Spills and Vessel Accidents

<u>Description of Impact</u>

Instantaneous spills of marine diesel and/or hydraulic fluid at the surface of the sea can potentially occur during all project activity phases. Such spills are usually of a low volume and occur accidentally during fuel bunkering or as a result of hydraulic pipe leaks or ruptures, or from deliberate, illegal bilge water discharges at sea. Larger volume spills of marine fuels could occur in the unlikely event of a vessel collision or vessel accident.

Oil spilled in the marine environment will have an immediate detrimental effect on water quality. Any release of liquid hydrocarbons thus has the potential for direct, indirect and cumulative effects on the marine environment. These effects include physical oiling and toxicity impacts to marine fauna and flora, localised mortality of plankton (particularly copepods), pelagic eggs and fish larvae, and habitat loss or contamination (CSIR 1998; Perry 2005).

Unlike large commercial vessels, which operate on heavy fuel oils, small vessels generally operate on marine diesel fuels. The consequences and effects of relatively small (2,000 – 20,000 litres) diesel fuel spills into the marine environment are summarised below (NOAA 1998). Diesel is a light oil that, when spilled on water, spreads very quickly to a thin film and evaporates or naturally disperses within a few days or less, even in cold water. Diesel oil can be physically mixed into the water column by wave action, where it adheres to fine-grained suspended sediments, which can subsequently settle out on the seafloor. As it is not very sticky or viscous, diesel tends to penetrate porous sediments quickly, but also to be washed off quickly by waves and tidal flushing. In the case of a coastal spill, shoreline cleanup is thus usually not needed, but the location of the spill (e.g. next to an island or an active bird feeding or transiting the area) may necessitate immediate remedial action. Diesel oil is degraded by naturally occurring microbes within one to two months. Nonetheless, in terms of toxicity to marine organisms, diesel is considered to be one of the most acutely toxic oil types. Many of the compounds in petroleum products are known to smother organisms, lower fertility and cause disease. Intertidal invertebrates and seaweed that come in direct contact with a diesel spill may be killed. Fish kills, however, have never been reported for small spills in open water as the diesel dilutes so rapidly. Due to differential uptake and elimination rates, filter-feeders (particularly mussels) can bio-accumulate hydrocarbon contaminants. Crabs and shellfish can be tainted from small diesel spills in shallow, nearshore areas.

Chronic and acute oil pollution is a significant threat to both pelagic and inshore seabirds. Seabird oiling events may result from vessels cleaning their bilges at sea or from accidental spills (including from disintegrating fuel tanks of vessels that have sunk years earlier). Diving seabirds that spend much of their time on the surface of the water, and especially flightless African Penguins, are particularly likely to encounter floating oil and if not collected, de-oiled and nursed back to health will die as a result of even light to moderate oiling. Oiling damages plumage, eyes and internal organs. Poisoning from the ingestion of oil when birds attempt to preen off the oil also leads to mortalities or long-term internal injury, which reduces their ability to reproduce (Barham *et al.* 2007; Wolfaardt *et al.* 2009). The majority of associated deaths are as a result of the properties of the oil and damage to the water repellent properties of the birds' plumage. This allows water to penetrate the plumage, decreasing buoyancy and leading to sinking and drowning. In addition, thermal insulation capacity is reduced, and birds eventually succumb to hypothermia or starvation. Even small spills can be detrimental to seabirds, for example if a spill occurs close to seabird breeding islands or foraging "hotspots". Any oil spill, including of hydraulic oils, no matter how small, therefore require urgent intervention to limit the probability of seabirds coming into contact with oil.

Impacts of oil spills on turtles is thought to primarily affect hatchling survival (CSIR & CIME 2011). Turtles encountered in the project area would mainly be migrating adults and vagrants. Similarly, little work has been done on the effect of an oil spill on fur seals.

The effects of oil pollution on marine mammals is poorly understood (White *et al.* 2001), with the most likely immediate impact of an oil spill on cetaceans being the risk of inhalation of volatile, toxic benzene fractions when the oil slick is fresh and unweathered (Geraci & St Aubin 1990, cited in Scholz *et al.* 1992). Common effects attributable to the inhalation of such compounds to include absorption into the circulatory system and mild irritation to permanent damage to sensitive tissues such as membranes of eyes, mouth and respiratory tract. Direct oiling of cetaceans is not considered a serious risk to the thermoregulatory capabilities, as cetacean skin is thought to contain a resistant dermal shield that acts as a barrier to the toxic substances in oil. Baleen whales may experience fouling of the baleen plates, resulting in temporary obstruction of the flow of water between the plates and, consequently, reduce feeding efficiency. Field observations record few, if any, adverse effects among cetaceans from direct contact with oil, and some species have been recorded swimming, feeding and surfacing amongst heavy concentrations of oil (Scholz *et al.* 1992) with no apparent effects.

Sensitive Receptors

In the unlikely event of an operational spills or vessel collision, this would primarily take place in the licence area and along the route taken by the vessels between the ML 220 and Lüderitz. The licence area extends offshore from the shore and is located within the NIMPA and Namibian Islands EBSA and therefore in close proximity to sensitive coastal receptors (e.g. key faunal breeding/feeding areas, bird or seal colonies). Diesel spills or accidents *en route* to the onshore supply base in Lüderitz could result in fuel loss closer to shore, thereby potentially having an environmental effect on the sensitive coastal environment.

Oil or diesel spilled in the marine environment will have an immediate detrimental effect on water quality. Being highly toxic, marine diesel released during an operational spill would negatively affect any marine fauna it comes into contact with. The taxa most vulnerable to hydrocarbon spills are coastal and pelagic seabirds. Some of the species potentially occurring in the survey area, are considered regionally or globally 'Critically Endangered' (e.g. Cape Gannet) or 'Endangered' (e.g. African Penguin, Bank and Cape Cormorant) or 'vulnerable' (e.g. Hartlaub's Gull, Swift Tern). The impact of oiling not only results in the death of oiled penguins, but also has cascade effects through the entire population by decreasing the breeding success. Oil pollution thus represents a significant threat to the seabird populations and may contribute to some of these species becoming extinct in the wild. The sensitivity of marine fauna to diesel spill is considered to be HIGH.

Assessment

In the unlikely event of an operational spill or vessel accident, the intensity of the impact would depend on (a) the amount of fuel spilled; (b) the location of a spill, i.e. proximity to the shore and seabird breeding habitats; and (c) in the event of a vessel collision, on the type of fuel that is spilled by one or both vessels. As marine diesel evaporates quickly the impact would persist only over the short-term and remain localised, while a spill involving heavy fuel oils would need quick intervention to contain and remove it. The survey and sampling/mining vessels are likely to carry in excess of 150 m^3 of marine diesel, so under the worse-case scenario of a vessel grounding or sinking, in the region of 100 - 130 m^3 could be lost to the marine environment. In the sensitive environment of the NIMPA, and the likely proximity of the spill to seabird nesting areas and the shoreline, the potential impact of a spill would be of HIGH to VERY HIGH intensity. The greatest risk of shoreline oiling would be from a spill that occurred within Hottentots Bay, as the diesel would travel as a narrow plume in a north-westward direction, potentially coming ashore along the coast between Saddle Hill and Mercury Island. The impact would remain REGIONAL over the SHORT TERM (days). In the case of marine diesel, the consequence would thus be MODERATE to HIGH. Although operational spills are POSSIBLE, vessel accidents and collisions are UNLIKELY. The significance of the impact is therefore considered **LOW** to **MODERATE** if not mitigated.

Mitigation Measures

The following mitigation measures must be implemented:

- Ensure that vessels operate in accordance with Namibian Maritime and Mining safety regulations to minimise risks of accidents.

- Refuelling of vessels is to occur under controlled conditions in a harbour only.
- Ensure that the vessel operator has prepared and implemented a Shipboard Oil Pollution Emergency Plan and an Oil Spill Contingency Plan. In doing so, take cognisance of the Namibian National Marine Pollution Contingency Plan, which sets out national policies, principles and arrangements for the management of emergencies including oil pollution in the marine environment.
- Since the National Marine Pollution Contingency Plan is still lacking a dedicated wildlife response plan, in the case of a spill the Lüderitz office of MFMR and the African Penguin Conservation Project must be alerted without delay. This early alert is essential for timely search and rescue operation for potentially affected seabirds and admission to the small seabird rehabilitation facility at the MFMR offices. Depending on the scale of need for seabird rescue and rehabilitation, additional assistance, including from outside Namibia, may be required as local capacity is limited.
- Ensure adequate resources are available to collect and transport oiled birds to the cleaning station.
- Ensure that sunken vessels are removed from the sea floor before chronic leaks can occur.
- Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Use dispersants only with the permission of MEFT/MFMR.

Operational Spills and Vessel Accidents		
	Without Mitigation	**Assuming Mitigation**
Intensity	High to Very High	Low to Moderate (seabirds)
Duration	Short-term: marine diesel evaporates rapidly	Short-term
Extent	Regional: limited to within ~100 km of the spill site	Local
Consequence	Moderate to High	Low to Moderate
Probability	Possible (operational Spill)/ Unlikely (vessel accident)	Unlikely
Significance	Low to Moderate	Low
Status	Negative	Negative
Confidence	High	High

Nature of cumulative impact	Cumulative impacts on marine fauna are not expected.
Degree to which impact can be reversed	Most effects on marine fauna would be fully reversible if timely action is taken, but there may be long-term effects with respect to the demography of impacted, threatened seabirds.
Degree to which impact can be mitigated	Moderate to High

9.2.13 Exclusion from Fishing Ground

Description of Impact

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), a vessel that is engaged in surveying is defined as a “vessel restricted in its ability to manoeuvre” which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. In addition to a statutory 500 m safety zone, a vessel operator would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond.

While the survey and sampling vessels are operational at a given location, a temporary 500 m operational safety zone around the unit would be in force, i.e. no other vessels (except the support vessels) may enter this area. A vessel conducting marine sampling operations would typically operate on a 3 or 4 anchor spread with unlit anchor mooring buoys. For the duration of operations a coastal navigational warning would be issued by the South African Navy Hydrographic Office (SANHO) requesting a 500 m clearance from the survey and mining vessels. The safety zones aim to ensure the safety both of navigation and of the project vessel, avoiding or reducing the probability of accidents caused by the interaction of fishing boats and gears and the survey and mining vessels.

The exclusion of vessels from entering the safety zone poses a direct impact to fishing operations in the form of loss of access to fishing grounds or displacement of fishing effort into alternative fishing grounds.

An overview of the Namibian fishing industry and a description of each commercial sector is presented in Sections 4.1 and 4.5, respectively. The affected fisheries sectors have been identified based on the extent of overlap of fishing grounds with the ML. The linefish and rock lobster sectors have historically operated within the area and are currently active.

The sensitivity of a particular fishing sector to the impact of the safety / exclusion zone would differ according to the degree of disruption to that fishing operation. The current assessment considers this to be related to the availability of alternative fishing grounds and the likelihood that activity can be relocated away from the affected area (the safety / exclusion zone) into alternative fishing areas.

Impact Assessment

The exclusion of vessels from entering the safety zone around a vessel engaged either in survey or mining activities poses a direct impact to fishing operations in the form of loss of access to fishing grounds.

Boat-based fishing for linefish takes place within ML 220. Although most of the fishing effort is centred offshore of the 100 m depth contour, snoek is targeted in nearshore waters over the period February to June. Data provided on the fishery show that very small amounts of snoek are occasionally caught either within ML220 or in the proximity of the area. Snoek availability is highly seasonal and the catches, which average 1.97 tonnes a year or 0.06% of the total snoek landings in Namibian waters, is considered negligible. Fishing effort expended within the area amounted to an average of 24 hours, or 40 lines per year. The potential impact of displacement of fishing operations is considered to be local in extent and of short-term duration. The consequence of the impact on the sector is expected to be low and, due to the low probability of occurrence, of overall low significance.

Rock lobster is targeted by a fleet of vessels based exclusively in the port of Lüderitz. ML 220 coincides with the Black Rock (Zone 5) and Hottentot Point (Zone 6) management zones which yielded an average of 17.2 tonnes of lobster per year over the period 2005 to 2016 –

this is equivalent to 22.2% of the total landings recorded by the sector. Effort within the ML is seasonal, from January to April. Fishing takes place on rocky grounds at a water depth of between 2-40 m. As the proposed mining and target areas are situated in areas of unconsolidated sediment, the probability of these areas coinciding with preferred fishing grounds is considered to be low. The potential impact of displacement of fishing operations is considered to be local in extent and of short-term duration. The consequence of the impact on the sector is expected to be moderate and, due to the low probability of occurrence, of overall low significance.

Mitigation

A process of notification and information-sharing should be followed with the rock lobster and linefish associations. The required safety zones around the survey and sampling vessels should be communicated via the issuing of Daily Navigational Warnings for the duration of the mining operations through the South African Naval Hydrographic Office and broadcast by Lüderitz radio.

The linefish sector targets snoek in close proximity to ML 220 over the period February to June. Timing of the survey and mining activities to avoid this fishing period would eliminate the impact on the sector.

The rock lobster sector operates within ML 220 during the period January to April. Timing of the survey and sampling activities to avoid this fishing period would eliminate the impact on the sector.

Impacts of exclusion of fisheries during survey and mining operations		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low (linefish) Moderate (rock lobster)	N/a
Duration	Short-term	N/a
Extent	Local	N/a
Consequence	Low	N/a
Probability	Unlikely	N/a
Significance	Low	No Impact
Status	Negative	N/a
Confidence	medium	N/a

Nature of cumulative impact	some cumulative impacts can be anticipated but not expected to raise the significance rating.
Degree to which impact can be reversed	Fully reversible
Degree to which impact can be mitigated	High

9.2.14 Economic Impacts at Local and National Level

Description of Impacts

LK Mining intends to purchase a supply vessel and convert it to a remote mining vessel. The vessel will mine at a rate of approximately 15m^2 per hour in shallow waters and operate at a much smaller scale than the DebMarine's mining vessel "Mafuta" and the IMDH vessel "Ya Toivo". The smaller scale will enable LK Mining to have considerably lower capital and operating costs.

Capital expenditure (CAPEX) for the initial implementation phase is expected to be approximately N$70 million (USD5 million)[30], compared to the N$51 million (USD 3.6 million) forecast in 2018. This CAPEX includes:

- the purchase of the vessel from Norway and its delivery to Cape Town, re-flagging and re-registration
- Vessel conversion from a supply vessel to a remote mining vessel
- the design, manufacture and installation of the processing plant and mining system
- In Port costs during the 4-month conversion period.
- Operational readiness
- Crew salaries and
- Project management and contingencies (LK Mining, 2019).

Operational costs are based on 11/12 months of operations at sea and one month in the Port of Walvis Bay for routine maintenance.

These were calculated to be approximately N$14.5 million (USD1.1 million) per annum in August 2018.

LK Mining made the following assumptions to calculate the anticipated revenue: Diamonds recovered from any exploration are excluded from revenue income. In addition, revenue is based on a fixed US$/carat – larger stones will sell for higher US$/ct prices, but this nuance was not considered in their financial evaluation. An average recovered grade of 0.4 cts/m^2 is applied for the base case and 0.5 cts/ m^2 for the most likely case. The revenue is based on estimating mining 6 cts/hr (base case) and 7.5 cts/hr (most likely) at a rate of 15 m^2/hr. The actual recovered grade will vary from year to year, and from target to target, based on the forecast Mine Plan.

Based on an anticipated revenue stream of recovering 6 carats per hour at USD146 per carat, the project is expected to breakeven within five years (after tax). In a more likely scenario of landing higher quality diamonds at a rate of 7.5 carats per hour, at USD156.6/carat, the project will breakeven within one year (**Table 21**).

Table 21: Summary of Project's Financial Evaluation.

Economic Inputs	Base case	Most Likely
2019 Exchange Rate (N$/USD)	14.44	14.44
2019 USD/carat	146.16	156.6
Hurdle Rate (Min rate of return expected)	10%	10%
Operational Inputs		

[30] Minutes of meeting with the CEO of Lüderitz Town Council on 8 April 2021.

Utilisation (average)	36%	37%
Mining rate per m²/hour	15	15
Grade (carats/hour)	6	7.5
Capital Inputs (as per 2018 feasibility study)		
Initial capital (N$ million)	52.9	52.9
Total annual capital (N$ million)	14.7	14.7
Working Cost Inputs		
Average Annual working cost (N$ million)	16.8	17
Net Present Value after tax (N$ million)	10.46	44.15
Internal Rate of Return	14.5%	27.3%
Breakeven (after tax) in Years	5	1

Source: (LK Mining, 2019)

In terms of taxes and royalties, LK Mining is expecting to contribute as follows, once accumulated tax losses are depleted:

- Royalties: Flat 10% on gross revenue of diamond sales
- Tax Rate: 55% for diamond mining companies in Namibia (Tax is calculated on the basis of 10% straight line depreciation of initial capital over 7 years, and is ring-fenced for the project)
- Diamond Export Fee: 1% (LK Mining, 2019).

Other direct economic impacts of the project will be the personal income tax paid by the 28 employees and any contractors' employees, VAT on goods and services they purchase, as well as suppliers and their employees in the supply chains of goods and services. Additional benefits will come from LK Mining having an office and store space in Lüderitz. Direct economic impacts also include any interest and amortisation payments on capital.

Indirect economic impacts arise through the provision of all inputs purchased in order to mine, such as provisions for the crews, fuel, boat maintenance in Walvis Bay etc., as well as the inputs purchased by their suppliers to produce the inputs, and so on down the production chain. This backward chain can be extensive and includes operating inputs and replacement parts, and a wide variety of scientific, financial, accounting, technical, security, etc. services.

Induced economic impacts are derived from the purchases of products and services by employees and contractors as a result of their spending power stemming from salaries and wages. If these products and services are produced in Namibia, there will be greater economic impact in Lüderitz and other parts of the country. Moreover, this induced level has its own backward chain of purchases by the employees and contractors down the supply chain.

Assessment

The LK Mining offshore diamond mining project, although relatively small in scale, will have positive economic impacts for its employees and suppliers in Lüderitz, for any employees in the Namibian supply chain, for Namibian shareholders and for the Namibian government through the taxes and royalties paid and contribution to the GDP.

The impact is therefore rated of HIGH (H+) intensity and it will contribute to both local and national economies, so its extent is rated HIGH (H). The impact will continue for the duration of the life of mine (H) and therefore the overall consequence is HIGH (H+). The probability of making an economic contribution is MOST LIKELY so the significance of this impact is HIGHLY POSITIVE (H+).

Mitigation and Enhancement

The rock lobster industry also makes an important contribution to the local economy, although very seasonal. Every effort must be made by LK Mining to avoid disturbing and impacting on the lobster habitats, catch and the industry and this needs to be monitored on a monthly basis. The EIA Team's marine experts assess LK Mining's impact as low after mitigation so the risk to the lobster industry is also low.

LK Mining can enhance the economic benefits by taking the following measures:

- Buy Namibian-made goods and services wherever possible, or otherwise from South African Development Community businesses, which will increase the multiplier effect on the Namibian and SADC economies.
- Prioritise the employment of Namibians wherever possible.
- Employ Namibians who normally reside in Lüderitz to maximise benefits to the local economy.

Impacts on the local and national economy		
	Without Mitigation	**Assuming Enhancement**
Intensity	High	High +
Duration	Long-term	Long-term
Extent	Local – Lüderitz and national	Local – Lüderitz and national
Consequence	High	High
Probability	High	Very High
Significance	High	Very High
Status	Positive	Positive
Confidence	High	High

Nature of cumulative impact	Economic activities create more economic and social opportunities and benefits
Degree to which impact can be reversed	Some economic benefits that increase aspects such as education, child health and housing, remain permanent benefits
Degree to which impact can be mitigated	Medium

9.2.15 Impact: Employment and Skills Development

Description of Impacts

The crew compliment will be 14 people, rotating 7 on duty for 12 hour shifts each on 28-day cycles with the other crew. The vessel will operate for 11 months and then it will be taken to Walvis Bay for maintenance.

The operational personnel will include:

- On Shore Project Manager: The on-shore Project Manager has total responsibly for the safe operation of the company and its assets. All environmental assessments, compilations, reporting, verifications and instructions are managed by this position.
- Master of the Vessel: The Master is in overall charge of the vessel and must at all times ensure the safety of the vessel, its operation and its crew. This would include vessel related environmental (and health and safety) matters.
- The Vessel Mine Manager: The Vessel Mine Manager is responsible for all matters relating to mining. This would include mining related environmental (and health and safety) matters.
- Specialised technicians to run the Xray machine.
- Plant operators, deck hands, cooks and bosuns to be sourced from Lüderitz.
- Office /Store Administrator, Lüderitz.

LK Mining anticipates that most of these skills can be sourced in Lüderitz, which has a long history of offshore mining.

Assessment

The life of mine is expected to be 7 years, and this may be extended by a further 10 years, if sampling of the other three target areas shows positive results. Long term, permanent employment for 28 people on the vessel, plus onshore staff, is rated as HIGH POSITIVE intensity.

The duration of employment and gains in training and work experience builds human capacity for a lifetime and can contribute to the nation's sustainable development beyond the life of project. In Namibia, employment not only contributes support to immediate household members but also to many in the extended family as cash remittances, the payment of education fees and other forms of support.

This is rated LONG TERM. The spatial scale is HIGH as people will be employed locally, nationally and some perhaps internationally. The consequence of these positive impacts is HIGH due to their high intensity, their widespread nature and long duration.

These impacts will have to occur in order to operate the project, so the probability rating is MOST LIKELY. The significance of these positive impacts is HIGH because the consequence and probability of the impacts occurring are both high. Given the relative high unemployment rate in Lüderitz and the //Kharas Region as a whole, the creation of new jobs is significant.

Enhancements

LK Mining can enhance the benefits of employment by:

- Maximising local (Lüderitz) employment
- Recruiting women and youth under 35
- Prioritizing training and skills transfer among employees, on and off-the-job

- Supporting youth development initiatives through its corporate social responsibility programme e.g., through bursaries in marine mining and seamanship, and courses at the Benguela COSDEC.

Impacts on employment, at household, local and national levels		
	Without Mitigation	**Assuming Enhancement**
Intensity	High	High +
Duration	Long-term	Long-term
Extent	Local – Lüderitz and national	Local – Lüderitz and national
Consequence	High	High
Probability	Most likely	Most likely
Significance	High	Very High
Status	Positive	Positive
Confidence	High	High

Nature of cumulative impact	Work experience builds human capacity that lasts a lifetime. Many skills are transferable across industries, and can contribute to the nation's sustainable development beyond the life of project.
Degree to which impact can be reversed	Employment will cease when the project ends.
Degree to which impact can be mitigated	High, if skills transfer occurs which will increase the probability of further employment when the project ends.

Job losses on project closure

The loss of permanent employment, when the project closes, will have a negative impact on those affected, and their families. However, as marine diamonds are thought to be a large and important resource off the Namibian coast, reliable and experienced mining and marine personnel are likely to find employment.

9.2.16 Damage of loss of archaeological heritage

Description of Impacts

The most likely impact of seabed diamond exploration and mining in the proposed ML 220 on sites and materials protected under the National Heritage Act (27 of 2004) would be damage through inadvertent disturbance and possible destruction in the course of mechanical exploration and mining activities. This impact could seriously compromise in particular the underwater cultural heritage resources of Hottentot Bay, bearing in mind that damage to archaeological sites is essentially irreparable. The consequences of such impacts must be considered as permanent. However, it is not possible to assess the likelihood of such impacts with any degree of certainty, given that no inspection of the seabed within the lease area has been carried out. The following assessment must therefore be treated as tentative.

Assessment

Assessment of seabed diamond exploration and mining in the proposed ML 220 on sites and materials protected under the National Heritage Act (27 of 2004) is based on the criteria in Appendix 1 which sets out the approach for determining impact consequence (combining nature and intensity, extent and duration) and impact significance (the overall rating of the impact). Following the criteria for ranking the NATURE & EXTENT of potential impacts, the project (without mitigation) is likely to have a **Very High (VH+) Negative Impact**. The EXTENT of this impact would be **Low (L)** in that its direct effect would be within the lease area itself, but since the maritime archaeological heritage of the lease area is considered to the national heritage the extent can be considered as **High (H)**. As with all impacts on archaeological sites, the DURATION is considered to be **Very High (VH)**, or permanent. Given the historical importance of the lease area site and the documentary record of shipping losses there the PROBABILITY of the impact is considered to be **High (H)**. On the basis of the assessment criteria set out in Appendix 1, the SIGNIFICANCE of the impacts is negative and should be considered as **High (H)** without mitigation and reduced to **LOW** if mitigation is applied. The consequence and significance of these impacts is potentially highly negative given the information at hand.

Mitigation

Desktop survey of potential underwater heritage sites, especially shipwrecks in the area through study of available databases and historical records and newspapers. Databases include published as well as unpublished sources of information.

Due to the lack of early historical records for Namibian shipwrecks and the high possibility of early wrecks being located here, a magnetometer survey is necessary. A magnetometer survey records the background magnetic variation, any shipwrecks, even old wooden ships have a large amount of ferrous metal in them, these are picked up as anomalies against the earth's magnetic field. The magnetic data can also be used by geologist to better understand the underlying geology of the area.

If magnetic anomalies are noted, diver searches will need to be undertaken to ascertain if they are maritime underwater cultural heritage.

Damage and Loss to archaeological heritage		
	Without Mitigation	**Assuming Mitigation**
Intensity	High to Very High negative	High positive
Duration	High	High
Extent	Low	Low
Consequence	High	Low
Probability	High	High
Significance	High negative	Moderate positive
Status	Negative	Positive
Confidence	High	High

Nature of cumulative impact	Damage or loss of archaeological heritage
Degree to which impact can be reversed	Impacts can be avoided after the additional archaeological survey to find possible shipwrecks
Degree to which impact can be mitigated	High

10 ENVIRONMENTAL MANAGEMENT PLAN

10.1 The Aim

The aim of the Environmental Management Plan (EMP) is to detail the actions required to effectively implement mitigation and management measures. These actions are required to minimise negative impacts and enhance positive impacts associated with the mining activities and further sampling.

The EMP gives the environmental commitments, which will be implemented by LK Mining. These commitments relate to, amongst others, monitoring, areas to be avoided (fisheries and wrecks), additional environmental surveys, pollution control and waste management.

10.2 Action Plans to Achieve Objectives and responsibilities

Action plans to achieve the objectives are listed in tabular format together, separated by activities. LK Mining's mine manager is ultimately responsible for the implementation of the EMP. However, all members of LK Mining's mining team, and any sub-contractor, are expected to understand the EMP requirements and implement them.

10.2.1 EMP monitoring and performance assessment

EMP Compliance:

- Ensure that a copy of the EMP is onboard the operational vessel
- Conduct and record monitoring of EMP compliance
- Compile and submit bi-annual environmental reports to MEFT and MFMR
- Ensure compliance with the International Maritime Organisation's International Safety Management (ISM) Code, developed for the proper implementation and assessment of safety and pollution prevention management in accordance with good practice.

EMP amendments:

- On an ongoing basis, identify and address new activities and remove obsolete ones, particularly when new or changed mining methods and/or equipment are used. If required, amend the EMP as required and submit to MEFT for approval.

Financial Provision

- Maintaining adequate Protection and Indemnity (P&I) Insurance Cover to allow for clean-ups in the event of oil spills and other eventualities.

Environmental Management Plan		
Activity	**Potential Impact**	**Management and Mitigation Measures**
Mining vessel	Pollution and loss of equipment	• In regard to pollution ensure that the contracted vessels: - Implement a waste and sewage management procedures for disposal of general waste, hazardous waste, organic waste (food waste and sewage effluent), greywater, sewerage, bilge water, incineration of shipboard waste and the maintenance of waste records. - Record types and volumes of chemical and hazardous substances brought on board during the mining operation (e.g. neon lights, fluorescent tubes, toner cartridges, batteries etc.) and destination of wastes. - Separate waste and recycle where possible - Dispose of ALL wastes generated during the mining operations through an acceptable recycling company or at a licensed landfill site in Lüderitz and hazardous wastes to the licensed hazardous waste disposal facilities in Windhoek or Walvis Bay. - Dispose of sewage at a licensed waste water treatment plant in Lüderitz. Where vessels are not equipped with sewage treatment facilities, install conservancy tanks to hold sewage. - Seal medical wastes in aseptic containers for appropriate disposal onshore. - Comply with MARPOL requirements with regards to exhaust emissions. - Equipped with holding tanks to contain all oily water on board. - Where proper facilities for pumping oily water ashore are not provided, Company management must ensure that empty drums are left at harbour and other landing facilities into which the oily waste should be pumped. - Maintain and ensure the bilge tanks are kept clean. It is especially important that oil generated during engine overhauls is pumped ashore and not to bilge tanks. • Ensure applicable crew is trained in spill management. • The positions of all lost equipment must be accurately recorded in a hazards database, and reported to maritime authorities. • Every effort should be made to remove lost equipment. • In regard to emergencies ensure the following: - Maintain all emergency procedures as legally required. - Adhere to obligations regarding other vessels in distress. - Where diesel, which evaporates relatively quickly, has been spilled, the water should be agitated or mixed using a propeller boat/dinghy to aid dispersal and evaporation.

Environmental Management Plan		
Activity	**Potential Impact**	**Management and Mitigation Measures**
		• In the event of an emergency including fire, grounding or sinking, or collision, ensure that the approved Shipboard Oil Pollution Emergency Plan and Emergency Response Manuals are followed, which include: - Ensuring safety of personnel onboard; - Stabilising the ship and limit damages; - Containing the spill, if possible; and - Immediately reporting accidental spills to the relevant Authorities and Professional Bodies providing full details of the incident. • Refuelling will occur under controlled conditions in a harbour only. • Install fuel-efficient equipment • Service and repair all equipment regularly.
	Fisheries	• Prior to the commencement of each phase of the project, the Namibia Rock Lobster Association and MFMR should be informed of the pending activity and the likely implications for the affected fishing sectors and research surveys via an informational Notice to Mariners; • Daily Coastal Navigational Warnings should be issued for the duration of the mining and sampling operations through the South African Naval Hydrographic Office (SANHO) and daily notifications should be issued by Lüderitz radio; • A daily electronic reporting routine should be circulated, informing affected parties (i.e. fishing industrial bodies and MFMR) of the mining activities and expected date of completion as well as recorded fisheries interactions; and • Where possible, the geophysical survey should be scheduled to avoid the commercial rock lobster season • Inform Rock Lobster Association and MFMR that the mining vessel has completed operations • Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Rule 18), survey vessels that are engaged in surveying or towing operations requires that power-driven and sailing vessels give way to a restricted vessel. Vessels engaged in fishing shall, so far as possible, keep out of the way of mining and surveying operations. During seismic surveying, at least a 500 m safety zone would be needed to be enforced around the mining/survey vessel at all times. • Consult with MFMR and the Benguela Current Commission (BCC) prior to the commencement of the mining operation to coordinate and minimise possible disruption of research activities.

Environmental Management Plan		
Activity	**Potential Impact**	**Management and Mitigation Measures**
		• Staff operating the vessel may not collect any marine species (fish, shellfish, etc.) without a permit.
	MPA	• Do not land with small craft on any island or willfully disturb any sea bird or seal without a permit from MFMR. • Do not approach or work within 500m of an Island or Islet or rock outcrop or jetty • No mining will be conducted in areas where bed rock is exposed
Geophysical survey on target areas	Impact on physiology and behaviour of marine organisms	• Onboard Marine Mammal Observers (MMOs) should conduct visual scans for the presence of cetaceans around the mining vessel prior to the initiation of any acoustic impulses. • Limit pre-survey scans to 15 minutes prior to the start of survey equipment. • Carry out "soft starts" for any equipment of source levels greater than 210 dB re 1 μPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity. • Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area. • Try to avoid planning geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of June to end of November), and ensure that migration paths are not blocked by sonar operations. • Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place between June and November. • Appoint a MMO to ensure compliance with mitigation measures during seismic geophysical surveying. • As no seasonal patterns of abundance are known for odontocetes occupying the proposed mining area, a precautionary approach to avoiding impacts throughout the year is recommended.
Mining	Loss of benthic fauna	• Sampling activities of any kind should avoid rocky outcrop areas or other identified sensitive habitats in the ML. • A recommended management measure for the mining phase of the project would be to develop a robust and defensible benthic sampling programme, the objective of which would be to determine pre- and post-mining benthic community composition and demonstrate natural post-mining recovery of impacted communities.
	Collision of Vessels with Marine Fauna	• All vessel operators should keep a constant watch for marine mammals and turtles in the path of the vessel.

Environmental Management Plan		
Activity	**Potential Impact**	**Management and Mitigation Measures**
	and Entanglement in Gear	• Ensure vessel transit speed between the survey area and port is a maximum of 12 knots (22 km/hr), except within 25 km of the coast where it is reduced further to 10 knots (18 km/hr) as well as when sensitive marine fauna are present in the vicinity. • A non-dedicated marine mammal observer (MMO) must keep watch for marine mammals behind the vessel when tension is lost on the towed equipment. Either retrieve or regain tension on towed gear as rapidly as possible. • Should a cetacean become entangled in towed gear, contact the Ministry of Fisheries and Marine Resources to provide specialist assistance in releasing entangled animals.
	Loss of rock lobster	• Produce a sensitivity map of the ML area prior to mining together with MFMR. • Avoid sampling in the immediate vicinity of rocky outcrop areas or other identified sensitive habitats in the ML. • Monitor sorting screens and terminate operations should large numbers of lobsters appear on the screens over a short period of time. • Mining to take place between 14 and 44m only
	Turbidity on marine ecology	• Monitor pelagic seabird and small mammal occurrence and activity around the mining vessel while in operation to determine if these are in any way affected by the suspended sediment plumes.
	Redepositing tailings on marine benthos	• Avoid rocky outcrop areas by referring to sensitivity map (see maps in Section 6).
	Ferrosilicon on marine ecology	• Reduce FeSi loss through the implementation of shell crushers or ball mills. • Maintain accurate records of all FeSi used and discarded overboard with tailings.
	Heritage	• Conduct a magnetometer survey prior to the start of the mining operation in mining Target area.. A magnetometer survey records the background magnetic variation, any shipwrecks, even old wooden ships have a large amount of ferrous metal in them, these are picked up as anomalies against the earth's magnetic field. The magnetic data can also be used by geologist to better understand the underlying geology of the area. If magnetic anomalies are noted, diver searches will need to be undertaken to ascertain if they are maritime underwater cultural heritage. • No shore-based operations or facilities are permitted, other than in situations of dire emergency.

Environmental Management Plan		
Activity	**Potential Impact**	**Management and Mitigation Measures**
		• In the event that archaeological resources are discovered, a chance find emergency procedure will be implemented which includes the following: - All work at the find will be stopped to prevent damage; - Mark submerged object with a floating buoy - An appropriate heritage specialist will be appointed to assess the find and related impacts; and - If the in-situ inspection warrants recovery of the objects located this should be referred to the National Heritage Council for a decision and the issuing of a permit as required under the Act. • Contractors working on the site will be made aware that under the National Heritage Act any items protected under the definition of heritage found in the course of development should be reported to the National Heritage Council.
All activities	Socio-economic	• Use local Namibian suppliers of goods and services where economically feasible - Include local service providers in the tendering process for supplies and services - Give hiring priority to suitably qualified or experienced Namibian citizens, as positions become available.
	Contributing to knowledge	• Where possible supply research/ mining data to the marine science and fisheries communities – particularly records of marine mammal and bird sightings and weather patterns (wind speed and direction, wave height, fog incidence etc.).
	Monitoring Survey during mining and sampling	• Baseline bathymetric (MBES) and surface sediment sidescan sonar or multibeam bathymetry surveys, to provide a record of the pre-mining topography and surface sediment characteristics of the mining area. • Baseline surveys of benthic community composition in unconsolidated sediments at selected impact and control sites in and adjacent to the mining area, to provide information on the pre-mining composition of these communities, and to provide control sites for comparison with post-mining surveys. Sediments samples taken concurrently will provide information on sediment structure and POM. • Post-mining sidescan sonar and MBES surveys of selected portions of mined areas, immediately after mining, and 3 - 5 years after mining, to demonstrate infilling and smoothing of mined areas by natural sediment movement and deposition. • Post-mining surveys of benthic community composition in unconsolidated sediments at the selected impact and control sites in and adjacent to the mining area, to document natural changes in community composition, and to demonstrate recovery of benthic faunal communities. Sediments samples taken concurrently will provide information on sediment structure and POM.

Environmental Management Plan		
Activity	**Potential Impact**	**Management and Mitigation Measures**
		• Pre- and post-mining surveys of reef communities in the vicinity of mining target areas. This is best undertaken by means of video footage. • Keep records of pelagic seabird and small mammal occurrence and activity around the mining vessel while in operation to determine if these are in any way affected by the suspended sediment plumes, and to help determine specific nearshore feeding grounds.
	All potential impacts	• Identify and address training needs of staff to implementation/operation of the EMP • Educate staff about the marine ecosystem, especially the importance of benthic fauna.

11 WAY FORWARD

11.1 Way forward for the scoping report

The way forward for the EIA scoping phase is as follows:

- Distribute the scoping report and a summary thereof for review by the IAPs and authorities;
- receive comments from IAPs and authorities on 07 June 2021 (at the end of the review period);
- submit the scoping report (with comments) to MME and MEFT; and
- follow up on MEFT's decision.

12 ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSIONS

The impact assessment presents the potential for positive and negative environmental and social impacts that can all be mitigated to acceptable levels. The most significant potential impacts (unmitigated) are:

- Oil spillage from a sinking vessel
- Exclusion of the rock lobster fishery to their fishing grounds
- Seabed mining and sampling on benthic organisms
- Physical destruction and/or disturbance of submerged archaeological remains

The environmental aspects associated with the proposed offshore diamond mining by LK Mining have been successfully identified and assessed as part of this EIA process. Relevant mitigation measures have been provided and are included in the EMP that accompanies this scoping report. ASEC believes that a thorough assessment of the proposed project has been achieved and that MEFT can make an informed decision regarding the application for an environmental clearance certificate.

Alexandra Speiser

A. Speiser Environmental Consultants cc

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Appendix A: Background Information Document and presentation during focus group meetings

BACKGROUND INFORMATION DOCUMENT

ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML 220 OF LK MINING, REQUIRED FOR AN ENVIRONMENTAL CLEARANCE CERTIFICATE

INTRODUCTION

LK Mining (Pty) Ltd (LKM) applied for a Mining Licence (ML 220) over their existing EPL5965 area. The EPL is located in Hottentots Bay, approximately 60 km north of Lüderitz, and falls within the Namibian Islands Marine Protected Area (MPA) of the Namibian Coast (**Figure 1**). The ML covers an area of 4227 Ha. The Mining Licence application was filed by LKM with MME in October 2019. The last outstanding document, before execution and grant of ML220 is to apply and obtain an Environmental Clearance Certificate (ECC) from the Ministry of Environment, Forestry and Tourism (MEFT).

ENVIRONMENTAL APPROVAL

In terms of the Environmental Management Act, 7 of 2007, a project of this nature requires an environmental impact assessment (EIA) process to apply for Environmental Clearance from the MEFT (Department of Environmental Affairs (DEA)).

Prior to the commencement of the proposed mining activities over ML220, an application will therefore be submitted by LKM, to MEFT to obtain the required Environmental Clearance Certificate (ECC).

PURPOSE OF THIS DOCUMENT

This document has been prepared to inform you:

* about the proposed exploration and mining activities
* about the EIA process to be followed
* of possible environmental impacts
* how you can have input into the EIA process.

YOUR ROLE

Public involvement is an essential part of the EIA process.

You have been identified as an interested and affected party (IAP) who may want to know about the exploration and mining activities and also have input into the EIA process.

All comments will be recorded and addressed in the EIA process.

HOW TO RESPOND

Responses to this document can be submitted by means of the comment sheet or through communication with the contact person listed below.

If you would like your comments to be addressed in the EIA report please submit them by

27th April 2021

WHO TO CONTACT

Alexandra Speiser (ASEC) **Werner Petrick**
Email: amspeiser@yahoo.com **or** wpetrick@namisun.com
Fax: +264 61 233820

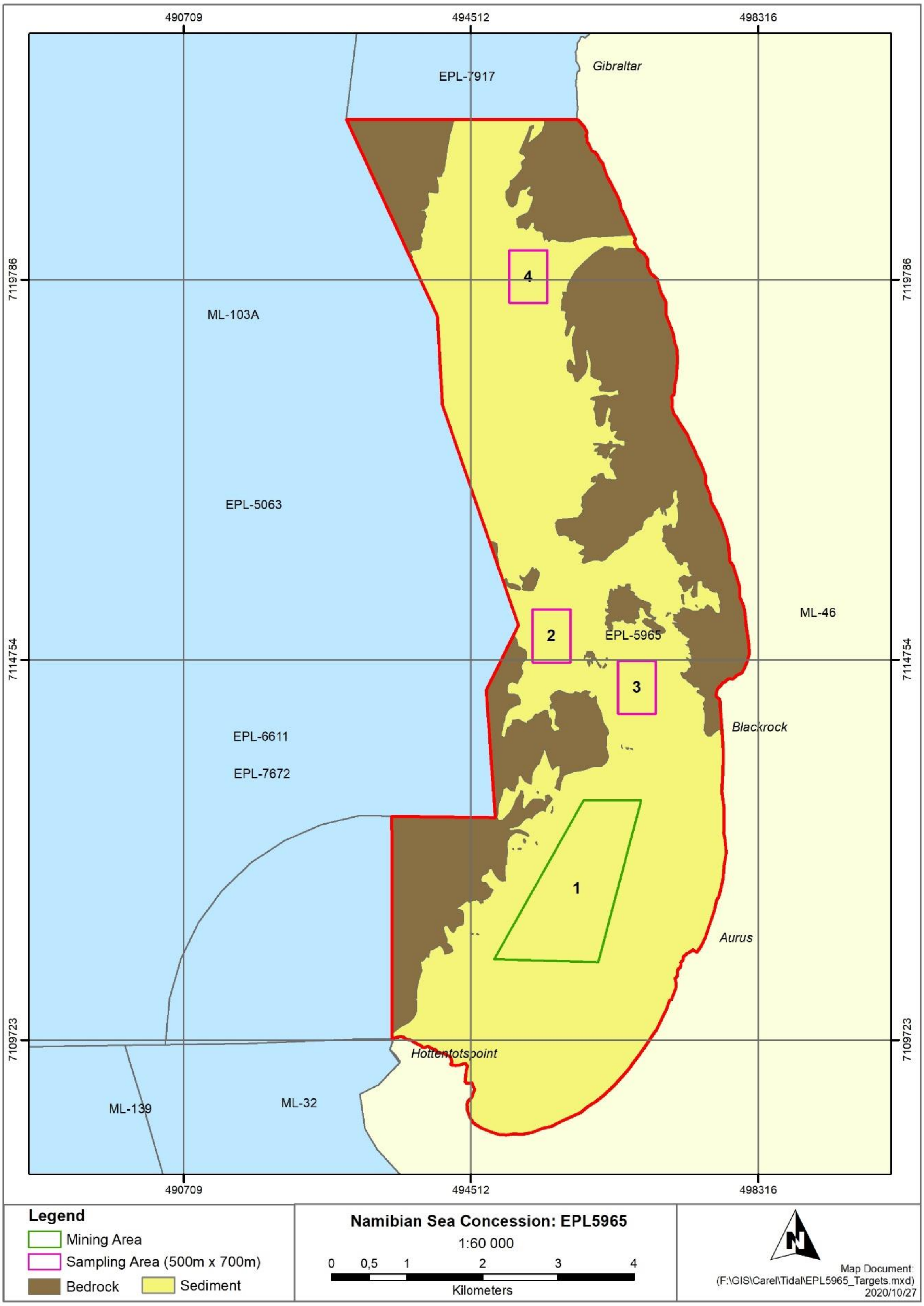

Figure 1: Location and size of the existing EPL5965 as the proposed ML220 area, as well as the proposed ML220 Mining Area 1, and Resource Development Areas, 2, 3 & 4

DESCRIPTION OF THE PROPOSED ACTIVITIES

The techniques required to prospect for and mine diamond resources vary according to the location of the area/operation, i.e. shallow water, mid water or deep-water areas. The proposed ML covers an area of shallow (10-30 m deep) and mid water (30-40 m deep) environments with the shallower (beach zone) areas in the eastern and southern extend of the ML around the Mining Target 1, and the deeper mid water areas (up to 40 m depths) in the central northern basin along the western boundaries between targets 2 and 4.

LKM proposes to mine the delineated resource area, making use of a small dredge pump vessel. Ongoing sampling, resource development, and some detail geophysical survey will cover selected target areas. The same methods were used during the exploration activities on EPL 5965.

LKM plans to buy a supply vessel and convert it to a remote mining vessel. This will take about 7 months before resource verification starts which will take another 2 months. Mining will commence over Mining Area 1, which covers a total area of 228 Ha, 5,4% of the total licence area. The current mine plan is for 7 years, and through additional resource development, with the planned mining vessel, over Target Areas, 2, 3 & 4 the mine plan could be extended with at least another 3 years.

Target areas 2, 3 & 4 each measure at 500 x 700m, and will be covered through a 100m grid sampling, total of 35 point samples per area. The target areas are shown in **Figure 1**.

The total area covered over the three target areas covers a total area of 2 100 m^2 (±20 m^2 per sample). LKM proposes to follow up these results with a bulk sampling phase during which a total of 12 block samples (50 x 50m) will be taken over another total area of 30 000m^2. In total, sampling and resource development will thus be conducted over a total area of 32 100 m^2. This equates to less than 0.07% of the total EPL area of the existing licence area.

Activities in Mining Area 1

The mining system (**Figure 2**) comprises a suspended steel mining tool, suction hoses and an on-board mining pump. The suction hoses and mining tool will be ~300 mm internal diameter. The mining tool itself consists of a 300 mm diameter steel pipe fitted with a mining head, referred to as the digging head, which has an opening fitted with grizzly cross-bars to allow sized gravel (nominally < 100 mm) to pass through and prevent blockages in the suction system. The digging head will also be fitted with high pressure water jetting nozzles to agitate the gravel on the seabed and improve mining efficiency.

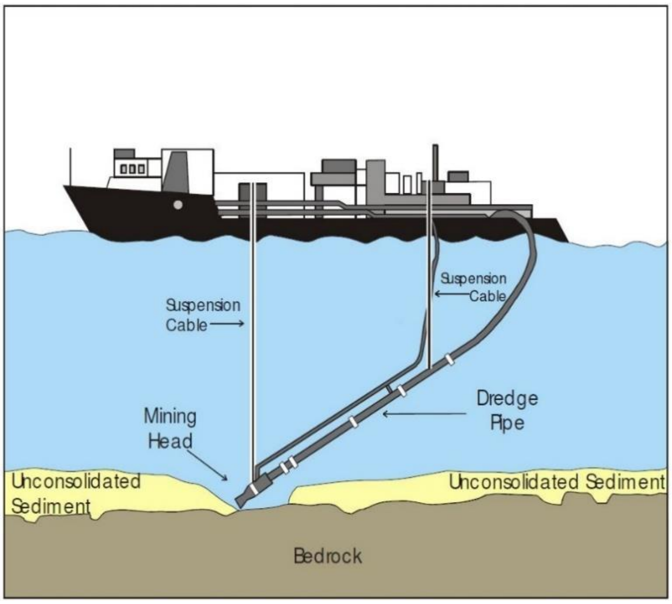

Figure 2: Diagram showing the operation of a mining system. The vessel is anchored at four point and 'moves across the target area removing overburden and ore down to bedrock. The maximum depth is 44m.

The retrieved gravel will be processed on board. The plant head feed has been sized for 60 tonnes per hour (tph) solids (450 m^3/hr slurry), fed by the 12" gravel pump. The mining system feed (run of mine) is discharged into a 250 mm gravel classifier. Undersize (-1.4 mm) and oversize (+12 mm) materials are discharged directly overboard. The screened fraction is fed via a jet pump onto a combined dewatering screen.

Shell and clay material will be discharged via a surge bin into a crusher (typically Barmac or similar) where after product will be discharged into the mixing box. Ferrosilicon (FeSi) is added and the mixture pumped via the cyclone feed-pump to the DMS cyclone. The cyclone sinks and floats are discharged onto a combined drain and rinse screen. Drained floats are then discharged overboard. FeSi from the screen drain is recovered via a magnetic separator and pumped into the medium circuit. The sinks product is rinsed and sized into two streams, nominally - 12+4 mm and -4+1.4 mm and discharged into the X-ray feed hopper. From this hopper, the two streams are run separately through a wet x-ray machine. The concentrate is then dried and fed into the glove box where the diamonds are recovered, weighed and placed into a drop safe.

Through a combined capacity study, a mining rate of 15 m^2 per hour has been applied in the mining program. At this applied rate a total of 50 000 sqm will be mined per year (0.12% of the licence area). Mining Area 1 has a total area of 350 616 m^2 (0.83% of the total licence area, have been identified as the current mineable resource which results in the exiting life of mine of 7 years.

Activities on Target Areas, 2, 3 & 4

Ongoing sampling, resource development, and some detail geophysical survey will cover target areas. This will entail the following:

- **Geophysical remote sensing** – this includes echo sounding for bathymetry; high resolution side-scan sonar to primarily determine sediment and seabed surface texture; depth sounding to identify soft mud; and low energy (<12 khz) shallow penetration seismic profiling to determine sediment thickness and bedrock morphology.

- **Multi-beam bathymetry** – the multi-beam system provides depth sounding information on either side of the vessel's track across a swath width of approximately twice the water depth. This will produce a digital terrain model of the seafloor.
- **Side scan sonar** – this produces acoustic intensity images of the seafloor and are used to map the different sediment textures of the seafloor. Side-scan uses a sonar device, which can be towed from a vessel or mounted on the ship's hull that emits conical or fan-shaped pulses down toward the seafloor across a wide angle perpendicular to the path of the sensor through the water.
- **Depth sounding** - Dual frequency depth/echo sounding has the ability to identify a layer of soft mud on top of a layer of coarse and hard sediment and or rock. The pulse emitted would typically be for more than 0.025 seconds and produces sound levels in the order of 180+ dB re 1 µPa at 1m.
- **Bottom profilers –** this methodology uses powerful low frequency echo-sounders that provide profiles of the upper layers of the ocean floor. The data resulting from these prospecting methods will be used to produce high-resolution maps of the seabed geomorphology, sediment and bedrock distribution, bathymetry and sediment type and thickness profiles. From these maps, areas of unconsolidated sediment suitable for sampling will be identified, and a sampling grid positioned over the area. Surveying activities are usually ongoing in order to develop geological models for further resource development.

DESCRIPTION OF THE ENVIRONMENT

The proposed ML area lies mainly within Hottentot Bay, extending approximately 15km north of the bay and up to 3 km offshore. The lease also includes the waters extending over a radius of approximately 3 km from the northern point of the Hottentot Bay headland. The seabed within the lease area lies mainly at a depth of less than 40mbsl. The coastline consists of unconsolidated aeolian sands with an extensive lagoon deposit to the south, and relatively little rock outcrop other than the Hottentot Bay headland, Black Rock near the northern end of the bay, and Neglectus Island, a small rock within the bay itself. These outcrop features are primarily Mokolian pre- and syntectonic biotite-rich augen gneisses, with some very large intrusive hydrothermal quartz veins. Almost entirely devoid of vegetation other than desert succulent species, the shoreline has no freshwater sources other than a weak spring at Anigab, about 10km inland of Douglas Bay.

The marine ecology of the area is shaped by the wind-induced upwelling characterising the Benguela ecosystem. Although the nearshore and coastal habitats in the area have all been assigned a threat status of 'least concern', numerous 'endangered' and 'critically endangered' seabird species occur in the area.

The licence area is located within the Namibian Islands MPA and Ecologically and Biologically Significant Area (EBSA). The proposed mining area overlaps with one of the biodiversity conservation zones proposed within this EBSA. The proposed conservation zone in Hottentots Bay is intended to protect Neglectus Islet and the disused jetty, both of which provide safe nesting sites for Bank, Cape, Crowned and White-breasted cormorants.

The licence area coincides with fishing grounds for rock lobster and snoek. ML 220 overlaps rock lobster management zones 5 (Black Rock) and 6 (Hottentot Point) where commercial operations are focussed in water depths less than 30 m. Snoek is targeted in the vicinity of the licence area by a small component of the traditional line fishery which operates from Lüderitz.

POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PROJECT, WHICH WERE ALREADY ADDRESSED IN THE EIA EPL 5965 AND ADDITIONAL ONES IDENTIFIED IN THE CURRENT EIA FOR ML 220

The table provides a list of potential environmental and social impacts associated with the proposed project.

ENVIRONMENTAL ASPECT	POTENTIAL ISSUES TO BE CONSIDERED IN THE EIA PROCESS
BIODIVERSITY AND MARINE ECOLOGY AND MPAs	• Acoustic impacts to marine fauna during geophysical surveying • Physical destruction and general disturbance of marine biodiversity and ecological processes through dredging, discharge of tailings causing smothering of benthic communities and compromised water quality • In-direct impact on marine protected areas, i.e. Neglectus Islet and the disused Jetty in Hottentots Bay • Potential injury to marine mammals and turtles through vessel strikes; • Marine pollution due to discharges such as deck drainage, machinery space wastewater, sewage, etc. and disposal of solid wastes from the survey vessel; and • Marine pollution due to fuel spills during refuelling, or resulting from collision or shipwreck
ARCHAEOLOGY/CULTURAL	• Damage to archaeological sites, e.g. ship wrecks
FISHERIES	• Changes to ecology affecting fish stocks • The geophysical survey methods will introduce a range of underwater noises into the surrounding water column which could result in effects on fish catch rates due to increased ambient noise levels • Localised, temporary exclusion of fishing operations during geophysical surveys, sampling and mining activities
SOCIO-ECONOMIC	• Economic (income and employment impacts – positive)

These aspects and others raised by IAPS and specialists, will be considered in the EIA and mitigation measures put into the Environmental Management Plan (EMP).

PLANNED TIMING OF THE PROPOSED ACTIVITIES

Approval of the EIA/EMP report is required in order for MEFT to grant an Environmental Clearance Certificate, which is a requirement before LK Mining can be granted a mining licence. Mining can only commence once these documents have been approved and granted.

LK MINING (PTY) LTD
ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML 220 REQUIRED FOR AN ENVIRONMENTAL CLEARANCE CERTIFICATE
REGISTRATION AND RESPONSE FORM FOR INTERESTED AND AFFECTED PARTIES

DATE		**TIME**	
PARTICULARS OF THE INTERESTED AND AFFECTED PARTY			
NAME			
POSTAL ADDRESS			
		POSTAL CODE	
STREET ADDRESS			
		POSTAL CODE	
WORK/ DAY TELEPHONE NUMBER		**WORK/ DAY FAX NUMBER**	
CELL PHONE NUMBER		**E-MAIL ADDRESS**	

PLEASE IDENTIFY YOUR INTEREST IN THE PROPOSED PROJECT
PLEASE WRITE YOUR COMMENTS AND QUESTIONS HERE

ASEC

LK Mining (Pty) Ltd

EIA & EMP FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML220 TO OBTAIN THE ENVIRONMENTAL CLEARANCE CERTIFICATE

Focus Group Meetings

(March – April 2021)

A. Speiser Environmental Consultants cc
Windhoek, Namibia
(Facilitator: Auriol Ashby or Werner Petrick)

ASEC

Agenda

- Welcome and introductions
- Meeting formalities & purpose of meeting
- Background
- Overview of the proposed mining activities
- The EIA process
- General discussion, comments and questions
- Way forward
- Meeting closure

ASEC

Purpose of meeting

- Provide overview of the proposed diamond mining activities
- Understand the EIA process being followed
- Discuss potential environmental impacts
- Provide input into the EIA process

ASEC

The EIA Team

- Project management and report compilation ASEC (A. Speiser) together with Namisun (W. Petrick) and Ashby Associates (A. Ashby)
- Environmental impacts and assessment on Fisheries - Capricorn Marine Environmental (S. Wilkinson)
- Marine Biodiversity - Pisces Environmental Services (A. Pulfrich)
- Archaeology – J. Kinahan
- Socio-economic - Ashby Associates (A. Ashby)

ASEC

Background

- LK Mining (Pty) Ltd (LKM) applied for a Mining Licence (ML 220) over their existing EPL 5965 area.
- The EPL is located in Hottentots Bay, approximately 60 km north of Lüderitz, and falls within the Namibian Islands Marine Protected Area (NIMPA) of the Namibian Coast.
- The ML covers an area of 4227 Ha.
- The Mining Licence application was filed by LKM with MME in October 2019.
- Previously been prospected and mined for diamonds by Tidal Diamonds (ML 30 from 1993 to 2013)

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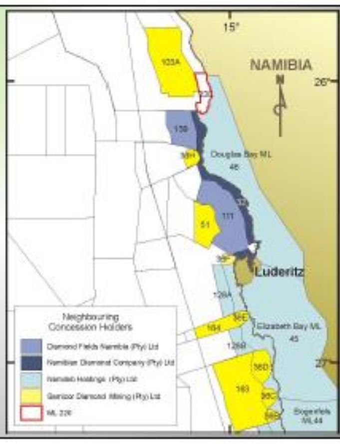
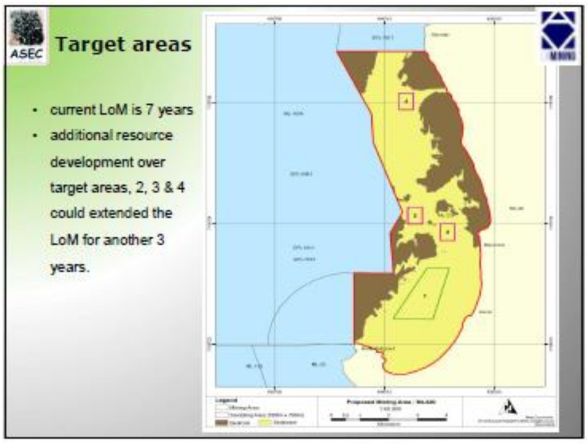
Location

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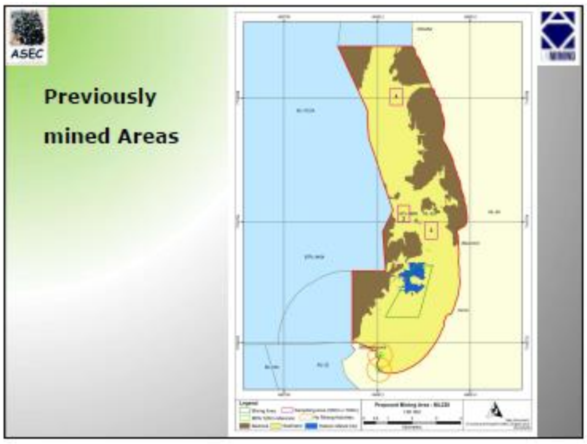
Target areas
current LoM is 7 years
additional resource development over target areas, 2, 3 & 4 could extended the LoM for another 3 years.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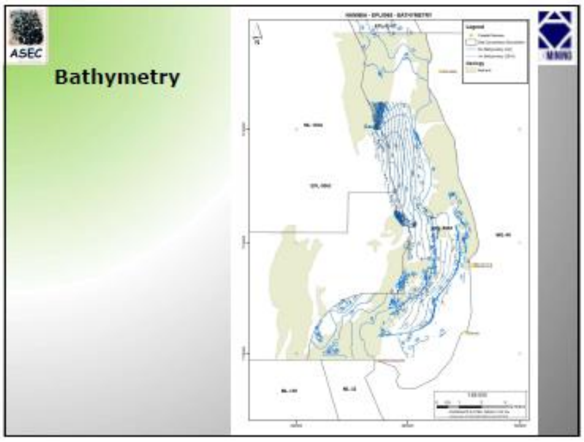
Previously mined Areas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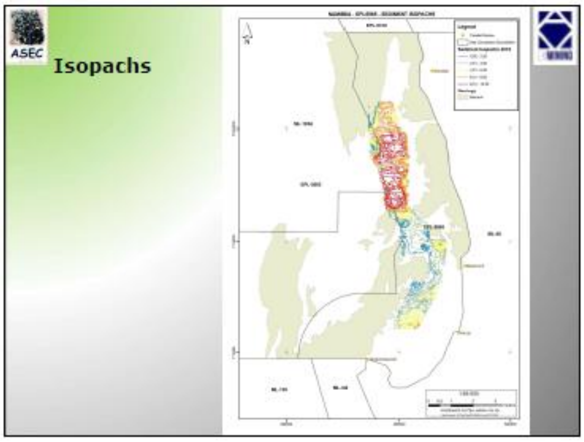
Bathymetry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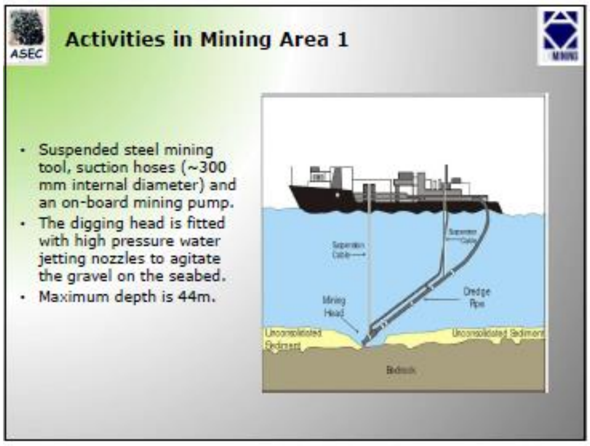
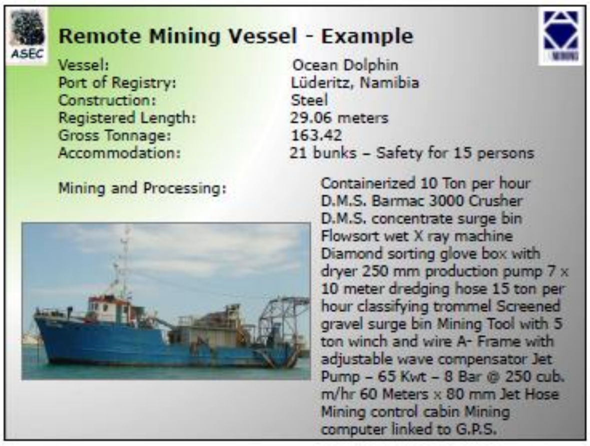
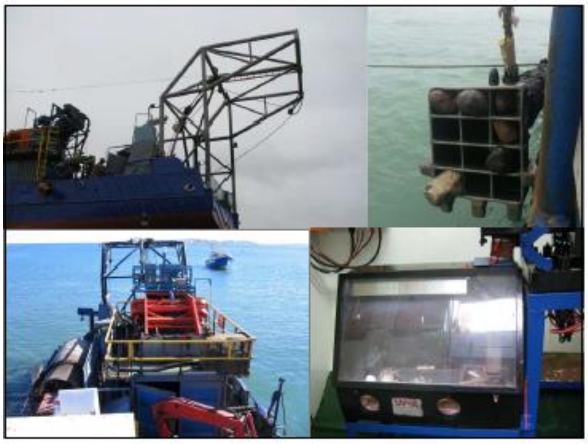
Isopachs


ASEC
Activities in Mining Area 1
Suspended steel mining tool, suction hoses (~300 mm internal diameter) and an on-board mining pump.
The digging head is fitted with high pressure water jetting nozzles to agitate the gravel on the seabed.
Maximum depth is 44m.
Separation Cable
Mining Head
Dredge Pipe
Unconsolidated Sediment
Bedrock


ASEC
Remote Mining Vessel - Example
Vessel: Ocean Dolphin
Port of Registry: Lüderitz, Namibia
Construction: Steel
Registered Length: 29.06 meters
Gross Tonnage: 163.42
Accommodation: 21 bunks – Safety for 15 persons
Mining and Processing:
Containerized 10 Ton per hour D.M.S. Barmac 3000 Crusher D.M.S. concentrate surge bin Flowsort wet X ray machine Diamond sorting glove box with dryer 250 mm production pump 7 x 10 meter dredging hose 15 ton per hour classifying trommel Screened gravel surge bin Mining Tool with 5 ton winch and wire A- Frame with adjustable wave compensator Jet Pump – 65 Kwt – 8 Bar @ 250 cub. m/hr 60 Meters x 80 mm Jet Hose Mining control cabin Mining computer linked to G.P.S.



Activities on Target Areas 2, 3 & 4

- **Geophysical remote sensing** – echo sounding for bathymetry; high resolution side-scan sonar to primarily determine sediment and seabed surface texture; depth sounding to identify soft mud; and low energy (<12 khz) shallow penetration seismic profiling to determine sediment thickness and bedrock morphology.
- **Multi-beam bathymetry** – This will produce a digital terrain model of the seafloor.
- **Side scan sonar** –acoustic intensity images of the seafloor to map the different sediment textures of the seafloor.
- **Depth sounding** - to identify a layer of soft mud on top of a layer of coarse and hard sediment and or rock.
- **Bottom profilers** – to produce high-resolution maps of the seabed geomorphology, sediment and bedrock distribution, bathymetry and sediment type and thickness profiles.

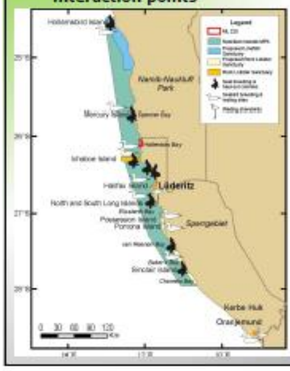
Biophysical Environment

- Seabed at a depth of less than 40mbsl.
- Marine ecology is shaped by the wind-induced upwelling characterising the Benguela ecosystem.
- Nearshore and coastal habitats are all been assigned a threat status of 'least concern', numerous 'endangered' and 'critically endangered' seabird species occur in the area.
- Fishing grounds for rock lobster and snoek.
- Rock lobster management zones 5 (Black Rock) and 6 (Hottentot Point) in water depths less than 30 m.
- Snoek is targeted in the vicinity of the ML 220 area.

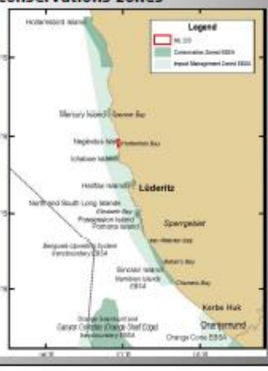
Biophysical Environment

- The proposed ML 220 is located within the Namibian Islands Marine Protected Area (NIMPA) and Ecologically and Biologically Significant Area (EBSA).
- The proposed mining area 1 overlaps with one of the biodiversity conservation zones proposed within this EBSA.
- Hottentots Bay is intended to protect Neglectus Islet and the disused jetty, both of which provide safe nesting sites for Bank, Cape, Crowned and White-breasted cormorants.

Namibian Islands Marine Protected Area and other project-environment interaction points



Ecologically and Biologically Significant Areas (EBSAs) and the biodiversity conservations zones



Benthic and coastal habitats

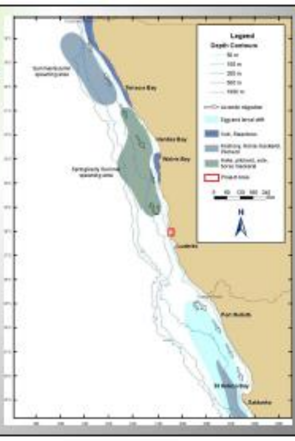
(1) Lüderitz Inner Shelf,
(2) Lüderitz Inshore,
(3) Lüderitz Intermediate Sandy Beach,
(4) Lüderitz Mixed Shore,
(5) Lüderitz Exposed Rocky Shore,
(6) Lüderitz Reflective Sandy Beach,
(7) Lüderitz Sheltered Rocky Shore.

The inshore and coastal habitats in the area have all been assigned a threat status of 'Least Concern', (Holness *et al*. 2014).

Major spawning areas in the central Benguela region

The preferred spawning grounds of numerous commercially exploited fish species are located to the north of the study area off central and northern Namibia.

Ichthyoplankton abundance off the study area is expected to be low.



Environmental Impact Assessment (EIA)

EIA process

Potential impacts

Archaeology impact:

- ✓ Damage to archaeological sites, e.g. ship wrecks.

Social and cultural impacts:

- ✓ Prospecting and mining activities within the NIMPA; and
- ✓ Interaction with the commercial rock-lobster fleet that operates within or traverses the survey area.

Potential impacts

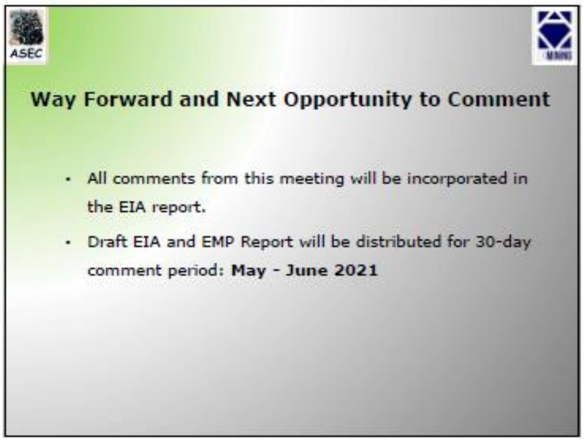
Biodiversity and marine ecology and MPAs:

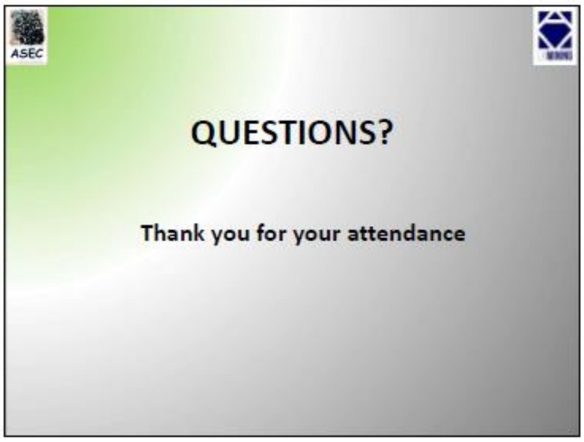
- ✓ Acoustic impacts to marine fauna during geophysical surveying
- ✓ Physical destruction and general disturbance of marine biodiversity and ecological processes through dredging, discharge of tailings causing smothering of benthic communities and compromised water quality
- ✓ In-direct impact on marine protected areas, i.e. Neglectus Islet and the disused Jetty in Hottentots Bay
- ✓ Potential injury to marine mammals and turtles through vessel strikes;
- ✓ Marine pollution due to discharges such as deck drainage, machinery space wastewater, sewage, etc. and disposal of solid wastes from the survey vessel; and
- ✓ Marine pollution due to fuel spills during refuelling, or resulting from collision or shipwreck

Potential impacts

Fisheries:

- ✓ Changes to ecology affecting fish stocks
- ✓ The geophysical survey methods will introduce a range of underwater noises into the surrounding water column which could result in effects on fish catch rates due to increased ambient noise levels.
- ✓ Localised, temporary exclusion of fishing operations during geophysical surveys, sampling and mining activities.


ASEC
Way Forward and Next Opportunity to Comment
• All comments from this meeting will be incorporated in the EIA report.
• Draft EIA and EMP Report will be distributed for 30-day comment period: May - June 2021


ASEC
QUESTIONS?
Thank you for your attendance

Appendix B: IAP List

Lüderitz Town Council		
Mr	Ochs	CEO
Ms	Martha	PA to the CEO
//Kharas Regional Council		
JA	Scholtz	//Kharas Regional Council
Ministry of Fisheries and Marine Resources		
L	Shivute	Senior Fisheries Biologist
A	Kreiner	Subdivision Environment
K	Grobler	
E	Nangolo	Senior Fisheries Biologist
A	Kreiner	Chief Fisheries Biologist
D	Bester	Chief Fisheries Inspector
D	Tom	Seabird Biologist
E	Maletzky	Senior Fisheries Biologist, Crustecea
VM	Libuku	Fisheries Biologist
T	Machado	Research technician
R	Jones	Technician
BNS	Tjandja	Research technician
DN	Mwaala	Fisheries Biologist
G	Hanghome	Fisheries Research technician
H	Skrypzeck	
CB	Bartholomae	
F	Hamukwaya	MFMR (FRT)
L	Sinvula	Fisheries Biologist
Ministry of Environment, Forestry and Tourism		
D	Nchindo	Ministry of Environment, Forestry and Tourism
S	Angula	Ministry of Environment, Forestry and Tourism
W	Handley	Ministry of Environment, Forestry and Tourism
Ministry of Mines and Energy		
E	Shivolo	Mines Directorate Head
A	Gideon	
Marine Specialists		
J	Roux	Cetaceans Biologist, MFMR retired
J	Kemper	Seabird bird biologist
A	Pulfrich	ASEC/ Pisces Environmental Services
S	Wilkinson	ASEC / Capricorn Marine Environmental
T	Nambala	Namibian Maritime & Fisheries Institute, Deputy Director
Ministry of Works and Transport		
K	Shapua	CAD: Directorate of Maritime Affairs
NamPort		
E	Gelderbloem	Executive: Port Authority
S.	Gariseb	NamPort SHEQ Manager, Walvis Bay
A	Zavitaa	Port Captain
JS	Isaaks	SHREQ Office
MM	Kooper	Port Manager
EW	Chimbuelengue	

Parastatals & State Owned Enterprises		
N	Alma	National Heritage Council of Namibia
E	Ndalikokule	National Heritage Council of Namibia
I	Mulunga	National Petroleum Corporation of Namibia (NAMCOR)
Mining		
P	Lombard	Sperrgebiet Diamond Mining (Pty) Ltd
V	Malango	Chamber of Mines of Namibia
N	Hagan	De Beers Consolidated Diamond Mines Ltd
R	Gray	De Beers Consolidated Diamond Mines Ltd
R	Van der Merwe	De Beers Marine Namibia (Pty) Ltd/Namdeb Diamond Corp
A	Baumann	Namdeb Diamond Corp
C	August	Namdeb Diamond Corp
J	Cloete	Namdeb Diamond Corp
M	Mwashindange	Namdeb Diamond Corp
Namibia Rock Lobster Fishing Association (NRLFA)		
J	Calaca	Blameha Fishing, Namibia Rock Lobster Fishing Association
RD	Shanjengange	Chairman 2015, Namibia Rock Lobster Fishing Association
C	Klein	Manager, Seaflower Rock Lobster factory
B	Brown	Secretary; NRLFA; Right's holder
H	Kooitjie	member, NRLFA
Hake		
N	Green	Confederation of Namibian Fishing Association
R	Walters	Confederation of Namibian Fishing Associations / Namibian Hake Association
S		Cato Fishing Company (Pty) Ltd
R	Shimooshili	Cavema Fishing (Pty) Ltd
H	Theron	Consortium Fishing Ltd / Hagana Seafood / Kuiseb Fish Products
	The Manager	Empire Fishing Co (Pty) Ltd
A	Olivier	Benguella Sea Products (Pty) Ltd
J-L	Reyero	Cadilu Fishing & Overberg Fishing
C	Dreyer	Etale Fishing
P	Conradie	Etosha Fishing Corp (Pty) Ltd
L	Kapundja	Etosha Fishing Corp (Pty) Ltd
P	Greeff	Etosha Fishing Corp (Pty) Ltd
G	Esau	Etosha Fishing Corp (Pty) Ltd
J	I.	Etosha Fishing Corp (Pty) Ltd
E	Pata	Demersal Fishing
	The Manager	Northern Fishing Industries (Pty) Ltd
PS	Kaulinge	Novanam (PTY) Ltd / Skeleton Coast Trawling
J	Magdalena	NovaNam Ltd
JR	Canosa	NovaNam Ltd
M	Mackenzie	NovaNam Ltd
N	Negonga	NovaNam Ltd
M	Quintana	NovaNam Ltd

S	Martin	Namibia Hake Fishing Association
	The Manager	Namibian Fisherman Association / Corvima Fishing
	The Manager	Namibian Fishing Industries (Pty) Ltd
L	Louw	Namibian Hake & Tuna Longline Association
P	Pahl	Namibian Hake Association
S	Kathindi	Namibian Hake Association
M	Goagoseb	Namibian Hake Association / Ark Fishing Industries
F	De Villiers	Novaship
A	Tordesillas	Pescanova Group
M	Nghipunya	National Fishing Corporation / Seaflower Whitefish Group
A	Marino	Tunacor Fisheries Ltd
R	Ahrens	United Fishing Enterprises (Pty) Ltd
J	Pretorius	Seaflower Whitefish Corp
S	Damens	Seaflower Whitefish Corp
P	Germishuys	Seaworks Fish Processors (Pty) Ltd
P	Le Roux	Seaworks Fish Processors (Pty) Ltd
P	Pahl	Seaworks Fish Processors (Pty) Ltd
T	Kjelgaard	Merlus Seafood Processors (Pty) Ltd
R	de Castro	Ondjaba Fisheries cc
M	Hlasek	Ondjaba Fisheries cc / South Rock Investments cc
G	Kessler	South Namibian Hake Fishing
B	Mathias	Southern Namibia Hake Fishing Industries (Pty) Ltd
K	Schroeder	Southern Namibia Hake Fishing Industries (Pty) Ltd
Monk and Sole		
L	Maree	Namibian Monk and Sole Association
P	Hitula	Freddie Fish Processors (Pty) Ltd
Small Pelagic		
E	Van Dyk	Namibian Pelagic Fishing Association
H	Viljoen	Namibian Pelagic Fishing Association
M	Van Wyk	Namibian Pelagic Fishing Association
W	Pronk	Namibian Small Pelagic Association
Large Pelagic tuna and shark		
M	Hambuda	Large Pelagic (Tuna and Swordfish) and Hake Longlining Association / Possessions Fishing
D	Russell	Large Pelagic and Hake Longlining Ass. of Namibia / Dave Russell Fisheries Consultancy
K	Laufer	Large Pelagic and Hake Longlining Ass. of Namibia / Marco Fishing (Pty) Ltd
R	de Castro	Large Pelagic Association / Ondjaba Fisheries cc
AW	Kakoro	Large Pelagic Association
Namibian Line Fish Association		
R	Coppin	
Lüderitz specific and mariculture		
H	du Plessis	Namibian Mariculture Association / Tetelestai Mariculture (Pty) Ltd
G	Murta	Goncalo Murta Aquaculture / Mariculture
M	Romero	Beira Aquaculture (Pty) Ltd
J	Baumeister	Joe's Oyster Company (Pty) Ltd

R	Erasmus	Hangana Abalone / Ludertiz Abalone Company
JP	Malherbe	Lalandi (Namfish)
AJ	Louw	Marco Fishing (Pty) Ltd
H	Burger	Marco Fishing (Pty) Ltd
	Neliwa	Marco Fishing (Pty) Ltd
J	Burgess	Lüderitz Mariculture / Tuna & JV
	Erasmus	Abalone Farm (O&L)
G	Kessler	
J	James	
J	Fleidl	
S	Struben	
Other Fishery Organisations		
D	Correia	Agatha Bay Fishing Company (Pty) Ltd / Merlus Marine / Helgoland Fishing (Pty) Ltd / Oryx Fisheries
T	Manshinho	Amstai (Pty) Ltd
M	Amadhila	Ark Fishing Industries
I	Mbili	Atab Fisheries Consortium (Pty) Ltd
A	Burger	Atlantic Pacific Fishing (Pty) Ltd
G	Diaz	Diaz Fishing (Pty) Ltd
BG	Edwards	Dun-al Fishing Co (Pty) Ltd
E	Ehanga	Ehanga Fishing
J	Magdelene	Esja Fishing (Pty) Ltd
J	Hangula	Grisham Assets Corp. Ltd.
	Gutierrez	Grupo Pereira
K	Hatutunga	Hatutunga Fishing
H	Kaune	Hodago Fishing
JHN	Labuschagne	Hottentot Bay Investments CC
	The Manager	Huab Fishing / Morcar Fishing / Omaru Fishing / Onbaye Fishing
	The Manager	Martin's Den Fisheries (Pty) Ltd
	The Manager	Mukorob Fishing (Pty) Ltd
T	Nambahu	Namibian Marine Resources
O	Shigwana	Omakete Investments
H	Kasper	Omaru Fishing
O	Sandro	Ompangona Fishing Company (Pty) Ltd
S	Kadhila	Omualu Fishing Company
O	Kadhila	Omuhuka Holdings
O	de Castro	Oryx Fisheries (Pty) Ltd
	The Manager	Pereira Fishing Co (Pty) Ltd
S	Tangeni	Rhino Resources Namibia (Pty) Ltd
B	van Zyl	South East Atlantic Fisheries Organisation
R	Rosalia Lunguti	Golden Horizon
A	Nantinda	HANGANA ABALONE (PTY) LTD
Business		
I	Namukonda	Chamber of Commerce and Industry Lüderitz
R	Eimbeck	Element Riders
C	Clay	Luderitz Foundation

SJ	Mwelwa	Namibia Media Holdings
R	Rademeyer	Republikein (newspaper)
J	Moses	Shamrock Investment
C	Bronkhorst	Southey Namibia
S	Struben	Southey Namibia
O	Thero	LSS / Ilog
D	Shoombe	Rock Breaking
D	Moses	Southey Namibia
J	James	LBSF
M	Morgan	LMR Construction
S	Struben	Struben Projects
D	Bishop	Radiowave
Environmental, NGOs and Others		
H	Hamukuaya	Benguela Current Commission
Z	Hutu	Benguela Current Commission
B	van Zyl	Benguela Current Commission
P	Ndjambula	Benguela Current Commission
P	Kumbi	Benguela Current Commission
M	Thomas	Benguela Current Commission
S	Susan	Coastal Environmental Trust of Namibia
B	Kohrs	Earthlife Namibia
S	Selma	GIZ- MARISMA (Marine Spatial Management and Governance Project)
R	Braby	GIZ- MARISMA (Marine Spatial Management and Governance Project)
C	Kandjii	NACOMA
A	Alexander	NACOMA
C	Brown	Namibia Chamber of Environment
H	Krohne	Namibia Chamber of Environment
J	Gelletich	Namibia Dolphin Project (Walvis Bay)
V	Muukua	Namibia Nature Foundation
A	Middleton	Namibia Nature Foundation
S	Elwen	Namibian Dolphin Project & University of Pretoria
T	Gridley	Namibian Dolphin Project & University of Pretoria
A	Burke	Environmental Practitioner
SA	Matjila	Namibia Nature Foundation
F	Löhnert	
FM	Stephanus	
B	Weidlich	
M	Schelke	
R	Hercules	
E	Leuschner	
F	Carney	
M	Namukomba	
	Rikambura	
J	Scholtz	
N	Amutenya	
V	Stein	NBRI

H	Hiveluah	

Appendix C: Site notice and advertisements

LK MINING **NOTICE OF ENVIRONMENTAL IMPACT ASSESSMENT PROCESS** ASEC

ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML220 TO OBTAIN THE ENVIRONMENTAL CLEARANCE CERTIFICATE

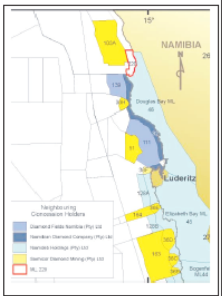
LK Mining (Pty) Ltd (LKM) herewith gives notice in terms of the Environmental Management Act, 7 of 2007 and Regulation 21 of the Environmental Impact Assessment (EIA) Regulations (January 2012), of their proposed offshore diamond mining activities on ML220 approximately 60km North of Lüderitz.

Prior to implementing the proposed Project, an EIA process will be conducted. An application for environmental clearance certificate (ECC) will be submitted to the relevant Component Authority (Ministry of Mines and Energy) who will review and forward the application to the Ministry of Environment, Forestry and Tourism (Environmental Commissioner) in terms of the above-mentioned regulations for the mining activities. This advertisement forms part of the EIA public participation process.

Applicant: LK Mining (Pty) Ltd

Nature and location of the proposed activity:
LKM applied for a Mining Licence (ML) on their existing EPL5965 area. The EPL is located in Hottentots Bay, approximately 60 km north of Lüderitz, and falls within the Namibian Islands Marine Protected Area (MPA) of the Namibian Coast. The proposed ML covers an area of 4227 Ha. The Mining Licence application was filed by LKM with MME in October 2019 and will only be granted after the ECC has been approved and granted.
The proposed mining activities will be similar to the activities conducted during exploration and will include, amongst others, the following:

- Mine the delineated resource area, making use of a small dredge pump vessel.
- A mining rate of 15 square meter per hour has been applied in the mining program. At this applied rate a total of 50 000m² will be mined per year (0.12% of the licence area). Mining Area 1 covers a total area of 350 616 sqm (0.83% of the total licence area,) have been identified as the current mineable resource which results in the proposed life of mine of 7 years.
- Ongoing sampling, resource development, and some detail geophysical survey will cover the target areas.



Independent Environmental Assessment Practitioner:
A. Environmental Consultants CC (ASEC) has been appointed by LKM as the independent Environmental Assessment Practitioner to undertake the EIA process for the proposed project.

Contact Person:	Alexandra Speiser or	Werner Petrick
Tel:		+264 (0)81 739 4591
E-mail:	amspeiser@yahoo.com	wpetrick@namisun.com

Registration to receive notifications / information and opportunity to comment:
To register as an interested and affected party for the proposed Project, please submit your name and contact details to ASEC by e-mail, or by contacting Werner Petrick. A Background Information Document (BID) is available for a review and comment period from **25th March to 27th April 2021**. Electronic copies of the BID are available on request from ASEC as per above details. Please note that due to COVID-19 restrictions, only focus group meetings are planned within the comments and registration period. Should you like to be invited to one of the Focus Group meetings, please contact ASEC.

If you would like your comments to be addressed in the EIA Report please submit them to ASEC **by no later than 27th April 2021**.

Electricity Control Board
21 Years of Successful Regulation

INVITATION
STAKEHOLDER ENGAGEMENT AND CONSULTATION WORKSHOP
DEVELOPMENT OF ENERGY STORAGE REGULATIONS

The Electricity Control Board (ECB) will be hosting a virtual Stakeholder Engagement and Consultation Workshop on the Development of Energy Storage Regulations on **31 March 2021.**

Energy Storage Technologies convert energy into a form that can be stored and subsequently converted into useful energy as and when required. The energy can be stored in any form, including as electrical energy, thermal energy and gravitational potential energy.

The intermittent nature of renewable energy resources prevented the larger uptake of renewables in Namibia. Energy Storage presents a great opportunity for power to be captured when it is available and released on demand. Cost-effective Energy Storage can potentially unlock the limitation of using intermittent renewable generation which will create additional avenues for the integration of intermittent generation sources into the generation mix.

Given the potential impact of the development of Energy Storage Technologies, this workshop will be aimed at all stakeholders in the energy sector and beyond, with the aim of constructively engaging on the development of Energy Storage Regulations for Namibia. The outcome of the workshop will help to inform the content of the to-be-developed Energy Storage Regulations.

It is for this reason that the ECB will be hosting a **virtual stakeholder engagement and consultation workshop** on **31 March 2021** from **08:30 until 16:00.**

Individuals who wish to attend the workshop are encouraged to register via email at storage@ecb.org.na on or before **Friday 26 March 2021.** Please note that **registration will be open until 16h30 on 26 March 2021 only**. Participants are requested to provide their full name, the name of their organisation, email address and contact number.

NB: Participants will be provided with a link to join the session on MS Teams.

The Agenda and the Draft Report on the Assessment of Requirements for the Regulation of Energy Storage will also be shared.

For enquiries, please contact Mr. Gideon Nasima at 061 – 374 300

No 35 Dr. Theo-Ben Gurirab Street, Klein Windhoek.
Business Hours: Weekdays from 07:30 - 16:30
P O Box 2923, Windhoek, Namibia | +264 61 374 300 | +264 61 374 305 | www.ecb.org.na

Get Your TERM 1 Educational Booklets

TRANSLATIONS & DELIVERY SCHEDULE TO REGIONS
(SCHOOLS, CENTERS & REGIONAL OFFICES)

WEEK 5&6

- 23 MARCH | **GRADE 3**
- 24 MARCH | **GRADE 2**
- 25 MARCH | **GRADE 1** (ALSO RUKWANGALI)
- 26 MARCH | **PRE-PRIMARY** (ALSO RUKWANGALI & RUMANYO)

English, Afrikaans, Oshikwanyama, Otjiherero, Oshindonga, German & Khoekhoegowab

INSERT SCHEDULE - STREET SALES ONLY
23 MARCH UNTIL 26 MARCH WEEK 5&6

23 MARCH:	REPUBLIKEIN	**GRADE 3 AFRIKAANS**
	AZ	**GRADE 3 DEUTSCH**
	NAMIBIAN SUN	**GRADE 3 ENGLISH**
24 MARCH:	REPUBLIKEIN	**GRADE 2 AFRIKAANS**
	AZ	**GRADE 2 DEUTSCH**
	NAMIBIAN SUN	**GRADE 2 ENGLISH**
25 MARCH:	REPUBLIKEIN	**GRADE 1 ENG/AFR**
	AZ	**GRADE 1 ENG/DEU**
	NAMIBIAN SUN	**GRADE 1 ENG/AFR**
26 MARCH:	REPUBLIKEIN	**PRE-PRIMARY ENG/AFR**
	AZ	**PRE-PRIMARY ENG/DEU**
	NAMIBIAN SUN	**PRE-PRIMARY ENG/AFR**

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Step 1: Find us at **www.zoshy.online or scan the QR code**
Step 2: Find your grade and select the year
Step 3: Choose your language
Step 4: Choose **the week you want to learn** out of
Step 5: Choose **lessons from what lessons** there are
Step 6: **Download booklet if you do not have it**
Step 7: Watch and follow the teacher as she explains what to do in the book
Step 8: **Follow us on Facebook (Zoshy & Active Kids)** to never miss a video
Step 9: **Subscribe to our Zoshy Telegram channel if you want to recieve daily updates**

Subscribe to our Telegram channel

Zoshy Telegram

Ministry of Education, Arts and Culture | NAMIBIAN COMMUNITY TRUST | unicef for every child | Anna Meerkat Syllabus | Zoshy ONLINE SCHOOL

LK MINING NOTICE OF ENVIRONMENTAL IMPACT ASSESSMENT PROCESS ASEC

ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML220 TO OBTAIN THE ENVIRONMENTAL CLEARANCE CERTIFICATE

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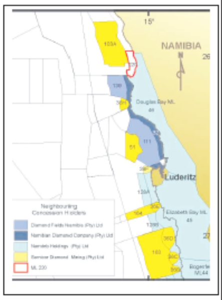

Independent Environmental Assessment Practitioner:
A. Speiser Environmental Consultants CC (ASEC) has been appointed by LKM as the independent Environmental Assessment Practitioner to undertake the EIA process for the proposed project.
Contact Person: Alexandra Speiser or Werner Petrick
Tel: +264 (0)81 739 4591
E-mail: amspeiser@yahoo.com wpetrick@namisun.com

Registration to receive notifications / information and opportunity to comment:
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If you would like your comments to be addressed in the EIA Report please submit them to ASEC by **no later than 27th April 2021.**

Ministry of Environment, Forestry and Tourism

Tender for Consulting Services to Undertake an Assessment, Catalogue and Develop a Management plan of the Archaeological and Historical Artefacts and sites of the Old Wagon Tourism Route in Tsau //Khaeb (Sperrgebiet) National Park (Post Qualification Procedure)

Tender number:	RFP - CS/017/TCD331
KfW number:	2013 65 626
Tender launch date:	01 April 2021
Date of compulsory pre-bid meeting:	Not applicable
Tender close time & date:	22nd April 2021, 12h00 noon
Expected contract signature:	14th May 2021
Expected commencement date:	17th May 2021
Expected completion date:	30 September 2021
Tender reference:	National Competitive bidding for Consulting Services for MEFT / NamParks V
Project executing agency:	Ministry of Environment, Forestry and Tourism (MEFT) of the Republic of Namibia
Objectives:	The objective of this consultancy is for a team of consultants to Unde take an Assessment, Calogue and Develop a Management plan of the Archaeological and Historical Artefacts and sites of the Old Wagon Tourism Route in Tsau //Khaeb (Sperrgebiet) National Park. This service tender will be guided by the January 2019 version of the "Guidelines for the Procurement of Consulting Services, Works, Plant, Goods and Non-Consulting Services in Financial Cooperation with Partner Countries" (refer to the homepage of KfW Development Bank: **www.kfw-entwicklungsbank.de.**

The tender procedure is open to suitably qualified and experienced Consultants. Further information is in the ***"Invitation to tender document"***, which shall be only made available electronically, free of charge, upon request to the following representative of the project executing agency:

Mr. Cameron Kandjii
Deputy Project Manager
NamParks V project
MET, Corner of Dr. Kenneth D. Kaunda & Robert Mugabe
Tel: +264-61-284 2079
Email: Cameron.Kandjii@namparks.org copy to: Michael.Sibalatani@namparks.org

REPUBLIC OF NAMIBIA

MINISTRY OF ENVIRONMENT, FORESTRY & TOURISM

Tender for Tourism Concessions

Inside Tsau //Khaeb (Sperrgebiet) National Park

The Tsau //Khaeb (Sperrgebiet) National Park is located in the south-western corner of Namibia. The following concession opportunities are available within the Tsau //Khaeb National Park (TKNP) tourism development areas (TDAs). The Ministry of Environment, Forestry & Tourism invites interested parties to register for the tender process and obtain the Request for Proposal (RFP) document. Bidder registration is compulsory to qualify for tendering and no registration will be allowed after the closure of the registration period.

CONCESSION TITLE	DESCRIPTION OF CONCESSION	CONCESSION RIGHTS & ACTIVITIES
Northern Sand & Sea	The Concession covers the area of the TKNP north of Lüderitz and is bordered on the west by the Atlantic Ocean and to the north and east by the Namib Naukluft National Park.	• 1 or 2-day guided 4x4 desert dune drives and coastal adventure safaris • Overnight camping in mobile camps at Dagger Rocks and Douglas Bay • Guided mining village history tours • Guided quad bike trails • Guided sandboarding • Guided off-shore angling (provided necessary permits are obtained) and Island Tours within the rules and regulations of the Sea Fisheries Act
Lüderitz Peninsula	The Concession covers the entire Peninsula which is situated directly south of Lüderitz. The south-eastern road linking the entrance gate at the southern tip of the lagoon with the Grosse Bucht is also the eastern boundary of this Concession.	• 60 bed resort at Griffith Bay offering o Guided tours (history, biodiversity, island, Diaz Cross and lighthouse) o Guided fishing tours and trips around Halifax Island o Non-motorized water sports on the lagoon (wind surfing, kayaking and kite surfing) o Conferencing • Parking Bays with viewpoints, signage and interpretative displays at bays along the coastline and some picnic sites equipped with toilets and concrete picnic tables and chairs with canopies for site-seeing, picnicking, angling and crayfish collection.
Kolmanskop	The Kolmanskop historic ghost town which forms the Kolmanskop Concession is situated 10km east of Lüderitz, just off the B4 road to Aus.	• Tours through Kolmanskop ghost town for general sight-seeing and photography
Lüderitz Coast & Mining	The Concession is situated within the coastal and mining history TDA which lies between the town of Lüderitz in the north, the Atlantic Ocean in the west, Bogenfels in the south and core "wilderness" zone area in the east.	• Guided one day bus tours to Grillental and Bogenfels Arch • Guided one-day and overnight coastal 4x4 safaris to Elizabeth Bay, Grillental, Pomona and Bogenfels Arch, • Guided one-day or overnight inland safaris to Grillental, Bogenfels Arch and views on the Klinghardt Mountain
Game viewing & Roter Kamm	The Concession is located on the eastern side of the TKNP and is bordered to the west by the core "wilderness" area and private farm land in the east.	• Guided 4x4 tours and game drives departing from Rosh Pinah • Roter Kamm Crater views, visits, overnight trails and camping • Development of concrete picnic table and chairs with canopy and a toilet at Rotter Kamm Crater viewpoint parking area at the Aurus Mountain saddle • Development of an overnight camping site east of the Roter Kamm viewpoint.
Orange River	The Concession combines two adventure zones northeast and east of Oranjemund, namely the guided adventure zone north of the main road into Oranjemund and the river adventure zone between the main road and the Orange River.	• Guided Adventure Zone o Guided 4x4 sand dune driving o Guided sandboarding • River Adventure Zone o A 30-unit,60-bed river resort with restaurant o Accommodation, conferences, camping and picnicking
Bidder Registration documents are available as from:	Thursday 1st April 2021 to Friday 16th April 2021	
Proposal submission date and time	Friday 18th June 2021 at 17h00	
Enquiries and documents:	Mukono Kamwi Tel: 061 2842902 Email: mukono.kamwi@meft.gov.na Fabiola Katamila Tel: 061 2842577 Email: fabiola.katamila@meft.gov.na	

LK MINING

NOTICE OF ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

ASEC

ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML220 TO OBTAIN THE ENVIRONMENTAL CLEARANCE CERTIFICATE

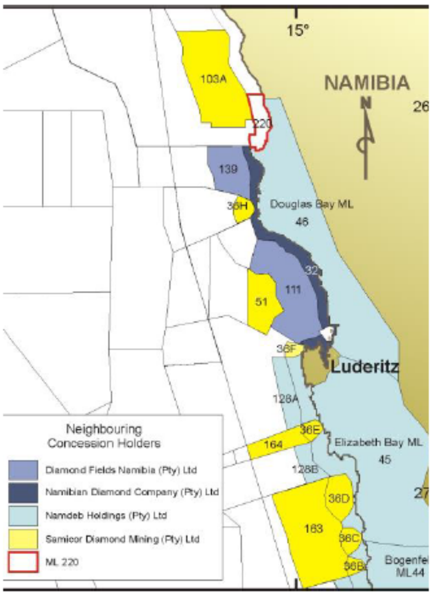
LK Mining (Pty) Ltd (LKM) herewith gives notice in terms of the Environmental Management Act, 7 of 2007 and Regulation 21 of the Environmental Impact Assessment (EIA) Regulations (January 2012), of their proposed offshore diamond mining activities on ML220 approximately 60km North of Lüderitz.

Prior to implementing the proposed Project, an EIA process will be conducted. An application for environmental clearance certificate (ECC) will be submitted to the relevant Component Authority (Ministry of Mines and Energy) who will review and forward the application to the Ministry of Environment, Forestry and Tourism (Environmental Commissioner) in terms of the above-mentioned regulations for the mining activities. This advertisement forms part of the EIA public participation process.

Applicant: LK Mining (Pty) Ltd

Nature and location of the proposed activity:
LKM applied for a Mining Licence (ML) on their existing EPL5965 area. The EPL is located in Hottentots Bay, approximately 60 km north of Lüderitz, and falls within the Namibian Islands Marine Protected Area (MPA) of the Namibian Coast. The proposed ML covers an area of 4227 Ha. The Mining Licence application was filed by LKM with MME in October 2019 and will only be granted after the ECC has been approved and granted.
The proposed mining activities will be similar to the activities conducted during exploration and will include, amongst others, the following:

- Mine the delineated resource area, making use of a small dredge pump vessel.
- A mining rate of 15 square meter per hour has been applied in the mining program. At this applied rate a total of 50 000m² will be mined per year (0.12% of the licence area). Mining Area 1 covers a total area of 350 616 sqm (0.83% of the total licence area,) have been identified as the current mineable resource which results in the proposed life of mine of 7 years.
- Ongoing sampling, resource development, and some detail geophysical survey will cover the target areas.



Independent Environmental Assessment Practitioner:
A. Speiser Environmental Consultants CC (ASEC) has been appointed by LKM as the independent Environmental Assessment Practitioner to undertake the EIA process for the proposed project.

Contact Person:	Alexandra Speiser or	Werner Petrick
Tel:		+264 (0)81 739 4591
E-mail:	amspeiser@yahoo.com	wpetrick@namisun.com

Registration to receive notifications / information and opportunity to comment:
To register as an interested and affected party for the proposed Project, please submit your name and contact details to ASEC by e-mail, or by contacting Werner Petrick. A Background Information Document (BID) is available for a review and comment period from **25th March to 27th April 2021**. Electronic copies of the BID are available on request from ASEC as per above details. Please note that due to COVID-19 restrictions, only focus group meetings are planned within the comments and registration period. Should you like to be invited to one of the Focus Group meetings, please contact ASEC.

If you would like your comments to be addressed in the EIA Report please submit them to ASEC by **no later than 27th April 2021**.

Appendix D: Minutes of the focus group meetings

Date	Organisation
31 March 2021	NamPort Walvis Bay
01 April 2021	Ministry of Fisheries and Marine Resources (MFMR) Swakopmund
07 April 2021	Sperrgebiet Diamond Mining (Pty) Ltd
08 April 2021	NamPort Boardroom, Lüderitz
08 April 2021	Town Council Lüderitz
09 April 2021	Ministry of Fisheries and Marine Resources (MFMR) Lüderitz and the Rock Lobster Fishing Association in Lüderitz

MINUTES OF FOCUS GROUP MEETING HELD ON 31ST MARCH 2021 AT 10H00 FOR THE EIA FOR LK MINING'S PROPOSED DIAMOND MINING ACTIVITIES ON ML220

Venue: NamPort Walvis Bay & Zoom call

Purpose:

- Provide overview of the proposed diamond mining activities
- Understand the EIA process being followed
- Discuss potential environmental impacts
- Provide input into the EIA process

Present:

Name	Organisation	Email
S. Gariseb	NamPort SHEQ Manager	s.gariseb@namport.com.na
W. Petrick	ASEC / Namisun	wpetrick@namisun.com
A. Speiser (joined via zoom)	ASEC	amspeiser@yahoo.com
A. Ashby (joined via zoom)	ASEC / Ashby Associates	ashby@aacc.com.na
C. Neethling (joined via zoom)	LK Mining	carel@lat.co.za

Mr Werner Petrick welcomed the participants and gave a presentation which is attached.

The following discussions took place.

Q/A/C	Name / Organisation	Issues
Q	S. Gariseb	Will there be any diving as part of the mining activities?
A	C. Neethling	No diving as part of the mining process. Potential inspection dives during mining operations by contractor. LKM will conduct a pre mining baseline benthic sampling program.
Q	S. Gariseb	Will the assessment be conducted on the basis of potential cumulative impacts – taking other mining activities in the area into consideration.
A	W. Petrick & A. Speiser	Yes, the EIA will consider the baseline environment and other, existing (relevant) activities as far as possible (i.e. where information is available). However, EIAs are not the same as a Strategic Environmental Assessment (SEA). Ideally a SEA has to be conducted for off-shore exploration / mining in this part of the Namibian coastline. This would help with better information and assessment of cumulative impacts when an EIA is done for a specific project.
Q	S. Gariseb	Will there be a Lüderitz base?
A	A. Speiser	Yes there will be a Lüderitz administrative office. All mining and processing activities will be conducted on board the vessel.
Q	A. Ashby	How will the off-loading of diamonds work, in terms of security? Will NamPort have to be informed and will NamPort provide security?
A	S. Gariseb	Yes, there will be communication between LK Mining and NamPort. NamPort will provide security up to the Quay.
Q	S. Gariseb	The re-establishment of habitats need to be monitored.
A	A. Speiser	Monitoring requirements will be included in the EMP.

The meeting closed at about 11h00.

MINUTES OF FOCUS GROUP MEETING HELD ON 1ST APRIL 2021 AT 10H00 FOR THE EIA FOR LK MINING'S PROPOSED DIAMOND MINING ACTIVITIES ON ML220

Venue: Ministry of Fisheries and Marine Resources (MFMR) Swakopmund & Zoom call

Purpose:

- Provide overview of the proposed diamond mining activities
- Understand the EIA process being followed
- Discuss potential environmental impacts
- Provide input into the EIA process

Present:

Name	Organisation	Email
F. Hamukwaya	MFMR (FRT)	Ferdinand. Hamukwaya@mfmr.go.na
L. Sinvula	MFMR (FB)	Larkin.Sinvula@mfmr.gov.na
V. Libuku	MFMR (FB)	Victor.Libuku@mfmr.gov.na
E. Nangolo	MFMR (SFB)	Esther.Nangolo@mfmr.gov.na
L. Shivute	MFMR (SFB)	LaToya.Shivute@mfmr.gov.na
A. Kreiner	MFMR (CFB)	Anja.Kreiner@mfmr.gov.na
E. Maletzky	MFMR – Lüderitz	erich.maletzky@mfmr.gov.na
K. Grobler	MFMR – Lüderitz	kolettegr@gmail.com
W. Petrick	ASEC / Namisun	wpetrick@namisun.com
A. Speiser (joined via zoom)	ASEC	amspeiser@yahoo.com
A. Ashby (joined via zoom)	ASEC / Ashby Associates	ashby@aacc.com.na
C. Neethling (joined via zoom)	LK Mining	carel@lat.co.za

Mr Werner Petrick welcomed the participants and gave a presentation which is attached.

The following discussions took place.

Q/A/C	Name / Organisation	Issues
Q	MFMR	LK Mining must please share their Bi-annual Environmental Reports with MFMR.
A	LK Mining	Noted – will do.
Q	MFMR	Is "Area 1" on the map the only area relevant to this EIA
A	LK Mining	No – the other areas will also be covered in the EIA. LK Mining first plan to conduct additional resource development over target areas 2, 3 & 4 and depending the results could conduct future mining in these areas as well.
Q	MFMR	Was Area 1 also previously mined and why would there be more diamonds?
A	LK Mining	Tidal Diamonds did mine between 1965 and 1970 in certain areas within the "Area 1".

		From the exploration / resource development in Area 1, LK Mining found that there is still a substantial resource in this bigger Area 1 to be mined.
Q	MFMR	The Depth profile of the sediment up to bedrock needs to be better described.
A	EIA Team	This will be included in the EIA report.
Q	MFMR	The map showing the bedrock and sediment – is the bedrock exposed or covered with sediment?
A	LK Mining	It is exposed. LK mining has no interest of mining in these areas where the bedrock is exposed.
Q	MFMR	These areas are very sensitive and there must be an exclusion zone around them (i.e. 200m).
A	EIA Team	Noted.
Q	MFMR	How deep is the sediment and the proposed mining activities
A	LK Mining	2 – 5 meters, at average of 3m over the Target 1 planned mining area m
Q	MFMR	The sedimentology needs to be explained (i.e. what the sediment consists of – sand or what ?).
A	EIA Team	Noted – this will be included in the EIA report.
Q	MFMR	Explain the process what happens after the material is sucked onto the vessel.
A	LK Mining	C. Neethling provided a brief explanation of the process activities. These activities, including discharges will be explained in the EIA report.
Q	MFMR	Concerned about the discharges at surface and the potential impacts. The turbidity profile needs to be understood. Can LK Mining discharges deeper under the surface.
		The siltation issues are of concern. There are also small currents that needs to be considered. The currents need to be well understood and the sediment plume understood.
A	LK Mining	LK Mining can potentially discharge up to 3m below surface, The technical and safety aspects will be considered during actual operations. The scale of activities need to be taken into account when assessing these impacts.
A	EIA Team	The potential impacts relating to discharges will be assessed as part of the EIA and the relevant mitigation requirements included in the EMP.
Q	MFMR	Which method will be used for further remote sensing?
A	LK Mining	Not all methods will be used. Side scanning will potentially not be applied.
Q	MFMR	The survey activities must be conducted outside the lobster season.
A	LK Mining	This can be incorporated.
Q	MFMR	The movement area of the vessels will be bigger that the mining area. This must also be considered.
A	EIA Team	The movement area will be shown in the report and be included as part of the impact assessment.
C	MFMR	The EBSA areas / boundaries are no shown correctly. These areas are still being revised / finalised.
C	EIA Team	The EIA Team will liaise with E. Maletzky after this meeting to obtain further details / updates regarding the EBSAs
Q	MFMR	The chemistry of the sediments also needs to be taken into account in the assessment. i.e. heavy metals that could be deposited and the impact thereof. This also needs to be considered in the sediment plume modelling. Even if the area is small, it could have impacts.
A	EIA Team	Comment noted. This will be addressed in the EIA.
Q	MFMR	There is kelp on the bedrock which plays an important role in the food chain. This must also be considered in the impact assessment.
A	EIA Team	Comment noted. This will be addressed in the EIA.
C	MFMR	The nutrient load needs to be re-established in the sediment that was removed.
A	EIA Team	Comment noted. This will be addressed in the EIA.

Q	MFMR	What information is available from previous sampling, i.e. physical and biological information? Can this be used? Are there any samples left that could be further analysed?.
A	LK Mining	There are no physical samples available. Resource information is available that will be used in the EIA. This information can also be shared with MFMR.
C	MFMR	Request to keep future samples and pass these on to MFMR for further analysis.
A	LK Mining	Noted
C	MFMR	It is critical to not have impacts on the Rock Lobster Association. No exclusion of the lobster fishing – not even for a day
		No smothering of exposed bedrock and kelp – used by the lobsters
A	EIA Team	Noted. These issues will be addressed in the EIA.
C	MFMR	Please include in the EMP that the Environmental Reporting (during operations) also be sent to MFMR.
A	EIA Team	Noted.

The meeting closed at about 11h30.

MINUTES OF FOCUS GROUP MEETING HELD ON 7TH APRIL 2021 AT 15H30 FOR THE EIA FOR LK MINING'S PROPOSED DIAMOND MINING ACTIVITIES ON ML220

Venue: Zoom call

Purpose:

- Provide overview of the proposed diamond mining activities
- Understand the EIA process being followed
- Discuss potential environmental impacts
- Provide input into the EIA process

Present:

Name	Organisation	Email
P. Lombard	Sperrgebiet Diamond Mining (Pty) Ltd	gm@sperrgebietdiamonds.com
W. Petrick	ASEC / Namisun	wpetrick@namisun.com
A. Speiser	ASEC	amspeiser@yahoo.com
A. Ashby	ASEC / Ashby Associates	ashby@aacc.com.na
C. Neethling)	LK Mining	carel@lat.co.za

Mr Werner Petrick welcomed the participants and gave a presentation which is attached. The following discussions took place.

Q/A/C	Name / Organisation	Issues
C	P. Lombard	P. Lombard explained where Sperrgebiet Diamond Mining (Pty) Ltd's MLs are located in relation to ML220 and provided information regarding their proposed activities, etc.
Q.	P. Lombard	If the Application for a ML was already submitted in 2019 to MME, why the long hold up, other than the completion of the EIA.
A	C. Neethling	Apart for the issues relating to COVID19, there were some administrative delays at MME also last year. LK Mining only really started following up with MME towards to end of 2020. MME send a confirmation letter regarding the ML and the relevant number to LK Mining in January 2021, indicating that the ML can only be officially granted after the EIA process has been completed and MEFT issues an ECC.
Q	P. Lombard	Who mined in the area previously?
A	C. Neethling	Tidal Diamonds.
Q	P. Lombard	Is this an active lobster harvesting area?
A	W. Petrick	Yes, the ML area does overlap with isolated lobster harvesting areas. The potential impacts on the Rock Lobster industry relevant to this area and the proposed activities will be assessed as part of the EIA.

C	P. Lombard	I don't see any significant impacts relating to the proposed activities on ML220.
Q	P. Lombard	The following question is not really an environmental issue, but rather an operation issue: will LK Mining have an Emergency Response Plan in term of evacuation.
A	C. Neethling	Yes. An Emergency Response Plan will be developed.
C	P. Lombard	The proposed project will benefit the local community, the region and the country, which is positive.
C	P. Lombard	We are considering to decrease our adjacent ML46 area to allow for potential tourism or renewable energy initiatives in the area.

The meeting closed at about 16h15.

ASEC	MINUTES of Focus Group Meeting with NamPort Lüderitz held on 8th April 2021 at 12h00 for the EIA for LK Mining proposed ML 220	LK MINING

Venue: NamPort Boardroom, Lüderitz

Purpose:

- To provide overview of the proposed diamond mining activities
- To explain the EIA process being followed
- To discuss potential environmental impacts
- To allow stakeholders the opportunity to provide input into the EIA process.

Present:

Name	Organisation	Position	Email
A. Zavitaa	NamPort	Port Captain	a.zavitaa@namport.com.na
J.S. Isaaks	NamPort	SHREQ Office	johannes@namport.com.na
M.M. Kooper	NamPort	Port Manager	Max.cooper@namport.com.na
A. Ashby	ASEC	EIA socio-economist	ashby@aacc.com.na
C. Neethling	LK Mining	General Manager	carel@lat.co.za
A. Speiser (joined via zoom)	ASEC	Team Leader	amspeiser@yahoo.com
W. Petrick (joined via zoom)	ASEC/NAMISUN	EAP	wpetrick@namisun.com

Ms Auriol Ashby welcomed the participants and individuals introduced themselves. Mr Werner Petrick went through the presentation which is attached. The following discussions took place.

Q/A/C	Name	Issues
Q	J. Isaaks	What is the timeline for the EIA?
A	A. Speiser	The first draft of the EIA and EMP will be ready in May and will be made available to IAPs for further input during May/June. The final EIA/EMP, including all comments, will be submitted to the authorities in late June.
Q	M. Kooper	Will there be a base from which LK Mining will operate?
A	C. Neethling	Yes, LK Mining will have an office and store space with container oils, filters, normal stock etc in Lüderitz. The vessel will work on a 28-day cycle with one crew working 28 days, then 28 days off. ML220 is about 3 hours away from Lüderitz so the vessel will come in the morning, alongside take on stock, water and switch the crews and go back for another 28 days.
Q	J. Isaaks	How are the two sensitive areas different from the other areas?
A	C. Neethling	The two sensitive areas within the bay are the disused jetty and the Neglectus islet. Previously in the exploration phase, LKM agreed to a no-go zone of 120m from these areas and during mining, they are prepared to extend the NO-GO zone to 500m for all activities and this will be clarified with MFMR going forward. In the Hottentots Bay

		there is bedrock and sediment. LK Mining is not interested in the bedrock areas as there are no diamonds there.
Q	J. Isaaks	Will LKM use a supply vessel to go out to the vessel while it is mining?
A	C. Neethling	Not under normal circumstances. We will not do offshore bunkering – it is not legal. If an emergency evacuation is required, we can go overland through the gate at Agate Beach which will be closer as there is no helicopter based in Lüderitz.
Q	J. Isaaks	What wastes can be generated and what waste management systems will you employ?
A	C. Neethling	The vessel will have standard waste management systems. Dirty oil will come to shore and be collected by a licensed operator; all the solid waste will be brought ashore and disposed of properly; the plant itself will potentially discharge to sea non-toxic Ferrosilicon at a rate of 2-3 drums per month, which is tiny compared to vessels such as the Ya Toivo.
Q	J. Isaaks	Where will you source your staff?
A	C. Neethling	LKM plans to get qualified marine staff from Namibia and to use Namibian staff as far as possible.
Q	J. Isaaks	Where will the survey vessel come from?
A	C. Neethling	The survey vessel will be a small Lüderitz-based shallow water vessel.
Q	M. Kooper	What is the legal amount of discharge allowed for the ppm discharge of Ferrosilicon?
A	C. Neethling	LKM does not want to lose FeSi as it is an expense, so we recover as much as possible with a magnetic separator. It is not toxic but we will monitor the discharge as agreed with MFMR. The other question which MFMR had was the extent of the plume. We will monitor e.g. 50m away from the boat, according to the EMP.
Q	M. Kooper	What is the size of the business?
A	C. Neethling	Our operations are small compared to the De Beers mining vessel Mafuta which mines at 1,200m^2 per hour in 120m of water or the Ya Toivo which covers an average 600-700m^2 per hour. LKM will mine 15m^2 per hour. To put it in perspective, what will take LKM to mine in 7 years, would take a large vessel 3 months, but these big vessels cannot mine in these shallow waters.
Q	M. Kooper	There are many ex-employees from Namdeb here. From where will LKM recruit their people?
A	C. Neethling	If Namibia has qualified people, we will recruit 100% Namibian crew. The crew compliment will be 14 people, rotating 7 on duty for 12 hour shifts each on 28 day cycles with the other crew.
Q	J. Isaaks	How will you ensure the EIA process is transparent, reaching all interested and affected parties?
A	W. Petrick	The EIA regulations guide the process to make sure it is transparent. We have advertised in national newspapers, and we used a very extensive database of people in the region and nationally to email out the Background Information Document. We have set up face to face meetings, such as this one, in Lüderitz. We welcome any IAP to share their comments and we want to engage with them as much as possible.
A	A. Ashby	We are meeting the Town Council, MFMR and the Lobster Association. People who have expressed interest in the project we have tried to engage with.
Q	J. Isaaks	How do you address all the economic aspects and those on board, such as health and safety?
A	W. Petrick	The EIA practitioners do not assess if the project is feasible or assess occupational health and safety aspects as there are other systems for that. We are concerned about the impacts on the environment and the people, such as the 3rd parties outside the project such as the fishing industry and locals. We also look at the positive impacts such as on local and regional job creation aspects.
C	J. Isaaks	I recently attended a training session with Peter Tarr who was recommending the EIA review process needs improving.
A	W. Petrick	I think Peter was referring to the review process between the competent authorities, i.e. in this case between the MEFT, the MFMR and MME. Werner reported that MEFT has been incorporating comments from consulting and competent authorities before making their decision.

With no further inputs, the meeting closed at 13h00.

MINUTES of Focus Group Meeting with Lüderitz Town Council held on 8th April 2021 at 16h00 for the EIA for LK Mining proposed ML 220

Venue: Town Council, Lüderitz

Purpose:

- To provide an overview of the proposed
- To explain the EIA process being followed
- To discuss potential environmental impacts
- To allow stakeholders the opportunity to provide input into the EIA process.

Present:

Name	Organisation	Position	Email
Reinhardt Ochs	Lüderitz TC	CEO	ceo@ltc.com.na
Martha Blockstein	LTC	Secretary	martha@ltc.com.na
Carel Neethling	LK Mining	General Manager	carel@lat.co.za
Auriol Ashby	ASEC cc /Ashby Associates cc	Socio-economist	ashby@mweb.com.na

Q/A/C	Name	Issues
Q	R. Ochs	Where will the project take place?
A	C. Neethling	LK Mining had a prospecting licence in Hottentots Bay, 60km north of Lüderitz. The last person that mined there in a big scale was Sammy Colins in 1960's and 1970's with a huge floating barge. The licence was held by Tidal Mining until 2013 when LK Mining secured the rights, did some sampling. We applied for a mining licence in October 2019 and the MME gave a conditional letter that the only outstanding issue was to have an EIA/EMP update and an Environmental Clearance Certificate.
C	A. Ashby	We will send you the full presentation. The EIA team includes marine fisheries and marine ecology experts as we need to assess the potential impacts, particularly on the rock lobster industry, which we will meet with MFMR tomorrow. This is to ensure that their concerns are addressed in the environmental management plan, as far as possible.
C	C. Neethling	One of the key impacts we want to avoid is to discharge over the rocky areas which could smother the crayfish and the other concern is not to disturb the breeding areas of the birds to the south on Neglectus Islet and the old jetty. During exploration, we proclaimed a 120m No-Go zone around these 2 areas, and I am happy to extend that to 500m, but we need clarity from MFMR where the protected zone should be. During exploration, we observed the rock lobster fishing outside the bay and their boats coming in at night to shelter in the bay, so we did not disturb each other at all.
C	C. Neethling	The sediment thickness is about 3m in shallow water. I intend to buy a vessel which is slightly bigger than the Ocean Dolphin, from overseas, convert it and put the plant on it. The total capital project investment will be about USD5 million/ N$70 million. I have been mining diamonds for 25 years offshore and in the ocean.

Q	R. Ochs	What is the lifespan of the project?
A	C. Neethling	The existing mining area will take about 7 years, because it is a small vessel which can cover 400square metres in a day, in waters between 12 – 30m deep. We might upscale it but that will require more capital. The other target areas for exploration might extend the project for another 10 years. The mining licence is issued for 10 years as from 15 January 2021
Q	R. Ochs	How many people will be on the vessel?
A	C. Neethling	There will be 14 people on the vessel, 7 working 12 hour shifts each. They stay on the vessel for 4 weeks and then swop with the other crew for 4 weeks leave. The vessel will operate for 11 months and then it will be taken to Walvis Bay annually, take it out of the water, clean the shaft, the vessel etc.
Q	R. Ochs	Why Walvis Bay?
A	C. Neethling	Because NamPort Lüderitz does not have a synchro-lift.
A	C. Neethling	I believe there is a lot of opportunity in that depth of water along the whole coast and we are happy to come to some agreement with the new owners of the Ocean Dolphin.
Q	R. Ochs	I may be sceptical but if there are still diamonds, why does it take so long for us to mine those diamonds. Namdeb is not interested in sporadic high grade deposits in difficult areas to mine. They operate on much bigger scale with a N$7 billion vessel.
A	C. Neethling	If you look at the scale of the old German plant at Elizabeth Bay, that is the scale of their business at sea. They are mining 1200sqm/hour, at a depth of 120m. Our scale of business is completely different. Even IMDH and the Ya Toivo vessel is not interested in our scale either. So, we have gone to private funding.
Q	R. Ochs	What of the EIA?
A	A. Ashby	The EIA team is contracted by LK Mining, but we are all independent practitioners, sworn to a code of ethics. We hope to get the EIA out within about a month, which we will share with all interested parties to check that what we are recommending in the management plan is acceptable. Then, the EIA goes to the MEFT, MME and MFMR as the competent authorities, and on the basis of their approval the MEFT awards the Environmental Clearance Certificate.
C	C. Neethling	I am very familiar with the whole process. We will buy the hull from overseas and bring it to Cape Town, by which time most of the whole plant will be ready. I take a 3D scanner of the vessel, mail it to the manufacturers, they design and build the plant. This will be the first new mining vessel of its size built from scratch and it has great future potential on this coast as it is a world-class deposit.
C	C. Neethling	NamPort asked this morning “Who are we employing” and I answered on the vessels I used to run in Namibia, 90% were Namibians, which I prefer.
C	R. Ochs	28 employed people will make a difference in Lüderitz.
C	R. Ochs	I was attending an EIA briefing about a NamPower turbine installation and the potential impacts on ants underground, bird impacts and the noise might affect oryx.
C	C. Neethling	One of the things we have done is gather benthic sampling data in the area before you mine and compare it to a similar area we are never going to mine. Every year you take samples to see what the changes are. This kind of precaution will come into the EMP.
C	R. Ochs	Yes, you need to take people’s concerns seriously.
C	C. Neethling	I like the interaction with the rock lobster and fisheries representatives because they have genuine concerns which I know we can address. We can sort it out.
C	A. Ashby	With MFMR it is an opportunity to get more data for research. It could be a win-win because they get data, and you get your licence.
C	C. Neethling	The problem with the big vessels is the majority of the people who work on them do not come from Lüderitz.
C	R. Ochs	Whenever a business comes to Lüderitz, we would prefer at least 50% of the employed people should come from Lüderitz. At least the semi-skilled and unskilled labour should come from here.
C	C. Neethling	There are more than enough people in this town that have the qualifications in the marine mining and fishing industries, and I know many of them.

C	R. Ochs	We also want companies to not only take the experienced ones but also the young ones so they can get experience.
C	C. Neethling	The biggest challenge for us is to have the correct qualifications/ticket to match that vessel. NAMDEB has an amazing system of training people themselves. Yes, I may have to bring in some specialised people such as the technicians to run the Xray machine but there are enough plant operators, deck hands, cooks and EDRs (bosuns) in Lüderitz. We will operate out of Lüderitz, changing personal every 28 days and picking up supplies.
C	A. Ashby	How does the toilet system work for a month at sea?
C	C. Neethling	The International regulations mean you have a small treatment plant on board so there is no discharge while at sea.
C	R. Ochs	So, if I have any further comments, I will send in the form on the BID. I will brief the councillors and pass on any questions. Please send me the presentation.

The meeting closed at 16h45.

MINUTES of Focus Group Meeting with MFMR Lüderitz held on 9th April 2021 at 09h00 for the EIA for LK Mining proposed ML 220

Venue:

Purpose:

- To provide an overview of the proposed
- To explain the EIA process being followed
- To discuss potential environmental impacts
- To allow stakeholders the opportunity to provide input into the EIA process

Present:

Name	Organisation	Position	Email
Auriol Ashby	ASEC cc /Ashby Associates cc	Socio-economist	ashby@mweb.com.na
Werner Petrick	ASEC / Namisun	EAP	wpetrick@namisun.com
Tiago Machado	MFMR, Lüderitz,	Research technician	Tiago.machado@mfmr.gov.na
Rian Jones	MFMR, Lüderitz,	Technician	mercuryrj@gmail.com
B.N.S. Tjandja	MFMR, Lüderitz,	Research technician	tjandja@gmail.com
D.N. Mwaala	MFMR, Lüderitz,	Fisheries Biologist	mwaalashiimbi@gmail.com
Hendrik Kooitjie	Lobster Association member		
Desmond Bester	MFMR, Lüderitz,	CHIEF Fisheries Inspector	Desmond.Bester@mfmr.gov.na
Basil Brown	Lobster Association	Secretary	athleen.m.brown@gmail.com
Jose Calaca	Blameha Fishing	MD	blameha@iway.na
Carel Neethling	LK Mining	General Manager	carel@lat.co.za
Erich Maletzky	MFMR, Lüderitz	Senior Fisheries Biologist	erich.maletzky@mfmr.gov.na
Gustaf Hanghome	MFMR, Lüderitz	Fisheries Research technician	gustafhanghome@gmail.com
Alex Speiser (via Zoom)	ASEC cc	EAP Team Leader	
Andrea Pulfrich (via Zoom)	ASEC/ Pisces Environmental Services	Marine Biodiversity	apulfrich@pisces.co.za
Sarah Wilkinson (via Zoom)	ASEC / Capricorn Marine Environmental	Fisheries	sarah@capfish.co.za

Q/A/C	Name	Issues
Q	J. Calaca	No questions for now, we need more time on this. We need a date and venue so that we can get the fishermen together to talk about this, because that area is very sensitive. In our view, it's a no-go at all. We need to talk about it, but that is a very, very sensitive area.
A	C. Neethling	Just for the rest of the group: In response to concerns raised by the Lobster Association that LK Mining acknowledge this is a very sensitive area, I have indicated that I will set up a separate forum to discuss on the practicalities of our operation. I am happy not to interfere with them and we will do the survey in the off-season period. Mining will be conducted away from the bedrock areas and specifically away from the Black Rock area. I also do not have a problem to impose a 500m no-go zone for the Black Rock area and the two other sensitive areas, disused jetty and Neclectus Islet. I think for the practicalities of going forward for myself as a mining operator, I am happy to set up a separate forum on the practicalities of the operation.
Q	E. Maletzky	Are the focus areas of the mining license the same as EPL5965 for 1,2,3 and 4 quadrants?
A	C. Neethling	The EPL is the exact same area we applied for which is ML220. The target Area 1 is a mineable area. For Areas, 2,3 and 4, we have got some historical information and we need to follow up and do 100m grid space sampling.
Q	E. Maletzky	So the EPL belongs to LK Mining?
A	C. Neethling	Yes
Q	E. Maletzky	We are a bit puzzled because we received another request for information based on that same area from another company.
A	C. Neethling	We have been granted a provisional ML220, conditional of the EIA/EMP. A provision of the EIA/EMP process is that we do not have to re-apply. Perhaps someone is sitting there hoping we are not going to re-apply. We have formally engaged with the MME to confirm whether we need to renew, because you can renew further for a third time, but we have been advised, that it is not necessary.
A	S. Wilkinson	I want to respond to the question about favoured fishing grounds in that Black Rock area. The information we have from Fisheries is very broad scale, so if the Rock Lobster Association could assist us with defining the hot spot fishing areas that will be very important for us to include in the study.
A	E. Maletzky	I can give you some clarity on this. The lobster fishing is a shallow inshore fishing process and at present they don't use any GPS information to report on the fishing they do there. What we have is a commercial zone from North to South that is defined by latitudes and that's what the fishermen use. That's how their logbooks are set up. The fishing vessels don't have a GPS setup to send data to a central recording station. So that's why we have very generalized reporting from the lobster catchers. I can understand that is a problem for the mining operation because you need actual physical locations to see the mining area that you are looking at.
Q	C. Neethling	With my limited knowledge of rock lobster catching, it does not take place over the rocky areas?
A	E. Maletzky	Not necessarily. It depends on where the traps are. There is a misconception that the fishing of rock lobsters is primarily targeted over the rocky areas, but that's not actually the case. The sheltering areas for the lobsters are the rocky areas and the valleys. You deploy traps anywhere it is feasible. You can even deploy on sandy areas and the bait that you use will attract the lobsters from the sheltered areas to the fishing traps. So, there are sandy areas that they fish on, that are adjacent to the rocky sheltered areas. It just depends if there is a reef where they are deploying their traps. The rocky areas are very important to the habitat of the rock lobsters. They provide shelter as well as feeding areas for the rock lobster. Aspects such as sediment, siltation etc. need to be looked at and minimized as far as possible, so we don't have a reduction of the rock lobster habitat through the mining activity. That is one of the main concerns.

		The second concern to the industry is obviously the exclusion of the area around the mining vessel. Are there specific areas the fishing vessels are not allowed to go? The mining vessel is anchored there, so this would be a big concern for the lobster operators. The other thing I wanted to mention is to have a layover of the bathymetry map together with the substrate. You have the sandy areas and the rocky areas, and you relate that to your bathymetry map. That will give you a very good indication of where exactly the fishermen are fishing. In the North, the rock lobster fishermen mainly operate in the waters from 30m down to 2m.
Q	S. Wilkinson	In terms of reporting of catches, is there any record of more fine scale fishing positions rather than just catch management areas that I could get and use?
A	E. Maletzky	Not at present.
C	S. Wilkinson	Okay, so we'll be looking at habitat mapping.
Q	J. Calaca	Is diamond mining normally sucking out gravel? If you suck out gravel you will disturb the whole habitat. So how will the mining industry rehabilitate the habitat of the lobster industry? If you look at all the diamond mining areas – I come from Kimberley – Kolmanskop, you won't see the effects of the diamond mining, but in Lüderitz, my main concern is the fishing area. If you suck out the gravel the whole habitat will move and how will you ever be able to rehabilitate? Look at what happened in Port Nolloth. The same thing happened in Port Nolloth. There's not one single lobster factory left in Port Nolloth. It's a very sensitive area and an industry that carries this town. That is my concern.
A	C. Neethling	Just to summarize. We note your concern regarding the sensitivity of the habitat. This will be covered in the report and it is an issue that has been studied since 1994 by the marine environmental specialist. The other aspect is the sensitive areas for the crayfish and the fishing as well. This is noted and recorded.
Q	D. Mwaala	Last year there were 6 Dusky Dolphins that died in the same area. There is some concern that any of these disturbances in the area might cause further stranding of some of these creatures. Noise is a concern as well.
A	C. Neethling	We need to cover the effect of the operation and of course our survey as well. It is an active area so I think we need to emphasize the historical information we have and how we're going to mitigate that in our EMP.
C	E. Maletzky	So on that I think we need to contact our ex staff member, Jackie; I don't think there were any conclusive results from that event.
Q	B. Tjandja	When you disturb the sediment, you also release nutrients into the water and when you look at the micro-organisms around, like the micro plankton, you create blooms, especially in this area where the water is coming. This is harmful because it reduces the oxygen in the water and when there is no oxygen in the water, the rock lobsters walk out. When there are blooms, we find them dead on the beach. It also affects the whales and the dolphins. I think for your EIA, you need to look at the micronutrients that are being released into the water. Phosphates are also harmful.
A	C. Neethling	We have identified that monitoring this discharge, from our first meeting with Erich. One of the potential solutions that we are looking at is this: Normally on a large vessel you would have your discharge at the main deck level and what we could propose is to use the same type of pipe to potentially discharge the material, especially the fines, below the sea level. The rocks and larger stuff will go straight down. One third of the discharge material in this case shell and sand, will go into a plume. In the past, we have monitored the plume continuously by going out every day and taking a bottle sample of the discharge, but as its underwater I'm not sure how we're going to do it. Then what we used to do was take a rubber duck and go in the direction of the plume and take a sample of the surface every 20m. Then we start to build up a record. In comparison to the normal scale of this type of business and the scale at which we are mining, it is a pin on the map. Our footprint and impact is going to be extremely small, compared to other mining vessels, in this large environment.

		We could potentially not mine closer than 200m away from the bedrock outcrop, to respond positively to these concerns.
C	W. Petrick	I just want to say that from my environmental team's point of view, we are taking note of all these concerns and comments and these are all obviously issues that we as a team have discussed and will consider as part of the EIA. We obviously need to address them as part of the assessment we do and the environmental management plan will include mitigating measures to address these. This ultimately becomes a legally binding document that LK Mining has to implement.
Q	S. Wilkinson	I know these sub surface disposal chutes are used by the hydrocarbon industry. They discharge about 10m below the surface of the water. In this case would it actually have an effect because if I understand the process correctly, your discharge is going to be fairly aerated? This means that once it comes out of the bottom of the pipe, the air is going to float to the surface and take a lot of the fines with it. The problem with sub-surface discharge is that it does not take the problem of turbidity away. There is still turbidity. It is not as visible from the surface, but the turbidity is still there.
A	C. Neethling	We could certainly look at having a discharge that is not aerated. We can enclose the discharge from the chute from the underside and ensure that it is 100% water and soft sediment. The discharge depth we can also have a look at - below keel would make a difference and the draught of the vessel is only going to be 3m, but this might be a safe operational hazard. There is another aspect in the safety and design thereof in respect of *(the discharge pipe*) recovery, in case of emergency when the vessel has to mobilize itself. I will cover this in the operational manual.
Q	T. Machado	Crustaceans. Lobsters are very slow growing organisms. I just wanted to know because in that area we have our sanctuaries. We have our management strategies where we have closed season and off season. How do you incorporate that in your operational principle? Are you going to close as well? These are legislated policies which govern the management process of these resources. How are you going to incorporate that?
A	C. Neethling	Sanctuary areas are no-go zones for us, in mining. Facilitating the lobster fishing vessels during the lobster fishing season is not a problem on this scale. Can I just point out that my vessel is smaller than the one that you see there in the harbour (MV Ya Yoivo). It's not even a fraction of that one. I know the guys catch a lot of crayfish west of the point and then they come in and stay in the evenings in the bay in shallow waters. So out of a manoeuvrability aspect, we are literally sea miles apart from each other. If they are at Black Rock, that is 2km away from us.
Q	T. Machado	As we heard before, lobsters contribute a lot to the socio-economic development of Lüderitz. How is this company going to work in terms of its contribution to the local economy and social development?
A	C. Neethling	I addressed this question to the Lüderitz Town Council yesterday and yes, we are planning to open an office in Lüderitz. And Yes, we are planning to employ Namibians, as far as possible. As we know in the marine industry, some vessels need some specially qualified people or technicians for specialised machines. However, we know there are people in this town that have these capabilities and potential qualifications. Especially EDR's or seamen. Some of them have worked for me in the past. I have worked in this town for 15 years. That will be our contribution.
Q	D. Mwaala	I see one of these areas is very close to one of the seal colonies. I think Hollamsbird
A	C. Neethling	Holamsbird is about 50 sea miles away.
Q	D. Mwaala	We are monitoring the fur seal population on south end and north end and it's all connected to food availability. Most of our seals go a bit further north, so it's very possible that any disturbances, around this area where the fur seals are supposed to be feeding, may actually force them to move from these established colonies. It might also be possible that it is in the migratory routes for sea birds which are mostly feeding up in the north. Especially the penguins.
A	C. Neethling	These concerns have been noted and recorded and we will respond in our environmental report.

Q	J. Calaca	Do you know the vessel that is currently there now?
A	C. Neethling	It is not our vessel. We are not currently sampling. The only vessel that works offshore there should be the Explorer or the Ya Toivo. The Ya Toivo is potentially sitting there now and it's mining in ML103A or ML111. There's a huge deposit that belongs to Samicor that sits offshore at 95km that was mined by Namco and now it's someone else. You can see them sitting out there. Again, the question is, what is the impact of that vessel? They're limited to area. They mine an average of 500 - 600m^2 per hour and I will do 15m^2 an hour, if I'm lucky. So what I mine in 7 years, they will do in 3 months! My vessel is like the Ocean Dolphin; it's a very small vessel. I used the Ocean Dolphin out there to do some sampling 3 years ago. It was not very successful for technical reasons.
Q	E. Maletzky	I want to ask if you can share the shape files with us?
A	C. Neethling	Yes, I'll do that so you have a much better database going forward and then you can share the smaller sensitive areas with us as well.
C	E. Maletzky	We're still working on that.
Q	B. Brown	Are you going to arrange a meeting with the Rock Lobster Association?
A	C. Neethling	The EIA process allows for all comments and concerns in writing, and we will respond and then we will submit the report. Before I start mining, I will arrange with people I know in this town and yourself, to form a forum so that we can have a practical solution on the way I operate and that we don't have a problem with each other.
C	E. Maletzky	Just a suggestion, do not make it too technical and most people speak Afrikaans in Lüderitz.
C	B. Brown	The rock lobster industry is sensitive. They put inspectors on the vessels to see what we are doing. Just to give you an idea of how protected the resource is.
Q	J. Calaca	How far away is the Mining Licence area from the Gibraltar Line?
A	C. Neethling	There's this specific rock they use as a reference. I think that is approximately 16 miles further North from us.
C	W. Petrick	He thanked Carel with the facilitation of the questions for the meeting participants on Zoom and he thanked everyone for their participation. It was very helpful to get the questions from the Lobster Association.
Q	A. Pulfrich	Is it possible that Erich can share the shape files or a map showing the new conservation areas, so I can update the map accordingly? It's always very difficult for us consultants because we use whatever information is available on the web. Obviously not being aware of what's happening in the background and all of the developments that are happening. We're often criticized for not using the most up to date information. It would be really useful if we could include that if you're in a positon to share.
A	E. Maletzky	It's actually work in progress. We are currently busy with re-drafting the regulations for the Namibian Islands Marine Protected Area (NIMPA) because all the MPA guidelines for NIMPA are actually elevated to the "Ecologically or Biologically Significant Marine Areas" (EBSA) level. So all the work that is done on the EBSA is based on the MPA guidelines. We are currently refining the regulations and actually noted that point where the area around the disused jetty has to be reduced quite substantially in order to cover the concerns we have there. That's what we're still busy with. I can't give a timeline on when it's going to be completed because there are quite a few steps that need to be followed before we actually have a final product. I can release some internal information and then you can use that to plot for now. We have already discussed it, in-house. I think it was just a mapping tool that defined the area quite broadly. They didn't focus on the disused jetty and the point north of that on the coastline.
C	A. Pulfrich	Thank you that could be very useful. What I could do on that map showing the conservation management control area is show the original area and then also show the revised area and point out that this is work in progress. Then both sides of the story are presented.
C	E. Maletzky	We also need to bear in mind that the technical team is working at the Nelson Mandela Metropolitan University. Everything that is finalized here, has to get into their process and then they have to update the maps that actually go onto the website where we have the repository for the EPSAs. That process also

		takes some time and then obviously EPSA task teams also have to sit and discuss that information before it's finalized. That's a time-consuming process that doesn't achieve a final result very quickly.
C	A. Pulfrich	Yes, I'm aware of that, but if we could just indicate on the map what the likely changes will be, it will also demonstrate to the EIA reviewing authorities that we are up to speed with changes.
C	E. Maletzky	Yes. So, once I get the go ahead from Jean-Paul, I'll forward you those co-ordinates.
Q	S. Wilkinson	From my side would it be possible to get some more recent data for the rock lobster sector including current vessels active and current rights holders for the area? I have up to 2016 at the moment.
A	E. Maletzky	Yes, I can give you 2019 – 2020 data.
Q	S. Wilkinson	Do I need to put in a formal request for that from Alex.
A	E. Maletzky	Yes. Once you receive authorisation from the Executive Director's office, they would issue an internal memo and through that we could respond to you.
Q	S. Wilkinson	I did get authorisation for release of data, but it wasn't for this particular project, so I'm sitting with data for a separate project and now I'm not sure if I have to re-submit an application for it.
A	E. Maletzky	I think maybe we just need to follow up on that and see if you need to do it through the Executive Director's office. Any communication with the public and private sectors have to go through the office of the Executive Director.
	C. Neethling	Thank you everyone for attending the meeting. I felt it was a good meeting regarding the questions and concerns that have been raised. The people that know me in this town, know that I will take your concerns seriously. Thank you everyone.

The meeting closed at about 10.45.

Appendix E: Issue & Response report and comments received

ISSUES AND RESPONSE REPORT - A Summary of all comments received

ISSUES AND RESPONSE REPORT			
Name and how raised	**Issue Raised / Comment**	**Response**	**Report Section**
Social issues			
R. Ochs, Town Council Lüderitz, 08 April 2021	Whenever a business comes to Lüderitz, we would prefer at least 50% of the employed people should come from Lüderitz. At least the semi-skilled and unskilled labour should come from here.	There are more than enough people in this town that have the qualifications in the marine mining and fishing industries.	5.5, 9.2.15 & 10.2
M. Kooper, 08 April 2021, Focus Group Meeting, NamPort, Lüderitz	There are many ex-employees from Namdeb here. From where will LKM recruit their people?	If Namibia has qualified people, we will recruit 100% Namibian crew. The crew compliment will be 14 people, rotating 7 on duty for 12 hour shifts each on 28 day cycles with the other crew.	5.5, 9.2.15 & 10.2
T. Machado, 09 April 2021, MFMR, Lüderitz	As we heard before, lobsters contribute a lot to the socio-economic development of Lüderitz. How is this company going to work in terms of its contribution to the local economy and social development?	LK Mining is planning to open an office in Lüderitz and it is planning to employ Namibians, as far as possible. In the marine industry, some vessels need some specially qualified people or technicians for specialised machines. However, there are people in this town that have these capabilities and potential qualifications, especially EDR's or seamen. Some of them have worked for Mr Neethling in the past, who has worked in this town for 15 years.	5.4, 9.2.13, 10.2
Bedrock area / rock lobster farming / Marine animals			
MFMR, Swakopmund, 01 April 2021, Focus Group Meeting	These areas are very sensitive and there must be an exclusion zone around them (i.e. 200m). It is critical to not have impacts on the Rock Lobster Association. No exclusion of the lobster fishing – not even for a day. No smothering of exposed bedrock and kelp – used by the lobsters.	Noted and will be discussed with the Rock Lobster farmers. (A meeting was held in Lüderitz on 9 April 2021),	5.4, 9.2.4, 9.2.7, 9.2.13 & 10.2
J. Calaca, 09 April 2021, MFMR, Lüderitz	No questions for now, we need more time on this. We need a date and venue so that we can get the fishermen together to talk about this, because that area is very sensitive. In our view, it's a no-go at all. We need to talk about it, but that is a very, very sensitive area.	In response to concerns raised by the Lobster Association, LK Mining acknowledges that the lobster fishing areas are very sensitive. LK Mining will set up a separate forum to discuss the practicalities of its operation. LK Mining is happy not to interfere with them and it will do the survey in the off-season fishing period. Mining will be conducted away from the bedrock areas and specifically away from the Black Rock area. LK Mining does not have a problem to impose a 500m no-go zone for the Black Rock area and the two other sensitive areas, disused jetty and Neglectus Islet.	5.4, 9.2.4, 9.2.7, 9.2.13 & 10.2
D. Mwaala, 09 April 2021,	Last year there were 6 Dusky Dolphins that died in the same area. There is some concern that these	We need to cover the effect of the operation and of course our survey as well. It is an active area so I think we need to emphasize the historical	5.2, 5.3, 9.2.1, 9.2.2 &10.2

ISSUES AND RESPONSE REPORT			
Name and how raised	**Issue Raised / Comment**	**Response**	**Report Section**
MFMR, Lüderitz	disturbances in the area might cause further stranding of some of these creatures. Noise is a concern as well.	information we have and how we're going to mitigate that in our EMP. MFMR added that the cause of these strandings was not established.	
B. Tjandja, 09 April 2021, MFMR, Lüderitz	When you disturb the sediment, you also release nutrients into the water and when you look at the micro-organisms around, like the micro plankton, you create blooms, especially in this area where the water is coming. This is harmful because it reduces the oxygen in the water and when there is no oxygen in the water, the rock lobsters walk out. When there are blooms, we find them dead on the beach. It also affects the whales and the dolphins. I think for your EIA, you need to look at the micronutrients that are being released into the water. Phosphates are also harmful.	We have identified that monitoring the discharge is important, from our first meeting with Erich. One of the potential solutions that LK Mining is looking at is this: Normally on a large vessel you would have your discharge at the main deck level and what we could propose is to use the same type of pipe to potentially discharge the material, especially the fines, below the sea level. The rocks and larger stuff will go straight down. One third of the discharge material in this case shell and sand, will go into a plume. In the past, we have monitored the plume continuously by going out every day and taking a bottle sample of the discharge, but as its underwater I'm not sure how we're going to do it. Then what we used to do was take a rubber duck and go in the direction of the plume and take a sample of the surface every 20m. Then we start to build up a record. In comparison to the normal scale of this type of business and the scale at which we are mining, it is a pin on the map. Our footprint and impact is going to be extremely small, compared to other mining vessels, in this large environment. We could potentially not mine closer than 200m away from the bedrock outcrop, to respond positively to these concerns. I know these sub surface disposal chutes are used by the hydrocarbon industry. They discharge about 10m below the surface of the water. In this case would it actually have an effect because if I understand the process correctly, your discharge is going to be fairly aerated? This means that once it comes out of the bottom of the pipe, the air is going to float to the surface and take a lot of the fines with it. The problem with sub-surface discharge is that it does not take the problem of turbidity away. There is still turbidity. It is not as visible from the surface, but the turbidity is still there.	5.2, 9.2.5, 5.2.6 & 10.2
T. Machado, 09 April 2021, MFMR, Lüderitz	Crustaceans. Lobsters are very slow growing organisms. In that area we have our sanctuaries. We have our management strategies where we have closed season and off season. How do you incorporate that in your operational principle? Are you going to close as well? These are legislated policies which govern the management process of	Sanctuary areas are no-go zones for us, in mining. Facilitating the lobster fishing vessels during the lobster fishing season is not a problem on this scale. Can I just point out that my vessel is smaller than the one that you see there in the harbour (MV Ya Yoivo). It's not even a fraction of that one. I know the guys catch a lot of crayfish west of the point and then they come in and stay in the evenings in the bay in shallow waters. So out of a maneuverability aspect, we are literally sea miles apart from each other. If they are at Black Rock, that is 2km away from us.	5.4, 9.2.4, 9.2.7, 9.2.13 & 10.2

ISSUES AND RESPONSE REPORT			
Name and how raised	**Issue Raised / Comment**	**Response**	**Report Section**
	these resources. How are you going to incorporate that?		
Operational issues			
J. Isaaks, 08 April 2021, Focus Group Meeting, NamPort, Lüderitz	What wastes can be generated and what waste management systems will you employ?	The vessel will have standard waste management systems. Dirty oil will come to shore and be collected by a licensed operator; all the solid waste will be brought ashore and disposed of properly; the plant itself will potentially discharge to sea non-toxic Ferrosilicon at a rate of 2-3 drums per month, which is tiny compared to vessels such as the Ya Toivo.	4.3.1, 9.2.10, 9.2.12, 10.2
M. Kooper, 08 April 2021, Focus Group Meeting, NamPort, Lüderitz	What is the legal amount of discharge allowed for the ppm discharge of Ferrosilicon?	LKM does not want to lose FeSi as it is an expense, so we recover as much as possible with a magnetic separator. It is not toxic but we will monitor the discharge as agreed with MFMR. The other question which MFMR had was the extent of the plume. We will monitor e.g. 50m away from the boat, according to the EMP.	4.3, 9.2.8, 10.2
A Ashby, 08 April 2021, Focus Group meeting with Lüderitz Town Council	How does the toilet system work for a month at sea?	The International regulations mean you have a small treatment plant on board so there is no discharge while at sea.	4.3.1, 9.2.10, 10.2
EIA Process			
J. Isaaks, 08 April 2021, Focus Group Meeting, NamPort, Lüderitz	How will you ensure the EIA process is transparent, reaching all interested and affected parties?	The EIA regulations guide the process to make sure it is transparent. We have advertised in national newspapers, and we used a very extensive database of people in the region and nationally to email out the Background Information Document. We have set up face to face meetings, such as this one, in Lüderitz. We welcome any IAP to share their comments and we want to engage with them as much as possible.	1.3 & 2.3 App. B, C, D & E
Comments received via email			
Miller Mwashindange, Environmental Intern MRM, Namdeb Diamond Corporation (28 April 2021)	The proposed mining activities are located in a biodiversity rich area, which is concerning as these ecological areas are meant for conservation. Whereas, mining processes can be highly distractive. It is highly important that these ecosystems are preserved and protected. With the mining activities being in the MPA with endangered species how is the proponent ensure that there is no significant loss of biodiversity in the area? The licence area further overlaps with an EBSA, it is worth	These issues have been addressed in the EIA Scoping Report and EMP	6, 9.2.3, 9.2.4, 9.2.6, 9.2.7, 10.2.1, App. G & H

ISSUES AND RESPONSE REPORT			
Name and how raised	**Issue Raised / Comment**	**Response**	**Report Section**
	noting that the possible disturbance to these ecological areas. How then will the mining operations safeguard the sustainability of the EBSA?		
Vanessa Stein, NBRI (06 April 2021)	Registered as an IAP	Send BID, no comments received	
Hafeni Hiveluah (31 March 2021)	Registered as an IAP	Send BID, no comments received	
Aune Ndapanda Nantinda, General Manager, Hangana Abalone (Pty) Ltd. (26 March 2021)	Registered as an IAP	Send BID, no comments received	
Wayne Handley, Ministry of E,F and T (Kharas Parks) (26 March 2021)	Thanks for this document. It gives a clear explanation of the companies' intention. From the documentation provided at appears clear that this is an offshore activity with minimum impacts on the shore. Please note that the Ministry of Environment, Forestry and Tourism has a number of documents in place to manage the onshore activities: Tsau Khaeb National Park Management Plan and Tourism Development Plan, Zonation Plan and The Mining and Prospecting in Parks Policy. Please also take note that the Ministry will be launching opportunities to bid for tourism Concessions in the area known as the "Norther Sea and Sand Tourism Development Area. This will allow a Concessionaire to take visitors into the area. Mobile campsites will also be set up along the coast at predetermined places. Please also note that I am one of the Ministries representatives on the	These issues have been addressed in the EIA Scoping Report and EMP.	6, 10.2.1

ISSUES AND RESPONSE REPORT			
Name and how raised	**Issue Raised / Comment**	**Response**	**Report Section**
	National Marine Pollution Contingency Plan Operations Team so I will pass this info onto the other members with a short explanation. This team is responsible to manage any off-on shore disasters.		
Dr. Chris Brown, Namibian Chamber of Environment (25 March 2021)	My main interest is in the benthic fauna, and the impact that suction dredging has on this component of the biodiversity. In particular, how long does it take for the seabed to reform, for the bedrock (and I understand that suction dredging will go down to the bedrock) to rebuild its covering of rocks, gravel and sand (and at what rate, and how similar is this structure to neighbouring undredged areas), and to what extent and at what rate does the benthic fauna recover? Is a point reached when the benthic fauna of a dredged area has recovered to the extent that its diversity and abundance is the same as neighbouring undredged areas, and what is this time period?	These issues have been addressed in the EIA Scoping Report and EMP.	4.2, 5.2, 9.2.3, 9.2.5, 9.2.7, 10.2.1, App. G

Emails received:

From: Mwashindange, Miller [mailto:Miller.Mwashindange@namdeb.com]
Sent: Wednesday, 28 April 2021 08:03
To: Werner Petrick <wpetrick@namisun.com>; amspeiser@yahoo.com
Subject: RE: ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE OIAIIOND MINING ACTIVITIES ON THE PROPOSED ML22O TO OBIAIN THE ENVIRONMENTAL CLEARANCE CERTIFICATE

Hi Werner,

Pease find attached the Namdeb comments and questions on the proposed activities.

Apologies for the delay, I seem to have had a mix up on the comment period.

Kind Regards

Miller N. Mwashindange (Mylar)

Environmental Intern MRM

Namdeb Diamond Corporation

Mineral Resources Development

P O Box 35

Oranjemund

Namibia

Tell: 063 239 666

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

From: Mwashindange, Miller [mailto:Miller.Mwashindange@namdeb.com]
Sent: Friday, 16 April 2021 12:35
To: amspeiser@yahoo.com
Cc: Werner Petrick <wpetrick@namisun.com>
Subject: ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE OIAIIOND MINING ACTIVITIES ON THE PROPOSED ML22O TO OBIAIN THE ENVIRONMENTAL CLEARANCE CERTIFICATE

Good Day,

I would like to register Namdeb Diamond Cooperation as an I&AP for this assessment.

Could you please share the BID with me.

Kind Regards

Miller N. Mwashindange (Mylar)

Environmental Intern MRM

Namdeb Diamond Corporation

Mineral Resources Development

P O Box 35

Oranjemund

Namibia

Tell: 063 239 663

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

From: Vanessa Stein [mailto:Vanessa.Stein@meft.gov.na]
Sent: Tuesday, 06 April 2021 10:26
To: amspeiser@yahoo.com; wpetrick@namisun.com
Cc: Sonja Loots <Sonja.Loots@meft.gov.na>
Subject: ENVIRONIVENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR THE OFFSHORE DIAMOND MINING ACTIVITIES ON THE PROPOSED ML22O TO OBTAIN THE ENVIRONMENTAL CLEARANCE CERTIFICATE

Dear sir

Kindly register me as an Interested and Affected Party (IAP) on behalf of the National Botanical Research Institute (NBRI). If the Background and Information Document (BID) is available, please forward it to me as well.

Thank you

Kind regards

Vanessa Stein
Forester
National Botanical Research Institute (NBRI)

Ministry of Environment, Forestry And Tourism
Windhoek
Namibia
Tel: +264-61-2022013
Fax: +264-61-258153
E-mail: Vanessa.Stein@mawf.gov.na
webpage: www.nbri.org.na

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

From: Hafeni Hiveluah [mailto:hafexx@gmail.com]
Sent: Wednesday, 31 March 2021 15:11
To: wpetrick@namisun.com
Subject: ML 220 IP registration

Good day Werner,

Pls do register me as an IP for the above EIA process as recently advertised in the media.

Pls do fwd me the BID.

Rgds,

Hafeni

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

From: Aune Nantinda [mailto:Aune.Nantinda@ol.na]
Sent: Friday, 26 March 2021 12:49
To: Werner Petrick <wpetrick@namisun.com>; amspeiser@yahoo.com
Cc: 'Auriol Ashby' <Ashby@aacc.com.na>
Subject: RE: Registration as an interested party

Thank you so much Werner

Kind regards

HANGANA ABALONE
PROUD TO BE PART OF O&L

AUNE NDAPANDA NANTINDA

GENERAL MANAGER

HANGANA ABALONE (PTY) LTD

Erf 514, Industry Road | Lüderitz, Namibia

T: +264 63 20 3392 | C: +264 812714626

Email: Aune.Nantinda@ol.na

Hangana Seafood subscribes to professional business practices.

(Telephone hotline 0800 225 230, or e-mail O&L@tip-offs.com)

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

On Friday, March 26, 2021, 06:30:49 AM GMT, Wayne Handley <metroshpinah@iway.na> wrote:

Good Morning Ms. Speiser

Thanks for this document. It gives a clear explanation of the companies' intention.

From the documentation provided at appears clear that this is an offshore activity with minimum impacts on the shore.

Please note that the Ministry of Environment, Forestry and Tourism has a number of documents in place to manage the onshore activities: Tsau Khaeb National Park Management Plan and Tourism Development Plan, Zonation Plan and The Mining and Prospecting in Parks Policy.

Please also take note that the Ministry will be launching opportunities to bid for tourism Concessions in the area known as the "Norther Sea and Sand Tourism Development Area. This will allow a Concessionaire to take visitors into the area. Mobile campsites will also be set up along the coast at predetermined places.

Please also note that I am one of the Ministries representatives on the National Marine Pollution Contingency Plan Operations Team so I will pass this info onto the other members with a short explanation. This team is responsible to manage any off-on shore disasters.

Please register the Ministry of E,F and T (Kharas Parks) as a I and AP.

Thanks

Wayne Handley

Chief Warden (Kharas Parks)

Rosh Pinah

081 2091148

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

From: Aune Nantinda [mailto:Aune.Nantinda@ol.na]
Sent: Thursday, 25 March 2021 13:32
To: wpetrick@namisun.com; amspeiser@yahoo.com
Subject: Registration as an interested party

Good day Werner

Ref: Offshore diamond activities on the proposed ML220

Please register me as an interested party

Name: Aune Nantinda

Email: Aune.Nantinda@ol.na

C: +264 812714626

I would also like to be invited to the focus group meetings in Lüderitz

Thank you and Kind regards

AUNE NDAPANDA NANTINDA

GENERAL MANAGER

HANGANA ABALONE (PTY) LTD

Erf 514, Industry Road | Lüderitz, Namibia

T: +264 63 20 3392 | C: +264 812714626

Email: Aune.Nantinda@ol.na

Hangana Seafood subscribes to professional business practices.

(Telephone hotline 0800 225 230, or e-mail O&L@tip-offs.com)

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Dear Alex,

Thank you for your e-mail on the EIA/EMP for ML220.

My main interest is in the benthic fauna, and the impact that suction dredging has on this component of the biodiversity. In particular, how long does it take for the seabed to reform, for the bedrock (and I understand that suction dredging will go down to the bedrock) to rebuild its covering of rocks, gravel and sand (and at what rate, and how similar is this structure to neighbouring undredged areas), and to what extent and at what rate does the benthic fauna recover? Is a point reached when the benthic fauna of a dredged area has recovered to the extent that its diversity and abundance is the same as neighbouring undredged areas, and what is this time period?

For the above reasons I would like to register the NCE as an I&AP.

Kind regards,

Chris

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Appendix F: Curriculum Vitae of competent person

A. Speiser Environmental Consultants cc
VAT Reg. No.: 3452708015 Reg. No.: cc 2003/0606
Alexandra Speiser
MSc MPhil
P.O. Box 40386 Windhoek Namibia Tel:+264 61 244 782 Cell: 081 124 5655 e-mail:amspeiser@yahoo.com

CURRICULUM VITAE
MARIE ALEXANDRA ANGELIKA SPEISER

A. PROFESSIONAL INFORMATION

First Names: Marie Alexandra Angelika
Surname: Speiser
Nationality: German (Permanent Residence in Namibia 1999)
Countries worked: Namibia, Mozambique, Angola, Botswana, Germany

Language: German and English (fluent)
Portuguese (reading, understanding: good; writing: poor)
Afrikaans (fair)
Profession: Environmental Scientists (MPhil), Geologist (MSc)
Contact details: P.O. Box 40386
Windhoek – Namibia
Tel +264 61 244782
Namibian cell 081 1245655; Portuguese mobile +351 922289857
E-mail: amspeiser@yahoo.com, aspeiser1910@gmail.com

B. EDUCATION

2000 **Master of Philosophy** in Environmental Science, University of Cape Town, South Africa.
Group Thesis Title: *Environmental Situation Analysis of the Orange and Fish River Catchments*
Individual Paper Title: *Small Scale Mining in Namibia*

1994 **Master of Science** in Geology and Paleontology, Georg-August University Göttingen/Germany.
Thesis Titles: *Fluid inclusion studies in vein quartz from the Kansanshi Mine (Zambia)* and *Geological mapping of the Kansanshi Mine and surroundings.*

C. Relevant Courses

November 2004
Environmental Auditor Trainings Course, Institute of Environmental Impact Assessment (IEMA) approved, Crystal Clear Consulting & Merchants (Pty) Ltd, RSA

D. Professional Activities

Professional Institutes & Membership:

- Lead Practitioner and Reviewer, Environmental Assessment Professionals of Namibia (EAPAN)
- Chamber of Mines of Namibia (member)
- Namibian Chamber of Environment (member)

- Geological Society of Namibia (member)

E. EMPLOYMENT HISTORY

2012 – to 2016 Associated Environmental Consultant to SLR Namibia

2003 - to date A. Speiser – Environmental Consultants cc, Director

Main work conducted and ongoing:

- Work packages 6 leader of the **HiTech AlkCarb Project** funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 689909 (Feb. 2016 to Jan. 2020)
- **Environmental Consultant to Virgo Resources Limited**: Environmental Impact Assessment (Scoping report & Environmental Management Plan (EMP)) for exploration activities on EPL 5796 (Namib Naukluft Park)
- **Environmental Consultant** to Kerry McNamara Architects Inc: Combined Scoping & EIA Report & EMP for the proposed Edelweiss Development (part of Okahandja Extension 7) in Okahandja
- **Environmental Consultant** to Bannerman Resources (Namibia) (Pty) Ltd: EIA/EMP for the proposed Pilot Plant on Bannerman Resources (Namibia) (Pty) Ltd EPL 3345
- **Environmental Consultant** to RPZC (Glencore): EIA/EMP for the proposed expansion of water and power infrastructure for RPZC Mine
- **Environmental Consultant** to RPZC (Glencore): EIA/EMP for the proposed zinc concentrate Storage shed at Lüderitz harbour
- **Environmental Consultant** to Metals Namibia. EO and EMP for exploration activities
- **Environmental Consultant** for the bulk chemical store of Crest Chemical Pty Ltd at Walvis Bay harbour
- **Environmental Coordinator** for the Kassinga (Angola) North and South Iron Ore Project – Area 1 (SMP / AEMR). JV between ASEC and Environmental Resource Management
- **Environmental Coordinator** for the exploration phase at Lofdal, Namibian Rare Earth (Pty) Limited
- **Environmental Consultant** to conduct bi-annual environmental audit reports for Glencore, Bannerman Resources (Namibia) Pty Ltd, Okorusu Fluorspar Pty Ltd, Namibia Rare Earth Pty Ltd, Swakop Uranium,
- **ESIA Coordinator** (amendments to the approved ESIA & ESMP) for the proposed U-mine at Etango (Bannerman Mining Resources Namibia (Pty) Ltd)
- **External Environmental Consultant** to Rössing Uranium (Rio Tinto) – SEMP: exploration drilling in the ML area within the Namib Naukluft Park
- **Reviewer** of Swakop Uranium SEIA conducted by Metago
- **ESIA Coordinator** (scoping phase) for the proposed Cu mine at Omitiomire (Craton Mining & Exploration (Pty) Ltd)
- **Mine Closure Plan** for Okorusu Fluorspar (Okorusu Fluorspar Pty Ltd)
- **Preliminary Environmental Overview** for Omitiomire Cu-deposit (Craton Mining & Exploration (Pty) Ltd)
- **ESIA Coordinator** for the proposed U-mine at Etango (Bannerman Mining Resources Namibia (Pty) Ltd) (Scoping & final ESIA approved by Government)
- **ESIA Coordinator** for the proposed Au-mine at Otjikoto, Central Namibia (Teal Exploration & Mining Inc.)
- Environmental Consultant to Walvis Bay Bulk Terminal (Pty) Ltd (EIA to construct a bulk sulphur loading & storage facility at WB harbour
- **Environmental Consultant** providing input to set up ISO 14001 & OSHAS 18000 at Rosh Pinah Mine, Rosh Pinah Zinc Corporation (Pty) Ltd
- **EIA Coordinator** for the proposed change to bulk sulphur at Skorpion Zinc, Chemical Initiatives (Pty) Ltd
- **September 2005 – June 2006, Environmental Coordinator** for the construction phase of Langer Heinrich Uranium (Pty) Ltd

- **EIA and EMP Coordinator** for proposed exploration activities for dimension stones, relevant document to grant licence by the Ministry of Mines and Energy, Olea Investment Number One (Pty) Ltd.
- **Standard Environmental Guidelines** for exploration activities, Helio Resource Corp., Canada
- **Coordinator** to compile the **Initial EMP for construction and operation** of the Langer Heinrich Uranium Mine, Paladin Resources Ltd
- **EIA & EMP (Phase 1 & 2) Coordinator** for exploration activities in the NW Namib Naukluft Park, West Africa Gold Exploration (Namibia) Pty. Ltd
- **EMP Coordinator** for Sarusas Mine, Skeleton Coast Park, Namibia, Igneous Mining Projects (Pty) Ltd
- **EIA & EMP Coordinator** for current & proposed mariculture projects of Alexkor, Alexander Bay, RSA
- **Environmental Consultant –** updating the EA & EMS for infrastructure changes at Navachab Mine, Anglogold Namibia (Pty) Ltd.
- **Team Leader**, Environmental and social assessment for World Bank/GEF Project 'Integrated ecosystem management in Namibia through the national conservancy network'
- **Bi-annual monitoring reports** auditing environmental performance of exploration activities (RPZC, B2Gold, Swakop Uranium, Okorusu Fluorspar, Namibia Rare Earth) - **ongoing**

2000 - 2003 Environmental Scientist at eco.plan (Pty) Ltd.

During this period, I conducted environmental assessments and developed environmental management plans for exploration and infrastructure projects. I further was involved in the project management, public participation processes and office administration.

1999 – 2000 University of Cape Town studying Environmental Science (MPhil degree)

1997 – 1999 Self-employed, Contract Geologist Scientist

- RC drilling supervision – Apatite Project / Monapo, Mozambique, subcontracted by GeoAfrica Prospecting Services (Pty.) Ltd.
- Mapping and evaluation of possible talc deposits in Central Namibia, subcontracted by Dr. T. Smaley.
- Involvement in the preliminary fact-finding phase to conduct an EIA to upgrade the Cement Factory in Otjiwarongo, Namibia.
- Several Desk Studies for Anglovaal Namibia (Pty) Ltd.
- Various investigations of diamondiferous gravels of the northern bank of the Orange River.
- Drilling Supervision in the Okavango Area for InterConsult Namibia (Pty) Ltd.
- Organization of the Public Meeting for the 'Proposed Klein Windhoek River Bridge and Upgrading of Mission Road.'

1995 to 1996 Project Assistant / Geologist at the German Technical Cooperation (GTZ)

- Participation in a six-week training course at the (GTZ) Headquarter in Eschborn/Frankfurt. Focus of the training course was on project management, rural public participation appraisal and social development workshops.
- Project Assistant to the GTZ-Adviser in the Ministry of Environment & Tourism. In cooperation with the Desert Research Foundation of Namibia (DRFN) the *Chemical Residue Analysis – Kavango Region* Project was conducted. The project assessed the environmental impacts of irrigation schemes along the Okavango River, special attention was given to the use of fertilisers and pesticides.
- Project Assistant/Geologist in the *Mineral Prospecting Promotion Project*. This project was set up in cooperation with the Geological Survey of Namibia (GSN) and the Federal Institute for Geo-science and Natural Resources (BGR). The work comprised geophysical interpretation and detailed geological/geophysical ground follow-ups.

1994 – 1995 Contract Geologist

- Supervision of construction sites and conduction of soil surveys to establish possible hydrocarbon-contamination (Germany).

F. PUBLICATIONS

Alexandra Speiser, Frances Wall, Kate Smith and Kathryn Moore (2019). Policy Brief - Social licence for exploration/mining in Europe is influenced by other georesource projects such as deep and shallow geothermal energy. Deliverable of the HiTech AlkCarb Project funded by the European Union's Horizon 2020 research and innovation programme (grant agreement No. 689909.

Boonzaier A., Kuiper S. and Speiser A. (1999). Community Benefits from the Richterveld National Park: The Golden Road to the future? in IAIAsa 1999 Conference Proceedings.

Speiser A., Hein U.F. and Porada H. (1995). The Kansanshi Copper Mine (Solwezi Area, northwestern Zambia): Geology, wall rock alteration and fluid inclusions, in Pasava J. Kirbek B. and Zak K. eds., Mineral deposits: From their origin to their environmental impacts: Third Biennial Society for Geology Applied to Ore Deposits Meetings, Rotterdam, Balkema, p. 289 – 392.

Du Plessis P., Eberle D. and Speiser A. Chapter 1: Enabling Host: Southern Namibia. in Eberle D. (eds.) (1997). Promising Patterns. A new approach to the Mineral Potential of Southern Namibia.

Speiser A., Hein U.F. and Porada H. (1995). The Kansanshi Copper Mine (Solwezi Area, northwestern Zambia): Geology, wall rock alteration and fluid inclusions, in Pasava J. Kirbek B. and Zak K. eds., Mineral deposits: From their origin to their environmental impacts: Third Biennial Society for Geology Applied to Ore Deposits Meetings, Rotterdam, Balkema, p. 289 – 392.

ENVIRONMENTAL IMPACT ASSESSMENT FOR LK MINING'S PROPOSED MARINE DIAMOND MINING ACTIVITIES IN EPL 5965

MARINE BIODIVERSITY SPECIALIST STUDY

Prepared for

ASEC cc

Prepared by

Andrea Pulfrich

March 2021

PISCES Environmental Services (Pty) Ltd

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Contact Details:

Andrea Pulfrich, Pisces Environmental Services

PO Box 302, McGregor 6708, South Africa, E-mail: apulfrich@pisces.co.za

ABBREVIATIONS, UNITS AND GLOSSARY

Abbreviations

CBA	Critical Biodiversity Area
CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species
CSIR	Council for Scientific and Industrial Research
dB	decibell
DMS	Dense Medium Separation
E	East
EBSA	Ecologically and Biologically Significant Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
FAO	Food and Agricultural Organisation
FeSi	ferrosilicon
EIA	Environmental Impact Assessment
HAB	Harmful Algal Blooms
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
JNCC	Joint Nature Conservation Committee
kts	knots
MBES	Multibeam Echosounder
MFMR	Ministry of Fisheries and Marine Resources (Namibia)
MMOs	Marine Mammal Observers
MPA	Marine Protected Area
NOAA	National Oceanic and Atmospheric Administration
PIM	Particulate Inorganic Matter
POM	Particulate Organic Matter
PTS	Permanent Threshold Shift
SACW	South Atlantic Central Water
TSPM	Total Suspended Particulate Matter
TTS	Temporary Threshold Shift
UNEP	United Nations Environmental Programme

Units used in the report

µg/ℓ	micrograms per litre
µPa	micro Pascal
cm	centimetres
cm/s	centimetres per second
g C/ m^2/ day	grams Carbon per square metre per day
h	hours

kHz	kiloHerz
kg	kilogram
km	kilometres
km^2	square kilometres
m	metres
m/s	metres per second
mm	millimetres
m^2	square metres
m^3/day	cubic metres per day
m/s	metres per second
mg/ℓ	milligrams per litre
mg Chl a/ m^3	milligrams Chlorophyll a per cubic metre
ppm	parts per million
s	seconds
%	percentage
~	approximately
<	less than
>	greater than
°C	degrees centigrade

Glossary

Barotropic	a fluid whose density is a function of only pressure
Bathymetry	measurements of the depths of the ocean relative to mean sea level.
Benthic	Referring to organisms living in or on the sediments of aquatic habitats (lakes, rivers, ponds, etc.).
Benthos	The sum total of organisms living in, or on, the sediments of aquatic habitats.
Benthic organisms	Organisms living in or on sediments of aquatic habitats.
Biodiversity	The variety of life forms, including the plants, animals and micro-organisms, the genes they contain and the ecosystems and ecological processes of which they are a part.
Biomass	The living weight of a plant or animal population, usually expressed on a unit area basis.
Biota	The sum total of the living organisms of any designated area.
Bivalve	A mollusk with a hinged double shell.
Community structure	All the types of taxa present in a community and their relative abundance.
Community	An assemblage of organisms characterized by a distinctive combination of species occupying a common environment and interacting with one another.

Dissolved oxygen (DO)	Oxygen dissolved in a liquid, the solubility depending upon temperature, partial pressure and salinity, expressed in milligrams/litre or millilitres/litre.
Ecosystem	A community of plants, animals and organisms interacting with each other and with the non-living (physical and chemical) components of their environment.
Epifauna	Organisms, which live at or on the sediment surface being either attached (sessile) or capable of movement.
Environmental impact	A positive or negative environmental change (biophysical, social and/or economic) caused by human action.
Habitat	The place where a population (e.g. animal, plant, micro-organism) lives and its surroundings, both living and non-living.
Intertidal	the area of a seashore which is covered at high tide and uncovered at low tide
Macrofauna	Animals >1 mm.
Mariculture	Cultivation of marine plants and animals in natural and artificial environments.
Marine environment	Marine environment includes estuaries, coastal marine and near-shore zones, and open-ocean-deep-sea regions.
Pollution	The introduction of unwanted components into waters, air or soil, usually as result of human activity; e.g. hot water in rivers, sewage in the sea, oil on land.
Population	Population is defined as the total number of individuals of the species or taxon.
Recruitment	The replenishment or addition of individuals of an animal or plant population through reproduction, dispersion and migration.
Sediment	Unconsolidated mineral and organic particulate material that settles to the bottom of aquatic environment.
Species	A group of organisms that resemble each other to a greater degree than members of other groups and that form a reproductively isolated group that will not produce viable offspring if bred with members of another group.
Subtidal	The zone below the low-tide level, *i.e.* it is never exposed at low tide.
Supralittoral	The supralittoral zone is situated above the high water spring tide level.
Surf zone	Also referred to as the 'breaker zone' where water depths are less than half the wavelength of the incoming waves with the result that the orbital pattern of the waves collapses and breakers are formed.
Suspended material	Total mass of material suspended in a given volume of water, measured in mg/ℓ.

Suspended matter	Suspended material.
Suspended sediment	Unconsolidated mineral and organic particulate material that is suspended in a given volume of water, measured in mg/ℓ.
Taxon (Taxa)	Any group of organisms considered to be sufficiently distinct from other such groups to be treated as a separate unit (e.g. species, genera, families).
Turbidity	Measure of the light-scattering properties of a volume of water, usually measured in nephelometric turbidity units.
Vulnerable	A taxon is vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

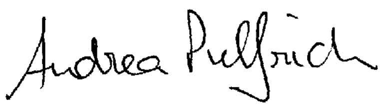
TABLE OF CONTENTS

EXPERTISE AND DECLARATION OF INDEPENDENCE

This report was prepared by Dr Andrea Pulfrich of Pisces Environmental Services (Pty) Ltd. Andrea has a PhD in Fisheries Biology from the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany.

As Director of Pisces since 1998, Andrea has considerable experience in undertaking specialist environmental impact assessments, baseline and monitoring studies, and Environmental Management Programmes relating to marine diamond mining and dredging, hydrocarbon exploration and thermal/hypersaline effluents. She is a registered Environmental Assessment Practitioner and member of the South African Council for Natural Scientific Professions, South African Institute of Ecologists and Environmental Scientists, and International Association of Impact Assessment (South Africa).

This specialist report was compiled for ASEC cc on behalf of LK Mining for their use in preparing an Environmental Impact Assessment and Management Programme for the proposed exploration activities and mining in EPL 5965. I do hereby declare that Pisces Environmental Services (Pty) Ltd is financially and otherwise independent of the Applicants and ASEC cc.



Dr Andrea Pulfrich

1. GENERAL INTRODUCTION

1.1 Background

LK Mining (Pty) Ltd holds Exclusive Prospecting License (EPL) 5965 over Hottentots Bay (Figure 1), approximately 60 km north of Lüderitz. The EPL is an offshore diamond prospecting area, which was previously prospected and mined by Tidal Diamonds, who held a Mining License (ML 30) from 1993 to 2013. In 2016, LK Mining (Pty) Ltd submitted a Social and Environmental Impact Assessment (SEIA) as part of an application for an Environmental Clearance Certificate (ECC) to undertake geophysical remote sensing and sampling operations within the EPL to explore the marine diamond resources. The EPL originally covered an area of ±56.8 km^2, but this was reduced to 42.3 km^2 during the first renewal in April 2019.

The EPL extends from the shore to 2 km off-shore (~45 m depth) and stretches along the coast over a distance of 6 km. The area falls within the Namibian Island Marine Protected Area (NIMPA).

LK Mining filed the Mining Licence (ML) application with the Ministry of Mines and Energy (MME) in October 2019. The proposed ML 220 covers the same area as the existing EPL 5965. LK Mining intends to mine the delineated resource area using a small dredge-pump vessel with an onboard processing plant. The application also covers further detailed geophysical geophysical exploration activities over specific target areas within the EPL as well as ongoing sampling and resource development.

With respect to the proposed project, and in line with Namibia's Environmental Impact Assessment Regulations (Government Gazette No. 4878) in terms of the Environmental Management Act, 7 of 2007, LK Mining requires the compilation of a Environmental Impact Assessment (EIA) as part of the Mining Licence Application. Alexander Speiser Environmental Consultant cc (ASEC), has been appointed to manage the EIA process for the proposed mining licence application and in turn has appointed Pisces Environmental Services Pty Ltd (Pisces) to provide the Marine Specialist Report.

1.2 Scope of Work

ASEC requested the compilation of a Marine Ecology Specialist Report based on:

- An update of the description of the baseline environment; and
- an assessment of the impacts of the proposed exploration and mining activities on the marine ecology of the project area.

The Marine Ecology Specialist Report is to provide input to the project-specific EIA, and shall further contribute to the marine component of a Environmental Management Plan (EMP), which will be submitted to the Ministry of Environment, Forestry and Tourism with an application for the environmental clearance certificate.

The Terms of Reference for the Marine EIA Report are to:

- provide a general description of the local marine fauna and flora in and around the EPL;
- identify, describe and assess the significance of potential impacts of the proposed geophysical surveying and mining on the local marine biota; and

- identify practicable mitigation measures to reduce any negative impacts and indicate how these could be implemented during the construction and management of the proposed project.

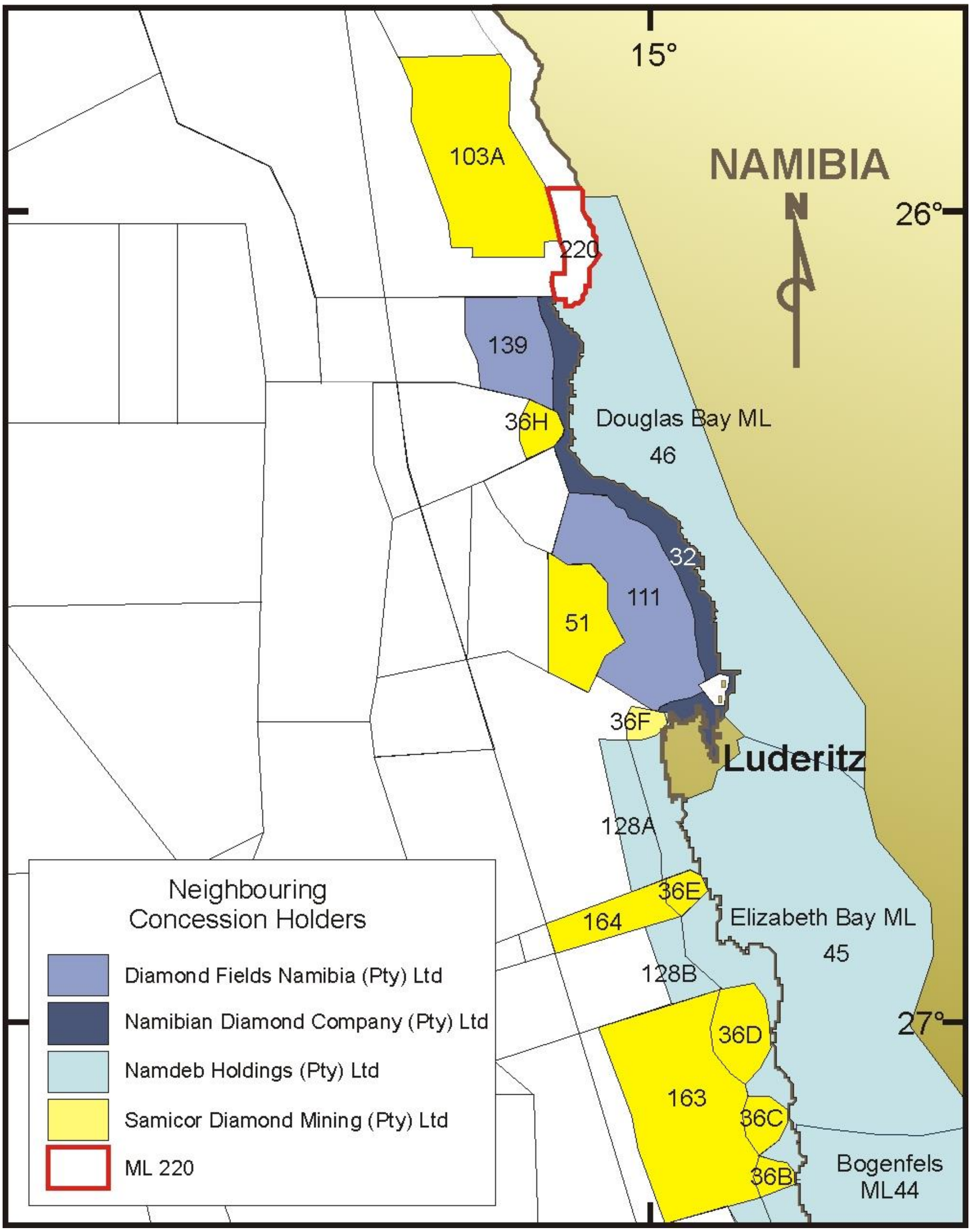


Figure 1: Map showing the location of the proposed ML 220 in relation to other licence areas and places mentioned in the text.

1.3 Approach to the Study

This marine biodiversity assessment has adopted a desktop approach. The specialist study is based on a review of available information and literature on marine ecosystems off the southern and central Namibian coasts. It comprises an expert interpretation of relevant local and international publications and information sources on the disturbances and risks associated with geophysical surveys and mining of diamondiferous gravels, and the anticipated effects of such activities on the local marine biodiversity.

1.4 Limitations and Assumptions

The following are the assumptions and limitations of the study:

- The study is based on the project description made available to the specialist at the time of the commencement of the study.
- The ecological assessment is limited to a "desktop" approach and thus relies on existing information only; no new data were collected as part of the study.

1.5 Interested and Affected Party (I&AP) Issues and Concerns

As part of the public scoping process a series of focus group and information-sharing meetings were held with key stakeholders in Walvis Bay, Swakopmund and Lüderitz at the end of March and beginning of April 2021. Advertisements announcing the proposed project and the availability of the BID were placed in Namibian newspapers as stipulated in the Environmental Management Act, 7 of 2007 and Environmental Impact Assessment Regulations. The details are provided in the main EIA Report. The issues and concerns raised during the public scoping phase are summarised in the main EIA report and detailed in the Issues and Responses Report, attached as an Appendix to the EIA report.

1.6 Structure of the Report

This Marine Specialist Study Report describes the effects of the proposed geophysical surveying and bulk sampling on the marine environment (i.e. the coastal zone below the high water mark), and its significance within the context of the receiving environment. The report is structured as follows:

Section 1: General Introduction - provides a general overview to the proposed project, and outlines the Scope of Work and objectives of the study and the report structure. Assumptions and limitations to the study are also given.

Section 2: Project Description relative to the Marine Environment - gives a brief overview of the proposed exploration activities.

Section 3: Methodology – provides details of the assessment methodology applied to the study.

Section 4: Description of the Marine Environment - describes the receiving biophysical environment that could be impacted by the exploration activities. Existing impacts on the environment are discussed and sensitive and/or potentially threatened habitats or species are identified;

Section 5: Identification of Key Issues and Assessment of Environmental Impact - here key issues identified by the marine specialist and during the public consultation are identified, and the significance of potential direct, indirect and cumulative environmental impacts on the marine environment of the proposed exploration activities are assessed;

Section 6: Recommendations and Conclusions - the environmental acceptability of the proposed exploration activities is discussed. A comparison between the "no development" alternative and the proposed development alternatives is also included. Mitigation measures and monitoring recommendations are presented.

Section 7: References - provides a full listing of all information sources and literature cited in this report.

2. PROJECT DESCRIPTION

The proposed ML 220 over Hottentots Bay lies approximately 60 km north of Lüderitz and covers an area of 42.3 km^2. The EPL extends from the shore to 2 km off-shore (~45 m depth) and stretches along the coast over a distance of 6 km. The area falls within the Namibian Island Marine Protected Area (NIMPA). In October 2019, LK Mining filed an application for a Mining Licence (ML 220) over the same area to mine the delineated resource area using a small dredge-pump vessel with an on-board processing plant. The application also covers further detailed geophysical geophysical exploration activities over specific target areas within the EPL as well as ongoing sampling and resource development.

The survey and mining will be undertaken in water depths of between 14 m to 40 m and are described in more detail below.

2.1 Geophysical remote sensing

The ongoing exploration and resource development programme will use a variety of geophysical remote sensing techniques to further delineate the resource in ML 220. These include multibeam bathymetry, high resolution side scan sonar, geophysical remote sensing techniques that will be employed are briefly described below.

2.1.1 Multibeam Echosounder

Multi-beam technology is a complex sonar array that provides depth-sounding information on either side of the vessel's track across a swath width of approximately two times the water depth (Figure 2), thereby allowing for highly accurate imaging and mapping of seafloor topography in the form of digital terrain models. The multi-beam echo sounder (MBES) emits a fan of acoustic beams from a hull-mounted transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1 µPa at 1 m. Most MBESs have soft-start capabilities where the sound can gradually be ramped up to that required for optimal operation.

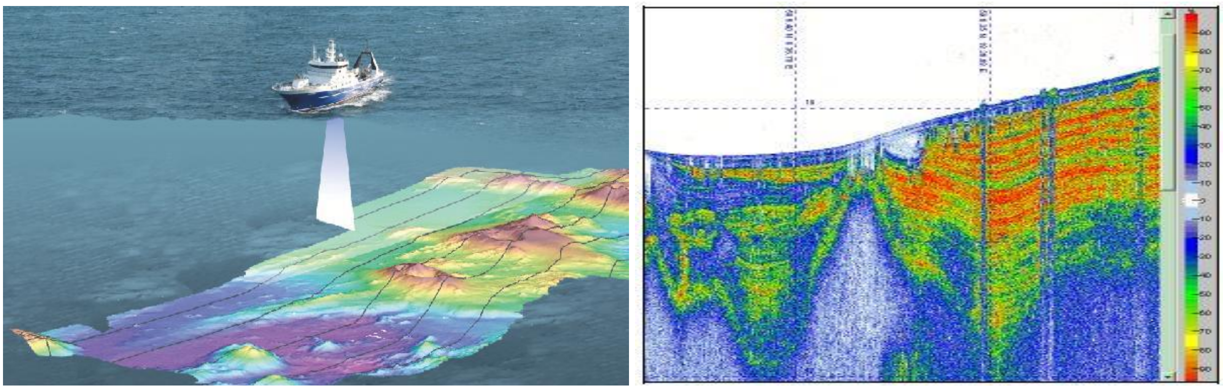


Figure 2: The geophysical survey techniques employed would include multibeam bathymetry (left) (http://www.gns.cri.nz/) and sub-bottom profiling (right).

2.1.2 Side-scan sonar

Side-scan sonar systems uses a sonar device, which can be towed from a vessel or mounted on the ship's hull. By ensonifying a swath of seabed and measuring the amplitude of the back-scattered return signals, an oblique image is built up of objects on the seabed, including information on the morphology and substrate content comprising the seabed. Sidescan sonars typically operate at frequencies of between 50 – 500 kHz and source levels of 220-230 dB re 1 µPa at 1m. High frequency sonar (e.g. 500 kHz) provides high-resolution images, but with a small width (50 – 100 m) of the seabed, whereas the lower frequency systems (e.g. 100 kHz) provide larger width coverage (e.g. 500 m) of the seabed but with lower resolution. Side-scan sonar systems typically do not have soft-start capabilities.

2.1.3 Dual Frequency Vertical Depth Sounding

Dual frequency echosounders transmit a low frequency pulse (typically around 24 kHz) at the same time as a high frequency pulse (typically around 200 kHz) directly below the vessel. Dual frequency echosounders enable the identification of a layer of soft mud over a layer of coarse and hard sediment, and/or rock rock. The pulse emitted would typically be for more than 0.025 seconds and produces sound levels in the order of 180+ dB re 1 µPa at 1 m.

2.1.4 Bottom profiler

There are various single-beam systems, operating at different frequencies, used for shallow seismic seabed profiling (www.ozcoasts.gov.au/geom_geol/toolkit). These include pingers, boomers, sparkers and chirp systems. The acoustic pulse travels through the water column (at a rate determined by water temperature, salinity and suspended material concentration), and penetrates the seafloor. Some of the acoustic signal is reflected from the seafloor, but the remainder penetrates the seafloor being reflected only when it encounters boundaries between layers that have different acoustic impedance. For ongoing exploration activities in ML 220, a hull-mounted 'pinger' chirp system will be used.

A typical sub-bottom chirp profiler emits an acoustic pulse from a transducer at frequencies ranging from 1.5 kHz to 12.5 kHz and typically produces sound levels in the order of 202 db re 1µPa at 1m. Longer chirp pulses can be used for deeper penetration. The chirp system can operate in water as shallow as 30 cm. Chirp sonars are wide-band, frequency modulated systems designed to replace pingers and boomers. By sweeping through a range of frequencies, usually between 1.5 to 15 kHz for shallow water applications, these systems achieve vertical resolutions down to ~5 cm, and can provide very high resolution profiles in soft sediments, attenuating to 100 m depth.

Table 2-1 provides a comparison of the frequency ranges and source levels of the acoustic equipment typically used during geophysical surveys. Although some of the equipment used does not have soft-start capabilities, to mitigate this, one could commence the survey by turning on the equipment that has a soft start (e.g. Multibeam Echosounder) and then only once those are started, start the other equipment (such as the Chirp and Side Scan Sonar) that does not have a soft start. The operating frequencies of the equipment proposed for the exploration activities over ML 220 would fall into the high frequency kHz range, and therefore into the hearing range of most fish, turtles and marine mammals.

The information obtained by the multibeam and sub-bottom profiler systems would be used to produce high-resolution maps of the seabed geomorphology, sediment and bedrock distribution and morphology, bathymetry and sediment type and thickness profiles. From these maps, areas of unconsolidated sediment suitable for sampling would be identified, and a sampling grid positioned over the area. In order to develop geological models for further resource development, surveying activities would be ongoing

Table 2-1: Specifications of acoustic equipment typically utilised in the geophysical surveys.

Type	Frequency (kHz)	Source level (dB re 1 μPa at 1m)	Soft start capability
Chirp sub - bottom profiler	1.5 – 12.5	206	No
Side Scan Sonar	100 – 850 kHz	190 - 242	No
Multibeam echo sounder	200 - 455	190 - 220	Yes
IXSEA "Echos" medium frequency chirp system	0.6 – 2.4	211	No
10 inch Sleeve gun system	0.1 - 0.8	~ 220	Yes
Single beam Echosounders	10 - 200	180+	No
Pingers	2-15	130-150	Yes

2.2 Mining

LK Mining plans to buy a supply vessel and convert it to a remote mining vessel. The mining vessel would use a suitable shallow/mid water 'air lift'-type vessel with a gravel pump system for operating in the 14 – 40 m depth range. The mining system would comprise a suspended steel mining tool fitted with a digging mining head, ~ 300 mm diameter suction hoses and an on-board mining pump. The opening of the mining tool would be fitted with grizzly cross-bars to allow sized gravel (nominally <100 mm) to pass through and prevent blockages in the suction system. The digging head will also be fitted with high pressure water jetting nozzles to agitate the gravel on the seabed and improve mining efficiency. Fixed-head remote exploration/mining systems (Figure 3), operating in the shallow and mid-water depth range, can efficiently extract gravel in areas of thicker overburden.

Mining would involve the removal of only the unconsolidated surficial sediments. The dredged sediment-slurry would be pumped to the surface and discharged onto a series of screens, which separate the oversize (>12 mm) and undersize (<1.2 mm) fractions. The tailings, which typically comprise ~99% of the dredged material, would be discarded overboard directly to the sea, as close to the water line as possible. The fine material forms turbid plumes that are carried away from the vessel by ambient currents, while the coarse material falls directly to the sea floor below the vessel. During the extraction process the operator generally attempts to deposit the coarse tailings in previously excavated areas to prevent re- mining of already processed material.

The fraction of interest (post-screened plant feed) is fed through a crusher to fragment the shell and clay components, mixed with ferrosilicon (FeSi) and pumped under pressure to an on-board Dense Media Separation (DMS) plant. Low density materials (floats) are separated from the concentrated plant feed and discarded overboard following magnetic recovery of the FeSi. The remaining high density fraction is dried and passed through an X-ray sorting process to separate the diamonds from the residual gravels. Non-fluorescent (gravel) material is discarded overboard with the float material, and the fluorescent fraction containing the diamonds is then hand sorted for diamonds under strict control on board the vessel. Plant feed rates for this technology at present average 8 tonnes per hour for the smaller vessels and up to 100 tonnes per hour for the deeper water vessels.

Mining would commence over Mining Area 1 (Figure 4), which at 228 ha covers 5.4% of the total licence area. The current mine plan if for seven years, and through additional resource development over Target Areas 2, 3 and 4 the mine plan could be extended another 3 years at least.

Target areas 2, 3 and 4 each measure 500 x 700 m. It is proposed to take a total of 35 point samples over a 100 m sampling grid in each target area. Each sample will disturb an area of ~ 20 m^2, with a total area of 2,100 m^2 being disturbed. The point sampling will be followed by a bulk sampling phase during which a total of 12 block samples (50 x 50m) will be taken over another total area of 30,000 m^2. In total, sampling and resource development will thus be conducted over a total area of 32,100 m^2, which equates to <0.07% of the total licence area.

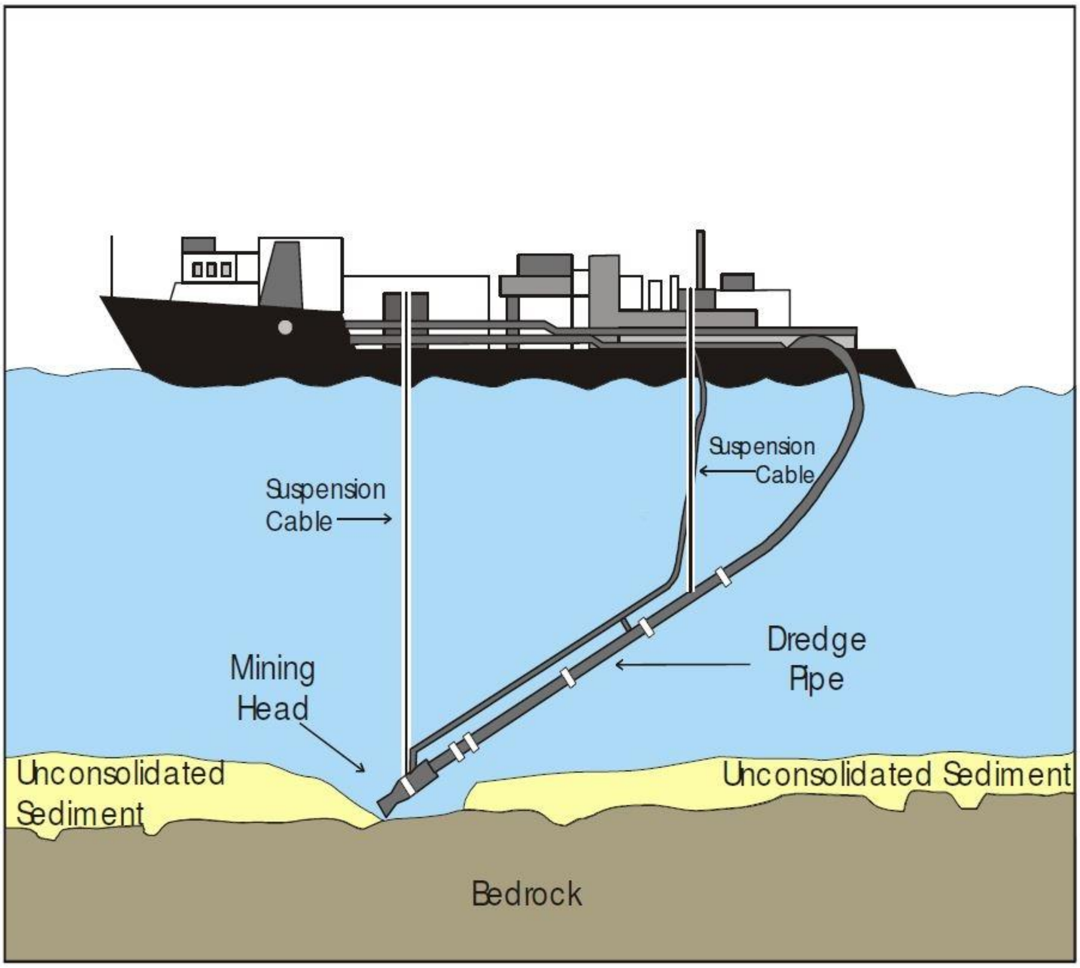


Figure 3: Schematic of the proposed mining system (Placer Resource Management (Pty) Ltd, January 2015).

Sampling and mining operations would be conducted to depths of between 14 m and 24 m from a fully self-contained mining vessel with an on board processing plant. The vessel would operate as semi-mobile mining platform, anchored by a static positioning system, commonly on a four anchor spread. Positioning winches will enable the vessel to be locate precisely over the mining block where it would 'crab' across the target area removing overburden and ore down to bedrock. The mining vessel would thus have limited manoeuvrability and other vessels should remain at a safe distance.

2.3 Supporting infrastructure

The sampling/mining vessel would use the Port of Lüderitz to provide supporting infrastructure (e.g. specialist engineering services, refueling, waste disposal, victualling). Crew changes would take place in the port and in emergencies small craft would be used for medical evacuations.

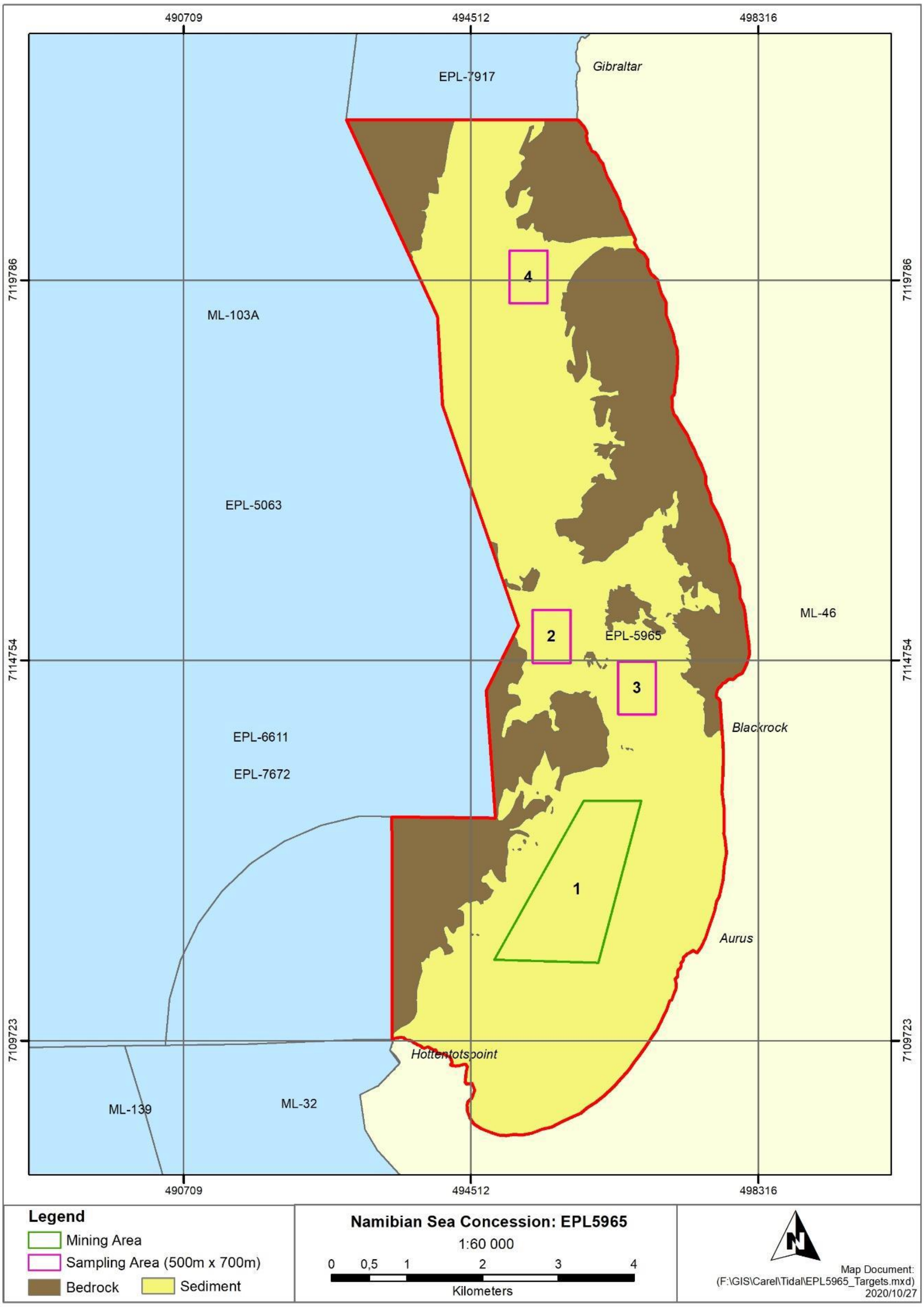


Figure 4: ML 220 showing the location of Mining Area 1 and the three resource

development areas. The distribution of unconsolidated sediments and bedrock across the licence area is also shown.

3. DESCRIPTION OF THE MARINE ENVIRONMENT

This environmental description encompasses the coastal zone and shallow nearshore waters (< 100 m depth) extending from Elizabeth Bay north to Walvis Bay. Some of the data presented are, however, more regional in nature, e.g. the wave climate, nearshore currents, etc. The purpose of this environmental description is to provide the marine baseline environmental context within which the mining and exploration activities would take place.

3.1 Physical Environment

3.1.1 Geology and Geomorphology

The underlying coastal geological formations around Lüderitz are composed primarily of gneisses and schists of the Namaqua Metamorphic complex. Where not covered by Quaternary, wind-blown sands, they crop out to form an extensive harsh and rugged rocky coastline. In the coastal hinterland the Namaqua Metamorphic complex is interrupted by a corridor of Cainozoic sediments and aeolian sands, which stretch from Elizabeth Bay, northwards to beyond Hottentots Bay (Rogers 1977; Pallett 1995). This represents a drowned trough formed by powerful aeolian erosion of the north-south striking schist within the more resistant gneiss. Aeolian deflation of the Tertiary sandstones filling this trough caused the concentration of diamonds which are mined in the area.

3.1.2 Seabed Topography, Bathymetry and Sediments

The surficial sediments in the intertidal and shallow subtidal areas are generally dominated by moderately to well-sorted fine to medium sand with median particle sizes of 200- 400 µm. However, some of the beaches in Lüderitz bay were recently identified as having comparatively coarse sediments. Agate Beach for example has a mean particle size of 551 µm, whereas the beach at Angra Point has a mean particle size of 447 µm. Grossebucht in contrast has much finer sediments (118 µm) (BCC, unpublished data).

Further offshore, the seafloor is dominated by undulated rock or hard sediment with occasional rock outcrops or reefs running either parallel or at an angle to the coastline (Figure 5). Sandy areas are sparse, and generally occur in small isolated patches scattered over the area. Unconsolidated sediments comprise only 53% of the licence area. The sediment accumulations are thin, typically with an observed thickness of <1 m.

The typical sediment sequence in Hottentots Bay, and within the proposed mining area, extends over ~3 m and comprises an overlying layer of Holocene mud/silt (20-50 cm) over a shell or sandy-shell horizon. Lenses of Glauconitic mud occur at the base of this horizon. Locally derived rubble containing quartzschists, vein quartz and limestone of the Gariep Complex lie below the shell. This basal angular gravel, with ventifacts/grit and sparse small cobbles is evidence of a deflation basin. The footwall consists of weathered quartzschists and Biotite schist occasionally covered by calcrete horizons and compacted Glauconitic sandstone. Below the calcrete horizon, the quartzschist is weathered to saprolite.

3.1.3 Waves

The Southern Namibian Coast is classified as exposed, experiencing strong wave action rating between 13-17 on the 20 point exposure scale (McLachlan 1980). The coastline is influenced by major swells generated in the roaring forties, as well as significant sea waves generated locally by the persistent southerly winds. The dominant peak energy period for swells is ~13 seconds, whilst

Figure 5: Bathymetry ML 220 showing bedrock areas (shaded), historically mined areas and environmentally sensitive areas.

Wind-induced waves have shorter wave periods (~8 seconds). Data collected by Voluntary Observing Ships indicate that the largest waves recorded in the area offshore of Lüderitz originate from the S-SSW sectors and may attain 7-10 m. Storms occur frequently, particularly during winter and spring. Swells are concentrated in a fairly narrow directional band with 43% of waves moving in the S direction sector, whilst 19% are in the SW sector and 15% are in the SSW sector. Although much less common, swells attaining maximum heights of 4-5 m occur in the N sector ~2% of the time (CSIR 1996).

The wave pattern within the licence area is largely protected by the north facing embayment of Hottentots Bay, which provides shelter from the prominent southerly wave patterns and significantly reduces the wave height.

3.1.4 Tides

In common with the rest of the southern African coast, tides in the study area are regular and semi-diurnal. The maximum tidal variation is approximately 2 m, with a typical tidal variation of ~1 m. Variations of the absolute water level as a result of meteorological conditions such as wind and waves can however occur adjacent to the shoreline and differences of up to 0.5 m in level from the tidal predictions are not uncommon.

Table 3-1: Tide statistics for Lüderitz (from SAN Tide Tables (SAN 2020), all levels referenced to Chart Datum).

	Level (m)
Lowest Astronomical Tide (LAT)	0
Mean Low Water Springs (MLWS)	0.23
Mean Low Water Neaps (MLWN)	0.65
Mean (Sea) Level (ML)	0.94
Mean High Water Neaps (MHWN)	1.22
Mean High Water Springs (MHWS)	1.65
Highest Astronomical Tide (HAT)	1.99

3.1.5 Coastal Currents

Current velocities in continental shelf areas of the Benguela region range generally between 10 – 30 cm/s (Boyd & Oberholster 1994). The flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington et al. 1990; Nelson & Hutchings 1983). Fluctuation periods of these flows are 3 - 10 days, although the long-term mean current residual is in an approximate NW (alongshore) direction. Currents in the nearshore environment along the coastline of the study area have not been well studied. Surface currents in the Lüderitz area appear to be quite variable, with flows primarily <30 cm/s and an average velocity of 14 cm/s. Near bottom shelf flow is mainly poleward (Nelson 1989) with low velocities of typically 5 cm/s.

In the nearshore zone, strong wave activity from the south and southwest (generated by winds and waves in the South Atlantic and Southern Ocean) drives a predominantly northward long-shore current (Shillington et al. 1990). Surface currents appear to be topographically steered, following the major topographic features (Nelson & Hutchings 1983). Current velocities vary accordingly

(~0.10-0.35 m/s), with increased speeds in areas of steep topography and reduced velocities in areas of regular topography.

3.1.6 Surf zone Currents

Typically wave-driven flows dominate in the surf zone (characteristically 150 m to 250 m wide), with the influence of waves on currents extending out to the base of the wave effect (~40 m; Rogers 1979). The influence of wave-driven flows extends beyond the surf zone in the form of rip currents. Longshore currents are driven by the momentum flux of shoaling waves approaching the shoreline at an angle, while cross-shelf currents are driven by the shoaling waves. The magnitude of these currents is determined primarily by wave height, wave period, angle of incidence of the wave at the coast and bathymetry. Surf zone currents have the ability to transport unconsolidated sediments along the coast in the northward littoral drift.

Nearshore velocities in the study area have not been reported and are difficult to estimate because of acceleration features such as surf zone rips and sandbanks. However, computational model estimates using nearshore profiles and wave conditions representative of this coastal region suggest time-averaged northerly longshore flows which have a cross-shore mean of between 0.2 to 0.5 m/s. Instantaneous measurements of cross-shore averaged longshore velocities are often much larger. Surf zone-averaged longshore velocities in other exposed coastal regions commonly peak at between 1.0 m/s to 1.5 m/s, with extremes exceeding 2 m/s for high wave conditions (CSIR 2002). The southerly longshore flows are considered to remain below 0.5 m/s.

3.1.7 Water Masses and Temperature

South Atlantic Central Water (SACW) comprises the bulk of the seawater in the study area, either in its pure form in the deeper regions, or mixed with previously upwelled water of the same origin on the continental shelf (Nelson & Hutchings 1983). Temperatures range between 6°C and 16°C and salinities range between 34.5‰ and 35.5‰ (Shannon 1985). Data recorded over a 36-year period at the Ministry of Fisheries and Marine Resources (MFMR) jetty in Robert Harbour (1973 – 2009) show that average monthly seawater temperatures vary between a minimum of 12.2°C in September to a maximum of 14.5°C in February, averaging 13.3°C (Kolette Grobler, MFMR, pers com.). They show a strong seasonality with lowest temperatures occurring during early spring when upwelling is at a maximum.

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations, especially on the bottom. SACW itself has depressed oxygen concentrations (~80% saturation value), but lower oxygen concentrations (<40% saturation) frequently occur (Visser 1969; Bailey et al. 1985; Chapman & Shannon 1985; Pulfrich et al. 2006) and can persist for extended periods.

3.1.8 Upwelling

The major feature of the Benguela system is upwelling and the consequent high nutrient supply to surface waters leads to high biological production and large fish stocks. The prevailing longshore, equatorward winds move nearshore surface water northwards and offshore. To balance the displaced water, cold, deeper water wells up inshore. Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest. The largest and most intense upwelling cell is in the vicinity of Lüderitz, and upwelling can occur there throughout the year (Figure 6). Off northern and central Namibia, several secondary upwelling cells occur. Upwelling in these cells is perennial, with a late winter maximum (Shannon 1985).

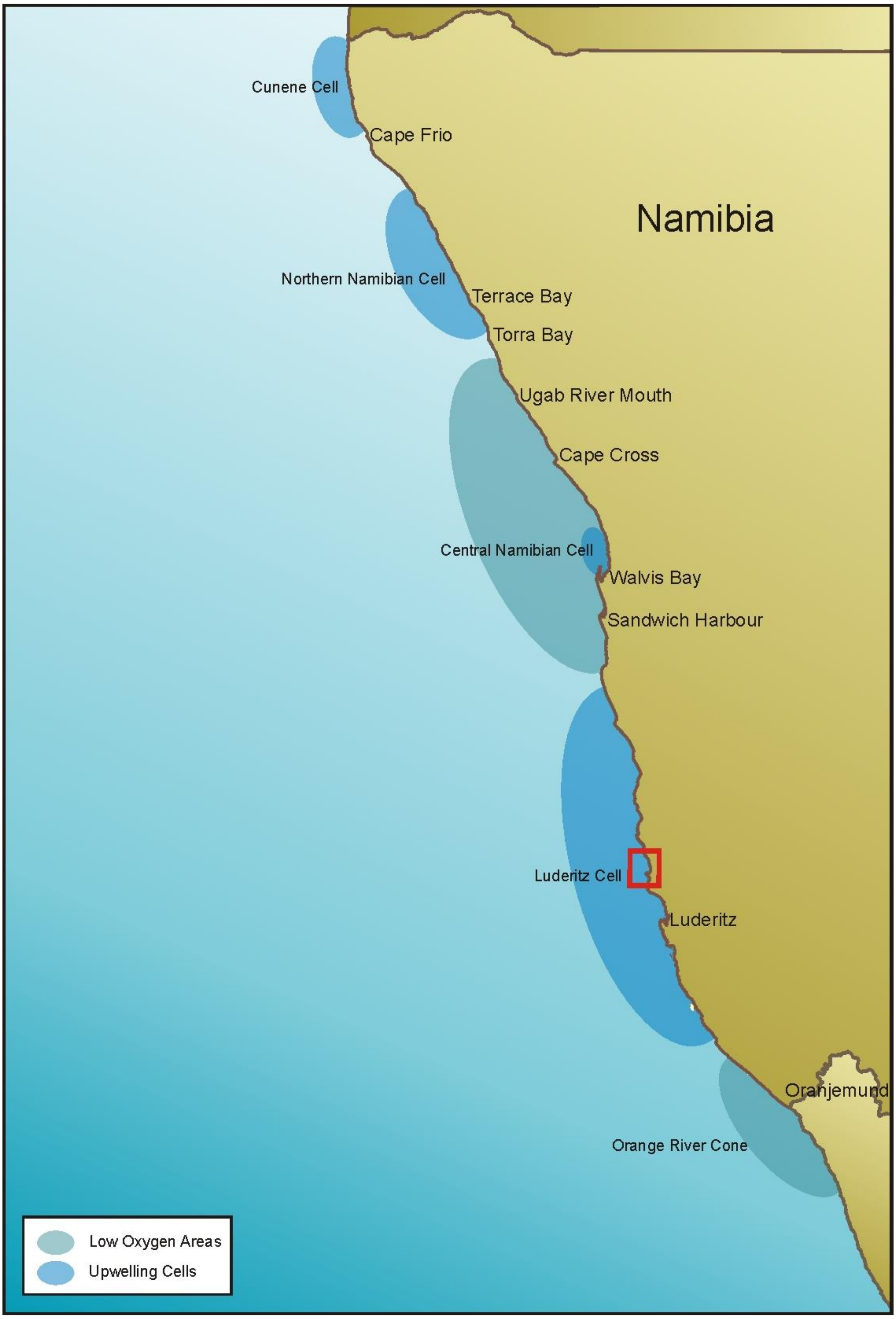


Figure 6: Map of the Namibian coastline showing the positions of the upwelling cells and the formation zones of low oxygen water in relation to the project area (red polygon).

Tomalin (1993) distinguished three upwelling seasons in Lüderitz cell:

1. Spring: From September to December the water is very cold, well mixed and upwelling is intense due to strong and uninterrupted southerly winds. Dissolved oxygen levels are high and swells are of moderate intensity.
2. Summer: From January to April the water is warmer and can be strongly stratified with extremely low near-bottom oxygen levels. "Warm events" of varying intensity can occur. Very low oxygen levels can develop suddenly and remain until May-June, although their intensity and persistence vary between years. Swell is low.
3. Autumn/Winter: Calm conditions are experienced between May and August when wind speeds are lower. Water is warmer, oxygen levels are higher and large swells of long wave length occur.

Nutrient concentrations of upwelled water of the Benguela system attain 20 µM nitrate-nitrogen, 1.5 µM phosphate and 15-20 µM silicate, indicating nutrient enrichment (Chapman & Shannon 1985). This is mediated by nutrient regeneration from biogenic material in the sediments (Bailey *et al.* 1985). Modification of these peak concentrations depends upon phytoplankton uptake which varies according to phytoplankton biomass and production rate. The range of nutrient concentrations can thus be large but, in general, concentrations are high.

3.1.9 Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) is typically divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. PIM loading in nearshore waters is strongly related to natural inputs from rivers or from 'berg' wind events, or through resuspension of material on the seabed.

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/ℓ to several tens of mg/ℓ (Bricelj & Malouf 1984; Berg & Newell 1986; Fegley *et al.* 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/ℓ, showing significant long-shore variation (Zoutendyk 1992, 1995). Considerably higher concentrations of PIM have, however, been reported from southern African west coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions.

The major source of turbidity in the swell-influenced nearshore areas off Namibia is the redistribution of fine inner shelf sediments by long-period Southern Ocean swells. The current velocities typical of the Benguela (10-30 cm/s) are capable of resuspending and transporting considerable quantities of sediment equatorwards. Under relatively calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow poleward undercurrent (Shillington *et al.* 1990; Rogers & Bremner 1991).

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This northward, nearshore transport is generated by the predominantly southwesterly swell and wind-induced waves. Longshore sediment transport, however, varies considerably in the shore-perpendicular dimension. Sediment transport in the surf zone is much higher than at depth, due to high turbulence and convective flows associated with breaking waves, which suspend and mobilise sediment (Smith & Mocke 2002).

In a shallow embayment such as Hottentots Bay and in the nearshore regions of the licence area, swell and wind-induced waves and currents result in the constant resuspension of sediments. Consequently, nearshore waters are naturally turbid, and underwater visibility seldom exceeds 1 m. Table 3.3 provides data on particulate inorganic matter concentrations from Lüderitz and the surrounding area.

The powerful easterly 'berg' winds occurring along the Namibian coastline in autumn and winter also play a significant role in sediment input into the coastal marine environment (Figure 7), potentially contributing the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Zoutendyk 1992; Shannon & O'Toole 1998; Lane & Carter 1999). For example, for a single 'berg'-wind event it was estimated that 50 million tons of dust were blown into the sea by extensive sandstorms along much of the coast from Cape Frio, Namibia in the north to Kleinzee, South Africa in the south (Shannon & Anderson 1982) with transport of the sediments up to 150 km offshore.

Table 3-2: Mean concentrations of particulate inorganic matter (PIM) expressed as mg/ℓ from the area around Lüderitz.

AREA	PIM	Source
Possession Island	66.3	CSIR (1993)
Elizabeth Bay Point	3.74	CSIR (1997)
Lüderitz	0.5-1.0	Emery *et al.* (1973)
	10.3	Zoutendyk (1995)
	9.7	CSIR (1998)
	4-5	Carter *et al.* (1998)
Penguin Island	4.1-6.1	Botha & Faul (2015)
Lüderitz Harbour	6.8-12.1	Botha & Faul (2015)
Hottentots Bay	<4	Midgley 2015

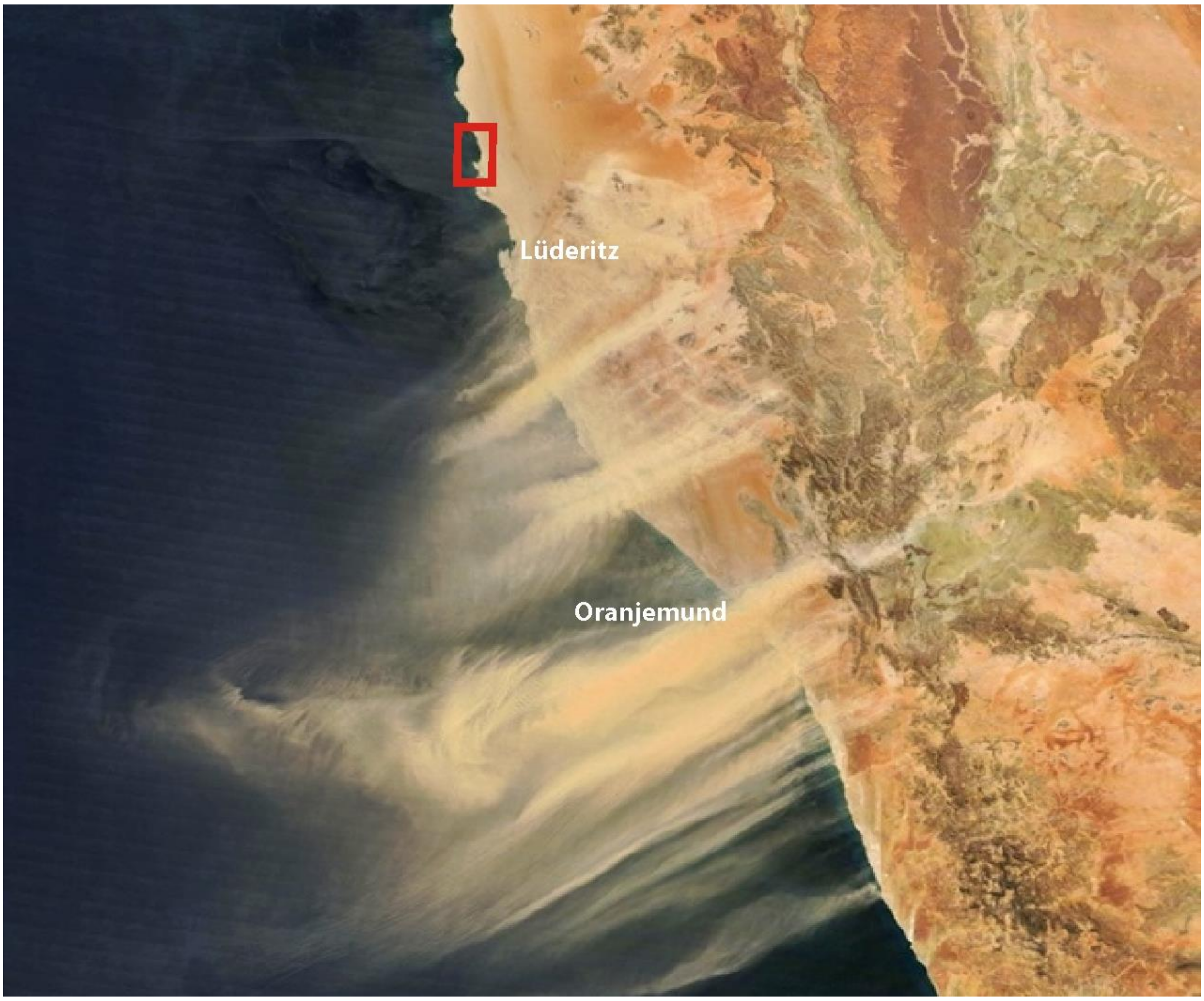


Figure 7: Satellite image showing aerosol plumes of sand and dust due to a 'berg' wind event on the southern African west coast in October 2019 (Image source: LandWaterSA). The project area is indicated by the red square.

3.1.10 Organic Inputs

The Benguela upwelling region is an area of particularly high natural productivity, with extremely high seasonal production of phytoplankton and zooplankton. These plankton blooms in turn serve as the basis for a rich food chain up through pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). All of these species are subject to natural mortality, and a proportion of the annual production of all these trophic levels, particularly the plankton communities, die naturally and sink to the seabed.

Balanced multispecies ecosystem models have estimated that during the 1990s the Benguela region supported biomasses of 76.9 tons/km^2 of phytoplankton and 31.5 tons/km^2 of zooplankton alone (Shannon *et al.* 2003). Thirty six percent of the phytoplankton and 5% of the zooplankton are estimated to be lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the southern African west coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters overlying these muds and the generation of hydrogen sulphide and sulphur eruptions along the coast.

An associated phenomenon ubiquitous to the Benguela system are red tides (dinoflagellate and/or ciliate blooms) (see Shannon & Pillar 1985; Pitcher 1998). Also referred to as Harmful Algal Blooms (HABs), these red tides can reach very large proportions, with sometimes spectacular effects. Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water. Periodic low oxygen events associated with massive algal blooms in the nearshore can have catastrophic effects on the biota (see below).

3.1.11 Low Oxygen Events

The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman & Shannon 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches, there are corresponding preferential areas for the formation of oxygen-poor water, the main one being off central Namibia (Chapman & Shannon 1985) (see Figure 6). The distribution of oxygen-poor water is subject to short (daily) and medium term (seasonal) variability in the volumes of oxygen depleted water that develops (De Decker 1970; Bailey & Chapman 1991). Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

Oxygen deficient water can affect the marine biota at two levels. It can have sub-lethal effects, such as reduced growth and feeding, and increased intermoult period in the rock-lobster population (Beyers *et al.* 1994). The oxygen-depleted subsurface waters characteristic of the southern and central Namibian shelf are an important factor determining the distribution of rock lobster in the area. During the summer months of upwelling, lobsters show a seasonal inshore migration (Pollock & Shannon 1987), and during periods of low oxygen become concentrated in shallower, better-oxygenated nearshore waters.

On a larger scale, periodic low oxygen events in the nearshore region can have catastrophic effects on the marine communities. Low-oxygen events associated with massive algal blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of other marine biota and fish (Newman & Pollock 1974; Matthews & Pitcher 1996; Pitcher 1998; Cockroft *et al.* 2000). In March 2008 a series of red tide or algal blooms dominated by the (non-toxic) dinoflagellate *Ceratium furca* occurred along the central Namibian coast (MFMR 2008). These bloom formations ended in disaster for many coastal marine species and resulted in what was possibly the largest rock lobster walkout in recent memory (Figure 8). While such mass mortalities have been reported from the central Namibian coast (www.nacoma.org.na), they are uncommon in the area around Lüderitz.

Figure 8: 'Walk-outs' and mass mortalities of rock lobsters at the central Namibian coast (Image source: Louw 2008).

3.1.12 Sulphur Eruptions

Closely associated with seafloor hypoxia is the generation of toxic hydrogen sulphide and methane within the organically-rich, anoxic muds following decay of expansive algal blooms. Under conditions of severe oxygen depletion, hydrogen sulphide (H_2S) gas is formed by anaerobic bacteria in anoxic seabed muds (Brüchert *et al.* 2003). This is periodically released from the muds as 'sulphur eruptions', causing upwelling of anoxic water and formation of surface slicks of sulphur discoloured water (Emeis *et al.* 2004). Such eruptions are accompanied by a characteristic pungent smell along the coast and the sea takes on a lime green colour (Figure 9). These eruptions strip dissolved oxygen from the surrounding water column. Such complex chemical and biological processes are often associated with the occurrence of harmful algal blooms, causing large-scale mortalities to fish and crustaceans (see above).

Sulphur eruptions have been known to occur off the Namibian coast for centuries (Waldron 1901), and the biota in the area are likely to be naturally adapted to such pulsed events, and to subsequent hypoxia. However, satellite remote sensing has recently shown that eruptions occur more frequently, are more extensive and of longer duration than previously suspected, and that resultant hypoxic conditions last longer than thought (Weeks *et al.* 2004).

The role of micro-organisms in the detoxification of sulphidic water was investigated by a collaborative group of German and Namibian scientists (http://www.mpi-bremen.de/ Projekte_9.html; http://idw-online.de/pages/de/news 292832). During a research cruise in January 2004, the scientists hit upon a sulphidic water mass off the coast off Namibia covering 7,000 km^2 of coastal seafloor. The surface waters, however, were well oxygenated. In the presence of oxygen, sulphide is oxidized and transformed into non-toxic forms of sulphur. Surprisingly though, there was an intermediate layer in the water column, which contained neither hydrogen sulphide nor oxygen. Further investigation indicated that sulphide diffusing upwards from the anoxic bottom water is consumed by autotrophic denitrifying bacteria below the oxic zone. The intermediate water layer is the habitat of detoxifying microorganisms, which by using nitrate transform sulphide into finely dispersed particles of sulphur that are non-toxic. Thus, the microorganisms create a buffer zone between the toxic deep water and the oxygenated surface waters. These results, however, also suggest that animals living on or near the seafloor in coastal waters may be affected by sulphur eruptions more often than previously thought. Up to now, sulphidic water masses were monitored with the help of satellites, taking pictures of the sea surface while orbiting the earth, as they show up as whitish/turquoise discolorations of surface water (Figure 9). However, many of these sulphidic events may go unnoticed by satellite because bacteria consume the hydrogen sulphide before it reaches the surface.

Figure 9: Satellite image showing discoloured water offshore the Namib Desert resulting from a nearshore sulphur eruption (satellite image source: www.intute.ac.uk). Inset shows a photograph taken from shore at Sylvia Hill, north of Lüderitz, during such an event in March 2002 (photograph by J. Kemper, Lüderitz).

3.2 Biological Environment

Biogeographically the coastline of the study area falls on the boundary between the cold temperate Namaqua Province, which extends from Cape Point up to Lüderitz, and the warm-temperate Namib Province, which extends northwards from Lüderitz into southern Angola (Emanuel *et al*. 1992). The coastal, wind-induced upwelling characterising the Benguela ecosystem, is the principle physical process that shapes the marine ecology of the study area. Pallett (1995) has assigned the coastline of southern Namibia as an area of high sensitivity, as the entire coastal strip contains hummock vegetation which supports many endemic animals, offshore islands and reefs harbouring various breeding seabird and Cape fur seal colonies, as well as virtually undisturbed rocky shores and sandy beaches.

The benthic and coastal habitats of Namibia were mapped as part of the Benguela Current Commission's Spatial Biodiversity Assessment (BCC-SBA) (Holness *et al.* 2014) to develop assessments of their ecosystem threat status and ecosystem protection level (Figure 10). The benthic habitats were subsequently assigned an ecosystem threat status based on their level of protection.

ML 220 fall into the Lüderitz Inshore and Lüderitz Inner Shelf habitats. Habitats occurring along the shoreline of ML 220 include Lüderitz Intermediate Sandy Beach, Lüderitz Mixed Shore, Lüderitz Exposed Rocky Shore, Lüderitz Reflective Sandy Beach, and Lüderitz Sheltered Rocky Shore. The inshore and coastal habitats in the area have all been assigned a threat status of 'Least Concern', (Holness *et al.* 2014). The coastline of the study area predominantly comprises sandy beaches punctuated by numerous rocky shores. Consequently, marine ecosystems along the coast comprise a limited range of habitats that include:

- sandy intertidal and subtidal substrates,
- intertidal rocky shores, subtidal reefs and hard grounds,
- the water body.

The benthic communities within these habitats are generally ubiquitous throughout the southern African West Coast region, being particular only to substratum type, wave exposure and/or depth zone. They consist of many hundreds of species, often displaying considerable temporal and spatial variability. The biological communities 'typical' of each of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened or sensitive species, which may be affected by the proposed project.

3.2.1 Sandy Beaches

On sandy beaches, the physical characteristics of the beach, namely the sand particle size, wave energy and beach slope play an important role in determining the composition of the biological communities inhabiting the beach. The physical factors are used to describe the beach morphodynamic state, classifying beaches as reflective, intermediate, or dissipative. Generally, dissipative beaches are fine-grained beaches with a gentle slope and well-developed, wide surf zone, harbouring high richness, abundance and biomass of invertebrate fauna. Reflective beaches on the other hand are coarse-grained beaches with relatively steep slopes, without well-developed surf zones and with a more depauperate fauna (McLachlan *et al.* 1993; Defeo & McLachlan 2005). Intermediate beach conditions exist between these extremes and have a very variable species composition (McLachlan *et al.* 1993; Jaramillo *et al.* 1995). This variability is mainly attributable to the amount and quality of food available. Beaches with a high input of e.g. kelp wrack have a rich and diverse drift-line fauna, which is sparse or absent on beaches lacking a drift-line (Branch & Griffiths 1988; Field & Griffiths 1991).

Most beaches in the vicinity of Lüderitz are classified as intermediate, although those of the nearby Grossebucht are dissipative, whilst others in Lüderitz Lagoon itself are classified as low energy reflective. These are generally composed of well-sorted fine to medium sands (Clark *et al.* 1998; Pulfrich & Hutchings 2019). Holness *et al.* (2014) identified the beaches around Hottentotas Point

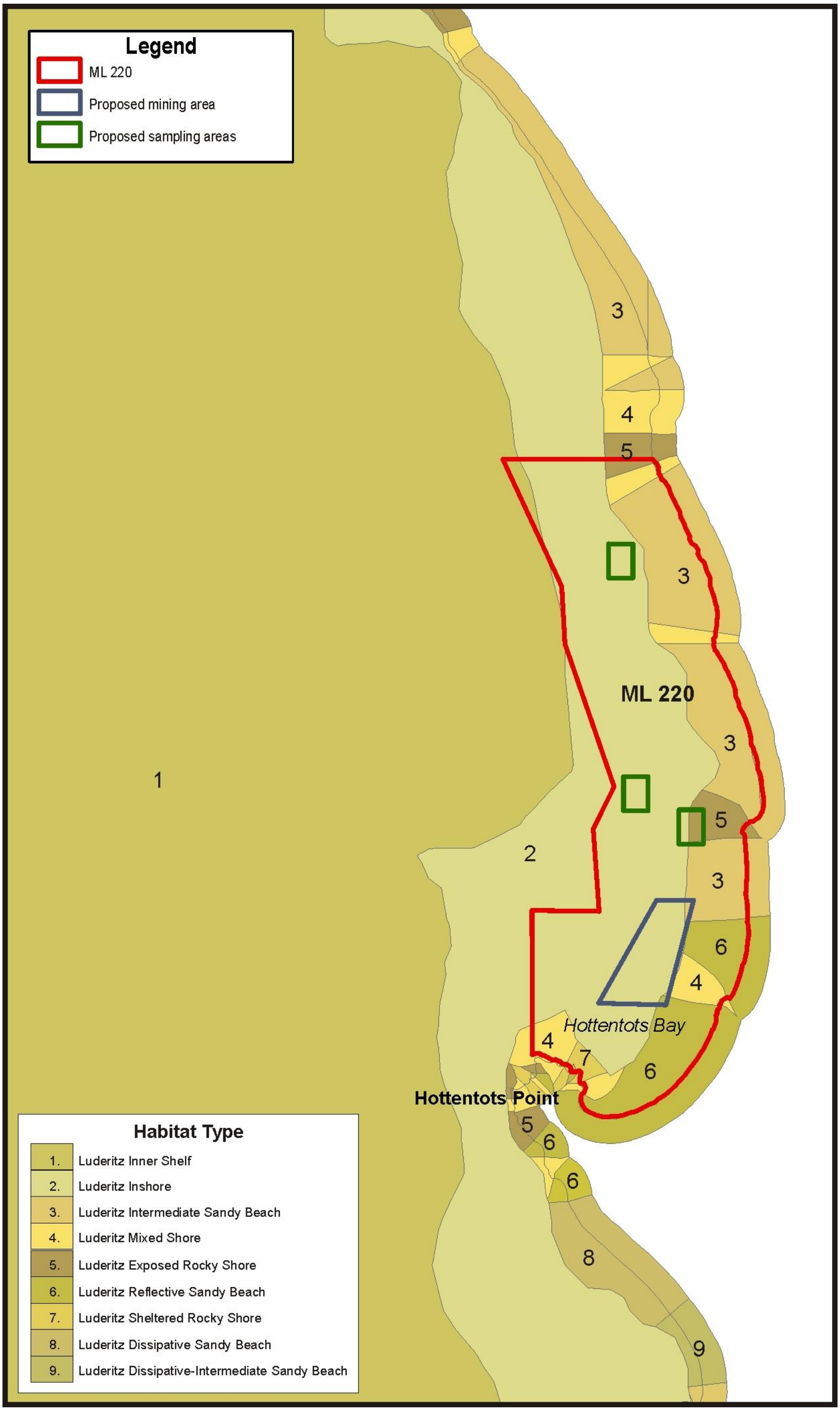


Figure 10: The proposed mining and sampling areas in relation to the Namibian benthic and coastal habitats (adapted from Holness *et al.* 2014).

to span the full range of morphodynamic types, with those in the licence area representing primarily intermediate and reflective types, while those just south of the point being dissipative intermediate and dissipative (Figure 10). This emphasises the considerable small-scale spatial and temporal variability in wave energy, beach slope and sand particle size, and beach macrofauna communities should therefore be viewed as extremely dynamic, changing in community composition with alterations of physical state.

Although sandy beaches between Oranjemund and Lüderitz have been relatively well studied (McLachlan & De Ruyck 1993; McLachlan et al. 1994; Nel et al. 1997; Meyer et al. 1998; Clark et al. 1998; Clark & Nel 2002; Pulfrich 2004; Clark et al. 2004, 2005, 2006; Pulfrich & Atkinson 2007; Pulfrich et al. 2007, 2008; Pulfrich& Hutchings 2020), information on beaches between Lüderitz and Walvis Bay is sparse, with the first surveys of Angra Point and Agate Beach in Lüderitz, Spencer Bay, Conception Bay and Sandwhich Harbour being undertaken in 2019 as part of the Benguela Current Commission Coastal Biodiversity Project (Kreiner et al. 2020). The beaches wre found to be biologically similar to those found in the rest of the Namaqua Province. Their pristine nature gives them considerable conservation value.

Numerous methods of classifying beach zonation have been proposed, based either on physical or biological criteria. The general scheme proposed by Branch & Griffiths (1988) is used below, supplemented by data from other studies (Bally 1983, 1987; Donn 1986; Nel et al. 1997; Meyer et al. 1998; Branch et al. 2014; Harris 2012).

The **supralittoral zone** is situated above high water spring (HWS), and receives water input only from large waves at spring high tides or through sea spray. The supralittoral is characterised by a mixture of air breathing terrestrial and semi-terrestrial fauna, most often associated with, and feeding on kelp deposited near or on the driftline (Figure 11). Terrestrial species include the isopod *Niambia* sp. (Isopoda, Crustacea), as well as a diverse array of beetles (Coleoptera : Insecta) and kelp flies (Diptera : Insecta) and some oligochaetes. Semi-terrestrial fauna include the oniscid isopod *Tylos granulatus*, and the talitrid amphipods (Amphipoda, Crustacea) *Talorchestia sp* and *Africorchestia quadrispinosa*. Community composition depends on the nature and extent of kelp wrack, in addition to the physical factors structuring beach communities.

The intertidal zone, also termed the **midlittoral zone**, has a vertical range of about 2 m. This mid-shore region is characterised by the cirolanid isopods *Pontogeloides latipes* and *Eurydice kensleyii*, the polychaetes *Scolelepis squamata, Nephtys hombergii* and *Orbinia angrapeguensis*, and the amphipod *Griffithsius latipes*. In some areas, juveline and adult sand mussels *Donax serra* (Bivalvia, Mollusca) may also be present in considerable numbers.

The **inner turbulent** zone extends from LWS to about -2 m depth. The mysid *Gastrosaccus namibensis* (Mysidacea, Crustacea), the ribbon worm *Cerebratulus fuscus* (Nemertea) and cumaceans and ostracods are typical of this zone, although they generally extend partially into the midlittoral above. Amphipods typical of this zone include *Bathyporeia* sp., *Culicus profundus* and *Urothoe elegans*. In areas where a suitable swash climate exists, the gastropod *Bullia digitalis* (Gastropoda, Mollusca) may also be present in considerable numbers, surfing up and down the beach in search of carrion.

The **transition zone** spans approximately 2-5 m depth. Extreme turbulence is experienced in this zone, and as a consequence this zone typically harbours the lowest diversity on sandy beaches. Typical fauna of this zone include amphipods such as *Cunicus profundus* and polychaetes such as *Glycera convoluta* and *Lumbrineris* sp.

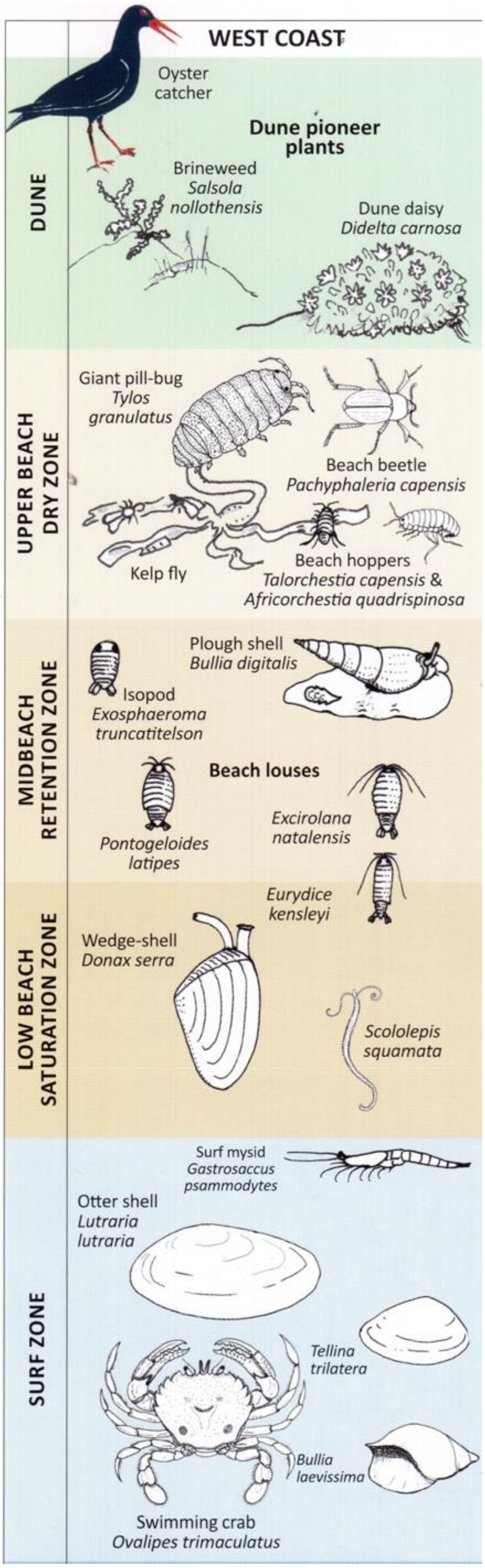


Figure 11: Schematic representation of the West Coast intertidal beach zonation (adapted from Branch and Branch 2018). Species commonly occurring on the Western Cape beaches are listed.

The **outer turbulent zone** extends below 5 m depth, where turbulence is significantly decreased and species diversity is again much higher. In addition to the polychaetes found in the transition zone, other polychaetes in this zone include *Pectinaria capensis*, *Sabellides ludertizi*, *Nephtys capensis* and *Orbinia angrapequensis*. The sea pen V*irgularia schultzi* (Pennatulacea, Cnidarian) is also common as is a host of amphipod species and the three spot swimming crab *Ovalipes punctatus* (Brachyura, Crustacea). In more sheltered and muddy areas, the fat plough whelk *Bullia laevissima* may reach high densities.

The surf zone and outer turbulent zone habitats of sandy beaches are considered to be important nursery habitats for marine fishes (Modde 1980; Lasiak 1981; Kinoshita & Fujita 1988; Clark *et al*. 1994). However, the composition and abundance of the individual assemblages seems to be heavily dependent on wave exposure (Blaber & Blaber 1980; Potter *et al*. 1990; Clark 1997a, b). Surf zone fish communities off the coast of southern Namibia have been studied by Clark *et al.* (1998) and Meyer *et al.* (1998), who reported only five species occurring off exposed and very exposed beaches, these being southern mullet/harders (*Liza richardsonii*), white stumpnose (*Rhabdosargus globiceps*), False Bay klipfish (*Clinus latipennis*), Super klipfish (*C. superciliosus*) and galjoen (*Dichistius capensis*). In contrast, species richness and abundance are relatively high in sheltered and semi-exposed surf zone areas in the vicinity of Lüderitz, and include over 20 species from 17 different families. The most abundant species included harders, silversides and False Bay klipfish, although white stumpnose, elf and St Joseph sharks were also caught. As few permanent estuaries exist along this stretch of coast, it is likely that Lüderitz Bay serves as an important nursery area for many of these species (Clark *et al.* 1998; Meyer *et al*. 1998).

Although no systematic studies have been undertaken of fish communities frequenting nearshore soft sediment areas in southern Namibia, kob (*Argyrosmus* sp.), westcoast steenbras (*Lithognathus aureti*) and white stumpnose are favoured angling fish.

3.2.2 Near- and Offshore Soft Sediments

Numerous studies have been conducted on southern Namibian inner shelf benthos, mostly focused on mining impacts (Goosen *et al*. 2000; Steffani & Pulfrich 2007; Steffani 2009a, 2009b, 2009c; Karenyi 2014; Steffani *et al*. 2015; Biccard & Clark 2016; Biccard *et al*. 2016; Duna *et al*. 2016; Karenyi *et al*. 2016; Biccard *et al*. 2017, 2018; Gihwala *et al*. 2018; Biccard *et al.*2019; Giwhala *et al*. 2019)). The description below is drawn from these. Generally, species richness increases from the inner-shelf across the mid-shelf and is influenced by sediment type. The highest total abundance and species diversity was measured in sandy sediments of the mid-shelf. Biomass is highest in the inshore (± 50 g/m^2 wet weight) and decreases across the mid-shelf averaging around 30 g/m^2 wet weight (Karenyi 2014; Karenyi *et al*. 2016).

Typical species occurring at depths of up to 60 m included the snail *Nassarius* spp., the polychaetes *Orbinia angrapequensis*, *Nepthys sphaerocirrata*, several members of the spionid genera *Prionospio*, and the amphipods *Urothoe grimaldi* and *Ampelisca brevicornis*. The bivalves *Tellina gilchristi* and *Dosinia lupinus orbignyi* are also common in certain areas. All these species are typical of the southern African West coast (Goosen *et al*. 2000; Steffani & Pulfrich 2007; Steffani, unpublished data) (Figure 12).

Benthic communities are structured by the complex interplay of a large array of environmental factors. Water depth and sediment grain size are considered the two major factors that determine benthic community structure and distribution on the South African west coast (Steffani & Pulfrich 2007; Steffani 2007a; 2007b). However, studies have shown that shear bed stress - a measure of the impact of current velocity on sediment – oxygen concentration (Post *et al*. 2006; Currie *et al*. 2009; Zettler *et al*. 2009, 2013), productivity (Escaravage *et al*. 2009), organic carbon and seafloor temperature (Day *et al*. 1971) may also strongly influence the structure of benthic communities. There are clearly other natural processes operating in the deep water shelf areas of the West Coast that can over-ride the suitability of sediments in determining benthic community structure, and it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro & van der Plas 2006; Pulfrich *et al*. 2006). In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure.

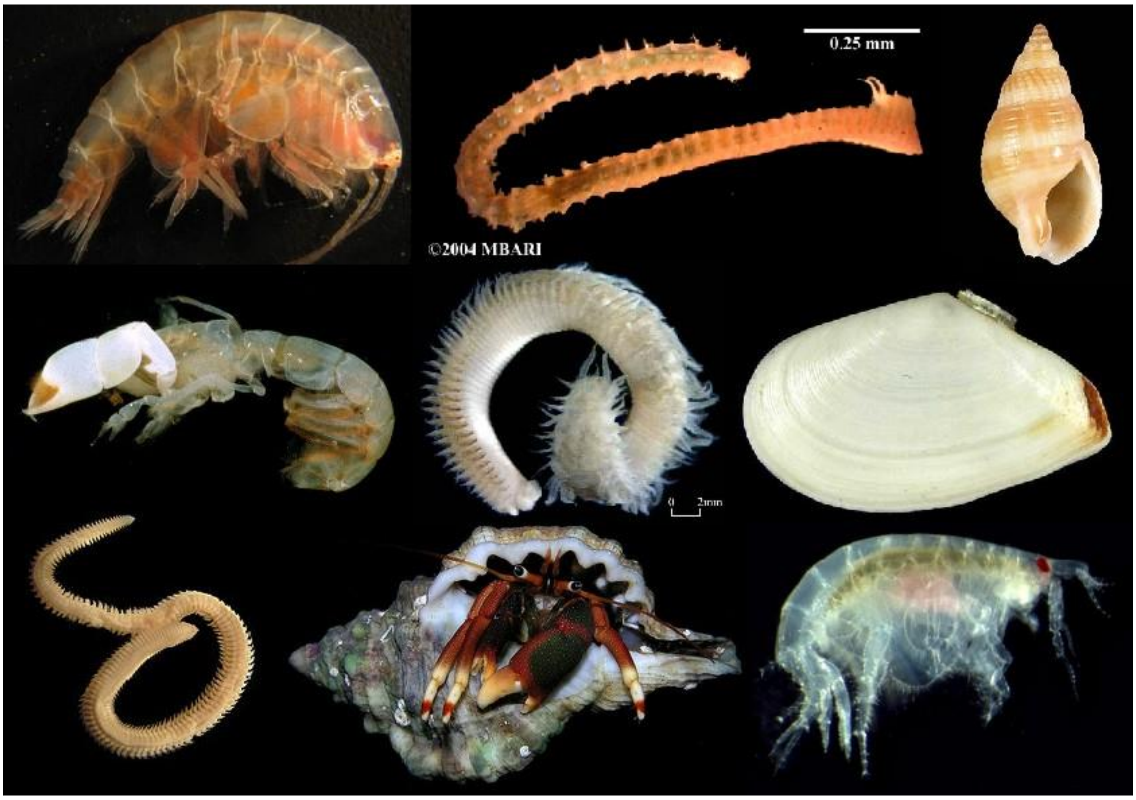


Figure 12: Benthic macrofaunal genera commonly found in nearshore sediments include: (top: left to right) *Ampelisca*, *Prionospio*, *Nassarius*; (middle: left to right) *Callianassa*, *Orbinia*, *Tellina*; (bottom: left to right) *Nephtys*, hermit crab, *Bathyporeia*.

3.2.3 Rocky Intertidal Shores

West Coast rocky intertidal shores can be divided into five zones on the basis of their characteristic biological communities: The Littorina, Upper Balanoid, Lower Balanoid, Argenvillei and the Infratidal Zones. These biological zones correspond roughly to zones based on tidal heights (Figure

13). Tolerance to the physical stresses associated with life on the intertidal, as well as biological interactions such as herbivory, competition and predation interact to produce these five zones.

The uppermost part of the shore is the supralittoral fringe, which is the part of the shore that is most exposed to air, perhaps having more in common with the terrestrial environment. The supralittoral is characterised by low species diversity, with the tiny periwinkle *Afrolittorina knysnaensis*, and the red alga *Porphyra capensis* constituting the most common macroscopic life.

Figure 13: Typical rocky intertidal zonation on the southern African west coast.

The upper mid-littoral is characterised by the limpet *Scutellastra granularis*, which is present on all shores. The gastropods *Oxystele variegata*, *Nucella dubia*, and *Helcion pectunculus* are variably present, as are low densities of the barnacles *Tetraclita serrata*, *Octomeris angulosa* and *Chthalamus dentatus*. Flora is best represented by the green algae *Ulva* spp.

Toward the lower Mid-littoral or Lower Balanoid zone, biological communities are determined by exposure to wave action. On sheltered and moderately exposed shores, a diversity of algae abounds with a variable representation of: green algae – *Ulva* spp, *Codium* spp.; brown algae – *Splachnidium rugosum*; and red algae – *Aeodes orbitosa*, *Mazzaella (=Iridaea) capensis*, *Gigartina polycarpa* (=*radula*), *Sarcothalia* (=*Gigartina*) *stiriata*, and with increasing wave exposure *Plocamium rigidum* and *P. cornutum*, and *Champia lumbricalis*. The gastropods *Cymbula granatina* and *Burnupena* spp. are also common, as is the reef building polychaete *Gunnarea capensis*, and the small cushion starfish *Patiriella exigua*. On more exposed shores, almost all of the primary space can be occupied by the dominant alien invasive mussel *Mytilus galloprovincialis*. First recorded in 1979 (although it is likely to have arrived in the late 1960s), it is now the most abundant and widespread invasive marine species spreading along the entire West Coast and parts of the South Coast (Robinson *et al*. 2005). *M. galloprovincialis* has partially displaced the local mussels *Choromytilus meridionalis* and *Aulacomya ater* (Hockey & Van Erkom Schurink 1992), and competes with several indigenous limpet species (Griffiths *et al*. 1992; Steffani & Branch 2003a, 2003b). Another alien invasive recorded in the past decade is the acorn barnacle *Balanus glandula*, which is native to the west coast of North America where it is the most common intertidal barnacle (Simon-Blecher *et al.* 2008). There is, however, evidence that it has been in South Africa since at least 1992 (Laird & Griffiths 2008). At the time of its discovery, the barnacle was recorded from 400 km of coastline from Cape Point to Elands Bay in South Africa (Laird & Griffith 2008). It has been reported on rocky shores as far north as Lüderitz in Namibia (Pulfrich 2016). When present, the barnacle is typically abundant at the mid zones of semi-exposed shores.

Along the sublittoral fringe, the large kelp-trapping limpet *Scutellastra argenvillei* dominates forming dense, almost monospecific stands achieving densities of up to 200/m^2 (Bustamante *et al.* 1995). Similarly, *C. granatina* is the dominant grazer on more sheltered shores, also reaching extremely high densities (Bustamante *et al.* 1995). On more exposed shores *M. galloprovincialis* dominates. There is evidence that the arrival of the alien *M. galloprovincialis* has led to strong competitive interaction with *S. argenvillei* (Steffani & Branch 2003a, 2003b, 2005). The abundance of the mussel changes with wave exposure, and at wave-exposed locations, the mussel can cover almost the entire primary substratum, whereas in semi-exposed situations it is never abundant. As the cover of *M. galloprovincialis* increases, the abundance and size of *S. argenvillei* on rock declines and it becomes confined to patches within a matrix of mussel bed. As a result, exposed sites once dominated by dense populations of the limpet, are now largely covered by the alien mussel. Semi-exposed shores do, however, offer a refuge preventing global extinction of the limpet. In addition to the mussel and limpets, there is variable representation of the flora and fauna described for the lower mid-littoral above, as well as the anemone *Aulactinia reynaudi*, numerous whelk species and the sea urchin *Parechinus angulosus*. Some of these species extend into the subtidal below.

Another mytilid, the hermaphroditic Chilean *Semimytilus algosus*, invaded Namibian shores many decades ago, although the vector and date of introduction of the Namibian population remain unknown. It was first recorded in Namibia in 1931 (Zeeman *et al.* 2020). As a dominant space occupier on the low shore, this species has been prevalent on rocky shores from Walvis Bay northwards since the early 1990s (B. Curry, NatMirc, unpublished data) (see also Pulfrich & Steffani 2007; Ssemakula 2010; Hooks & Duvenhage 2013; Laird *et al.* 2018), but has only recently been recorded from Lüderitz (Pulfrich 2017, 2018, 2019). It now extends along almost the entire West Coast to as far south as Cape Point inSouth Africa (de Greef *et al.* 2013). Where present, it occupies the lower intertidal zone completely dominating primary rock space, while *M. galloprovincialis* dominates higher up the shore. Many shores on the West Coast have thus now been effectively partitioned by the three introduced species, with *B. glandula* colonizing the upper intertidal, *M. galloprovincialis* dominating the mid-shore, and now *S. algosus* smothering the low-shore (de Greef *et al.* 2013). The shells of *S. algosus* are, however, typically thin and weak, and have a low attachment strength to the substrate, thereby making the species vulnerable to predators, interference competition, desiccation and the effects of wave action (Zeeman 2016). The competitive ability of *S. algosus* is strongly related to shore height. Due to intolerance to desiccation, it cannot survive on the high shore, but on the low shore its high recruitment rate offsets the low growth rate, and high mortality rate as a result of wave action and predation.

Some of the rocky shores in Lüderitz Bay more resemble mixed shores as they are strongly influenced by sand. Such shores will harbour more sand-tolerant and opportunistic foliose algal genera (e.g. *Ulva* spp., *Grateloupia belangeri, Nothogenia erinacea)* many of which have mechanisms of growth, reproduction and perennation that contribute to their persistence on sand-influenced shores (Daly & Matheison 1977; Airoldi *et al.* 1995; Anderson *et al.* 2008). Of the benthic fauna, the sand-tolerant anemone *Bunodactis reynaudi*, the Cape reef worm *Gunnarea gaimardi*, and the siphonarid *Siphonaria capensis* were prevalent, with the anemone in particular occupying much of the intertidal space.

3.2.4 Subtidal Reefs and Kelp Beds

The biological communities of the sublittoral habitat can be broadly grouped into an inshore zone (from the supralittoral fringe to a depth of ~10 m), and an offshore zone (below 10 m depth). The shift in communities from the flora-dominated inshore zone to the fauna-dominated offshore zone is not knife-edge, however, representing instead a continuum of species distributions, merely with changing abundances. As wave exposure is moderated with depth, wave action is less significant in structuring the communities than in the intertidal, with prevailing currents, and the vertical distribution of oxygen and nutrients playing more important roles.

Research on subtidal organisms along the Namibian coastline has been limited. Current knowledge is primarily restricted to macrobenthic reef communities in depths of less than 30 m in the area around Lüderitz (Tomalin 1993; Parkins & Branch 1995, 1996, 1997; Pulfrich & Penney 1998, 1999, 2001; Pulfrich 2019). The following descriptions are summarised from these studies and Lane & Carter (1999).

Rocky subtidal habitats along the southern Namibian coastline and within Lüderitz Bay are dominated by kelp beds *(Laminaria pallida* and *Ecklonia maxim*a) (Figure 14). As wave exposure in the region is very high, kelp beds play a major role in absorbing and dissipating much of the wave energy reaching the shore, thereby providing important semi-exposed and sheltered habitats for a wide diversity of both marine flora and fauna. The community structure of the subtidal benthos in the bays around Lüderitz is typical of the southern African West Coast kelp bed environment. In the inshore zone, the benthos is largely dominated by algae, in particular the kelp *L. pallida*, which forms a canopy to a height of about 2 m in the immediate subtidal region to a depth of ~10 m. *Ecklonia maxima*, which is the dominant species along the southern South African coastline is poorly represented in southern Namibia. Growing beneath the kelp canopy and epiphytically on the kelps themselves are a diversity of understorey algae which provide both food and shelter for predators, grazers and filter-feeders associated with the kelp bed ecosystem (Figure 14). These plants and animals all have specialised habitat and niche requirements, and together form complex communities with highly inter-related food webs. Representative under-storey algae include *Botryocarpa prolifera*, *Neuroglossum binderianum*, *Botryoglossum platycarpum*, *Hymenena venosa* and *Epymenia obtusa*, various coralline algae, as well as subtidal extensions of some algae occurring primarily in the intertidal zones (Bolton 1986). Epiphytic species include *Suhria vittata* and *Carpoblepharis flaccida*.

The sublittoral invertebrate fauna is dominated by suspension and filter feeders, such as the ribbed mussel *Aulacomya ater* and Cape Reef worm *Gunnarea capensis*, a variety of sponges, and the sea cucumbers *Pentacta doliolum* and *Thyone aurea* (Holothuroidea, Echinodermata) (Figure 15). Grazers are less common with most herbivory being restricted to grazing of juvenile algae or debris feeding of detached macrophytes. The dominant grazer is the sea urchin *Parechinus angulosus*, with lesser pressure from limpets, the isopod *Paridotea reticulata* and the amphipod *Ampithoe humeralis*. Key predators in the sublittoral include the commercially important rock lobster *Jasus lalandii* (Macrura, Crustacea) and the isopod *Cirolana imposita*. Of lesser importance although numerically significant is the starfish *Henricia ornata*, various feather and brittle stars (Crinoidea and Ophiuroidea, Echinodermata), and gastropods (*Nucella* spp. and *Burnupena* spp.).

Figure 14: Typical kelp bed dominated by *Laminaria pallida* occurring off Elizabeth Point (left), and its diverse understorey community (right) (Photo: Kolette Grobler).

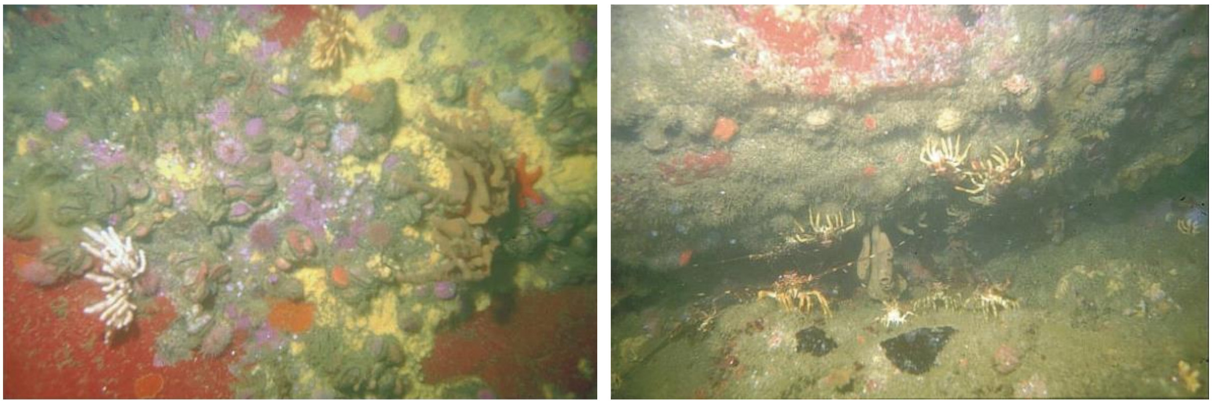


Figure 15: Nearshore reef communities off Lüderitz dominated by a diversity of encrusting sponges, encrusting coralline algae, soft corals, echinoderms and ribbed mussels (left), and providing optimal habitat for rock lobsters (right).

The fish fauna of rocky reefs off the southern African West Coast has not been specifically studied, and it is necessary to refer to fish catches for a review. Shore- and boat-angling is extremely limited along the southern Namibian coastline due to restricted access by the public. Catches from the area around Lüderitz, however, cite the common and widespread hottentot (*Pachmetopon blochii*), the galjoen (*Dichistius capensis*), snoek (*Thrysites atun*), maned blennies (*Scartella emarginata*), and blacktail (*Diplodus sargus*) as being common reef-associated species (Sauer & Erasmus 1997; Brouwer *et al*. 1997; Sakko 1998).

3.2.5 Mixed Shores

Most semi-exposed to exposed shores on the Southern African West coast are strongly influenced by sediments, and may include considerable amounts of sand intermixed with the benthic biota. Mixed shores contribute only 6.3% to the total Namibian shoreline habitats (Holness *et al.* 2014).

Mixed shores incorporate elements of the trophic structures of both rocky and sandy shores. As fluctuations in the degree of sand coverage are common (often adopting a seasonal affect), the fauna and flora of mixed shores are generally impoverished when compared to more homogenous shores. The macrobenthos is characterized by sand tolerant species whose lower limits on the shore are determined by their abilities to withstand physical smothering by sand (Daly & Mathieson 1977; Dethier 1984; van Tamelen 1996).

On the southern African West coast, for example, semi-exposed to exposed shores influenced by sand are inhabited by the sand tolerant *Choromytilus meridionalis.* (Brown *et al.* 1991; Marshall & McQuaid 1993). The predatory gastropod *Burnupena* sp., common on rocky shores, is also found on mixed shores due to its adaptive ability of both moving over sand as well as burrowing into it. Likewise various species of sea cucumbers (*Roweia frauenfeldii* and *Thyone aurea*) common in rock crevices and between mussels can tolerate sand burial (Branch *et al.* 2014; Brown 1996). Of the intertidal limpets, only *Siphonaria capensis* extends its distribution into regions where sand deposition is a regular occurrence (Marshall & McQuaid 1989).

On mixed shores, the composition of the intertidal and subtidal macrophytes is dominated by sand-tolerant and opportunistic filamentous genera, such as *Cladophora*, *Chaetomorpha*, and *Chondria* spp. Many of the psammophytic (sand-tolerant) algal species have mechanisms of growth, reproduction and perennation that contribute to their persistence on sand-influenced shores such as peak growth and reproduction just prior to seasonal burial, abbreviated life cycles, regeneration of fronds from basal parts, or rhizomatous growth (Daly & Matheison 1977; Airoldi *et al.* 1995; Anderson *et al.* 2008).

The mixed-shore habitat also provides important refuges for opportunistic species capable of sequestering, but susceptible to elimination by competition in more uniform intertidal environments.

3.2.6 Pelagic Communities

The pelagic communities are typically divided into plankton and fish, and their main predators, marine mammals (seals, dolphins and whales), seabirds and turtles.

Plankton

Plankton is abundant in the shelf waters off Namibia, being associated with the upwelling characteristic of the area. Plankton range from single-celled bacteria to jellyfish of 2-m diameter, and include bacterio-plankton, phytoplankton, zooplankton, and ichthyoplankton.

Off the Namibian coastline, phytoplankton are the principle primary producers with mean annual productivity being comparatively high at 2 g C/m^2/day. The phytoplankton is dominated by diatoms, which are adapted to the turbulent sea conditions. Diatom blooms occur after upwelling events, whereas dinoflagellates are more common in blooms that occur during quiescent periods, since they can grow rapidly at low nutrient concentrations (Barnard 1998). In the surf zone, diatoms and dinoflagellates are nearly equally important members of the phytoplankton, and some silicoflagellates are also present. Charateristic species belong to the genus *Gymnodinium*, *Peridinium*, *Navicula*, and *Thalassiosira* (McLachlan 1986).

Namibian zooplankton reaches maximum abundance in a belt parallel to the coastline and offshore of the maximum phytoplankton abundance. The mesozooplankton (<2 mm body width) community included egg, larval, juvenile and adult stages of copepods, cladocerans, euphausiids, decapods, chaetognaths, hydromedusae and salps, as well as protozoans and meroplankton larvae (Hansen *et al*. 2005). Copepods are the most dominant group making up 70–85% of the zooplankton. Seasonal patterns in copepod abundance, with low numbers during autumn (March–June) and increasing considerably during winter/early summer (July–December), appear to be linked to the period of strongest coastal upwelling in the northern Benguela (May–December), allowing a time lag of about 3–8 weeks, which is required for copepods to respond and build up large populations (Hansen *et al*. 2005). This suggests close coupling between hydrography, phytoplankton and zooplankton. Timonin *et al*. (1992) described three phases of the upwelling cycle (quiescent, active and relaxed upwelling) in the northern Benguela, each one characterised by specific patterns of zooplankton abundance, taxonomic composition and inshore-offshore distribution. It seems that zooplankton biomass closely follows the changes in upwelling intensity and phytoplankton standing crop.

Ichthyoplankton constitutes the eggs and larvae of fish. The preferred spawning grounds of numerous commercially exploited fish species are located to the north of the study area off central and northern Namibia (Figure 16), where their eggs and larvae form an important contribution to the ichthyoplankton. South of the Lüderitz upwelling cell, between approximately 29°S – 31°S, lies the Lüderitz Upwelling Cell Orange River Cone (LUCORC) area, which is considered to be an environmental barrier to the transport of ichthyoplankton from the southern to the northern Benguela upwelling ecosystems. Areas of powerful upwelling are considered unfavourable fish spawning habitats, with pelagic fish species, such as anchovy, redeye round herring, horse mackerel and shallow-water hake, reported as spawning on either side of the Lüderitz upwelling cell, but not within it (Lett *et al*. 2007). Ichthyoplankton abundance off the study area is thus expected to be low.

Small pelagic species include the sardine/pilchard (*Sadinops ocellatus*) (Figure 17, left), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) (Figure 17, right) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes (Crawford *et al*. 1987), and generally occur within the 200 m contour, although they may often be found very close inshore, just beyond the surf zone. They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried up the coast in northward flowing waters. The Namibian pelagic stock is currently considered to be in a critical condition due to a combination of over-fishing and unfavourable environmental conditions as a result of Benguela Niños. Abundance of small pelagics in the study area is expected to be low due to its location within the Lüderitz upwelling cell.

Since the collapse of the pelagic fisheries, jellyfish biomass has increased and the structure of the Benguelan fish community has shifted, making the bearded goby (*Sufflogobius bibarbatus*) the new predominant prey species. However, despite increased predation pressure, the gobies are thriving. Recent research has shown that gobies have a very high tolerance of low oxygen and high H_2S levels, which enables them to feed on benthic fauna within hypoxic waters during the day, and then move to oxygen-richer pelagic waters at night, when predation pressure is lower, to feed on live jellyfish (Utne-Palm *et al*. 2010; van der Bank *et al*. 2011).

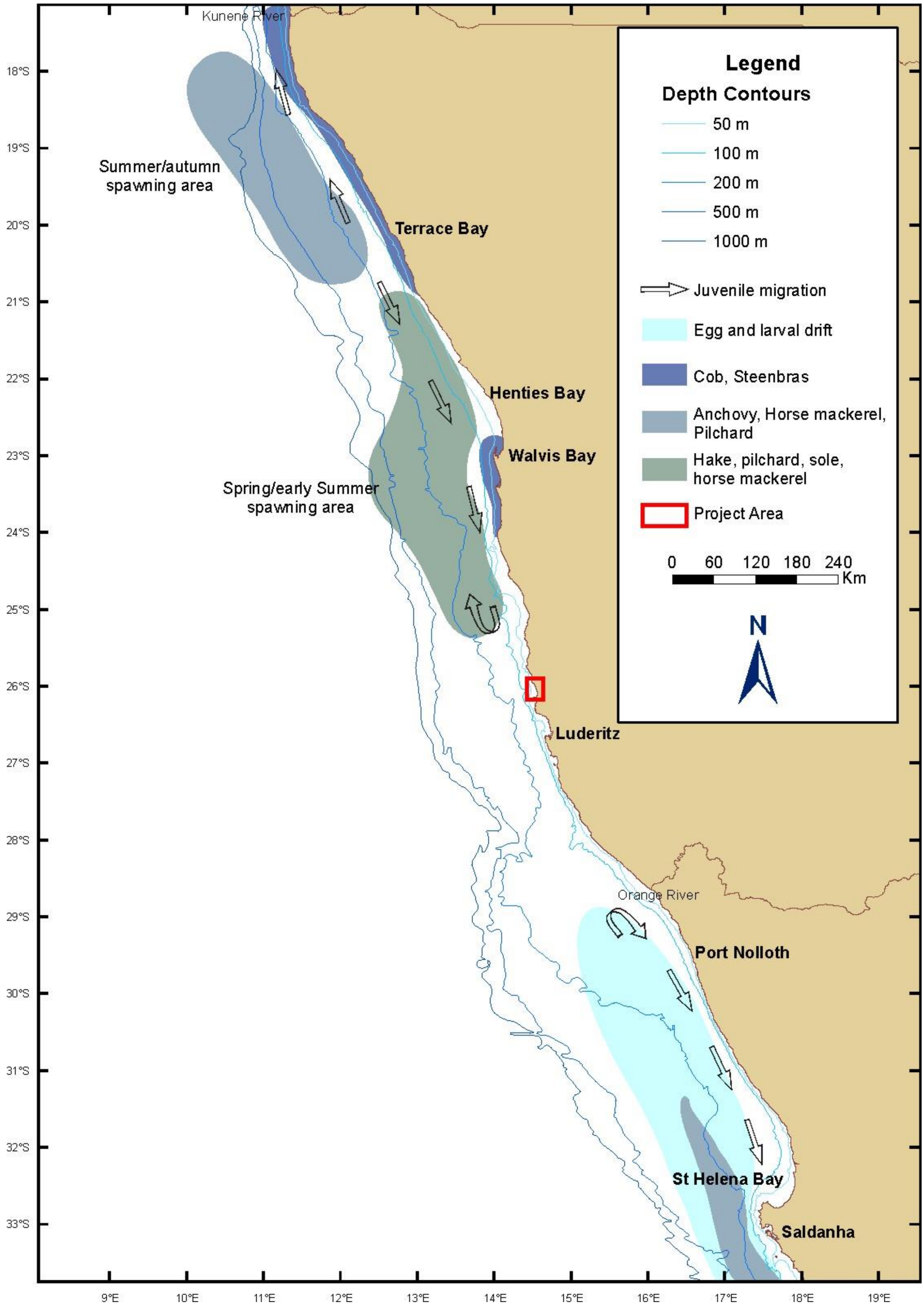


Figure 16: Major spawning areas in the central Benguela region (adapted from Cruikshank 1990) in relation to the study area (red rectangle – not to scale).

Figure 17: Cape fur seal preying on a shoal of pilchards (left). School of horse mackerel (right) (photos: www.underwatervideo.co.za; www.delivery.superstock.com).

Turtles

Five of the eight species of turtle worldwide occur off Namibia (Bianchi *et al*. 1999). Limited information is available on marine turtles in Namibian waters, although the leatherback turtle (*Dermochelys coriacea*), which are known to frequent the cold southern ocean, are the most commonly-sighted turtle species in the region. Observations of Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*), Hawksbill (*Eretmochelys imbricata*) and Olive Ridley (*Lepidochelys olivacea*) turtles in the area are rare. Only one species, the Green turtle, breeds on the Namibian shores, in the far north of the Skeleton Coast. Table 3-3 details their conservation status.

Table 3-3: Marine turtles known from Namibian waters with their overall species conservation status. *The Leatherback turtle species is divided into seven subpopulations worldwide, and turtles found in Namibian waters are known from three of these subpopulations including two (Southwest Indian Ocean and Southwest Atlantic Ocean subpopulations) that are rated as critically endangered (Wallace *et al.* 2013).

English name	Scientific name	IUCN status
Loggerhead turtle	*Caretta caretta*	Vulnerable
Green turtle	*Chelonia mydas*	Endangered
Hawkbill turtle	*Eretmochelys imbricata*	Critically Endangered
Olive ridley turtle	*Lepidochelys olivacea*	Vulnerable
Leatherback turtle*	*Dermochelys coriacea*	Vulnerable (Critically Endangered)

The South Atlantic population of leatherback turtles is the largest in the world, with as many as 40,000 females thought to nest in an area centred on Gabon, yet the trajectory of this population is currently unknown (Witt *et al.* 2011). Namibia is gaining recognition as a feeding area for leatherback turtles that are either migrating through the area or undertaking feeding excursions into Namibian waters (Figure 18). The turtles are thought to be attracted by the large amount of gelatinous plankton in the in central and southern Namibian waters (Lynam *et al.* 2006, Roux *et al.* 2013). These turtles are from three different subpopulations, two of which (Southwest Indian Ocean and Southwest Atlantic Ocean) are ranked as 'critically endangered' (Wallace *et al.* 2013). Satellite tracking of Leatherback turtles from Gabon and Mozambique/KwaZulu-Natal in South Africa has shown animals of these regions migrating to Namibian waters while tagged animals from Brazil and Gabon have also been sighted or recovered dead after entanglement in the Lüderitz area.

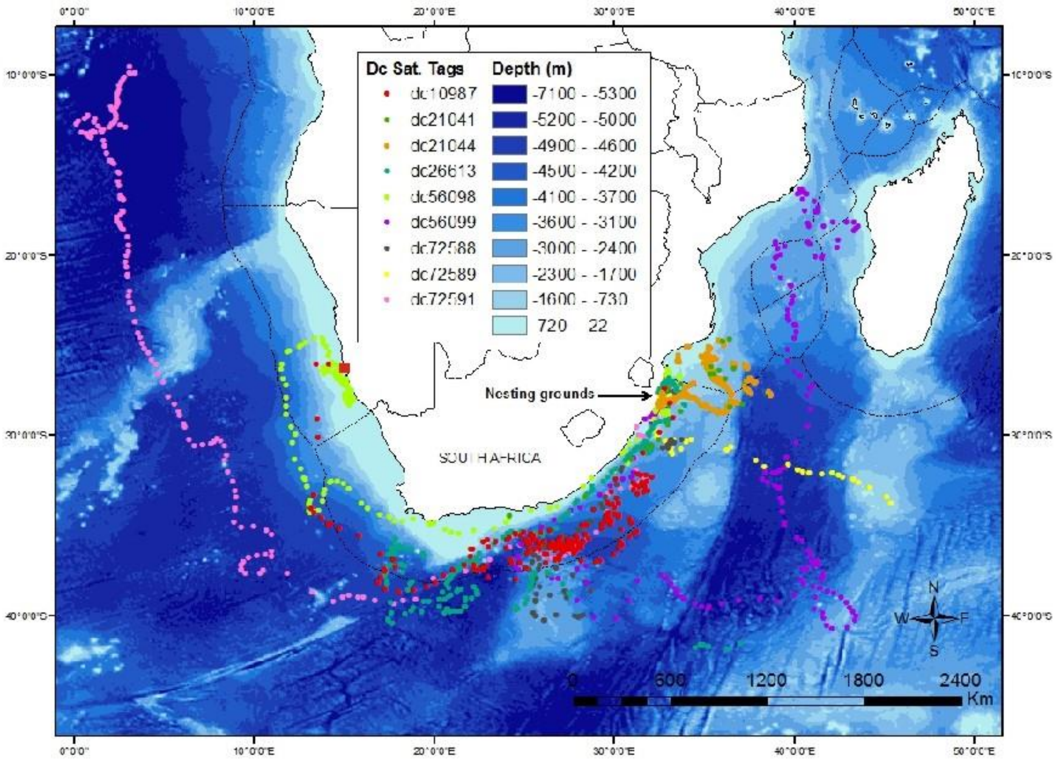


Figure 18: The post-nesting distribution of nine satellite tagged leatherback females (1996 – 2006; Oceans and Coast, unpublished data).

Leatherback turtles are listed as "Vulnerable" worldwide by the IUCN (Red List 2013), with the regional population considered "Endangered" (Hughes & Nel 2014) and are in need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species).

Seabirds

The Namibian coastline sustains large populations of breeding and foraging seabird and shorebird species, which require suitable foraging and breeding habitats for their survival. In total, 12 species of seabirds are known to breed along the southern Namibian coast, mainly on islands. Six of these species are considered globally threatened or near-threatened; nine are considered threatened or near-threatened in Namibia (Table 3-4).

Most seabirds breeding in Namibia are restricted to areas where they are safe from land predators, with the islands and islets along the southern Namibian coast from Meob Bay in the north to Baker's Bay in the south therefore providing vital breeding habitats. Although some species are able to breed on the mainland coast in inaccessible places, in general most breed on islands. However, the number of successfully breeding birds at the particular breeding sites varies with food abundance (J. Kemper, MFMR Lüderitz, pers. comm.). Within the licence area, Neglectus Islet and the disused jetty in Hottentots Bay provide important breeding areas. The jetty presently has the largest breeding colony of White-breasted cormorants along the southern Namibian coast (Currie *et al*. 2009).

Figure 19: Cape Gannets *Morus capensis* (left) (Photo: NACOMA) and African Penguins *Spheniscus demersus* (right) (Photo: Klaus Jost) breed primarily on the Namibian offshore Islands.

A number of shorebird species are found along Namibia's coast, both on rocky shores and sandy beaches. These include the common breeding resident White-fronted Plovers *Charadrius marginatus,* as well as various migratory shorebirds, some of which may overwinter. They mostly feed on a range of small invertebrates, from polychaete worms to small crustaceans, mussels and kelp flies, often searching through washed-up kelp for food.

Most of the seabird species breeding in Namibia generally feed relatively close inshore (10-30 km). Some species may forage further offshore, such as Cape Cormorants (Roux 2007), Cape Gannets (Figure 19, left), which may forage up to 140 km offshore (Dundee 2006; Grémillet *et al*. 2008; Ludynia *et al*. 2012), and African Penguins (Figure 19, right), which have been recorded more than 60 km offshore (Ludynia *et al*. 2012). Gulls are largely opportunistic surface-feeders or feed along the shore or scavenge on land, while oystercatchers feed on mussels, limpets and other invertebrates along the shore and in the intertidal zone.

In addition to these coastal seabirds that breed in Namibia, about 50 species of non-breeding seabird species are found off the southern coast of Namibia. These consist of a number of albatrosses, petrels, giant petrels, storm-petrels, shearwaters skuas and prions, and include several globally and/or nationally threatened species (Simmons *et al*. 2015; IUCN 2020). Information on their exact seasonal distributions and abundances in Namibian waters is generally limited (Roux 2007; Simmons *et al*. 2015). Highest densities of pelagic seabirds occur in winter on the shelf-break, but some species may venture closer inshore and some can even be observed occasionally from the shore, including Giant Petrels and White-Chinned Petrels (J-P Roux, J Kemper pers. obs.). These seabirds forage in open waters, covering vast distances, and feed on a range of fish, krill and squid.

Table 3-4: Seabird species breeding along the Namibian coastline with their Namibian and global IUCN Red-listing classification* (from Simmons *et al*. 2015; IUCN 2020).

SPECIES	Namibian	Global IUCN
African Penguin *Spheniscus demersus*	Endangered	Endangered
Bank Cormorant *Phalacrocorax neglectus*	Endangered	Endangered
Cape Cormorant *Phalacrocorax capensis*	Endangered	Endangered
Cape Gannet *Morus capensis*	Critically Endangered	Endangered
Crowned Cormorant *Phalacrocorax coronatus*	Near Threatened	Near Threatened
White-breasted cormorant *Phalacrocorax carbo*	Least Concern	Least Concern
African Black Oystercatcher *Haematopus moquini*	Near Threatened	Least Concern
Kelp Gull *Larus dominicanus*	Least Concern	Least Concern
Hartlaub's Gull *Larus hartlaubii*	Vulnerable	Least Concern
Caspian Tern *Hydroprogne caspia*	Vulnerable	Least Concern
Swift Tern *Sterna bergii bergii*	Least Concern	Least Concern
Damara Tern *Sterna balaenarum*	Near Threatened	Vulnerable

*In the IUCN scheme Endangered is a more extinction-prone class than Vulnerable, and differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

[1]. May move to Critically Endangered if mortality from long-lining does not decrease.

3.2.7 Marine Mammals

Pinnipeds (Seals and Fur seals)

Two species of true seals are known to occur (as rare vagrants) in Namibian waters, the Southern elephant seal (*Mirounga leonina*), and the Leopard seal (*Hydrurga leptonyx*). The sub-Antarctic fur seal (*Arctocephalus tropicalis*) is also a rare vagrant to our shores. All three species are ranked as "Least concern" for their conservation status by the IUCN and have a marginal distribution in the region.

The Cape fur seal (*Arctocephalus pusillus pusillus*) (Figure 20) is the only species of seal resident along the west coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs. The species as a whole is ranked "Least concern" as a conservation status by the IUCN (Hofmeyr 2015). Cape fur seals are endemic to the Benguela Current region and are opportunistic predators with a diet composed mostly of epi- and meso-pelagic preys dominated by fish and squid species caught in the water column over the inner and mid continental shelf. The diet composition varies regionally, seasonally and interannually according to local prey abundance and availability (De Bruyn *et al*. 2003, De Bruyn *et al*. 2005, Mecenero *et al*. 2006a, 2006b; MFMR unpubl. data).

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles (~220 km) offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991). Namibian populations declined precipitously during the warm events of 1993/94 (Wickens 1995), as a consequence of the impacts of these events on pelagic fish populations. Population estimates fluctuate widely between years in terms of pup production, particularly since the mid-1990s (MFMR unpubl. Data; Kirkman *et al.* 2007).

In the Lüderitz region fur seal colonies are found at Dolphin Head (Spencer Bay), Little Ichaboe, Marshall Reef, Staple, Boat Bay and Dumfudgeon Rocks, Seal Island (Lüderitz Bay), Wolf Bay, Atlas Bay, Long Island, North Reef (Possession Island). Off those, a complex of three colonies (Wolf Bay, Atlas Bay and Long Island) about 18 km south of Lüderitz comprise the bulk of the population of southern Namibian fur seal population. It consists of about 300,000 seals, producing roughly 100,000 pups per year. Further colonies are located at van Reenen Bay and Bakers Bay, with a further ~9,600 individuals existing on Hollamsbird Island south of Sandwich Harbour. All colonies have important conservation value since they are largely undisturbed at present, as public access to the southern Namibian coast is restricted.

The Cape fur seal population in the Benguela is regularly monitored by the South African and Namibian governments (e.g. Kirkman *et al.* 2012). Surveys of the full species range done every three years providing data on seal pup production (which can be translated to adult population size), thereby allowing for the generation of high quality data on the population dynamics of this species. While the Namibian fur seal population as a whole seems to have remained relatively stable in the last three decades, the southern Namibian part has declined by about 50% since 1993 (Kirkman *et al.* 2007, Kirkman *et al.* 2013, MFMR unpublished data). The cause of this long term regional decline is probably linked to changes in the regional prey abundance, prey quality and diet composition (e.g. Roux *et al.* 2013).

Figure 20: Colony of Cape fur seals Arctocephalus pusillus pusillus (Photo: Dirk Heinrich).

There is a controlled annual quota, determined by government policy, for the harvesting of Cape fur seals on the Namibian coastline. The Total Allowable Catch (TAC) currently stands at 60,000 pups and 5,000 bulls, distributed among four licence holders. The seals are exploited mainly for their pelts (pups), blubber and genitalia (bulls). The pups are clubbed and the adults shot. These harvesting practices have raised concern among environmental and animal welfare organisations (Molloy & Reinikainen 2003).

Cetaceans (Whales and Dolphins)

The southern African region (including Namibian waters) has a very high diversity of whales and dolphins (Best 2007). The cetacean fauna of southern Namibia comprises at least 33 species of whales and dolphins known (from historical sightings or strandings and recent surveys) or likely (habitat projections based on known species parameters) to occur here (3-5) (Findlay *et al*. 1992; Findlay 1996; Bianchi *et al*. 1999; Best 2007). The majority of these occur in offshore waters, near the shelf edge and are highly unlikely to be present on the inner shelf and the project area.

Table 3-5: List of cetacean species known (from historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur in Namibian waters. Likely occurrence in probable habitat (Shelf, Shelf edge or Offshore) is indicated. IUCN Conservation Status is based on the SA Red List Assessment (2014) (Child *et al.* 2016). * denotes species known to occur in the project area.

Common Name	Species	Habitat	IUCN Conservation Status
Delphinids			
Dusky dolphin*	*Lagenorhynchus obscurus*	Shelf (0- 800 m)	Data Deficient
Heaviside's dolphin*	*Cephalorhynchus heavisidii*	Shelf (0- 200 m)	Least Concern
Common bottlenose dolphin*	*Tursiops truncatus*	Shelf	Least Concern
Common (short beaked) dolphin	*Delphinus delphis*	Shelf	Least Concern
Southern right whale dolphin*	*Lissodelphis peronii*	Shelf	Least Concern
Pantropical spotted dolphin	*Stenella attenuata*	Shelf Edge	Least Concern
Striped dolphin	*Stenella coeruleoalba*	Offshore	Least Concern
Long-finned pilot whale	*Globicephala melas*	Shelf Edge	Least Concern
Short-finned pilot whale	*Globicephala macrorhynchus*	Offshore	Least Concern
Rough-toothed dolphin	*Steno bredanensis*	Offshore	Least Concern
Killer whale*	*Orcinus orca*	Shelf	Data Deficient
False killer whale	*Pseudorca crassidens*	Offshore	Least Concern
Pygmy killer whale	*Feresa attenuata*	Offshore	Least Concern
Risso's dolphin	*Grampus griseus*	Shelf Edge	Least Concern
Sperm whales			
Pygmy sperm whale	*Kogia breviceps*	Offshore	Data Deficient

Common Name	Species	Habitat	IUCN Conservation Status
Dwarf sperm whale	*Kogia sima*	Shelf Edge	Data Deficient
Sperm whale	*Physeter macrocephalus*	Offshore	Vulnerable

Common Name	Species	Habitat	IUCN Conservation Status
Beaked whales			
Cuvier's	*Ziphius cavirostris*	Offshore	Data Deficient
Arnoux's	*Beradius arnouxii*	Offshore	Data Deficient
Southern bottlenose	*Hyperoodon planifrons*	Offshore	Least Concern
Layard's	*Mesoplodon layardii*	Offshore	Data Deficient
True's	*M. mirus*	Offshore	Data Deficient
Gray's	*M. grayi*	Offshore	Data Deficient
Blainville's	*M. densirostris*	Offshore	Data Deficient
Baleen whales			
Antarctic Minke*	*Balaenoptera bonaerensis*	Shelf	Least Concern
Dwarf minke*	*B. acutorostrata*	Shelf	Least Concern
Fin whale*	*B. physalus*	Shelf	Endangered
Blue whale	*B. musculus*	Offshore	Critically Endangered
Sei whale	*B. borealis*	Shelf edge	Endangered
Bryde's (inshore)*	*B brydei (subspp)*	Shelf	Vulnerable
Bryde's (offshore)	*B. brydei*	Shelf	Not assessed
Pygmy right*	*Caperea marginata*	Shelf	Data Deficient
Humpback*	*Megaptera novaeangliae*	Shelf	Least Concern
Humpback B2 population*	*Megaptera novaeangliae*	Shelf	Vulnerable
Southern right*	*Eubalaena australis*	Shelf	Least Concern

The most abundant of the migratory mysticete (baleen) whales frequenting the inner shelf habitat are the humpback whales and southern right whales (Figure 21). In the last decade, both species have been increasingly observed to remain along the west coast of southern Africa well after the 'traditional' southern African whale season (June - November) into spring and summer (October - February) where they have been observed feeding in upwelling zones, especially off Saldanha and St Helena Bays in South Africa (Barendse *et al*. 2011; Mate *et al*. 2011). Increasing numbers of summer records of both species in Namibia, suggest that animals may also be feeding in the southern half of the country near the Lüderitz upwelling cell and may therefore occur in or pass through the Lüderitz Bay area throughout the year.

The southern African population of southern right whales historically extended from southern Mozambique (Maputo Bay) to southern Angola (Baia dos Tigres) and is considered to be a single population within this range (Roux *et al*. 2015). The most recent abundance estimate for this population is available for 2017 which estimated the population at ~6,100 individuals including all age and sex classes, and still growing at ~6.5% per annum (Brandaõ *et al*. 2017). Due to historical overexploitation the local population crashed nearly two centuries ago and the range contracted down to just the south coast of South Africa. Internationally protected since the early 20th century the population has been slowly recovering and repopulating its historical distribution including Namibia (Roux *et al*. 2001, 2015; de Rock *et al*. 2019) and Mozambique (Banks *et al*. 2011).

Southern right whales are seen regularly in Namibian coastal waters (<3 km from shore), especially in the southern half of the Namibian coastline (Roux *et al.* 2001, 2011). Right whales have been recorded in Namibian waters in all months of the year (J-P. Roux pers. obs.), with numbers peaking in winter and spring (June - October). Notably, all available records have been very close to shore with only a few out to 100 m depth. While globally ranked in the "Least concern" category by the IUCN (due to the growing population and adequate conservation measures) it should be noted that the global population is still only ~10% of the estimated original pre-whaling levels.

Figure 21: The Southern Right whale *Eubalaena australis* (left) and the humpback whale *Megaptera novaeangliae* (right) migrate along the coastal and shelf waters of southern Africa, including Namibia (Photos: www.NamibianDolphinProject.com).

The majority of humpback whales passing through the region are migrating to breeding grounds off tropical west Africa, between Angola and the Gulf of Guinea (Rosenbaum *et al.* 2009; Barendse *et al.* 2010). A recent synthesis of available humpback whale data from Namibia (Elwen *et al.* 2014) shows that in coastal waters, the northward migration stream is larger than the southward peak supporting earlier observations from whale catches (Best & Allison 2010). This supports suggestions that animals migrating north strike the coast at varying places mostly north of St Helena Bay (South Africa) resulting in increasing whale density in shelf waters as one moves northward towards Angola, but with no clear migration 'corridor'. On the southward migration, there is evidence from satellite tagged animals and a smaller secondary peak in numbers in Walvis Bay, that many humpback whales follow the Walvis Ridge offshore then head directly to high latitude feeding grounds, while others follow a more coastal route (including the majority of mother-calf pairs), possibly lingering in the feeding grounds off west South Africa in summer (Elwen *et al.* 2014, Rosenbaum *et al.* 2014). Regular sightings of humpback whales in spring and summer in Namibia, especially in the Lüderitz area, suggest that summer feeding is occurring in Namibian waters as well (or at least that animals foraging off West South Africa range up into southern Namibia). The most recent abundance estimates available put the number of animals in the west African breeding population to be in excess of 9,000 individuals in 2005 (IWC 2012) and it is likely to have increased since this time at about 5% per annum (IWC 2012). Humpback whales are thus likely to be the most frequently encountered baleen whale in the project area, ranging from the coast to beyond the shelf, with year round presence but numbers peaking in June – July (northern migration) and a smaller peak with the southern breeding migration around September – October but with regular encounters until

February associated with subsequent feeding in the Benguela ecosystem.

Fin whales have been sighted several times in recent years off the coast and in inshore waters near Lüderitz. W hile uncommon visitors in the project area they are the longest whale species likely to be encountered with a total length reaching close to 25 m (Best 2007).

The Odontoceti (toothed whales) are a varied group of animals that includes the dolphins, porpoises, beaked whales and sperm whales. Species occurring within Namibian waters display a diversity of features, for example their habitats vary from extremely coastal and highly site specific to oceanic and wide ranging. Those in the region can range in size from 1.6 m long (Heaviside's dolphin) to 17 m (bull sperm whale).

Dusky dolphins (*Lagenorhynchus obscurus*) (Figure 22, left) are likely to be the most frequently encountered small cetacean in the project area. The species is very boat friendly and will often approach boats to bowride. This species is resident year round throughout the Benguela ecosystem in waters from the coast to at least 500 m deep (Findlay *et al*. 1992). Although no information is available on the size of the population, they are regularly encountered in the inner and mid shelf waters, with most records coming from beyond 5 nautical miles from the coast (Elwen *et al*. 2010; De Rock *et al*. 2019). In recent surveys of the Namibian Islands' Marine Protected Area (between latitudes of 24˚29' S and 27˚57' S and depths of 30-200 m) dusky dolphin were the most commonly detected cetacean species with group sizes ranging from 1 to 70 individuals (Martin *et al*. submitted), although group sizes up to 800 have been reported in southern African waters (Findlay *et al*. 1992).

Figure 22: The dusky dolphin *Lagenorhynchus obscurus* (left) (Photo: scottelowitzphotography.com) and endemic Heaviside's dolphin *Cephalorhynchus heavisidii* (right) (Photo: www.NamibianDolphinProject.com)) are common residents in the Lüderitz coastal region.

Heaviside's dolphins (Figure 22, right) are relatively abundant in both the southern and northern Benguela ecosystem with several hundred animals living in the areas around Walvis Bay and Lüderitz. Heaviside's dolphins are resident year-round. This species occupies waters from the coast to at least 200 m depth (Elwen *et al*. 2006, 2010; Best 2007), and may show a diurnal onshore-offshore movement pattern feeding offshore at night, although this varies throughout the range (Elwen *et al*. 2009b). In the Lüderitz area the species is present in the inshore area from the breakers in less than 2 m depth as well as bays and coves along the coast. Some pods specialize in feeding on the edge and within established natural kelp beds (J-P. Roux, pers. obs).

Heaviside's dolphins (together with African Penguins) are particularly important economically near Lüderitz as they constitute the highlight of the growing local marine tourism sector.

Common bottlenose dolphins (*Tursiop struncatus*) are widely distributed in tropical and temperate waters throughout the world, but frequently occur in small (10s to low 100s) isolated coastal populations. Within Nambian waters two populations of bottlenose dolphins occur. A small population inhabits the very near shore coastal waters (mostly <15 m deep) of the central Namibian coastline from approximately Lüderitz in the south to at least Cape Cross in the north, and is considered a conservation concern. The population is thought to number less than 100 individuals (Elwen *et al*. 2011). An offshore 'form' of common bottlenose dolphins occurs around the coast of southern Africa including Namibia and Angola (Best 2007) with sightings restricted to the continental shelf edge and deeper. Members of the small Namibian coastal population visit Lüderitz Bay on a regular basis.

The cold waters of the central region of the Benguela current associated with the Lüderitz upwelling cell allow a northwards extension of the normally sub Antarctic habitat of Southern right whale dolphins (*Lissodelphis peronii*) (Best 2007). Most records in the region originate in a relatively restricted region between 26°S and 30°S (Rose & Payne 1991; Best 2007; MFMR unpubl. data). They are often seen in mixed species groups with dusky dolphins in the region. There was a live stranding of two individuals in Lüderitz Bay in December 2013 (J-P. Roux pers. obs.). It is possible that the Namibian sightings represent a regionally unique and resident population (Findlay *et al*. 1992).

All whales and dolphins are given protection under the South African Law. The Marine Living Resources Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished. No vessel or aircraft may approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.

3.3 Biological Resources

3.3.1 Rock Lobster Sanctuaries

Two rock lobster sanctuaries exist in the vicinity of the project area (Figure 23, left). The Ichaboe lobster sanctuary, which lies about 20 kms south of ML220, was proclaimed in 1951 and extends from Danger Point to Douglas Point in Douglas Bay. No western boarder has been defined making it extend to the outer boundary of the Exclusive Economic Zone (EEZ). The sanctuary has been effective in preserving the natural size structure of the rock lobster population, which in the sanctuary has resulted in a significantly higher abundance of large-sized lobsters compared with commercially fished areas (Currie *et al*. 2009).

The whole of the Lüderitz Bay, which lies 60 kms south of the licence area, was proclaimed a rock lobster sanctuary in 1939. The bay serves primarily as a recruitment settlement area and high numbers of lobster puerulus larvae and juvenile lobsters are reported to occur there, due to the protective environment provided by various bays, small fjords, two islands and a lagoon area

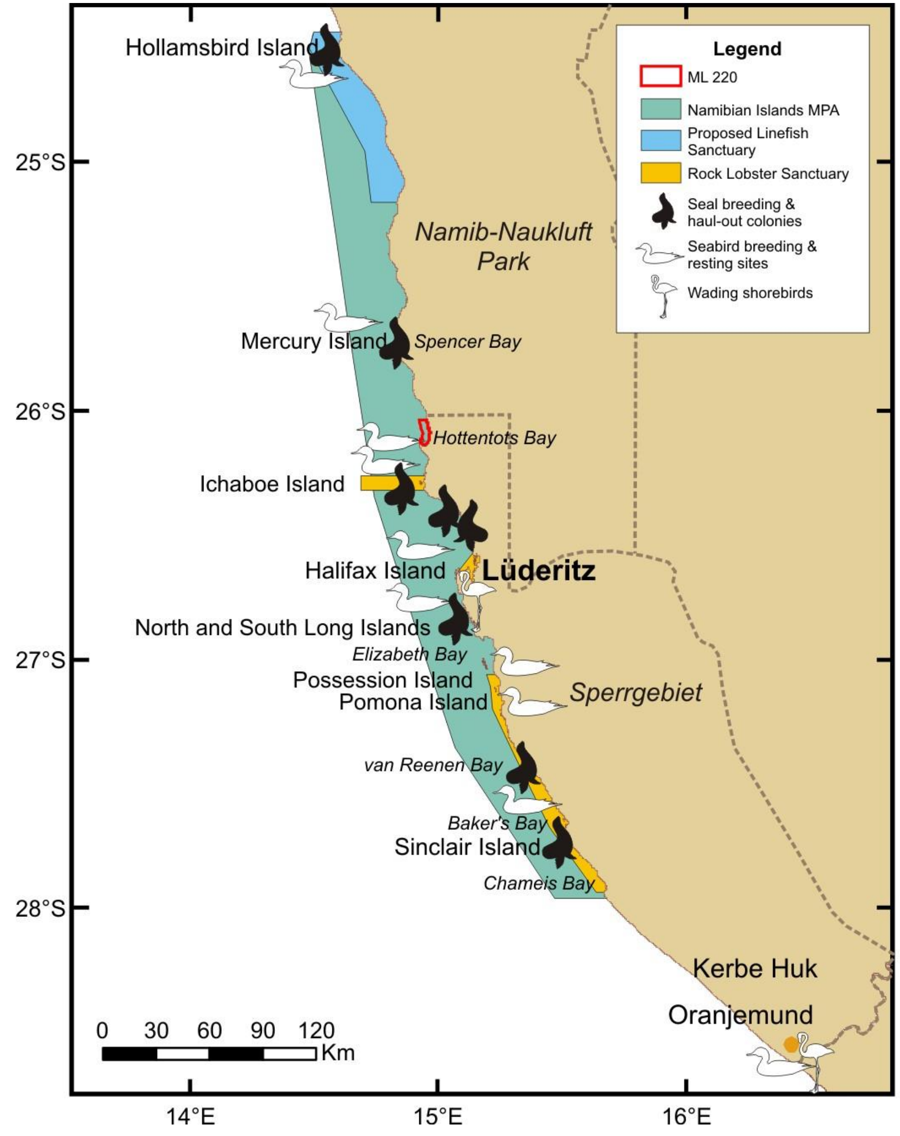
(Keulder 2005; Currie *et al*. 2009). Neither commercial nor recreational fisheries are permitted in either of these sanctuaries.

3.3.2 Marine Protected Areas

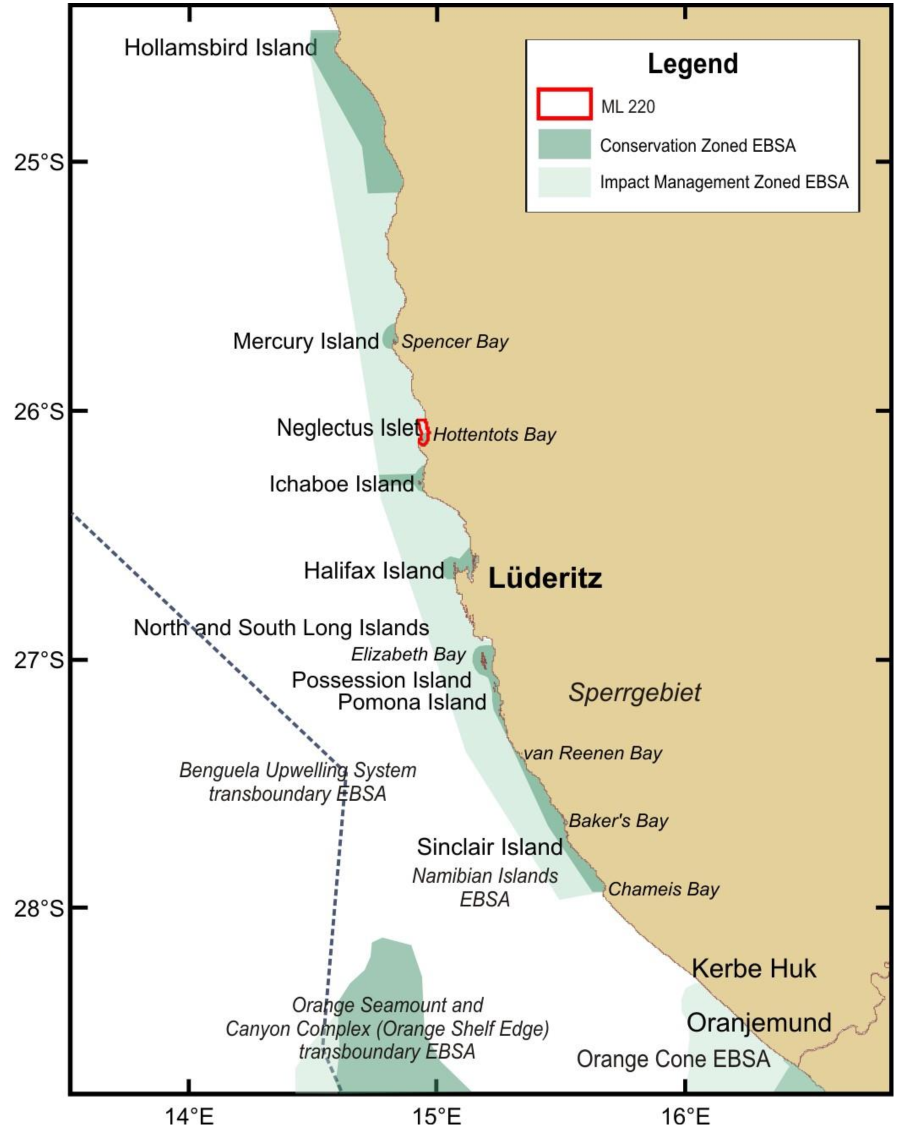
Mining Licence 220 falls within the Namibian Islands Marine Protected Area (NIMPA) ((Figure 23, left). The NIMPA comprises a coastal strip extending roughly 400 km from Hollamsbird Island (24°38'S) in the north, to Chamais Bay (27°57'S) in the south, spanning approximately three degrees of latitude and an average width of 30 km, including 16 specified offshore islands, islets and rocks (Currie *et al*. 2008). The NIMPA spans an area of 9,555 km^2, and includes a line fish sanctuary near Meob Bay and a 478 km^2 rock lobster sanctuary between Prince of Wales Bay and Chameis Bay. The offshore islands, whose combined surface area amounts to only 2.35 km^2 have been given priority conservation and highest protection status (Currie *et al*. 2009). The area has been further zoned into four degrees of incremental protection. The regulations pertaining to the NIMPA (Government Gazette 5111, of 31 December 2012) detail which activities are permitted in each of the zones. The NIMPA was launched on 2 July 2009 under the Namibian Marine Resources Act (No. 29 of 1992 and No. 27 of 2000), with the purpose of protecting sensitive ecosystems and breeding and foraging areas for seabirds and marine mammals, as well as protecting important spawning and nursery grounds for fish and other marine resources (such as rock lobster).

Of particular significance in ML 220 is Neglectus Islet and the disused Jetty in Hottentots Bay. These provide important breeding sites for African Penguins, Bank, Cape, Crowned and White-breasted cormorants and are given special protection under NIMPA. In 2009, the jetty had the largest breeding colony of White-breasted cormorants along the southern Namibian coast. Access to Neglectus Islet is only allowed with a permit and the islet has a buffer zone extending from the low water mark to 120 m off the islet in which activities are restricted. Access to the jetty is not allowed at all and no approach is permitted to within 50 m of the jetty from the seaward side.

Other conservation areas in southern Namibia include the Sperrgebiet, which was proclaimed in 1908 and covers an area of approximately 22,000 km^2 between latitude 26° in the north and the Orange River in the south, extending inland from the coast for 100 km. The Sperrgebiet was proclaimed to prevent public access to the rich surface diamond deposits occurring in the area, and has largely remained closed off to general public access since then. However, as diamond mining has actually remained confined to the narrow coastal strip and along the banks of the Orange River, most of the area has effectively been preserved as a pristine wilderness. Large parts of the Sperrgebiet have since been de-proclaimed from exclusive prospecting and mining licences, and reverted to unproclaimed State land. Consequently, the **Tsau//Khaeb-Sperrgebiet National Park** was proclaimed in 2008. The park has been zoned in accordance with IUCN guidelines for Protected Area Management Categories. Management and tourism plans for the park are at an advanced stage of development.



Legend
ML 220
Namibian Islands MPA
Proposed Linefish Sanctuary
Rock Lobster Sanctuary
Seal breeding & haul-out colonies
Seabird breeding & resting sites
Wading shorebirds
Hollamsbird Island
Namib-Naukluft Park
Mercury Island
Spencer Bay
Hottentots Bay
Ichaboe Island
Halifax Island
Lüderitz
North and South Long Islands
Elizabeth Bay
Possession Island
Pomona Island
Sperrgebiet
van Reenen Bay
Baker's Bay
Sinclair Island
Chameis Bay
Kerbe Huk
Oranjemund
0 30 60 90 120 Km
25°S
26°S
27°S
28°S
14°E
15°E
16°E



Legend
ML 220
Conservation Zoned EBSA
Impact Management Zoned EBSA
Hollamsbird Island
Mercury Island
Spencer Bay
Neglectus Islet
Hottentots Bay
Ichaboe Island
Halifax Island
Lüderitz
North and South Long Islands
Elizabeth Bay
Possession Island
Pomona Island
Sperrgebiet
van Reenen Bay
Benguela Upwelling System transboundary EBSA
Baker's Bay
Sinclair Island
Namibian Islands EBSA
Chameis Bay
Kerbe Huk
Orange Seamount and Canyon Complex (Orange Shelf Edge) transboundary EBSA
Oranjemund
Orange Cone EBSA
25°S
26°S
27°S
28°S
14°E
15°E
16°E

Figure 23: Mining Licence 220 (red polygons) in relation to the Namibian Islands Marine Protected Area and other project-environment interaction points (left) and Ecologically and Biologically Significant Areas (EBSAs) and the biodiversity conservations zones within these (right).

3.3.3 Ecologically or Biologically Significant Areas

Ecologically or Biologically Significant Areas (EBSAs) are marine areas that provide important services to an ecosystem or to one or more species / populations within an ecosystem. These areas require targeted conservation management actions to limit marine biodiversity declines. An inventory of EBSAs aids marine spatial planning by advising which activities would be (in)compatible with areas of high ecological value (Dunn *et al.* 2014).

In the spatial marine biodiversity assessment undertaken for Namibia (Holness et al. 2014), a number of offshore and coastal area were identified as being of high priority for place-based conservation measures. To this end, EBSAs spanning the coastline between Angola and South Africa were proposed and successfully submitted for international recognition to the Convention of Biological Diversity (CBD) in March 2020. The principal objective of the EBSAs is identification of features of higher ecological value that may require enhanced conservation and management measures. The EBSAs are delineated to minimise conflict and avoid negative impacts with industries. In line with Namibia's National Development Plan 5, the EBSAs will in future be used to inform and enhance Marine Spatial Planning in the country's EEZ.

Of the eight identified EBSAs off Namibia, two fall solely within Namibian national jurisdiction (Namib Flyway and Namibian Islands), while one is shared with Angola (Namibe) and two are shared with South Africa (Orange Shelf Edge and Orange Cone) (Figure 23, right). The Benguela Upwelling System transboundary EBSA extends along the entire southern African West Coast from Cape Point to the Kunene River and includes a portion of the high seas beyond the Angolan EEZ. The following summary was adapted from http://cmr.mandela.ac.za/EBSA-Portal/Namibia/.

The **Namibian Islands** are located offshore of the central Namibian coastline and within the intensive Lüderitz upwelling cell. These islands and their surrounding waters are significant for life history stages of threatened seabird species as they serve as crucial seabird breeding sites within the existing Namibian Islands Marine Protected Area (NIMPA). The surrounding waters are also key foraging grounds for both seabirds and for 'Critically Endangered' leatherback turtles that nest along the northeastern coast of South Africa.

Although at this stage no specific management actions have as yet been formulated for the EBSAs and they carry no legal status, two biodiversity zones have recently been defined within each EBSA as part of the marine spatial planning process (Figure 23, right)(https://cmr.mandela.ac.za/EBSA-Portal/Namibia/Namibian-EBSA-Status-Assessment-Management; accessed 16 March 2021). Although the proposed zonation of the EBSAs is still under discussion, and industry has not been approached for comments, the management objective in the zones marked for 'Conservation' is "*strict place-based biodiversity protection aimed at securing key biodiversity features in a natural or semi-natural state, or as near to this state as possible*". The management objective in the zones marked for 'Impact Management' is "*management of impacts on key biodiversity features in a mixed-use area to keep key biodiversity features in at least a functional state*". In the list of sea-use activities provided for this EBSA, the marine spatial planning zone for mining recommends that <u>mining be prohibited</u> in the Biodiversity Conservation zone (or Critical Biodiversity Area, CBA) and be conditionally permissible within the Impact Management zone. Conditional activities are defined as activities that "*are recommended to be managed as Consent activities, which are those that can continue in the zone subject to specific regulations and controls, e.g. to avoid unacceptable impacts on biodiversity features, or to avoid intensification or expansion of impact footprints of uses that are already occurring and where there are no realistic prospects of excluding these activities*" (MARISMA Project 2019).

The proposed mining area overlaps with the recommended, but not proclaimed, conservation zone proposed to offer biodiversity protection to Neglectus Islet and the disused jetty in Hottentots Bay.

LK Mining had imposed a voluntary 500 m 'no activity' buffers around these sensitive habitats (Figure 24).

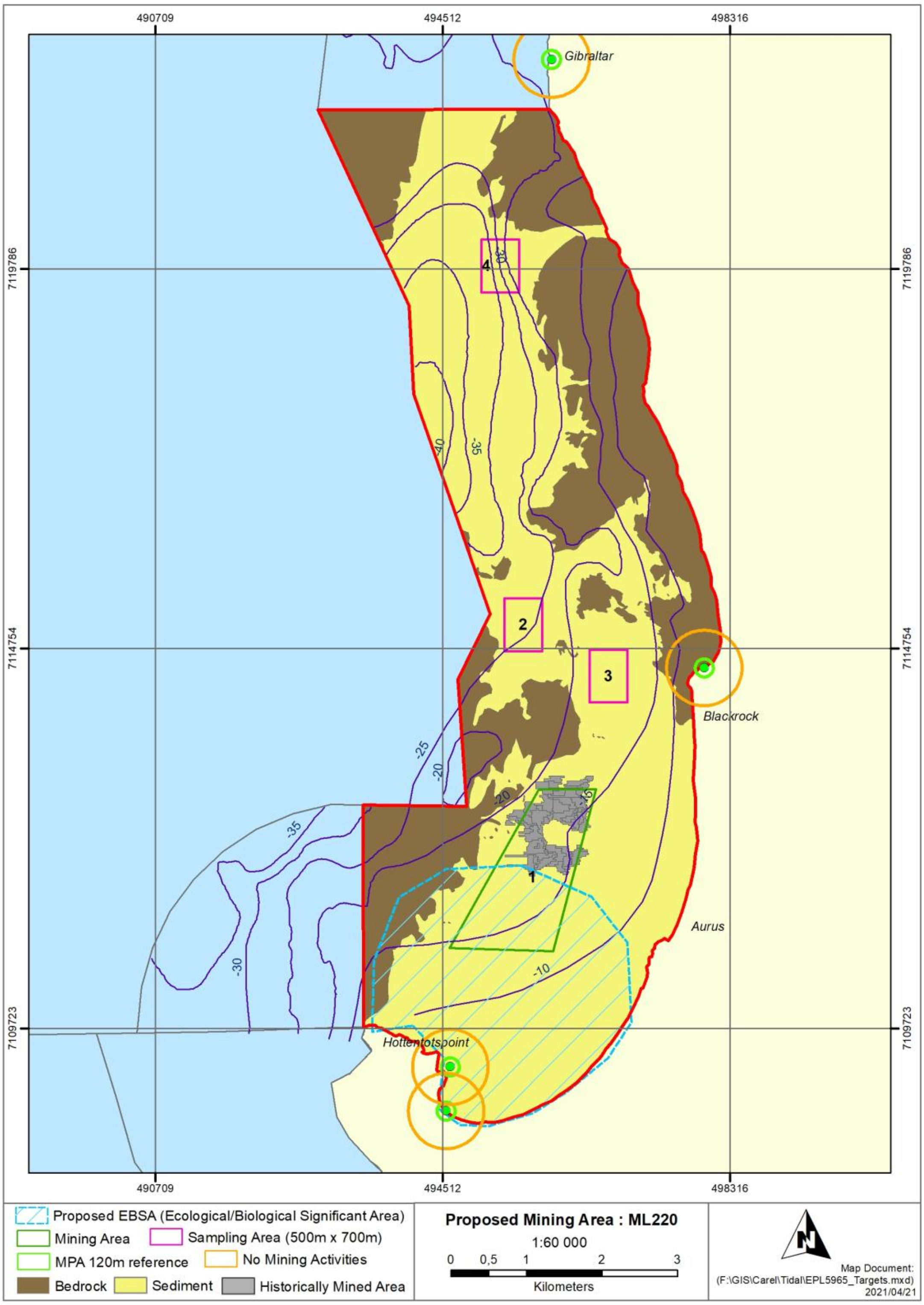


Figure 24: Details of Mining Licence 220 (red polygon) and the mining target area (green polygon) in relation to the marine spatial planning conservation zone (blue polygon) in Hottentots Bay within the Namibian Islands EBSA. The 500 m 'no activity' buffers around sensitive habitats are also shown.

3.3.4 Important Bird Areas (IBAs)

Important Bird and Biodiversity Areas (IBAs) are areas that are considered critical for birds at a global or regional scale. Although they do not carry any legal obligations as such, they provide decision-makers with a catalogue of areas of high bird conservation importance. Of the 19 Important Bird Areas (IBAs) designated by BirdLife International in Namibia, those located along the southern Namibian coastline and relevant to the planned activities are listed in Table 3-5.

The Namib-Naukluft Park and Sperrgebiet IBAs are largely terrestrial but extend to the coastline and are therefore of relevance for shorebirds. The Lüderitz Bay Islands IBA consists of Flamingo, Seal, Penguin and Halifax islands and includes Lüderitz Harbour and the adjacent rocky shore to just south of Guano Bay. These islands, as well as Mercury, Ichaboe and Possession Islands are listed as global IBAs as they regularly support significant numbers of seabirds or waterbirds. More recently, an additional set of marine IBAs have been proposed by BirdLife (see https://maps.birdlife.org/marineIBAs/default.html). ML 220 falls within the proposed Sperrgebiet Marine IBA (Figure 25).

Table 3-5: List of Important Bird Areas (IBAs) and their criteria listings.

Site Name	IBA Criteria
Mercury Island	A1, A4i, A4ii, A4iii
Ichaboe Island	A1, A4i, A4ii, A4iii
Lüderitz Bay Islands	A1, A4i, A4iii
Possession Island	A1, A4i, A4ii, A4iii
Namib-Naukluft Park	A1, A2, A3, A4i
Sperrgebiet	A1, A2, A3, A4i
Sperrgebiet Marine (proposed)	A1, A4i, A4ii, A4iii

A1. Globally threatened species

A2. Restricted-range species

A3. Biome-restricted species

A4. Congregations

- **i.** applies to 'waterbird' species
- **ii.** This includes those seabird species not covered under i.
- **iii.** modeled on criterion 5 of the Ramsar Convention for identifying wetlands of international importance. The use of this criterion is discouraged where quantitative data are good enough to permit the application of A4i and A4ii.

3.3.5 Unique Biodiversity Resources

The marine benthic communities in the study area are generally typical for the West Coast, are not unique to the licence area and cannot be classified as locally, regionally or internationally important biodiversity resources. Concequently, the inshore and coastal benthic habitats in the area have all been assigned a threat status of 'Least Concern' (Holness *et al.* 2014). This rationale also applies to the pelagic and demersal fish, and marine mammals occurring in the exploration area as these are widespread on the Southern African west coast, and do not rely on the area as a critically important foraging or breeding area.

In contrast, the resident seabird community can be considered important biodiversity resources, especially the Cape, Crowned, White-breasted and Bank Cormorants (Kemper 2008). The total breeding population of Cape Cormorants in Namibia has declined by 57% during the last three generations (Crawford et al. 2007) warranting it being listed as 'Endangered'. The Namibian breeding population of Bank Cormorants declined by 86% from 5,182 to 732 in the five years between 1992/93 and 1887/97. Due to their population size, endemism and conservation classification these species represent internationally significant biodiversity resources. The main threats include a lack of prey, human disturbance at breeding sites, oil and plastic pollution, and lack of suitable breeding habitat.

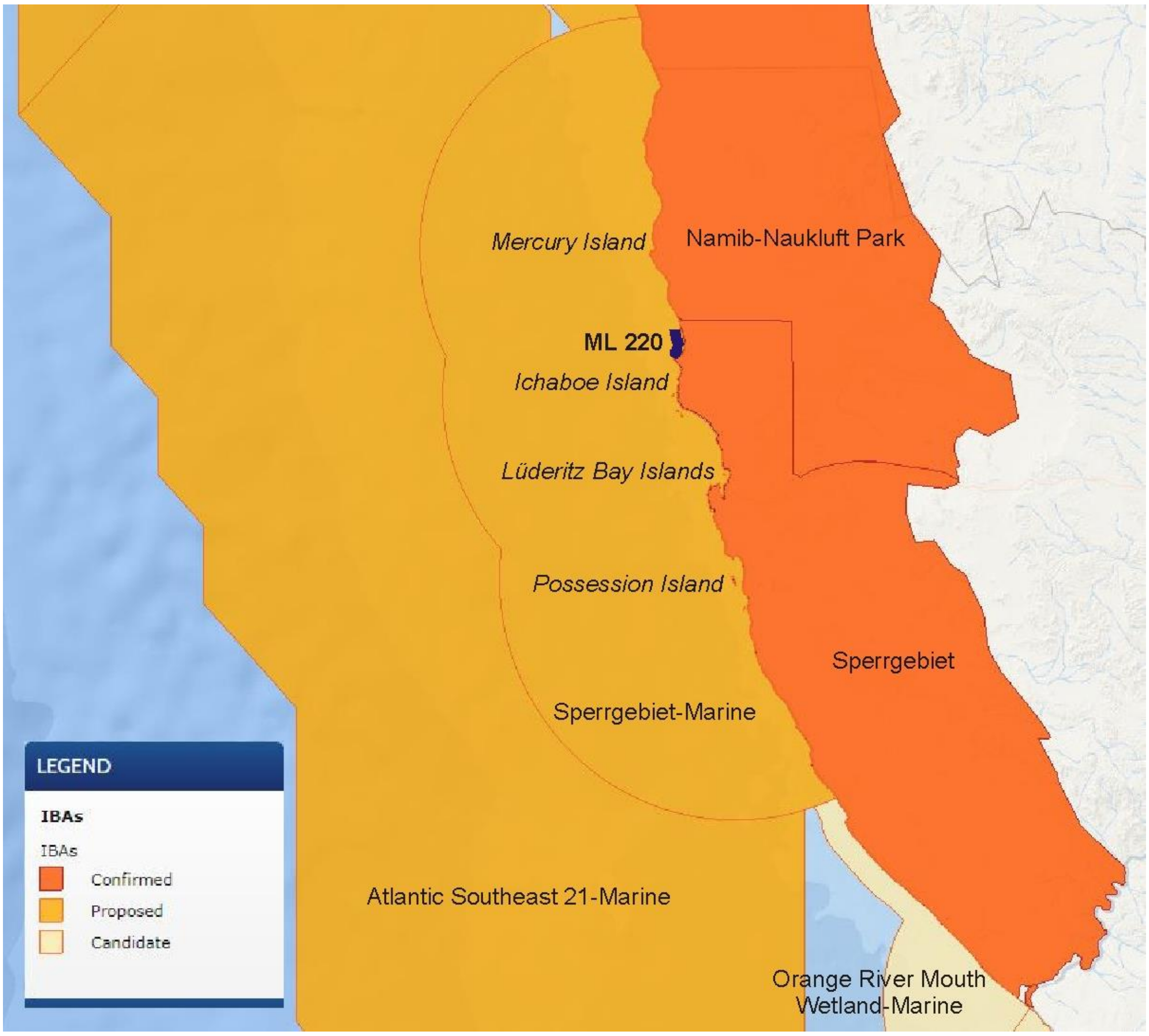


Figure 25: ML 220 (blue polygon) in relation to confirmed, proposed and candidate coastal and marine IBAs in Namibia (Source: https://maps.birdlife.org/marineIBAs).

4. METHODOLOGY

Assessment of predicted significance of impacts for a proposed development is by its nature, inherently uncertain – environmental assessment is thus an imprecise science. To deal with such uncertainty in a comparable manner, standardised and internationally recognised methodology has been developed, and is applied in this study to assess the significance of the potential environmental impacts of the proposed construction and operation of the desalination plant.

For each impact, the INTENSITY (size or degree scale), EXTENT (spatial scale) and DURATION (time scale) are described.

The impact assessment criteria applied to the study are outlined below.

IMPACT assessment criteria	
SIGNIFICANCE determination	Significance = consequence x probability
CONSEQUENCE	Consequence is a function of: •Nature and Intensity of the potential impact •Geographical extent should the impact occur •Duration of the impact

Ranking the NATURE and INTENSITY of the potential impact	
Negative impacts	
Low (L)	The impact has no / minor effect/deterioration on natural, cultural and social functions and processes. No measurable change. Recommended standard / level will not be violated. (Limited nuisance related complaints).
Moderate (M)	Natural, cultural and social functions and processes can continue, but in a modified way. Moderate discomfort that can be measured. Recommended standard / level will occasionally be violated. Various third party complaints expected.
High (H)	Natural, cultural or social functions and processes are altered in such a way that they temporarily or permanently cease. Substantial deterioration of the impacted environment. Widespread third party complaints expected.
Very high (VH)	Substantial deterioration (death, illness or injury). Recommended standard / level will often be violated. Vigorous action expected by third parties.
Positive impacts	
Low (L) +	Slight positive effect on natural, cultural and social functions and processes Minor improvement. No measurable change.
Moderate (M) +	Natural, cultural and social functions and processes continue but in a noticeably enhanced way. Moderate improvement. Little positive reaction from third parties.
High (H) +	Natural, cultural or social functions and processes are altered in such a way that the impacted environment is considerably enhanced /improved. Widespread, noticeable positive reaction from third parties.
Very high (VH) +	Substantial improvement. Will be within or better than the recommended level. Favourable publicity from third parties.

Ranking the EXTENT	
Low (L)	Local: confined to within the project concession area and its nearby surroundings
Moderate (M)	Regional: confined to the region, e.g. coast, basin, catchment, municipal region, district, etc.
High (H)	National; extends beyond district or regional boundaries with national implications
Very high (VH)	International: Impact extends beyond the national scale or may be transboundary

Ranking the DURATION	
Low (L)	Temporary/short term. Quickly reversible. (Less than the life of the project).
Moderate (M)	Medium Term. Impact can be reversed over time. (Life of the project).
High (H)	Long Term. Impact will only cease after the life of the project.
Very high (VH)	Permanent

Ranking the PROBABILITY	
Low (L)	Unlikely
Moderate (M)	Possibly
High (H)	Most likely
Very high (VH)	Definitely

These criteria are used to determine the CONSEQUENCE of the impact, which is a function of severity, spatial extent and duration.

		EXTENT			
INTENSITY	**DURATION**	**Local (L)**	**Regional (M)**	**National (H)**	**International (VH)**
LOW	**Permanent**	Moderate	Moderate	High	High
	Long-term	Moderate	Moderate	Moderate	Moderate
	Medium-term	Low	Low	Low	Moderate
	Short-term	Low	Low	Low	Moderate

		EXTENT			
INTENSITY	**DURATION**	**Local (L)**	**Regional (M)**	**National (H)**	**International (VH)**
MODERATE	**Permanent**	Moderate	High	High	High
	Long-term	Moderate	Moderate	High	High
	Medium-term	Moderate	Moderate	Moderate	Moderate
	Short-term	Low	Moderate	Moderate	Moderate

		EXTENT			
INTENSITY	**DURATION**	**Local (L)**	**Regional (M)**	**National (H)**	**International (VH)**
HIGH	**Permanent**	High	High	Very High	Very high
	Long-term	High	High	High	Very High
	Medium-term	Moderate	Moderate	High	High
	Short-term	Moderate	Moderate	High	High

INTENSITY	DURATION	EXTENT			
		Local (L)	Regional (M)	National (H)	International (VH)
VERY HIGH	Permanent	Very high	Very High	Very High	Very high
	Long-term	High	High	Very High	Very high
	Medium-term	High	High	High	Very High
	Short-term	Moderate	High	High	Very High

The SIGNIFICANCE of an impact is then determined by multiplying the consequence of the impact by the probability of the impact occurring, with interpretation of the impact significance outlined below.

PROBABILITY		CONSEQUENCE			
		L	M	H	VH
Definite	VH	Moderate	High	High	Very high
Most Likely	H	Moderate	Moderate	High	Very high
Possibly	M	Low	Moderate	High	High
Unlikely	L	Low	Low	Moderate	High

SIGNIFICANCE Description		
	Positive	Negative
Low (L)	Supports the implementation of the project	No influence on the decision.
Moderate (M)	Supports the implementation of the project	It should have an influence on the decision and the impact will not be avoided unless it is mitigated.
High (H)	Supports the implementation of the project	It should influence the decision to not proceed with the project or require significant modification(s) of the project design/location, etc. (where relevant).
Very high (VH)	Supports the implementation of the project	It would influence the decision to not proceed with the project.

5. IDENTIFICATION OF KEY ISSUES AND ASSESSMENT OF ENVIRONMENTAL IMPACTS

5.1 Identification of Key Issues

During the course of the environmental scoping process for the proposed mining and prospecting operations in ML 220, the following key issues were identified relating to potential impacts on the marine environment:

- Disturbance of marine mammals by the sounds emitted by the geophysical survey equipment;
- Disturbance and loss of benthic fauna during sampling and mining operations;
- Disturbance of nesting and roosting seabirds on Neglectus Islet and the jetty;
- Generation of suspended sediment plumes;
- Smothering of benthos in redepositing tailings;
- Loss of ferrosilicon;
- Potential loss of equipment;
- Potential injury to marine mammals and turtles through vessel strikes;
- Marine pollution due to discharges such as deck drainage, machinery space wastewater, sewage, etc. and disposal of solid wastes from the survey vessel; and
- Marine pollution due to fuel spills during refuelling, or resulting from collision or shipwreck.

Potential social and cultural impacts of the proposed prospecting operations are:

- Prospecting and mining activities within the NIMPA; and
- Interaction with the commercial rock-lobster fleet that operates within or traverses the survey area.

5.2 Assessment of Impacts

5.2.1 Acoustic Impacts of Geophysical Surveying

<u>Description of Impact</u>

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation (see references in McCauley 1994). Such acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean may thus interfere directly or indirectly with such activities. Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 dB re 1 μPa at 1 m (NRC 2003). Especially at low frequencies between 5 to 100 Hz, vessel traffic is a major contributor to noise in the world's oceans, and under the right conditions, these sounds can propagate 100s of kilometres thereby affecting very large geographic areas (Coley 1994, 1995; NRC 2003; Pidcock *et al*. 2003). Other forms of anthropogenic noise include 1) aircraft flyovers, 2) multi-beam sonar systems, 3) seismic acquisition, 4) hydrocarbon and mineral exploration and recovery, and 5) noise associated with underwater blasting, pile driving, and construction (Figure 26).

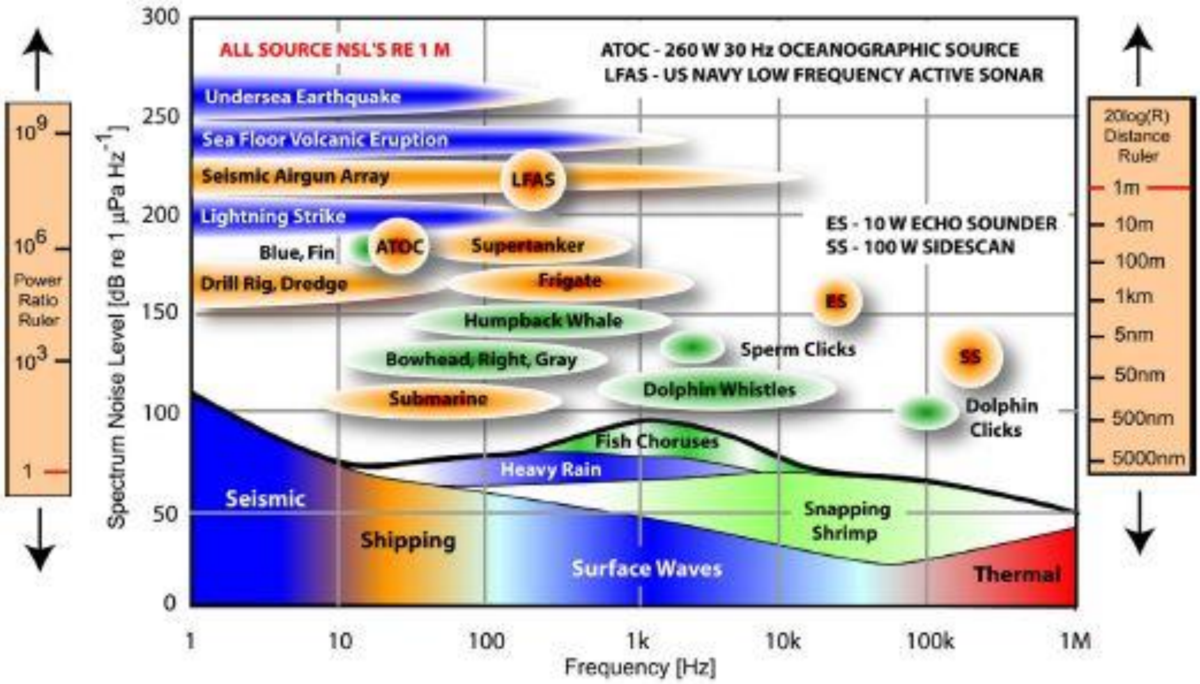


Figure 26: Comparison of noise sources in the ocean (Goold & Coates 2001).

Typical natural ambient noise levels in the study area are estimated to have overall root-mean-square sound pressure levels (RMS SPLs) in the range of 80 – 120 dB re 1 µPa, with a median level around 100 dB re 1µPa upon calm to strong sea state conditions (Li & Lewis 2020). The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern (Koper & Plön 2012), as such sound sources interfere directly or indirectly with the animals' biological activities. Reactions of marine mammals to anthropogenic sounds have been reviewed by McCauley (1994), Richardson *et al*. (1995), Gordon & Moscrop (1996) and Perry (1998), who concluded that anthropogenic sounds could affect marine animals in the surrounding area in the following ways:

- Physiological injury and/or disorientation;
- Behavioural disturbance and subsequent displacement from key habitats;
- Masking of important environmental sounds and communication;
- Indirect effects due to effects on prey.

It is the received level of the sound, however, that has the potential to traumatise or cause physiological injury to marine animals. As sound attenuates with distance, the received level depends on the animal's proximity to the sound source and the attenuation characteristics of the sound.

The noise generated by the acoustic equipment utilized during geophysical surveys falls within the hearing range of most fish, turtles and marine mammals (Table 3-6), and at sound levels of between 140 to 230 dB re 1 µPa at 1 m, will be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels (Findlay 2005). High frequency active sonar sources, in particular, have energy profiles that clearly overlap with cetacean's hearing sensitivity frequency range, particularly for cetaceans of High Frequency (e.g. odontocetes: dolphins, toothed whales (e.g. sperm), beaked whales, bottle-nose whales) and Very High Frequency (e.g. Heavisides dolphins, pygmy sperm and dwarf sperm whales) hearing groups. However, unlike the noise generated by airguns during seismic surveys, the emission of underwater noise from geophysical surveying and vessel activity is not considered to be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals in the region. The noise emissions are highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction, and only directly below or adjacent to the systems (within 10 m of the source) would sound levels be in the 230 dB range where exposure would result in permanent threshold shifts (PTS[1]). In the case of very-high-frequency cetaceans the maximum zones of PTS effect were predicted to occur within 70 m from the source along the cross-track direction. Temporary threshold shifts (TTS[2]) for marine mammals of all hearing groups except very-high-frequency cetaceans were predicted to be within approximately 25 m from the sonar source, extending to within 140 m from the source along the cross-track direction for very-high frequency cetaceans (Li & Lewis 2020b). Therefore, only directly below or within the sonar beam would received sound levels be in the range where exposure result in trauma or physiological injury. As most pelagic species likely to be encountered within the concessions are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur. Furthermore, the statistical probability of crossing a cetacean or pinniped with the narrow multi-beam fan several times, or even once, is very small.

The underwater noise from the survey systems may, however, induce localised behavioural changes (e.g. avoidance of the source) in some marine mammal, but there is no evidence of significant behavioural changes that may impact on the wider ecosystem (Perry 2005) and no evidence of physical damage (i.e. PTS and TTS) (Childerhouse & Douglas 2016). The maximum impact distance for behavioural disturbance caused by the immediate exposure to individual sonar pulses was predicted to be within 1.8 km from the source for marine mammals of all hearing groups, at cross-track directions (Li & Lewis 2020b).

Similarly, the sound level generated by sampling or mining operations fall within the 120-190 dB re 1 µPa range at the sampling/mining unit, with main frequencies between 3 – 10 Hz. The noise generated by sampling operations thus falls within the hearing range of most fish and marine mammals, and depending on sea state would be audible for up to 20 km around the vessel before attenuating to below threshold levels (Table 3-5). In a study evaluating the potential effects of vessel-based diamond mining on the marine mammal community off the southern African West Coast, Findlay (1996) concluded that the significance of the impact is likely to be minimal based on the assumption that the radius of elevated noise level would be restricted to ~20 km around the mining vessel. Whereas the underwater noise from sampling operations may induce localised behavioural changes in some marine mammal, it is unlikely that such behavioural changes would

[1] A permanent threshold shift is a shift in the auditory threshold, which results in permanent hearing loss.

[2] A temporary threshold shift is a shift in the auditory threshold, which results in temporary hearing loss.

impact on the wider ecosystem (see for example Perry 2005). The responses of cetaceans to noise sources are often also dependent on the perceived motion of the sound source as well as the nature of the sound itself. For example, many whales are more likely to tolerate a stationary source than one that is approaching them (Watkins 1986; Leung-Ng & Leung 2003), or are more likely to respond to a stimulus with a sudden onset than to one that is continuously present (Malme *et al*. 1985).

Table 3-5: Known hearing frequency and sound production ranges of various marine taxa (adapted from Koper & Plön 2012).

Taxa	Order	Hearing frequency (kHz)	Sound production (kHz)
Shellfish	Crustaceans	0.1 - 3	
Snapping shrimp	*Alpheus/ Synalpheus* spp.		0.1 - >200
Ghost crabs	*Ocypode* spp.		0.15 - 0.8
Fish	Teleosts		0.4 - 4
Hearing specialists		0.03 - >3	
Hearing generalists		0.03 - 1	
Sharks and skates	Elasmobranchs	0.1 - 1.5	Unknown
African penguins	Sphenisciformes	0.6 - 15	Unknown
Sea turtles	Chelonia	0.1 - 1	Unknown
Seals	Pinnipeds	0.25 - 10	1 - 4
Northern elephant seal	*Mirounga agurostris*	0.075 - 10	
Manatees and dugongs	Sirenians	0.4 - 46	4 - 25
Toothed whales	Odontocetes	0.1 - 180	0.05 - 200
Baleen whales	Mysticetes	0.005 - 30	0.01 - 28

<u>Sensitive Receptors</u>

The taxa most vulnerable to disturbance by high-frequency underwater sonar noise are marine mammals, particularly the very-high frequency (e.g. Heaviside's dolphin, pygmy sperm and dwarf sperm whales) and high-frequency species (e.g. odontocetes: dolphins, toothed whales (e.g. sperm), beaked whales, bottle-nose whales). Some of the species potentially occurring in the project area, are considered regionally or globally 'Endangered' (e.g. fin and sei whales). Although species listed as 'Endangered' may potentially occur in the project area, due to their extensive distributions their numbers are expected to be low.

<u>Assessment</u>

The effects of high frequency sonars on marine fauna are considered to be localised, short-term (for duration of survey i.e. weeks) and of medium intensity. The sounds generated during acoustic surveys are unlikely to result in physiological damage to marine fauna, although behavioural disturbance is possible. The significant of the impact is thus considered of **LOW** significance both without and with mitigation.

The impact of underwater noise generated during sampling operations is considered to be of low intensity in the target area and for the duration of the sampling campaign (short-term). During mining operations, however, the underwater noise will continue over the medium term. For both sampling and mining operations, it is unlikely that underwater noise would cause damage or discomfort to marine fauna. The impact of underwater noise is thus considered of **LOW** significance without mitigation.

<u>Mitigation</u>

No mitigation measures are possible, or considered necessary for the generation of noise by the sampling/mining tools and vessels.

Despite the low significance of impacts for geophysical surveys, the Joint Nature Conservation Committee (JNCC) provides a list of guidelines to be followed by anyone planning marine sonar operations that could cause acoustic or physical disturbance to marine mammals (JNCC 2017). These have been revised to be more applicable to the southern African situation.

Recommendations for mitigation include:

- Onboard Marine Mammal Observers (MMOs) should conduct visual scans for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses.
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
- "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 μPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- Avoid planning geophysical surveys during the movement of migratory cetaceans (particularly baleen whales) from their southern feeding grounds into low latitude waters (beginning of **June to end of November**), and ensure that migration paths are not blocked by sonar operations. As no seasonal patterns of abundance are known for odontocetes occupying the licence area, a precautionary approach to avoiding impacts throughout the year is recommended.
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place between June and November.
- A MMO should be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.

Impacts of multi-beam and sub-bottom profiling sonar on marine fauna		
	Without Mitigation	**Assuming Mitigation**
Severity	Medium	Low
Duration	Short-term; for the duration of the survey	Short-term
Extent	Local: limited to survey area	Local
Consequence	Low	Low
Probability	Unlikely (physiological injury) - Possible (behavioural disturbance)	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High
Nature of cumulative impact	No cumulative impacts as a result of the high frequency sonars are anticipated, although cumulative impacts of general anthropogenic ocean noise is likely	
Degree to which impact can be reversed	Fully reversible - any disturbance of behaviour, auditory "masking" or reductions in hearing sensitivity that may occur as a result of survey noise below 220 dB would be temporary	
Degree to which impact can be mitigated	High	

Impacts of underwater noise from sampling and mining on marine fauna		
	Without Mitigation	**Assuming Mitigation**
Severity	Low	No mitigation is proposed
Duration	Short-term (sampling) to Medium term (mining)	
Extent	Local: limited to survey area	
Consequence	Low	
Probability	Unlikely	
Significance	Low	
Status	Negative	
Confidence	High	
Nature of cumulative impact	No cumulative impacts as a result of the sampling or mining noise are anticipated, although cumulative impacts of general anthropogenic ocean noise is likely	
Degree to which impact can be reversed	Fully Reversible - any disturbance of behaviour, auditory "masking" or reductions in hearing sensitivity that may occur would be temporary.	
Degree to which impact can be mitigated	None	

5.2.2 Disturbance and loss of benthic fauna during sampling and mining operations

Description of Impact

Sampling

The proposed sampling activities are expected to result in the disturbance and loss of benthic macrofauna through removal of sediments by the mining vessel. It is proposed to take in the order of 35 point samples from each of three sampling target areas thereby disturbing a total area of 2,100 m^2. Later bulk sampling in specific target areas would affect a further 30,000 m^2. The total cumulative area impacted by sampling activities would thus amount to 32,100 m^2, which equates to less than 0.07% of the total licence area.

Mining

The proposed mining activities would be undertaken in an area of 2,280,000 m^2 (228 ha), which amounts to 5.4% of the total licence area. Mining operations would totally remove the sediments and the associated benthic invertebrate communities.

As benthic fauna typically inhabits the top 20 - 30 cm of sediment, the sample operations would result in the elimination of the benthic infaunal and epifaunal biota in the sample and mining footprints. As many of the macrofaunal species serve as a food source for demersal and epibenthic fish, cascade effects on higher order consumers may result. However, considering the available area of similar habitat on the continental shelf off the Namibian coast, this reduction in benthic biodiversity can be considered negligible and impacts on higher order consumers are thus unlikely. The Lüderitz Inshore habitat type covers a total area of 356.2 km^2. Sampling and mining operations would directly disturb 0.65% of the available habitat.

The ecological recovery of the disturbed seafloor is generally defined as the establishment of a successional community of species that achieves a community similar in species composition, population density and biomass to that previously present (Ellis 1996). The rate of recovery (recolonisation) depends largely on the magnitude of the disturbance, the type of community that inhabits the sediments in the sampling area, the extent to which the community is naturally adapted to high levels of sediment disturbances, the sediment character (grain size) that remains following the disturbance, and physical factors such as depth and exposure (waves, currents) (Newell *et al*. 1998). Generally, recolonisation starts rapidly after a sampling/mining disturbance, and the number of individuals (*i.e.* species density) may recover within short periods (weeks). Opportunistic species may recover their previous densities within months. Long-lived species like molluscs and echinoderms, however, need longer to re-establish the natural age and size structure of the population. Biomass therefore often remains reduced for several years (Kenny & Rees 1994, 1996; Kenny *et al*. 1998).

The structure of the recovering communities is typically also highly spatially and temporally variable reflecting the high natural variability in benthic communities at depth. The community developing after an impact depends on (1) the nature of the impacted substrate, (2) differential re-settlement of larvae in different areas, (3) the rate of sediment movement back into the disturbed areas and (4) environmental factors such as near-bottom dissolved oxygen concentrations etc. For the current project, the proposed sampling would be undertaken in depths within the wave base (14-40 m). In shallower waters affected by swell (such as in ML 220), near-bottom sediment transport is comparatively high and excavations are not expected to persist for more than a few weeks or months. Beyond the wave base, however, near-bottom sediment transport is reduced and excavations are therefore expected to have slow infill rates and may persist for extended periods (years). In deeper waters, long-term or permanent changes in grain size characteristics of sediments may thus occur, potentially resulting in a shift in community structure if the original community is unable to adapt to the new conditions. Depending on the texture of the sediments at the sampling target sites, slumping of adjacent unconsolidated sediments into the excavations can, however, be expected over the very short-term. Although this may result in localised disturbance of macrofauna associated with these sediments and alteration of sediment structure, it also serves as a means of natural recovery of the excavations.

Natural rehabilitation of the seabed following sampling operations, through a process involving influx of sediments and recruitment of invertebrates, has been demonstrated on the southern African continental shelf (Penney & Pulfrich 2004; Steffani 2007a, 2009b, 2010, 2012; Biccard et al. 2018, 2019; Gihwala et al. 2018, 2019) in much deeper waters than those of the ML 220. Recovery rates of impacted communities were variable and dependent on the sampling /mining approach, sediment influx rates and the influence of natural disturbances on succession communities. Results of on-going research on the southern African West Coast suggest that differences in biomass, biodiversity or community composition following mining with drill ships or crawlers below the wave base may endure beyond the medium term (6-15 years) (Parkins & Field 1998; Pulfrich & Penney 1999a; Steffani 2012). Savage *et al*. (2001), however, noted similarities in apparent levels of disturbance between mined and unmined areas off the southern African west coast, and areas of the Oslofjord in the NE Atlantic Ocean, which is known to be subject to periodic low oxygen events. Similarly, Pulfrich & Penney (1999a) provided evidence of significant recruitments and natural disturbances in recovering succession communities off southern Namibia. These authors concluded that the lack of clear separation of impacted from reference samples suggests that physical disturbance resulting from sampling or mining may be no more stressful than the regular naturally occurring anoxic events typical of the West Coast continental shelf area.

<u>Sensitive Receptors</u>

The sampling activities would be undertaken in the nearshore marine environment where the Lüderitz Inshore habitat type has been assigned a threat status of ‘Least Threatened’. Being located within the wave-base, the unconsolidated sediments will be extremely dynamic. The benthic fauna inhabiting unconsolidated sediments at the depths of the proposed sampling and mining operations are thus expected to be relatively robust. The benthic communities will be ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the unconsolidated sediments in ML 220. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered LOW.

Assessment

During sampling and mining operations the negative impact of sediment removal and its effects on the associated communities will definitely occur and is unavoidable. In the case of sampling, the intensity of the impact is considered LOW, whereas for mining the intensity of the impact is MODERATE. In both cases, the impacts will be extremely localised, constitute only about 0.07% and 5.4% of the licence area, respectively. As the licence area is located within the wave base and all sampling and mining targets are located shallower than 25 m, recovery will occur over the short-term. For both sampling and mining, the impact by definition is therefore rated as being of **MODERATE** significance. However, considering the highly localise nature of the impact, and that the disturbance will only affect 0.65% of the Lüderitz Inshore habitat type, the impact may be downscaled to being of **LOW** significance.

Mitigation

No mitigation measures are possible, or considered necessary for the direct loss of macrobenthos due to sampling, bulk sampling and mining. However, sampling/mining activities of any kind should avoid rocky outcrop areas or other identified sensitive habitats in the licence area.

A recommended management measure for the mining phase of the project would be to develop a robust and defensible benthic sampling programme, the objective of which would be to determine pre- and post-mining benthic community composition and demonstrate natural post-mining recovery of impacted communities.

Disturbance and loss of benthic fauna through sampling and mining		
	Without Mitigation	**Assuming Mitigation**
Severity	Low (sampling) to Moderate (mining)	Low (sampling) to Moderate (mining)
Duration	Short-term	Short-term
Extent	Local: limited to sampling/mining area	Local
Consequence	Low	Low
Probability	Definite	Definite
Significance	Moderate	Moderate
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	The highly localised disturbance and loss of benthic macrofauna during sampling operations is not expected to result in cumulative impacts
Degree to which impact can be reversed	The impact is partially reversible as natural recovery over the short- to medium-term will occur
Degree to which impact can be mitigated	Low

5.2.3 Disturbance to and loss of rock lobsters during sampling/mining operations

Description of Impact

Sampling

The proposed sampling activities are expected to result in the disturbance and removal of sediments by the mining vessel. The total area disturbed during sampling will amount to 2,100 m^2, with later bulk sampling in specific target areas affecting a further 30,000 m^2.

Mining

The proposed mining activities would be undertaken in an area of 2,280,000 m^2 (228 ha). Mining operations would totally remove the sediments and the associated benthic invertebrate communities. Following on-board treatment, all oversized and undersized tailings are discharged back to the sea on site.

There are concerns that the remote mining heads used during sampling and mining operations may physically suck up rock lobsters migrating between reefs or into deeper water during their seasonal inshore/offshore migrations. However, during a 26-day bulk sampling operation covering an area of ~3,100 m^2 of unconsolidated seabed, Tarras-Wahlberg (1999) recorded only 21 rock-lobster and 6 fish on the sorting screens. Existing data therefore suggest that numbers captured are insignificant compared to the annual quota landed by the commercial rock lobster industry. Records kept during sampling operations undertaken by LK Mining in February 2017 indicate that in the week-long sampling campaign, only one rock lobster was caught in the trammel before being returned to sea.

The damage to, and survival of rock-lobsters through mining activities was assessed by Barkai & Bergh (1992) in a manipulated lobster pumping experiment using a small shore-based 'walpomp'. Of the 85 animals sucked up the hose and fed through the screening unit, a total of 61 survived. Most of these were below 60 mm carapace length, and it was found that greater limb and antennae loss resulted in far higher mortality of larger lobsters. In general, however, rock-lobsters are easily able to avoid the pump nozzle and are seldom sucked up during regular diver-assisted mining operations. In the case of remote mining, where suction pressures are greater, lobsters may not be able to actively avoid the mining head. However, the digging mining head would create substantial underwater noise and vibrations during operation, and it is expected that lobsters would be able to detect this from some distance away and therefore avoid the active mine site. Only in cases where animals are forced to leave an area due to the onset of hypoxia, would the natural flight response to the mining head be overrun by physiological responses.

The West Coast rock lobster exhibits a strong association with creviced habitats, and avoidance of gravel and sand areas (Beyers & Wilke 1990; Pulfrich & Penney 2001; Pulfrich *et al*. 2006; see also Cobb 1971; Spanier 1994). Depth distribution and availability of rock lobsters is strongly influenced by environmental conditions (Newman & Pollock 1971; Pollock 1978; Beyers 1979; Pollock & Beyers 1981; Bailey *et al*. 1985; Pollock & Shannon 1987; Tomalin 1993, amongst others). During winter lobsters occur in deep waters, possibly seeking shelter from winter swells, or to feed and release larvae (Pollock & Shannon 1987; Noli & Grobler 1998). During summer (January to April) the lobster migrate inshore again in response to intrusion off near-bottom low-oxygen water brought inshore by upwelling and seawards movement of nearshore waters. This inshore migration and concentration of lobsters in shallower, better-oxygenated water coincides with the commercial fishing season (Noli & Grobler 1998). During such migrations lobsters will leave the shelter of their preferred reef habitats and move across unconsolidated sediments, often in large numbers. This would make them vulnerable both to predation as well as mining operations targeting areas of unconsolidated sediments in their migration path.

Lobsters found on mud or sand are therefore unlikely to be there by preference, but are moving across such areas in response to imposition or relaxation of the near-bottom hypoxia.

By its nature, marine mining removes unconsolidated sediments with the larger boulders that have been screened out by the mining tools, remaining on the seabed. Studies investigating the impacts of shallow-water mining operations on rock lobsters concluded that removal of sediment from gullies resulted in temporary creation of areas of suitable habitat for lobsters with resultant localised increases in lobster abundance (Pulfrich & Penney 1998, 1999b, 2001). The abundance, mean sizes or catch rates of lobsters were not negatively affected by the mining operations (Barkai & Bergh 1992; Tomalin 1995, 1996; Parkins & Branch 1996, 1997; Pulfrich 1998a; Pulfrich et al. 2003; Pulfrich & Branch 2014), and benthic communities within metres of the mined gulley remained unaffected by the mining-induced disturbance. Disturbance of rock lobsters as a result of shallow-water mining operations were thus considered negligible, particularly when seen in context with responses to natural disturbances such as low oxygen events. The use of remote mining systems will obviously have effects on a larger scale, but if mining operations move progressively from one side of the mining block to another, there is no reason why mined-out areas dominated by boulders would not provide high-profiled habitat for rock lobsters. This habitat creation would, however, be temporary only as sediments from adjacent unmined areas, as well as tailings released from the mining vessel, would be redistributed into the mined-out areas by wave action and the long-shore littoral drift.

The principle impacts of mining activities on rock lobsters relate to alteration of suitable lobster habitat through discharge of tailings. This is discussed further in Section 5.2.5 below.

<u>Sensitive Receptors</u>

The West Coast rock lobster *Jasus lalandii* is a key predator in kelp beds and on nearshore reefs along the southern African West Coast. It is the target of a small but valuable fishery based exclusively in the port of Lüderitz. The lobster stock is commercially exploited between Kerbe Huk in the south to Easter Cliffs/Sylvia Hill north of Mercury Island, with the fishery operates in water depths of between 10 m and 80 m.

<u>Assessment</u>

Reductions in rock lobster populations through large numbers of animals being sucked up by the mining tool is highly unlikely, and should it occur would persist only over the very short term (hours), be highly localised and result in only a limited loss of resources. The impact would be of low intensity and is consequently deemed to be of **(VERY) LOW** significance.

<u>Mitigation</u>

The following mitigation measures are recommended:

- Monitor sorting screens and terminate operations should large numbers of lobsters appear on the screens over a short period of time.
- Avoid sampling and mining in the immediate vicinity of rocky outcrop areas or other identified sensitive habitats in the licence area.

Disturbance to and loss of rock lobsters		
	Without Mitigation	**Assuming Mitigation**
Severity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to sampling/mining area	Local
Consequence	Low	Low
Probability	Unlikely	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	The highly localised disturbance and loss of rock lobsters during sampling operations is not expected to result in cumulative impacts
Degree to which impact can be reversed	The impact is partially reversible as natural recovery of injured lobsters and the rock lobster populations will occur
Degree to which impact can be mitigated	Low

5.2.4 Increased turbidity due to generation of suspended sediment plumes

Description of Impact

The sampled/mined seabed sediments are pumped to the surface and discharged onto sorting screens on the sampling/mining vessel. The screens separate the fine sandy silt and large gravel, cobbles and boulders from the size fraction of interest, the 'plantfeed' (>1.2 to <12 mm). The fine tailings are immediately discarded overboard where they form a suspended sediment plume in the water column, which is advected away from the mining vessel by wind and ambient currents and is rapidly diluted. The 'plantfeed' is mixed with a high density ferrosilicon (FeSi) slurry and pumped under pressure into a Dense Medium Separation (DMS) plant resulting in a high density concentrate. The majority of the ferrosilicon is magnetically recovered for re-use in the DMS plant and the fine tailings (-2 mm) from the DMS process are similarly deposited over board. Furthermore, fine sediment re-suspension by the sampling tools will generate suspended sediment plumes near the seabed.

After discharge, the tailings material typically forms a negatively-buoyant sediment plume that either mixes directly with the receiving waters as it sinks (surface plume) or sinks as a density-driven current (dynamic plume). The dynamic plume undergoes convective descent through the water column until it either reaches the seabed or achieves neutral buoyancy, at which point it collapses and spreads laterally. As the dynamic plume sinks, some fine sediment may be entrained due to wind-generated turbulence; this is mixed through the water column and can contribute to the formation of a surface plume. Surface plumes are visible on the surface and thus likely to have a greater effect on organisms in the upper water column than dynamic plumes. In many cases, both types of plumes develop simultaneously, resulting in a composite plume which possess characteristics of surface and dynamic plumes. These are classified as transitional plumes.

Various factors influence which types of plume form: outflow velocity of tailings discharged from the vessel; water density and movement; and density of the plume (sand and silt composition of the mined sediments can vary greatly). The mining method also influences the sediment plume, with air-lift systems, which entrain air in the sediment, making the plume more buoyant and persistent in the upper water column, whereas dredge-pumped sediments have little or no air entrained, enabling the plume to sink much faster. Dredge-pumping is the proposed mining method for ML220.

Potential impacts on the water column associated with sediment plumes from mining vessels are primarily linked with increased turbidity and its effects on light penetration through the water column, remobilisation of dissolved constituents from seafloor sediments (see section 5.2.5), and reduction in oxygen levels in the water column resulting from high levels of primary production.<u>Sensitive Receptors</u>

The taxa most vulnerable to increased turbidity and reduced light penetration are phytoplankton. Due to the location of the mining licence within the Lüderitz upwelling cell, the abundance of phytoplankton can be expected to be seasonally high. Being dependent on nutrient supply, plankton abundance is typically spatially and temporally highly variable and is thus considered to have a low sensitivity. Fish likely to be encountered in the water column are highly mobile and would be expected to avoid elevated suspended sediment plumes in the water column. Likewise, demersal fish would be expected to avoid elevated suspended sediment plumes near the seabed. These fauna are thus considered to have a low sensitivity.

<u>Assessment</u>

The formation, extent and dynamics of turbidity plumes generated by deepwater mining vessels have been comprehensively investigated in numerous studies (Environmental Evaluation Unit 1996; O'Toole 1997; Carter & Midgley 2000; CSIR 2006; Carter 2008). During continuous discharge of tailings from remote mining vessels, the major source of water column turbidity results from the dynamic collapse of the sediment-laden jet and the subsequent dilution, spreading and settling of the particulate constituents. In all cases, the suspended sediment concentrations generated at the point of discharge, the extent and area over which plumes disperse, and their duration, depend largely on the proportions of silts, muds and clays (<63 µm) in the mined sediments, as well as the sea-surface conditions during disposal. The higher the proportion of silts and clays in the target sediments, the larger and more persistent the suspended sediment plume is likely to be (Newell *et al*. 1998; Johnson & Parchure 1999; Posford Duvivier Environment 2001). Modelling studies, field measurements and aerial observations of tailings plumes from mining vessels found that concentrations reduce rapidly with distance from the vessel, indicating fairly fast settlement and dilution of even the fine fractions (Shillington & Probyn 1996; CSIR 1998b; Carter & Midgley 2000). In their study of tailings plumes from a deepwater mining vessel using an air-lift Wirth drill off Lüderitz, Carter & Midgley (2000) found that local tailings plumes ranged from 700 - 5,500 m in length and 700 - 3,500 m in width. Maximum plume sediment concentrations near the discharge point were found to be 60 mg/l, compared to background levels of <5 mg/l. These reduce rapidly with distance to a mean of <7 mg/l (maximum of 11 mg/l) 2 km downstream of the mining vessel, confirming fairly rapid settlement and dilution. Similarly, Holton *et al*. (2015) reported on measurements of suspended solids in the plume that extended downstream of the MV Mafuta, which operates a dredge-pump subsea crawler, in the Atlantic 1 MLA. Elevated turbidity (compared to <2 mg/l background levels) was detected in the upper water column extending to a maximum depth of ~70 m in the immediate vicinity of the mining vessel. The depth of the elevated turbidity signal decreased with distance away from the vessel, and the surface and deeper water expression of the signal dissipated almost entirely within ~500 m from the mining vessel. Beyond this point, little to no evidence of a turbidity signal throughout the water column could be detected.

Distribution and re-deposition of suspended sediments are the result of a complex interaction between oceanographic processes, sediment characteristics and engineering variables that ultimately dictate the distribution and dissipation of the plumes in the water column. Ocean currents, both as part of the meso-scale circulation and due to local wind forcing, are important in distribution of suspended sediments. Turbulence generated by surface waves can also increase plume dispersion by maintaining the suspended sediments in the upper water column.

One of the more apparent effects of increased concentrations of suspended sediments and consequent increase in turbidity, is a reduction in light penetration through the water column with potential adverse effects on the photosynthetic capability of phytoplankton (Poopetch 1982; Kirk 1985; Parsons *et al*. 1986a, 1986b; Monteiro 1998; O'Toole 1997) and the foraging efficiency of visual predators (e.g. pelagic fish, seabirds and marine mammals) (Simmons 2005; Braby 2009; Peterson *et al*. 2001). However, due to the rapid dilution and widespread dispersion of settling particles, any adverse effects in the water column would be ephemeral and highly localised. Any biological effects on nectonic and planktonic communities would be negligible (Aldredge *et al*. 1986). Turbid water is a natural occurrence along the Southern African coast, resulting from aeolian and riverine inputs, resuspension of seabed sediments in the wave-influenced nearshore areas and seasonal phytoplankton production in the upwelling zones.

High sediment loading can also impair the egg and/or larval development of fish and invertebrates may be impaired through. Bivalves and crustaceans in particular may be impacted by near-bottom plumes include. Suspended sediment effects on juvenile and adult bivalves occur mainly at the sublethal level with the predominant response being reduced filter-feeding efficiencies at concentrations above about 100 mg/l. Lethal effects are seen at much higher concentrations (>7,000 mg/l) and at exposures of several weeks.

Due to the naturally turbid nearshore waters, kelp is restricted to the immediate subtidal regions to a maximum depth of ~10 m. Those fringing kelp beds occurring around Black Rock and the rocky shoreline to the north are unlikely to be affected by the turbidity plumes generated as a result of tailings discharges. Similarly, the depths of the proposed sampling areas lie beyond those at which kelp is likely to occur on adjacent reefs and no shading of these canopy forming macrophytes by mining-related turbidity plumes is expected.

As the unconsolidated sediments in the mining target area in ML220 comprise primarily medium to fine sands, with a minimal silt and clay fraction, the suspended sediment plumes generated through discharge of tailings during sampling and mining operations in ML220 are expected to remain far more localised than those reported from previous studies of deepwater mining vessels. Furthermore, the sediments will be dredge-pumped at a mining rate orders of magnitude lower than the mining vessels for which the previous studies have been undertaken. As Hottentots Bay is relatively protected, the spreading of the plume by winds and currents will be minimal and any plumes generated during the sampling and mining process will thus remain highly localised. The low-intensity, negative impact of suspended sediments generated during sampling and onboard processing operations and its effects on the associated communities will therefore be extremely localised and very short-term. The plumes will be ephemeral and negative effects of increased suspended sediment concentrations on marine communities are highly unlikely as biota would be well adapted to naturally high suspended sediment concentrations. Even the highest concentrations in the immediate discharge are unlikely to reach concentrations that would have lethal effects on marine fauna. The impacts from suspended sediment plumes can confidently be rated as being of **LOW** significance.

Mitigation

No mitigation measures are possible, or considered necessary for the discharge of fine tailings from the sampling vessel.

A recommended management measure would be to monitor pelagic seabird and small mammal occurrence and activity around the sampling/mining vessel while in operation to determine if these are in any way affected by the suspended sediment plumes.

Increased turbidity in suspended sediment plumes and at the seabed		
	Without Mitigation	**Assuming Mitigation**
Severity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to around the sampling/mining vessel and mining tool	Local
Consequence	Low	Low
Probability	Unlikely: lethal or sublethal effects on biota are highly improbable	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Increased turbidity in suspended sediment plumes would not result in cumulative impacts
Degree to which impact can be reversed	Suspended sediment plumes are short-lived and any effects will be fully reversible
Degree to which impact can be mitigated	Low

5.2.5 Remobilisation of contaminants and nutrients

Description of Impact

Recently deposited sediments in specific areas on the Namibian shelf may be characterised by high levels of heavy metals of marine and/or terrestrial origin (Calvert & Price 1970; Chapman & Shannon 1985; Bremner & Willis 1990). In the Atlantic 1 Mining Licence Area off Oranjemund, high metal concentrations have been measured in samples of surficial sediments (Environmental Evaluation Unit 1996; Biccard *et al*. 2020), some of which exceeded the Recommended Guideline Values (RGV) and in some cases Probable Effects Concentrations (PEC) published by the Benguela Current Commission (BCC). Geographic variation in the levels of trace metals tested in that area was considerable, and while it is considered likely that inputs from terrestrial sources (principally the Orange River) are responsible for elevated trace metal levels in proximity to the river mouth, in the northern portion of the Atlantic 1 MLA elevated levels of trace metals were consistent with similarly elevated levels observed in the the mudbelt between Lüderitz and Walvis Bay (Borchers *et al*. 2005; Carter 2010). Indeed, on the Namibian shelf, there appears to be a consistent relationship between trace metal concentrations and elevated organic carbon concentrations in the sediments. From this it can be inferred that the distribution of trace metal concentrations will follow that of the high Particulate Organic Carbon (POC) mud belts and that concentrations outside of these will be relatively low. This is consistent with general and widespread observations on sediment trace metals in that they are largely associated with silt and clay sized particles and generally have lower concentrations in coarser sediments (e.g. ANZECC 2000).

Changes in nutrient concentrations off the coast of Namibia are strongly driven by large-scale wind induced upwelling, which brings nutrient-rich waters to the surface. The shelf waters off Namibia are characterised by elevated concentrations of nutrients in comparison with those in the surface mixed layer of adjacent oceanic waters, and with concentrations in the SACW source waters. Local nutrient regeneration processes within the sediments and water column are thus important throughout the Benguela, but particularly off Namibia (Shannon & O'Toole 1998).

The re-suspension of sediments during mining can release these trace metals and nutrients into the water column. Metal bio-availability and eco-toxicology is complex and depends on the partitioning of metals between dissolved and particulate phases and the speciation of the dissolved phase into bound or free forms (Rainbow 1995; Galvin 1996). Although dissolved forms are regarded as the most bio-available, many of these are not readily utilisable by aquatic organisms. Consequently those forms that are ultimately bio-available and potentially toxic to marine organisms usually constitute only a fraction of the total concentration. Trace metal uptake by organisms may occur through direct absorption from solution, by uptake of suspended matter and/or *via* their food source. Toxic effects on organisms may be exerted over the short term (acute toxicity), or through bioaccumulation.

<u>Sensitive Receptors</u>

The benthic fauna inhabiting unconsolidated sediments in ML220 are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the continental slope unconsolidated sediments.

The taxa in the water column most vulnerable to bio-available contaminants are phytoplankton, which will be seasonally abundant during upwelling periods. Being dependent on nutrient supply, plankton abundance is typically spatially and temporally highly variable and is thus considered to have a low sensitivity. These fauna are thus considered to have a low sensitivity.

<u>Assessment</u>

Chemical analyses of tailings samples from mining vessels in the Atlantic 1 MLA found that heavy metal concentrations did not exceeded the SA chronic water-quality guidelines or the "prohibition limit" as imposed by the London Convention, for any of the measured contaminants (Steffani & Pulfrich 2004; CSIR 2006). In some cases, however, concentrations were in the category which requires some form of "action or special care" (CSIR 2006). Despite concentrations within surficial sediments in the Atlantic 1 MLA being high (Biccard et al. 2020), it appears that those contaminants released during the mining process are rapidly diluted and their concentrations in the water column following discharge of tailings is very low. Furthermore, as plumes generated during mining are highly dynamic, neither acute effects nor bioaccumulation are likely to be of concern. In ML220, in particular, organic carbon concentrations in the sediments is expected to be low due to the low contribution by silts and muds. Trace metal concentrations are thus likely to be negligible and potential chemical contamination of the water column and bio-accumulation in the sediments or in biological receptors is highly unlikely. The impacts associated with the potential release of contaminants from disturbed sediments is therefore considered of **LOW** significance.

Similarly, the introduction of nutrients into the upper layers of the water column as a result of tailing discharge is considered negligible given the highly localised area affected by the suspended sediment plumes generated during sampling and mining operations, relative to that influenced by upwelling (Schloemann 1996).

Mitigation

No mitigation measures are possible, or considered necessary for the possible remobilisation of contaminants and nutrients in the sediments.

Remobilisation of Contaminants and Nutrients		
	Without Mitigation	**Assuming Mitigation**
Severity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to around the sampling/mining vessel and mining tool	Local
Consequence	Low	Low
Probability	Unlikely: lethal or sublethal effects on biota are highly improbable	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Remobilised contaminants and nutrients in discharged tailings would not result in cumulative impacts
Degree to which impact can be reversed	Suspended sediment plumes are short-lived and any effects will be fully reversible
Degree to which impact can be mitigated	Low

5.2.6 Smothering of benthos in redepositing tailings

Description of Impact

The sampled seabed sediments are pumped to the surface and discharged onto sorting screens, which separate the large gravel, cobbles and boulders and fine silts from the 'plantfeed'. The oversize tailings are discarded overboard and settle back onto the seabed beneath the vessel where they can result in a localised smothering of benthic communities adjacent to the sampled areas. Smothering involves physical crushing, a reduction in nutrients and oxygen, clogging of feeding apparatus, as well as affecting choice of settlement site, and post-settlement survival.

In general terms, the rapid deposition of the coarser fraction from the water column is likely to have more of an impact on the soft-bottom benthic community than gradual sedimentation of fine sediments to which benthic organisms are adapted and able to respond. However, this response depends to a large extent on the nature of the receiving community. Studies have shown that some mobile benthic animals are capable of actively migrating vertically through overlying sediment thereby significantly affecting the recolonization of impacted areas and the subsequent recovery of disturbed areas of seabed (Maurer *et al*. 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger *et al*. 2000; but see Harvey *et al*. 1998; Blanchard & Feder 2003). In contrast, sedentary communities may be adversely affected by both rapid and gradual deposition of sediment. Filter-feeders are generally more sensitive to suspended solids than deposit-feeders, since heavy sedimentation may clog the gills. Impacts on highly mobile invertebrates and fish are likely to be negligible since they can move away from areas subject to redeposition.

Of greater concern is that sediments discarded during sampling operations may impact rocky-outcrop communities adjacent to sampling target areas hosting sensitive reef communities and rock lobsters. Studies investigating the discard of the oversize tailings during diver-assisted mining found that benthic communities characterising tailings dump sites were significantly different from those of unaffected reef areas as a result of the change in seabed type, being dominated by detritus feeders. However, the effects remained highly localised and persisted over the short-term only as tailings were rapidly redistributed by wave action (Barkai & Bergh 1992; Parkins & Branch 1995, 1996, 1997; Pulfrich 1998b; Pulfrich & Penney 1998, 1999b, 2001). Excessive and repetitive dumping on the same area may, however, preclude dispersion and thus induce persistent change by reducing biodiversity, changing community structure, potentially altering preferred rock lobster habitat and smothering of benthic organisms, thereby reducing food availability for lobsters.

The abundance of lobsters within a habitat, however, also depends on the availability and suitability of food (Parrish & Polovina 1994; Hudon 1987; Branch & Griffiths 1988; Wahle & Steneck 1991, 1992). In the Lüderitz area, rock lobsters feed primarily on mussels and algae (Tomalin 1993). Smothering of reef areas and their associated benthic communities adjacent to mining targets through the discharge of oversize tailings may therefore indirectly affect rock lobster abundance in an area as well as reducing growth and reproductive rates of the animals.

<u>Sensitive Receptors</u>

The sampling activities would be undertaken in the offshore marine environment where the Lüderitz Nearshore benthic habitat types have been rated as of 'Least Concern'. The benthic fauna inhabiting unconsolidated sediments at the depths of the proposed sampling are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the unconsolidated sediments in ML 220. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered LOW.

Assessment

The impacts of redepositing tailings onto seabed of unconsolidated sediments would be of low intensity but highly localised, and short-term as recolonization from adjacent areas or upward migration through deposited sediments would occur rapidly. Considering the available area of unconsolidated seabed habitat on the continental shelf off southern Namibia, the reduction in biodiversity of macrofauna associated with unconsolidated sediments through smothering can be considered negligible. The potential impact of smothering on communities in unconsolidated habitats is consequently deemed to be of **LOW** significance. In the case of rocky outcrop communities, however, impacts could be of medium intensity and highly localised, but potentially enduring over the medium-term due to their slower recovery rates. As the mining target is far removed from reef habitats, there is a very low likelihood of the impact occurring. Also, as the sampling and mining target areas are located within the wave base, any fine sediments settling on adjacent reefs would be periodically resuspended and redistributed by near-bottom currents. Smothering effects would therefore likely be ephemeral. The potential impact of smothering on rocky outcrop communities is consequently deemed to be of **LOW** significance.

Mitigation

No mitigation measures are possible, or considered necessary for the loss of macrobenthos due to smothering by redepositing sediments. However, sampling activities of any kind should avoid rocky outcrop areas or other identified sensitive habitats in the exploration area.

Redeposition of discarded sediments on soft-sediment macrofauna		
	Without Mitigation	**Assuming Mitigation**
Severity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to around the sampling/mining vessel	Local
Consequence	Low	Low
Probability	Possible	Possible
Significance	Low*	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Redeposition of tailings on unconsolidated seabed would not result in cumulative impacts
Degree to which impact can be reversed	The impact is fully reversible as natural recovery of affected communities will occur from adjacent areas and deposited sediments will be rapidly redistributed by swell action
Degree to which impact can be mitigated	Low

*although by definition this should be rated as MEDIUM, when seen in the context of similar available habitat on the continental shelf, it is reduced to LOW.

Redeposition of discarded sediments: smothering effects on rocky outcrop communities		
	Without Mitigation	**Assuming Mitigation**
Severity	Medium	Low
Duration	Medium-term	Short-term
Extent	Site specific: limited to isolated reef areas	Local
Consequence	Medium	Low
Probability	Unlikely	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Redeposition of tailings on reefs is unlikely to lead to cumulative impacts as sampling activities will focus on targets over the very short-term only
Degree to which impact can be reversed	The impact is fully reversible as natural recovery of affected communities will occur over the medium-term
Degree to which impact can be mitigated	Low

5.2.7 Loss of Ferrosilicon

Description of Impact

The only additive used in the diamond extraction process onboard the mining vessels is Ferrosilicon (FeSi). Although most of the FeSi is magnetically recovered for re-use, recovery is lower when mining sediments with a high shell content, as the FeSi becomes trapped in the shells. On average ~6-8 tons are lost annually per vessel of this magnitude during full-scale mining operations.

Sensitive Receptors

The benthic fauna inhabiting unconsolidated sediments at the depths of the proposed sampling are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the unconsolidated sediments in the licence area. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered low.

Assessment

Ferrosilicon is made up of sand (silicon) and iron oxides, with small amounts of trace elements. It therefore oxidises rapidly in seawater and has no detrimental effect of marine life. There is, however, a risk of exceeding established water quality guidelines by the heavy metal constituents of the FeSi. Dilution of these trace elements would be rapid, and any effects are likely to be brief. The potential impact would thus be of low intensity, persisting only locally over the short-term and can confidently be considered of **LOW** significance.

Mitigation

The following mitigation measures are recommended:

- Reduce FeSi loss through the implementation of shell crushers or ball mills.
- Maintain accurate records of all FeSi used and discarded overboard with tailings.

Loss of Ferrosilicon		
	Without Mitigation	**Assuming Mitigation**
Severity	Low	Low
Duration	Short-term	Short-term
Extent	Site specific: limited to around the vessel	Local
Consequence	Low	Low
Probability	Unlikely	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	Loss of FeSi would not result in cumulative impacts
Degree to which impact can be reversed	Fully Reversible
Degree to which impact can be mitigated	Medium

5.2.8 Potential loss of Equipment

Description of Impact

Equipment such as anchors and sampling tools are occasionally lost on the seabed, although every effort is usually made to retrieve them. Equipment that sinks to the seabed, would crush benthic fauna in its footprint and potentially disturb or damage seabed habitats, but ultimately provide a hard surface for colonisation. If lost anchor cables float to the surface, they would pose a shipping hazard, and an entanglement risk to turtles and marine mammals, potentially leading to physiological injury or death.

Sensitive Receptors

The benthic fauna inhabiting unconsolidated sediments at the depths of the proposed sampling are expected to be relatively ubiquitous, varying only with sediment grain size, organic carbon content of the sediments and/or near-bottom oxygen concentrations. These benthic communities usually comprise fast-growing species able to rapidly recruit into areas that have suffered natural environmental disturbance. Epifauna living on the sediment typically comprise urchins, burrowing anemones, molluscs, seapens and sponges, many of which are longer lived and therefore more sensitive to disturbance. No rare or endangered species have been reported or are known from the unconsolidated sediments in the licence area. The sensitivity of the benthic communities of unconsolidated sediments is therefore considered low.

In contrast, the benthos of hard substrata, are typically vulnerable to disturbance due to their longer generation times. The closest reefs and hard grounds lie ~500 m to the west of the mining target and these amy harbour more sensitive biota such as sponges, gorgonians and soft corals. The sensitivity of such reef communities is considered moderate.

Assessment

If left on the seabed, large items such as anchors and sampling tools would form a hazard to other users. If not retrieved, the loss of equipment would be considered of low intensity, resulting in only highly localised damage to or loss of biota and would thus be rated as being of **LOW** significance. Although they would eventually be colonised by benthic organisms typical of hard seabeds, every effort should be made to remove such foreign objects.

In the case of anchor cables or ropes, the loss of such equipment would be of moderate intensity due to the entanglement risks posed to seals, turtles and cetaceans. The moderate-intensity negative impact of lost cables and ropes would be extremely localised but if not retrieved could result in mortality of the entangled animal. Entanglement by small cetaceans and seals in ropes and cables is considered possible and the impact is thus rated as being of **MODERATE** significance.

Mitigation

The positions of all lost equipment must be accurately recorded in a hazards database, and reported to maritime authorities. Every effort should be made to remove lost equipment, especially anchor ropes and cables.

Equipment lost to the seabed or watercolumn		
	Without Mitigation	**Assuming Mitigation**
Severity	Low to Moderate (cables and ropes)	Low
Duration	Permanent	Short-term
Extent	Local: limited to mining area	Local
Consequence	Moderate	Low
Probability	Unlikely to Possible (cables and ropes)	Unlikely
Significance	Low to Moderate (cables and ropes)	Low
Status	Negative	Negative
Confidence	High	High

Nature of Cumulative impact	No cumulative impacts are anticipated
Degree to which impact can be reversed	Fully Reversible – any lost equipment is likely to be recovered
Degree to which impact can be mitigated	High

5.2.9 Pollution of the marine environment through Operational Discharges from Vessel

<u>Description of Impact</u>

During the geophysical surveying and sampling and mining operations, normal discharges to the sea can come from a variety of sources (from survey and sampling/mining vessel) potentially leading to reduced water quality in the receiving environment. These discharges are regulated by onboard waste management plans and shall be MARPOL compliant. For the sake of completeness, they are listed and briefly discussed below:

- **Deck drainage**: all deck drainage from work spaces is collected and piped into a sump tank on board the vessel to ensure MARPOL compliance (15 ppm oil in water). The fluid would be analysed and any hydrocarbons skimmed off the top prior to discharge. The oily substances would be added to the waste (oil) lubricants and disposed of on land.
- **Sewage**: sewage discharges would be comminuted and disinfected. In accordance with MARPOL Annex IV, the effluent must not produce visible floating solids in, nor causes discolouration of, the surrounding water. The treatment system must provide primary settling, chlorination and dechlorination before the treated effluent can be discharged into the sea. The discharge depth is variable, depending upon the draught of the vessel / support vessel at the time, but would not be less than 3 m below the surface.
- **Vessel machinery spaces and ballast water**: the concentration of oil in discharge water from vessel machinery space or ballast tanks may not exceed 15 ppm oil in water. If the vessel intends to discharge bilge or ballast water at sea, this is achieved through use of an oily-water separation system. Oily waste substances must be shipped to land for treatment and disposal.
- **Food (galley) wastes**: food wastes may be discharged after they have been passed through a comminuter or grinder, and when the vessel is located more than 12 nautical miles from land. For vessels outside of special areas, discharge of comminuted food wastes is permitted when >3 nautical miles from land and en route. Discharge of food wastes not comminuted may be discharged from vessels en route when >12 nautical miles from shore. The ground wastes must be capable of passing through a screen with openings <25 mm. The daily volume of discharge from a standard mining/survey vessel is expected to be <0.5 m^3.
- **Detergents**: detergents used for washing exposed marine deck spaces are discharged overboard. The toxicity of detergents varies greatly depending on their composition, but low-toxicity, biodegradable detergents are preferentially used. Those used on work deck spaces would be collected with the deck drainage and treated as described for deck drainage above.
- **Cooling Water**: electrical generation on sampling vessels is typically provided by large diesel-fired engines and generators, which are cooled by pumping water through a set of heat exchangers. The cooling water is then discharged overboard. Other equipment is cooled through a closed loop system, which may use chlorine as a disinfectant. Such water would be tested prior to discharge and would comply with relevant Water Quality Guidelines.

Sensitive Receptors

The operational waste discharges would primarily take place in the licence area and along the route taken by the support vessels between the ML 220 and Lüderitz. The licence area extends offshore from the shore and is located within the NIMPA and Namibian Islands EBSA and therefore in close proximity to sensitive coastal receptors (e.g. key faunal breeding/feeding areas, bird or seal colonies). Vessel discharges *en route* to the onshore supply base in Lüderitz could similarly result in discharges closer to shore, thereby potentially having an environmental effect on the sensitive coastal environment.

The taxa most vulnerable to routine operational discharges are pelagic seabirds, turtles, and pelagic fish and marine mammals. Some of the species potentially occurring in the licence area, are considered regionally or globally 'Critically Endangered' (e.g. leatherback turtles, Cape Gannet), 'Endangered' (e.g. African Penguins, Bank and Cape Cormorant), 'Vulnerable' (e.g. loggerhead turtles, Hartlaub's Gull, Caspian Tern and humpback whales) or 'Near Threatened' (e.g. Crowned cormorant, African Black Oystercatcher). Although species listed as 'Critically Endangered' or 'Endangered' may potentially occur in ML 220, compliance with MARPOL will ensure reduced discharges and reduced sensitivity of marine fauna to these discharges. Thus, the overall sensitivity is considered to be medium.

Assessment

The potential impact on the marine environment of such operational discharges from the survey, sampling and mining vessel would be limited to the licence area over the short-term. As volumes discharged would be low, they would be of low intensity, and are therefore considered to be of (**VERY) LOW** significance, both without or with mitigation.

Mitigation

The following mitigation measures are recommended:

- Ensure compliance with MARPOL 73/78 standards,
- Develop a waste management plan using waste hierarchy.

Impacts of operational discharges to the sea from vessels		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Low
Duration	Short-term	Short-term
Extent	Local: limited to immediate area around exploration vessel	Local
Consequence	Low	Low
Probability	Most likely	Most likely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High
Nature of Cumulative impact	None	
Reversibility	Fully Reversible	
Loss of resources	N/A	
Mitigation potential	High	

5.2.10 Collision of Vessels with Marine Fauna and Entanglement in Gear

Description of Impact

The potential effects of vessel presence and towed equipment on turtles and cetaceans include physiological injury or mortality due to the survey/sampling/mining vessel, or support vessels colliding with animals basking or resting at the sea surface. Entanglement of cetaceans in towed equipment lines is also possible if tension is lost.

Sensitive Receptors

The leatherback turtles that occur in offshore waters around southern Africa, and likely to be encountered in ML 220 is considered regionally 'Critically Endangered'. However, due to their extensive distributions and feeding ranges, the numbers of individuals encountered are likely to be low.

Thirty-three species or sub species/populations of cetaceans (whales and dolphins) are known or likely to occur off the Namibian coast. The majority of migratory cetaceans in Namibian waters are baleen whales (mysticetes), while toothed whales (odontocetes) may be resident or migratory. Of the 33 species, the blue whale is listed as 'Critically Endangered', the fin and sei whales are 'Endangered' and the sperm, Bryde's (inshore) and humpback whales are considered 'Vulnerable' (South African Red Data list Categories). Due to the extensive distributions of the various species concerned and their unlikely occurrence within the Hottentots Bay inshore areas (with the possible exception of Humpback whales), and mobility of these animals to avoid project vessels, the numbers of individuals encountered during operations are likely to be low.

The overall sensitivity is considered to be MEDIUM.

<u>Assessment</u>

Collisions between turtles or cetaceans and vessels are not limited to survey and mining vessels. Given the slow speed (about 2 - 3 kts) of the survey vessel while towing the sonar sources, ship strikes and entanglement whilst surveying are unlikely, but may occur during the transit of the survey/sampling/mining vessel to or from the area of interest. Ship strikes by the support vessels may also occur. As the mining vessel is largely stationary, collisions would occur only while in transit to and from the support base in Lüderitz.

Ship strikes have been reported to result in medium-term effects such as evasive behaviour by animals experiencing stress, or longer-term effects such as decreased fitness or habitual avoidance of areas where disturbance is common and in the worst case death (see for example Constantine 2001; Hastie et al. 2003; Lusseau 2004, 2005; Bejder et al. 2006; Lusseau et al. 2009). Ship strikes have been documented from many regions and for numerous species of whales (Panigada et al. 2006; Douglas et al. 2008; Elvin & Taggart 2008) and dolphins (Bloom & Jager 1994; Elwen & Leeney 2010), with large baleen whales being particularly susceptible to collision. Any increase in vessel traffic through areas used as calving grounds or through which these species migrate will increase the risk of collision between a whale and a vessel. The chances of collisions would increase between May and December when humpback and fin whales are known to migrate through the area.

The sidescan sonar towfish and MBES towed astern of the survey vessel also increases the potential for collision with or entrapped in equipment and towed streamers when these are being lowered from the vessel into the water. Entanglement of cetaceans in gear is possible in situations where tension is lost on the towed array. The major cause of large whale entanglements (mainly southern right and humpback whales) in South Africa are static fishing gear, anchor, mooring and buoy lines and the large-mesh shark nets set off KwaZulu-Natal to reduce shark attacks (Meÿer et al. 2011).

Basking turtles are particularly slow to react to approaching objects and may not be able to move rapidly away from approaching equipment. Entrapment occurs either as a result of 'startle diving' in front of towed equipment. Depending on the equipment design, once stuck inside or in front of the sonar source, the water pressure generated by the 2–3 knot towing speed, would hold the animal against the source with little chance of escape.

Due to their extensive distributions and feeding ranges, and the extended distance (over 1 000 km) from their nesting sites, the number of turtles encountered during the proposed geophysical survey is expected to be low. Should collisions or entanglements occur, the impacts would be of high intensity for individuals but of LOW intensity for the population as a whole. Furthermore, as the duration of the impact would be limited to the short-term and be restricted to the survey area (LOCAL), the potential for collision and entanglement in equipment is therefore considered to be unlikely and therefore of **LOW** significance.

The potential for ship strikes and entanglement of cetaceans in the towed equipment, is similarly highly dependent on the abundance and behaviour of cetaceans in the survey area at the time of the survey and vessel speed. Due to their extensive distributions and feeding ranges, the number of cetaceans encountered is expected to be low. In the unlikely event of an entanglement occurring, the impacts would be of high intensity for individuals but of LOW intensity for the population as a whole. Furthermore, as the duration of the impact would be limited to the short-term, and be restricted to ML 220, the potential for entanglement in towed equipment is therefore considered to be of **LOW** significance.

Mitigation

The following mitigation measures are recommended:

- All vessel operators should keep a constant watch for marine mammals and turtles in the path of the vessel.
- Ensure vessel transit speed between the survey area and port is a maximum of 12 knots (22 km/hr), except within 25 km of the coast where it is reduced further to 10 knots (18 km/hr) as well as when sensitive marine fauna are present in the vicinity.
- A non-dedicated marine mammal observer (MMO) must keep watch for marine mammals behind the vessel when tension is lost on the towed equipment. Either retrieve or regain tension on towed gear as rapidly as possible.
- Should a cetacean become entangled in towed gear, contact the Ministry of Fisheries and Marine Reources to provide specialist assistance in releasing entangled animals.

Impacts on turtles and cetaceans due to ship strikes, collision and entanglement with towed or moored equipment		
	Without Mitigation	**Assuming Mitigation**
Intensity	Low	Very Low
Duration	Short-term	Short-term
Extent	Local: limited to immediate area around exploration vessel	Local
Consequence	Low	Low
Probability	Unlikely	Unlikely
Significance	Low	Low
Status	Negative	Negative
Confidence	High	High
Nature of Cumulative impact	None	
Reversibility	Fully Reversible	
Loss of resources	N/A	
Mitigation potential	High	

5.2.11 Operational Spills and Vessel Accidents

Description of Impact

Instantaneous spills of marine diesel and/or hydraulic fluid at the surface of the sea can potentially occur during all project activity phases. Such spills are usually of a low volume and occur accidentally during fuel bunkering or as a result of hydraulic pipe leaks or ruptures, or from deliberate, illegal bilge water discharges at sea. Larger volume spills of marine fuels could occur in the unlikely event of a vessel collision or vessel accident.

Oil spilled in the marine environment will have an immediate detrimental effect on water quality. Any release of liquid hydrocarbons thus has the potential for direct, indirect and cumulative effects on the marine environment. These effects include physical oiling and toxicity impacts to marine fauna and flora, localised mortality of plankton (particularly copepods), pelagic eggs and fish larvae, and habitat loss or contamination (CSIR 1998; Perry 2005).

Unlike large commercial vessels, which operate on heavy fuel oils, small vessels generally operate on marine diesel fuels. The consequences and effects of relatively small (2,000 – 20,000 litres) diesel fuel spills into the marine environment are summarised below (NOAA 1998). Diesel is a light oil that, when spilled on water, spreads very quickly to a thin film and evaporates or naturally disperses within a few days or less, even in cold water. Diesel oil can be physically mixed into the water column by wave action, where it adheres to fine-grained suspended sediments, which can subsequently settle out on the seafloor. As it is not very sticky or viscous, diesel tends to penetrate porous sediments quickly, but also to be washed off quickly by waves and tidal flushing. In the case of a coastal spill, shoreline cleanup is thus usually not needed, but the location of the spill (e.g. next to an island or an active bird feeding or transiting the area) may necessitate immediate remedial action. Diesel oil is degraded by naturally occurring microbes within one to two months. Nonetheless, in terms of toxicity to marine organisms, diesel is considered to be one of the most acutely toxic oil types. Many of the compounds in petroleum products are known to smother organisms, lower fertility and cause disease. Intertidal invertebrates and seaweed that come in direct contact with a diesel spill may be killed. Fish kills, however, have never been reported for small spills in open water as the diesel dilutes so rapidly. Due to differential uptake and elimination rates, filter-feeders (particularly mussels) can bio-accumulate hydrocarbon contaminants. Crabs and shellfish can be tainted from small diesel spills in shallow, nearshore areas.

Chronic and acute oil pollution is a significant threat to both pelagic and inshore seabirds. Seabird oiling events may result from vessels cleaning their bilges at sea or from accidental spills (including from disintegrating fuel tanks of vessels that have sunk years earlier). Diving seabirds that spend much of their time on the surface of the water, and especially flightless African Penguins, are particularly likely to encounter floating oil and if not collected, de-oiled and nursed back to health will die as a result of even light to moderate oiling. Oiling damages plumage, eyes and internal organs. Poisoning from the ingestion of oil when birds attempt to preen off the oil also leads to mortalities or long-term internal injury, which reduces their ability to reproduce (Barham *et al.* 2007; Wolfaardt *et al.* 2009). The majority of associated deaths are as a result of the properties of the oil and damage to the water repellent properties of the birds' plumage. This allows water to penetrate the plumage, decreasing buoyancy and leading to sinking and drowning. In addition, thermal insulation capacity is reduced, and birds eventually succumb to hypothermia or starvation. Even small spills can be detrimental to seabirds, for example if a spill occurs close to seabird breeding islands or foraging “hotspots”. Any oil spill, including of hydraulic oils, no matter how small, therefore require urgent intervention to limit the probability of seabirds coming into contact with oil.

Impacts of oil spills on turtles is thought to primarily affect hatchling survival (CSIR & CIME 2011). Turtles encountered in the project area would mainly be migrating adults and vagrants. Similarly, little work has been done on the effect of an oil spill on fur seals.

The effects of oil pollution on marine mammals is poorly understood (White *et al.* 2001), with the most likely immediate impact of an oil spill on cetaceans being the risk of inhalation of volatile, toxic benzene fractions when the oil slick is fresh and unweathered (Geraci & St Aubin 1990, cited in Scholz *et al.* 1992). Common effects attributable to the inhalation of such compounds to include absorption into the circulatory system and mild irritation to permanent damage to sensitive tissues such as membranes of eyes, mouth and respiratory tract. Direct oiling of cetaceans is not considered a serious risk to the thermoregulatory capabilities, as cetacean skin is thought to contain a resistant dermal shield that acts as a barrier to the toxic substances in oil. Baleen whales may experience fouling of the baleen plates, resulting in temporary obstruction of the flow of water between the plates and, consequently, reduce feeding efficiency. Field observations record few, if any, adverse effects among cetaceans from direct contact with oil, and some species have been recorded swimming, feeding and surfacing amongst heavy concentrations of oil (Scholz *et al.* 1992) with no apparent effects.

Sensitive Receptors

In the unlikely event of an operational spills or vessel collision, this would primarily take place in the licence area and along the route taken by the vessels between the ML 220 and Lüderitz. The licence area extends offshore from the shore and is located within the NIMPA and Namibian Islands EBSA and therefore in close proximity to sensitive coastal receptors (e.g. key faunal breeding/feeding areas, bird or seal colonies). Diesel spills or accidents *en route* to the onshore supply base in Lüderitz could result in fuel loss closer to shore, thereby potentially having an environmental effect on the sensitive coastal environment.

Oil or diesel spilled in the marine environment will have an immediate detrimental effect on water quality. Being highly toxic, marine diesel released during an operational spill would negatively affect any marine fauna it comes into contact with. The taxa most vulnerable to hydrocarbon spills are coastal and pelagic seabirds. Some of the species potentially occurring in the survey area, are considered regionally or globally 'Critically Endangered' (e.g. Cape Gannet) or 'Endangered' (e.g. African Penguin, Bank and Cape Cormorant) or 'vulnerable' (e.g. Hartlaub's Gull, Swift Tern). The impact of oiling not only results in the death of oiled penguins, but also has cascade effects through the entire population by decreasing the breeding success. Oil pollution thus represents a significant threat to the seabird populations and may contribute to some of these species becoming extinct in the wild. The sensitivity of marine fauna to diesel spill is considered to be HIGH.

Assessment

In the unlikely event of an operational spill or vessel accident, the intensity of the impact would depend on (a) the amount of fuel spilled; (b) the location of a spill, i.e. proximity to the shore and seabird breeding habitats; and (c) in the event of a vessel collision, on the type of fuel that is spilled by one or both vessels. As marine diesel evaporates quickly the impact would persist only over the short-term and remain localised, while a spill involving heavy fuel oils would need quick intervention to contain and remove it. The survey and sampling/mining vessels are likely to carry in excess of 150 m^3 of marine diesel, so under the worse-case scenario of a vessel grounding or sinking, in the region of 100 - 130 m^3 could be lost to the marine environment. In the sensitive environment of the NIMPA, and the likely proximity of the spill to seabird nesting areas and the shoreline, the potential impact of a spill would be of HIGH to VERY HIGH intensity. The greatest risk of shoreline oiling would be from a spill that occurred within Hottentots Bay, as the diesel would travel as a narrow plume in a north-westward direction, potentially coming ashore along the coast between Saddle Hill and Mercury Island. The impact would remain REGIONAL over the SHORT TERM (days). In the case of marine diesel, the consequence would thus be MODERATE to HIGH. Although operational spills are POSSIBLE, vessel accidents and collisions are UNLIKELY. The significance of the impact is therefore considered **LOW** to **MODERATE** if not mitigated.

Mitigation Measures

The following mitigation measures must be implemented:

- Ensure that vessels operate in accordance with Namibian Maritime and Mining safety regulations to minimise risks of accidents.
- Refuelling of vessels is to occur under controlled conditions in a harbour only.
- Ensure that the vessel operator has prepared and implemented a Shipboard Oil Pollution Emergency Plan and an Oil Spill Contingency Plan. In doing so, take cognisance of the Namibian National Marine Pollution Contingency Plan, which sets out national policies, principles and arrangements for the management of emergencies including oil pollution in the marine environment.
- Since the National Marine Pollution Contingency Plan is still lacking a dedicated wildlife response plan, in the case of a spill the Lüderitz office of MFMR and the African Penguin Conservation Project must be alerted without delay. This early alert is essential for timely search and rescue operation for potentially affected seabirds and admission to the small seabird rehabilitation facility at the MFMR offices. Depending on the scale of need for seabird rescue and rehabilitation, additional assistance, including from outside Namibia, may be required as local capacity is limited.
- Ensure adequate resources are available to collect and transport oiled birds to the cleaning station.
- Ensure that sunken vessels are removed from the sea floor before chronic leaks can occur.
- Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds. Use dispersants only with the permission of MEFT/MFMR.

Operational Spills and Vessel Accidents		
	Without Mitigation	**Assuming Mitigation**
Intensity	High to Very High	Low to Moderate (seabirds)
Duration	Short-term: marine diesel evaporates rapidly	Short-term
Extent	Regional: limited to within ~100 km of the spill site	Local
Consequence	Moderate to High	Low to Moderate
Probability	Possible (operational Spill)/ Unlikely (vessel accident)	Unlikely
Significance	Low to Moderate	Low
Status	Negative	Negative
Confidence	High	High

Nature of cumulative impact	Cumulative impacts on marine fauna are not expected
Degree to which impact can be reversed	Most effects on marine fauna would be fully reversible if timely action is taken, but there may be long-term effects with respect to the demography of impacted, threatened seabirds
Degree to which impact can be mitigated	Moderate to High

5.2.12 Cumulative Impacts

Anthropogenic activities in the nearshore marine environment can result in complex immediate and indirect effects on the natural environment. Effects from disparate activities can combine and interact with each other in time and space to cause incremental or cumulative effects. Cumulative effects can also be defined as the total impact that a series of developments, either present, past or future, will have on the environment within a specific region over a particular period of time (DEAT IEM Guideline 7, Cumulative effects assessment, 2004).

To define the level of cumulative impact in the subtidal environment, it is therefore necessary to look beyond the environmental impacts of the current project and consider also the influence of other past or future developments in the area.

The proposed project area cannot be considered particularly "pristine" as it has already been impacted by past mining activities and seasonal fisheries. Cumulative effects of the proposed exploration activities are thus anticipated, although these will be difficult to quantify over and above natural variability. Cumulative impacts are thus expected to remain of low severity at the local scale, persisting over the short- to medium-term, and are therefore rated as being of **LOW** significance.

6. Recommendations and Conclusions

6.1 Environmental Acceptability and Impact Statement

The main marine impacts associated with the proposed exploration activities are related to acoustic impacts on marine mammals and disturbance and loss of benthic macrofauna in the sampling footprint. No fatal flaws have been identified. Environmental impacts associated with the sampling and survey operations are summarised below:

Impact	Probability	Significance (before mitigation)	Significance (after mitigation)
Noise from geophysical surveying on marine fauna	Possible	Low	Low
Noise from sampling/mining operations on marine fauna	Unlikely	Low	Low
Disturbance and loss of benthic macrofauna	Definite	Low	--
Disturbance and loss of rock lobster	Unlikely	Low	Low
Generation of suspended sediment plumes	Unlikely	Low	Low
Remobilisation of contaminants and nutrients	Unlikely	Low	Low
Smothering of benthos in unconsolidated sediments by redepositing tailings	Possible	Low	Low
Smothering of reef communities by redepositing tailings	Unlikely	Low	Low
Impacts due to loss of ferrosilicon	Unlikely	Low	Low
Potential loss of equipment to the seabed	Unlikely/Possible	Low/Moderate	Low
Pollution of the marine environment through operational discharges to the sea from mining vessel	Most likely	Low	Low
Vessel strikes and entanglement in gear	Unlikely	Low	Low
Operational Spills and vessel accidents	Possible/Unlikely	Low/Moderate	Low

Most of the potential impacts associated with the exploration and mining activities would occur in the immediate vicinity of the vessel, would be of short term duration and of low to high severity, and can thus mostly be considered to be of LOW significance. Exceptions are potential entanglement of marine mammals in lost anchor cables and grounding or sinking of the survey vessel when impacts can be considered of MODERATE significance, although with low likelihood of occurrence. The impacts identified above, along with other areas of concern raised by stakeholders during the scoping process and highlighted in this document, are addressed in more detail in the SEMP. The process followed meets the requirements of the Environmental Management Act (2007) to ensure that the regulatory authorities receive sufficient information to enable informed decision-making.

Two negative impact of moderate significance (before mitigation) were identified:

- Entanglement of turtles, seals and cetaceans in lost anchor cables and ropes;
- Operational spills and vessel accidents.

With the exception of the disturbance and loss of benthic fauna (which is unavoidable and cannot be mitigated), recommended management actions and mitigation measures would reduce the negative impacts to low.

6.2 Recommendations

6.2.1 Compliance with EMP and Marpol 73/78 standards

All phases of the exploration and mining activities must comply with the Environmental Management Programme compiled for the project. Furthermore, the survey and mining vessel must ensure compliance with MARPOL 73/78 standards.

6.2.2 Notification and communication with key Stakeholders

- Notify all key stakeholders prior to the commencement of mining activities;
- Liaise with the rock lobster industry to ensure that there is no overlap of activities in the same area over the same time period;
- Prior to the commencement of activities, notify relevant bodies including: MME, the South African Navy (SAN) Hydrographic Office, relevant Port Captains and MFMR. These bodies must be notified of the navigational coordinates of any location prior to commencement of such activities;
- Appropriate notices should be distributed timeously to mariners providing:
    - The co-ordinates of the sampling/mining and survey activities;
    - An indication of the survey timeframes; and
    - Reports on the location of mining vessels.

6.2.3 Discharges and Emissions

- Provide training and awareness to crew members of the need for thorough cleaning up of any spillages immediately after they occur in order to minimise the volume of contaminants washing off decks;
- Use low toxicity, biodegradable detergents and reusable absorbent cloths during deck cleaning to further minimise the potential impact on the marine environment;
- Machinery spaces must drain into bilge tanks in compliance with MARPOL Annex I;
- 'Save-alls' must be utilised around specific equipment, bunkering points and vents on open deck areas to prevent release of contaminated water overboard;
- Undertake adequate maintenance of all hydraulic systems;
- No solid waste may be disposed to the marine environment;
- Ensure that stringent waste management practices are in place at all times; and

- The vessel operator would be required to comply with the MARPOL 73/78 Annex IV requirements, wherever possible.

6.2.4 Vessel Seaworthiness and Safety

- The survey and mining vessel must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas);
- The survey and mining vessel should be equipped with collision prevention equipment including radar, multi-frequency radio, foghorns, etc. Safety equipment and training of personnel to ensure the safety and survival of the crew in the event of an accident is a further legal requirement;
- Seek to reduce the probabilities of accidental and/or operational spills through enforcement of stringent oil spill management systems. These should incorporate plans for emergencies; and
- Refueling will occur under controlled conditions in a harbour only.

6.2.5 Geophysical Surveying

- Onboard Marine Mammal Observers (MMOs) should conduct visual scans for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses.
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
- "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 μPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- The geophysical surveying should largely be undertaken between December and May, thereby avoiding the main migration period of baleen whales from their southern feeding grounds into low latitude waters. However, during the transition periods in June and November, surveying would be possible with stricter mitigation measures. As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended.
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place between June and November.
- A MMO should be appointed to ensure compliance with mitigation measures during seismic geophysical surveying. This will also reduce the chances of the vessel colliding with a marine mammal.
- All vessel operators should keep a constant watch for marine mammals and turtles in the path of the vessel.
- Ensure vessel transit speed between the survey area and port is a maximum of 12 knots (22 km/hr), except within 25 km of the coast where it is reduced further to 10 knots (18 km/hr) as well as when sensitive marine fauna are present in the vicinity.
- A non-dedicated marine mammal observer (MMO) must keep watch for marine mammals behind the vessel when tension is lost on the towed equipment. Either retrieve or regain tension on towed gear as rapidly as possible.
- Should a cetacean become entangled in towed gear, contact the MFMR to provide specialist assistance in releasing entangled animals.

6.2.6 Monitoring Surveys

Recommended management actions include the monitoring and demonstration of natural recovery processes by conducting the following surveys before, during and after mining:

- Baseline bathymetric (MBES) and surface sediment sidescan sonar or multibeam bathymetry surveys, to provide a record of the pre-mining topography and surface sediment characteristics of the mining area.
- Baseline surveys of benthic community composition in unconsolidated sediments at selected impact and control sites in and adjacent to the mining area, to provide information on the pre-mining composition of these communities, and to provide control sites for comparison with post-mining surveys. Sediments samples taken concurrently will provide information on sediment structure and POM.
- Post-mining sidescan sonar and MBES surveys of selected portions of mined areas, immediately after mining, and 3 - 5 years after mining, to demonstrate infilling and smoothing of mined areas by natural sediment movement and deposition.
- Post-mining surveys of benthic community composition in unconsolidated sediments at the selected impact and control sites in and adjacent to the mining area, to document natural changes in community composition, and to demonstrate recovery of benthic faunal communities. Sediments samples taken concurrently will provide information on sediment structure and POM.
- Pre- and post-mining surveys of reef communities in the vicinity of mining target areas. This is best undertaken by means of video footage.
- Keep records of pelagic seabird and small mammal occurrence and activity around the mining vessel while in operation to determine if these are in any way affected by the suspended sediment plumes, and to help determine specific nearshore feeding grounds.

6.3 Conclusions and Impact Statement

If all environmental guidelines, and appropriate mitigation measures advanced in this report, and the EIA for the proposed project as a whole, are implemented, there is no reason why the proposed mining and ongoing exploration activities should not proceed.

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PROPOSED OFFSHORE DIAMOND MINING ACTIVITIES WITHIN ML220, NAMIBIA

COMMERCIAL FISHERIES IMPACT ASSESSMENT

May 2021

Prepared for the Environmental Assessment Practitioner:

A. Speiser Environmental Consultants (ASEC) cc

On behalf of :

LK Mining

LK MINING (pty) ltd

CapMarine

Capricorn Marine Environmental

INDEX

CapMarine
Capricorn Marine Environmental

PO Box 50035 Waterfront
Cape Town South Africa 8002
Unit 15 Foregate Square
FW de Klerk Boulevard
Cape Town South Africa 8001
Telephone +27 21 425 2161
Fax +27 21 425 1994
www.capfish.co.za

27 May 2021

This report was prepared by Sarah Wilkinson of CapMarine (Pty) Ltd. Sarah Wilkinson has a BSc (Hons) degree in Botany from UCT and is registered with the South African Council for Natural Scientific Professions (SACNASP).

Sarah Wilkinson has worked on marine resource assessments, specializing in spatial and temporal analysis (GIS), as well as the economic impacts of fisheries exploitation in the southern African region. Nikita Steele has worked as an environmental assessment practitioner conducting environmental impact assessments and has experience in marine research.

This specialist report was compiled for Spieser Environmental Consultants cc (ASEC) for their use in compiling an Environmental Impact Assessment (EIA) Report and Environmental Management Plan (EMP) for proposed exploration and sampling activities in ML 220 in the Karas region of Namibia. We do hereby declare that we are financially and otherwise independent of the Applicant and of ASEC.

Sarah Wilkinson

EXECUTIVE SUMMARY

LK Mining (Pty) Ltd (LKM) has applied for a Mining Licence (ML 220) over their existing Exclusive Prospecting Licence area, EPL5965. The EPL is located in Hottentots Bay, approximately 60 km north of Lüderitz, and falls within the Namibian Islands Marine Protected Area (NIMPA) of the Namibian Coast. The ML covers an area of 4227 Ha. In terms of the Environmental Management Act, 7 of 2007 before mining activities can be undertaken, Environmental Clearance is required from the Ministry of Environment, Forestry and Tourism (MEFT). Speiser Environmental Consultants cc (ASEC) has been appointed by LKM to undertake an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed activities. As part of this report, Capricorn Marine Environmental (Pty) Ltd has been contracted to provide an assessment of the potential impacts on the Namibian fishing industry. The assessment has been prepared in line with the requirements of the Namibian Environmental Management Act (Act 7 of 2007) and specifically, the Environmental Impact Assessment Regulations (Government Notice 30 of 2011).

The existing EPL5965 covers an area of shallow (10-30 m deep) and mid water (30-40 m deep) environments. Proposed activities include geophysical surveys in three targeted areas within the EPL and mining activities within an area of 228 Ha (5.4% of the total licence area). Geophysical survey techniques would include the use of echo sounders, high resolution side-scan sonar, depth sounding and low frequency seismic profiling. Mining would involve the removal of unconsolidated superficial sediments via a small dredge pump vessel.

Several aspects of the proposed activities were identified as posing a potential risk to the fishing industry. The potential impact on fisheries have been identified as: 1) noise emissions during geophysical survey and the resulting effect on catch rates; 2) localised, temporary exclusion of fishing operations during geophysical surveys, sampling and mining activities and 3) discharge of sediment into the marine environment and the resulting impact of the sediment plume on fish stock recruitment. The impacts of sound and exclusion are were assessed in the current report whereas the impact of the sediment plume on fish stocks was assessed in the marine fauna impact assessment report (Pulfrich, 2021).

Various types of survey equipment alternatives have been proposed for the current project, some of which produce an acoustic signal that would fall within the hearing range of fish and crustaceans. The noise emissions from the multibeam echosounder, side-scan sonar and depth sounding equipment are mid- to high-frequency and highly directional, spreading as a fan from the sound source. The anticipated radius of influence would thus be significantly less than that for a deeper penetration, low frequency seismic airgun array. However, the noise generated by bottom profiling and mining operations would fall within the hearing range of most fish, and depending on sea state would be audible for several kilometres around the vessel before attenuating to below threshold levels. Based on the location of the ML 220 well inshore of the fishing grounds of most commercial sectors, only the linefish and rock lobster fisheries are expected to be susceptible to elevated sound levels. The impact on these sectors was assessed to be of overall low negative significance. No mitigation measures are possible, or considered necessary for the generation of noise by the geophysical survey and mining methods proposed in the current project.

During the geophysical survey and mining activities, fishing vessels would be required to maintain a safe operational distance of 500 m from the project vessel. The impact of potential exclusion was assessed for each commercial sector based on the affected area of fishing ground and the relative quantities of catch reported within ML 220 The impact of exclusion from fishing grounds was assessed to be of overall low significance to the linefish and rock lobster sectors. The impact on the rock lobster sector could be eliminated by timing the proposed activities to avoid the seasonal fishing period January to April. There is no impact expected on the small pelagic purse-seine, midwater trawl, demersal trawl, demersal longline, large pelagic longline tuna pole-and-line, deepsea crab or deep-water trawl sectors.

The table below provides a summary of the impacts on fisheries of each of the identified project activities, where the impact significance range across fishing sectors is presented before and after the implementation of recommended mitigation measures.

Fishery Sector	Noise Effects		Temporary Safety Zone	
	Pre-Mitigation	Residual Impact	Pre-Mitigation	Residual Impact
Small Pelagic Purse-Seine	No impact	No impact	No impact	No impact
Mid-Water Trawl	No impact	No impact	No impact	No impact
Demersal Trawl	No impact	No impact	No impact	No impact
Demersal Longllne	No impact	No impact	No impact	No impact
Large Pelagic Longline	No impact	No impact	No impact	No impact
Tuna Pole	No impact	No impact	No impact	No impact
Linefish	Low	No impact	Low	No impact
Deepsea Crab	No impact	No impact	No impact	No impact
Deep-Water Trawl	No impact	No impact	No impact	No impact
Rock Lobster	Low	No impact	Low	No impact

A process of notification and information-sharing should be followed with the relevant fishing industry associations including the Namibian Rock Lobster and Linefish Associations. Other key stakeholders should be notified prior to commencement and on completion of the project. These include; the South African Navy Hydrographic Office (HydroSAN) and the Ministry of Fisheries and Marine Resources (MFMR).

A Coastal Navigational Warning should be issued for the duration of the mining operations by the South African Naval Hydrographic Office and Lüderitz Radio.

ACRONYMS, ABBREVIATIONS AND UNITS

CapMarine	Capricorn Marine Environmental (Pty) Ltd
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
CPUE	Catch Per Unit Effort
DEA	Department of Environmental Affairs
EAP	Environmental Assessment Practitioner
ECC	Environmental Clearance Certificate
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPL	Exclusive Prospecting Licence
ESIA	Environmental and Social Impact Assessment
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GRT	Gross Registered Tonnage
Ha	Hectares
HP	Horse Power
ICCAT	International Convention for the Conservation of Atlantic Tunas
ICSEAF	International Commission for South East Atlantic Fisheries
IUU	Illegal, Unreported and Unregulated fishing
kg	Kilogram
LKM	LK Mining (Pty) Ltd
m	Metres
MEFT	Ministry of Environment, Forestry and Tourism
MFMR	Ministry of Fisheries and Marine Resources
MME	Ministry of Mines and Energy
NAMPORT	Namibian Ports Authority
NatMIRC	National Marine Information and Research Centre
NEMA	Namibian Environmental Management Act
QMAs	Quota Management Areas
RFMO	Regional Fisheries Management Organisation
t	Tonnes
TAC	Total Allowable Catch
TAE	Total Allowable Effort
UNCLOS	United Nations Convention of the Law of the Sea
VMS	Vessel Monitoring System

1. INTRODUCTION

LK Mining (Pty) Ltd (LKM) has applied for a Mining Licence (ML 220) over their existing Exclusive Prospecting Licence area, EPL5965. The EPL is located in Hottentots Bay, approximately 60 km north of Lüderitz, and falls within the Namibian Islands MPA of the Namibian Coast (refer to Figure 1-1). The licence covers an area of 4227Ha. The licence area was reduced by 25% from the original grant size of 5677Ha during the first renewal in April 2019. The Mining Licence application was filed by LKM with MME in Oct 2019, and has been processed. The last outstanding document, before execution and grant of ML 220 is to apply and obtain an Environmental Clearance Certificate (ECC) from MET before such activities can commence. Speiser Environmental Consultants cc (ASEC) has been appointed as the independent Environmental Assessment Practitioner (EAP) to undertake the EIA for the proposed activities and Capricorn Marine Environmental (Pty) Ltd has been contracted by ASEC to undertake a Fisheries Impact Assessment Specialist Study required for the EIA process.

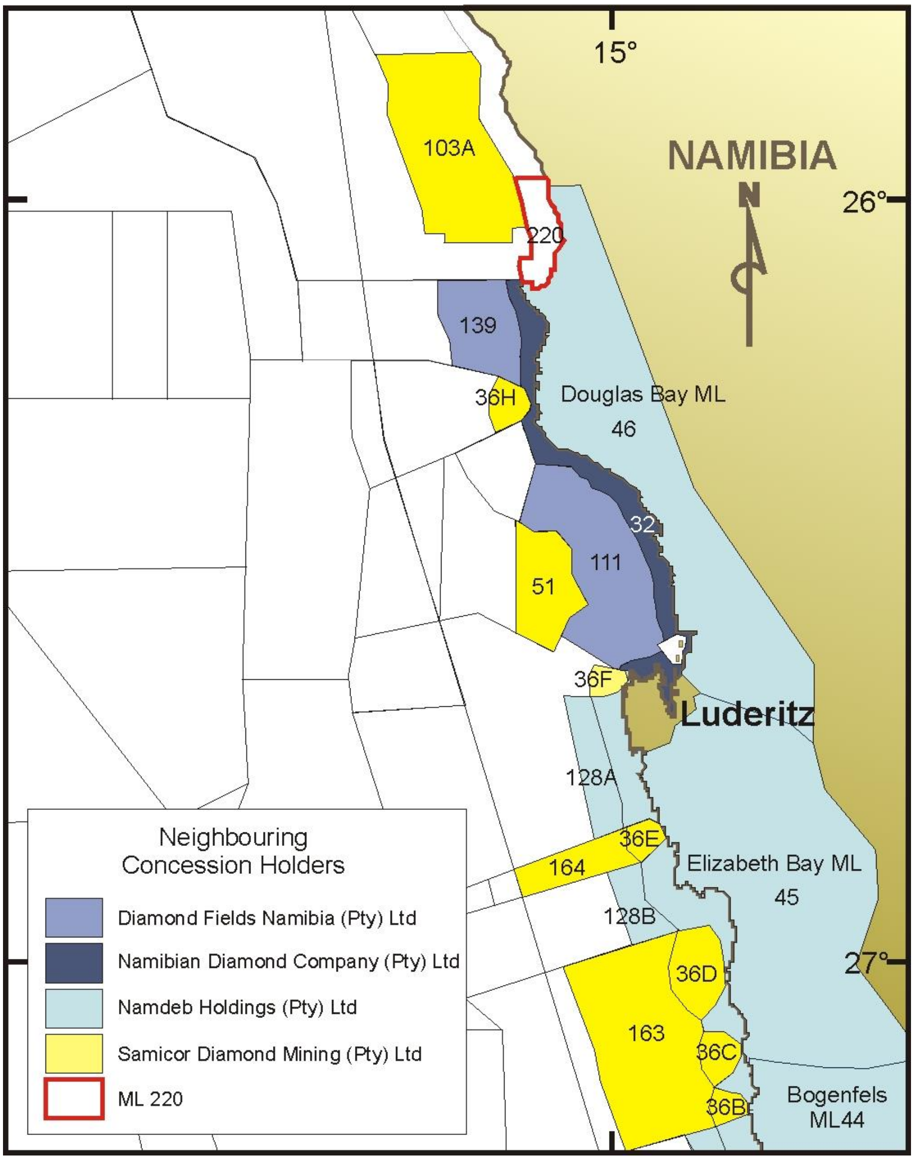

Figure 1-1: Location of the proposed ML 220 area and neighbouring Concession Holders.

This report provides a description of the Namibian commercial fisheries and an assessment of the impact of the proposed activities on the Namibian fishing industry. The assessment has been prepared in line with the requirements of the Namibian Environmental Management Act (Act 7 of 2007) and specifically, the Environmental Impact Assessment Regulations (Government Notice 30 of 2011).

2. PROJECT DESCRIPTION

The techniques required to prospect for and mine diamond resources vary according to the location of the area/operation, i.e. shallow water, mid water or deep-water areas. EPL5965 covers an area of shallow (10-30 m deep) and mid water (30-40 m deep) environments with the shallower (beach zone) areas in the eastern and southern areas of the EPL, and the deeper mid water areas (up to 45 m depths) in the central basin.

LKM proposes to mine the delineated Mining Area 1, making use of a small dredge pump vessel. Ongoing sampling, resource development, and detailed geophysical surveys would be undertaken within Resource Development Areas 2, 3 and 4. Figure 2.1 shows the location of the EPL, as well as the proposed ML 220 Mining Area 1, and Resource Development Areas, 2, 3 & 4.

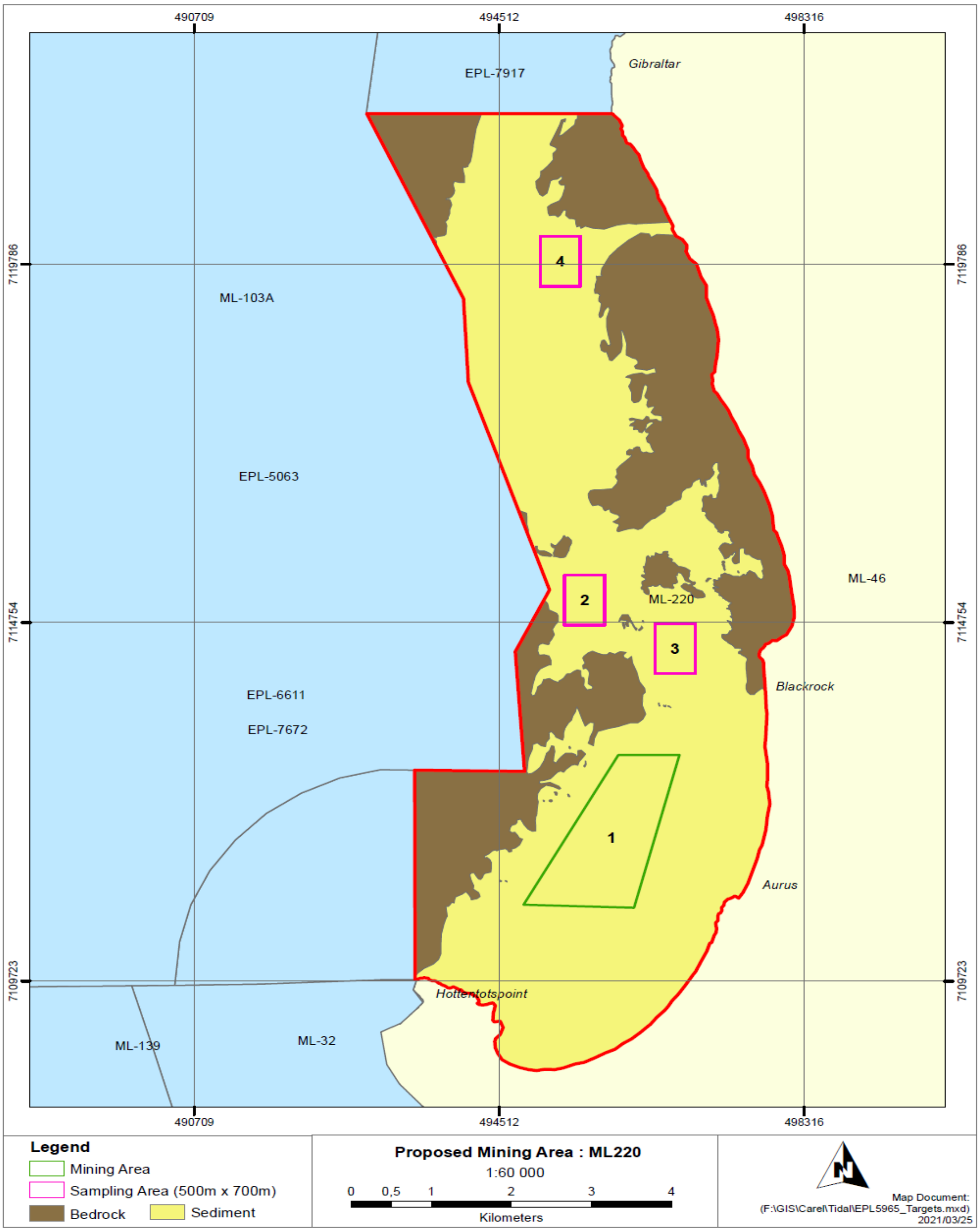

Figure 2-1: Location and size of the proposed ML area, as well as the proposed ML 220 Mining Area 1, and Resource Development Areas, 2, 3 & 4

Mining Area 1 covers a total area of 228 Ha, 5.4% of the total licence area. The current mine plan is for 7 years, and through additional resource development over Target Areas, 2, 3 & 4 the mine plan could be extended by at least another 3 years.

Resource verification would take 2 months to complete, including a geophysical survey of 2-weeks duration across Target areas 2, 3 & 4, each of which measure 500 x 700m. A total of 35 point samples would be collected per area. The total sample size over the three target areas would be 2100 m^2 (±20 m^2 per sample). LKM proposes to follow up these results with a bulk sampling phase during which a total of 12 block samples (50 x 50m) would be taken over another total area of 30 000 m^2. In total, sampling and resource development would thus be conducted over a total area of 32 100 m^2. This equates to less than 0.07% of the total EPL area of the existing licence area.

2.1 Geophysical Surveys

The ongoing exploration and resource development programme are planned to cover Target Areas 2, 3 and 4. The geophysical remote sensing techniques to be employed include echo sounding for bathymetry; high resolution side-scan sonar to primarily determine sediment and seabed surface texture; depth sounding to identify soft mud; and low energy (<12 khz) shallow penetration seismic profiling to determine sediment thickness and bedrock morphology. A short description of each of these technologies is provided below.

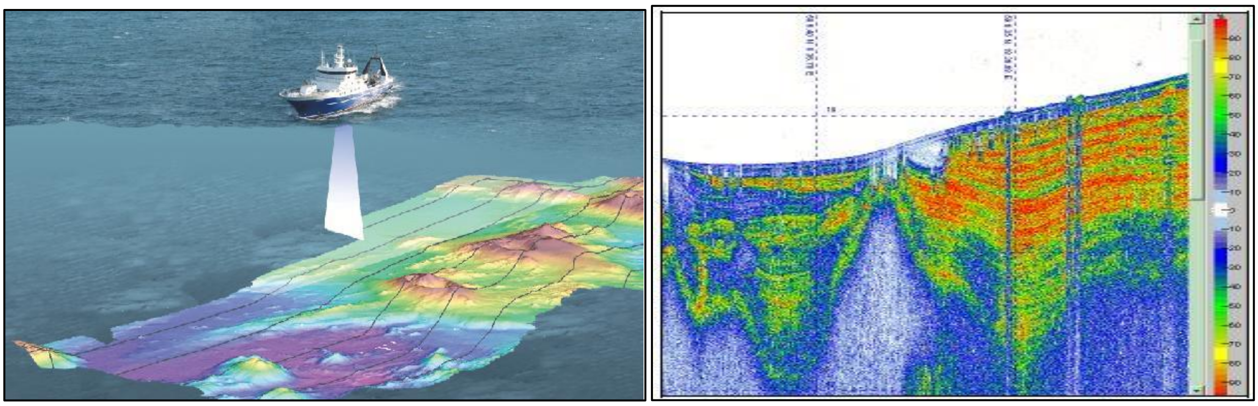

Figure 2-2: The geophysical survey techniques employed during the proposed prospecting operations would include swath bathymetry (left) and sub-bottom profiling (right).

2.1.1 Multi-Beam Bathymetry

The use of a multi-beam bathymetry survey allows the operator to produce a digital terrain model of the seafloor. The survey vessel would be equipped with a multi-beam echo sounder to obtain swath bathymetry. The multi-beam system provides depth sounding information on either side of the vessel's track across a swath width of approximately twice the water depth. The equipment is hull-mounted,

A typical multi-beam echo sounder emits a fan of acoustic beams from a transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1µPa at 1m.

2.1.2 Side Scan Sonar

Side scan sonar systems produce acoustic intensity images of the seafloor and are used to map the different sediment textures of the seafloor. Side-scan uses a sonar device, which can be towed from a vessel or mounted on the ship's hull that emits conical or fan-shaped pulses down toward the seafloor across a wide angle perpendicular to the path of the sensor through the water. The intensity of the acoustic reflections from the seafloor of this fan-shaped beam is recorded in a series of cross-track slices. When collated along the direction and processed for motion, these slices form an image of the sea bottom within the swath (coverage width) of the beam. A typical side scan sonar emits a pulse at frequencies ranging from 50 to 500 kHz and typically produces sound levels in the order of 220-230 db re 1µPa at 1m.

2.1.3 Depth Sounding

The majority of hydrographic depth/echo sounders are dual frequency, transmitting a low frequency pulse (typically around 24 kHz) at the same time as a high frequency pulse (typically around 200 kHz). Dual frequency depth/echo sounding has the ability to identify a layer of soft mud on top of a layer of coarse and hard sediment and or rock. The pulse emitted would typically be for more than 0.025 seconds and produces sound levels in the order of 180+ dB re 1 μPa at 1m.

2.1.4 Bottom Profilers

Bottom profilers are powerful low frequency echo-sounders that provide profiles of the upper layers of the ocean floor. A typical sub-bottom profiler emits an acoustic pulse from a transducer at frequencies ranging from 3 kHz to 40 kHz and typically produces sound levels in the order of 206 db re 1μPa at 1m.

A typical bottom profiler emits an acoustic pulse at frequencies ranging from 0.4 to 30 kHz and typically produces sound levels in the order of 200-230 db re 1μPa at 1m.

The data resulting from these prospecting methods will be used to produce high-resolution maps of the seabed geomorphology, sediment and bedrock distribution, bathymetry and sediment type and thickness profiles. From these maps, areas of unconsolidated sediment suitable for sampling will be identified, and a sampling grid positioned over the area. Surveying activities are usually ongoing in order to develop geological models for further resource development.

2.2 Seabed Mining and Resource Development

Mining would commence over Mining Area 1, which covers a total area of 228 Ha, 5,4% of the total licence area. LK Mining will use a suitable shallow/mid water remote mining type vessel with a gravel pump system, which can operate in the shallow to mid-water depth range of 10 – 70 m. The lifted material will be processed on-board with a Dense Media Separating (DMS) Plant. The gravel pump delivers the sediment on board through hoses with steel section at the bottom. The steel section gets moved around with two wires attached to the steel section, and two wire winches on board the vessel.

The mining process will involve the removal of only the unconsolidated superficial sediments. This involves the dredged sediment-slurry being pumped to the surface and typically discharged on to a series of screens that separate the oversize (>12 mm) and undersize (<1.2 mm) (unwanted) fractions that are discarded overboard. The fraction of interest is fed through a crusher, then mixed with ferrosilicon and pumped under pressure to the DMS plant. Low density materials are separated, and then discharged, but with the ferrosilicon recovered. The remaining high density fraction is dried and then passed through an X-ray sorting device to separate out diamonds. Non-fluorescent (gravel) material is discarded overboard with the float material, and the fluorescent fraction containing the diamonds is then hand sorted for diamonds.

The mining system (Figure 2-3) comprises a suspended steel mining tool, suction hoses and an on-board mining pump. The suction hoses and mining tool will be ~300 mm internal diameter. The mining tool itself consists of a 300 mm diameter steel pipe fitted with a mining head, referred to as the digging head, which has an opening fitted with grizzly cross-bars to allow sized gravel (nominally < 100 mm) to pass through and prevent blockages in the suction system. The digging head will also be fitted with high pressure water jetting nozzles to agitate the gravel on the seabed and improve mining efficiency.

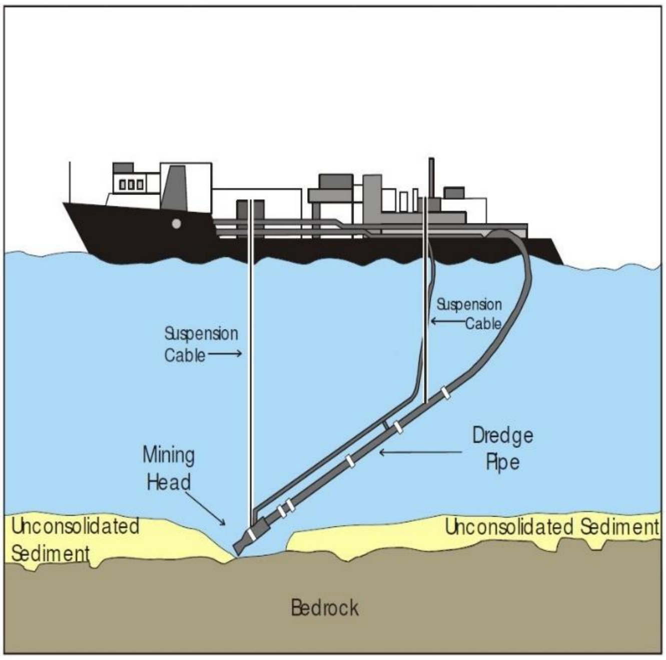

Figure 2-3: Diagram showing the operation of a mining system. The vessel is anchored at four point and 'moves across the target area removing overburden and ore down to bedrock. The maximum depth is 45m.

The retrieved gravel will be processed on board. The plant head feed has been sized for 60 tonnes per hour (tph) solids (450 m^3/hr slurry), fed by the 12" gravel pump. The mining system feed (run of mine) is discharged into a 250 mm gravel classifier. Undersize (-1.4 mm) and oversize (+12 mm) materials are discharged directly overboard. The screened fraction is fed via a jet pump onto a combined dewatering screen. Shell and clay material will be discharged via a surge bin into a crusher (typically Barmac or similar) where after product will be discharged into the mixing box. Ferrosilicon (FeSi) is added and the mixture pumped via the cyclone feed-pump to the DMS cyclone. The cyclone sinks and floats are discharged onto a combined drain and rinse screen. Drained floats are then discharged overboard. FeSi from the screen drain is recovered via a magnetic separator and pumped into the medium circuit. The sinks product is rinsed and sized into two streams, nominally -12+4 mm and -4+1.4 mm and discharged into the X-ray feed hopper. From this hopper, the two streams are run separately through a wet x-ray machine. The concentrate is then dried and fed into the glove box where the diamonds are recovered, weighed and placed into a drop safe.

Through a combined capacity study, a mining rate of 15 m^2 per hour has been applied in the mining program. At this applied rate a total of 50 000 sqm will be mined per year (0.12% of the licence area). A total area of 350 616 m^2 (0.83%) of the total licence area has been identified as the current mineable resource.

3. APPROACH AND METHODOLOGY

3.1 IMPACT ASSESSMENT METHODOLOGY

The spatial distribution of fishing effort and catch was mapped at an appropriate resolution for each fishing sector (based on the fishing method and resulting area covered by fishing gear). Any records of fishing activity having taken place within ML 220 was expressed as a percentage of the total effort and catch figures for each sector. This provided an indication of the proportion of fishing ground that could be affected by the presence of the project vessels in relation to each fishing sector.

The convention used to evaluate the significance of the impact was provided by ASEC. The impact consequence was determined based on a combination of the "intensity", "duration" and "extent" of the impact. Thereafter the impact significance rating was determined as a function of the consequence and probability of the impact occurring. Significance was assigned to the predicted impact pre-mitigation and post-mitigation (residual) after considering all possible feasible mitigation measures in accordance with the mitigation hierarchy. Terminology, criteria and ratings are outlined further below.

The potential impacts were cumulatively assessed, where relevant, taking into consideration the existing environment and all other activities and facilities associated with the proposed Project.

IMPACT assessment criteria	
SIGNIFICANCE determination	Significance = consequence x probability
CONSEQUENCE	Consequence is a function of: • Nature and Intensity of the potential impact • Geographical extent should the impact occur • Duration of the impact

Ranking the NATURE and INTENSITY of the potential impact	
Negative impacts	
Low (L)	The impact has no / minor effect/deterioration on natural, cultural and social functions and processes. No measurable change. Recommended standard / level will not be violated. (Limited nuisance related complaints).
Moderate (M)	Natural, cultural and social functions and processes can continue, but in a modified way. Moderate discomfort that can be measured. Recommended standard / level will occasionally be violated. Various third party complaints expected.
High (H)	Natural, cultural or social functions and processes are altered in such a way that they temporarily or permanently cease. Substantial deterioration of the impacted environment. Widespread third party complaints expected.
Very high (VH)	Substantial deterioration (death, illness or injury). Recommended standard / level will often be violated. Vigorous action expected by third parties.
Positive impacts	
Low (L) +	Slight positive effect on natural, cultural and social functions and processes. Minor improvement. No measurable change.
Moderate (M) +	Natural, cultural and social functions and processes continue but in a noticeably enhanced way. Moderate improvement. Little positive reaction from third parties.
High (H) +	Natural, cultural or social functions and processes are altered in such a way that the impacted environment is considerably enhanced /improved. Widespread, noticeable positive reaction from third parties.
Very high (VH) +	Substantial improvement. Will be within or better than the recommended level. Favourable publicity from third parties.

Ranking the EXTENT	
Low (L)	Local: confined to within the project concession area and its nearby surroundings
Moderate (M)	Regional: confined to the region, e.g. coast, basin, catchment, municipal region, district, etc.
High (H)	National; extends beyond district or regional boundaries with national implications
Very high (VH)	International: Impact extends beyond the national scale or may be transboundary

Ranking the DURATION	
Low (L)	Temporary/short term. Quickly reversible. (Less than the life of the project).
Moderate (M)	Medium Term. Impact can be reversed over time. (Life of the project).
High (H)	Long Term. Impact will only cease after the life of the project.
Very high (VH)	Permanent

Ranking the PROBABILITY	
Low (L)	Unlikely
Moderate (M)	Possibly
High (H)	Most likely
Very high (VH)	Definitely

These criteria are used to determine the CONSEQUENCE of the impact, which is a function of severity, spatial extent and duration.

INTENSITY	DURATION	EXTENT			
		Local (L)	**Regional (M)**	**National (H)**	**International (VH)**
LOW	**Permanent**	**Moderate**	**Moderate**	**High**	**High**
	Long-term	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Medium-term	**Low**	**Low**	**Low**	**Moderate**
	Short-term	**Low**	**Low**	**Low**	**Moderate**

INTENSITY	DURATION	EXTENT			
		Local (L)	**Regional (M)**	**National (H)**	**International (VH)**
MODERATE	**Permanent**	**Moderate**	**High**	**High**	**High**
	Long-term	**Moderate**	**Moderate**	**High**	**High**
	Medium-term	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Short-term	**Low**	**Moderate**	**Moderate**	**Moderate**

INTENSITY	DURATION	EXTENT			
		Local (L)	Regional (M)	National (H)	International (VH)
HIGH	Permanent	High	High	Very High	Very high
	Long-term	High	High	High	Very High
	Medium-term	Moderate	Moderate	High	High
	Short-term	Moderate	Moderate	High	High

INTENSITY	DURATION	EXTENT			
		Local (L)	Regional (M)	National (H)	International (VH)
VERY HIGH	Permanent	Very high	Very High	Very High	Very high
	Long-term	High	High	Very High	Very high
	Medium-term	High	High	High	Very High
	Short-term	Moderate	High	High	Very High

The SIGNIFICANCE of an impact is then determined by multiplying the consequence of the impact by the probability of the impact occurring, with interpretation of the impact significance outlined below.

PROBABILITY		CONSEQUENCE			
		L	M	H	VH
Definite	VH	Moderate	High	High	Very high
Most Likely	H	Moderate	Moderate	High	Very high
Possibly	M	Low	Moderate	High	High
Unlikely	L	Low	Low	Moderate	High

SIGNIFICANCE Description		
	Positive	Negative
Low (L)	Supports the implementation of the project	No influence on the decision.
Moderate (M)	Supports the implementation of the project	It should have an influence on the decision and the impact will not be avoided unless it is mitigated.
High (H)	Supports the implementation of the project	It should influence the decision to not proceed with the project or require significant modification(s) of the project design/location, etc. (where relevant).
Very high (VH)	Supports the implementation of the project	It would influence the decision to not proceed with the project.

3.2 DATA SOURCES

Namibian commercial fisheries catch and effort data were sourced from the Ministry of Fisheries and Marine Resources (MFMR) for the period 2005 to 2019, where available. Data on fishing rights holdings and industrial bodies was sourced from the 2019 edition of the Fishing Industry Handbook[1]. Information on species distribution was taken from the Benguela Current Large Marine Ecosystem (BCLME) Annual State of the Stocks Report 2011[2].

Table 3-2: Date range of data used for each fishery sector assessed.

Section Ref.	Sector	Date Range		Comment
		Catch	Effort	
4.5.1	Small pelagic purse-seine	2005 – 2017	2005 – 2017	Fishery currently closed
4.5.2	Midwater trawl	2005 – 2018	2005 – 2018	Active
4.5.3	Demersal trawl	2005 – 2018	2005 – 2018	Active
4.5.4	Demersal longline	2005 – 2018	2005 – 2018	Active
4.5.5	Large pelagic longline	2004 – 2019	2004 – 2019	Active
4.5.6	Tuna pole	2004 – 2019	2004 – 2019	Active
4.5.7	Linefish	2000 – 2019	2000 – 2019	Active
4.5.8	Deep-sea crab	2013 – 2018	2013 – 2018	Active
4.5.9	Deep-water trawl	1994 – 2007	N/A	Fishery currently closed
4.5.10	Rock lobster	2005 – 2016	2005 – 2016	Seasonal closure 01 May to 31 October

3.3 ASSUMPTIONS, LIMITATIONS AND INFORMATION GAPS

The study is based on a number of assumptions and is subject to certain limitations listed below. The outcome of the impact assessment is, however, not expected to be affected by these assumptions and limitations:

- The official governmental record of Namibian commercial fisheries data was used to show fishing catch and effort relative to the licence area. These data are derived from logbooks that are completed by skippers whilst at sea and then transcribed into electronic format by the Ministry of Fisheries and Marine Resources (MFMR). It is assumed that there would be a proportion of erroneous data due to inaccurate reporting and recording, but that this is likely to be minimal in comparison to the total volume of the dataset. Where obvious errors in the reporting of fishing positions were identified these were excluded from the analysis.
- Fishing positions are reported by the skippers as the start latitude and longitude of each fishing event and the accuracy of the reported positions is assumed to be to the nearest nautical minute.
- The dataset used to map the spatial distribution for each fishery covers at least a ten-year period and includes the most recent available data. The time span for each sector is listed in Table 4-4.
- The effects of sound on the CPUE of fish and invertebrates have been drawn from the findings of international studies. To date there have been no studies focused directly on the species found locally. Although the results from international studies are likely also to be representative for local species, current gaps in knowledge on the topic lead to uncertainty when attempting to accurately quantify the potential loss of catch for each type of fishery. Research into the effects of sound on marine fauna is ongoing.

[1] Fishing Industry Handbook South Africa, Namibia and Moçambique (2019) 47th edition George Warman Publications, Cape Town, South Africa

[2] Benguela Current Large Marine Ecosystem State of Stocks Review 2011 (2nd Edition; Ed C. Kirchner). Benguela Current Commission.

4. DESCRIPTION OF RECEIVING ENVIRONMENT

4.1 BACKGROUND

Namibia has one of the most productive fishing grounds in the world, based on the Benguela Current System (FAO, August 2015). Namibia is Africa's fourth largest capture fisheries nation behind Morocco, South Africa and Mauritania, and 36th worldwide.[3] Namibia's 200 nautical mile Exclusive Economic Zone (EEZ) supports some 20 different commercially exploited marine species. The three main Namibian commercial species (hake, sardine and horse mackerel) comprise the primary species of historical importance in Namibia. Other species of more recent importance include orange roughy, the deepwater crab trap fishery, monk, rock lobster and the large pelagic fisheries for tuna. The majority of sectors are considered by MFMR to be sustainably utilised.

Prior to Namibian independence in 1990, fisheries in Namibian water were managed under a Regional Fisheries Management Organisation (RFMO) known as the International Commission for South East Atlantic Fisheries (ICSEAF). During this time fish resources were heavily exploited by foreign fishing fleets operating under ICSEAF as well as Illegal, Unreported and Unregulated fishing (IUU). The ICSEAF RFMO was disbanded in 1989, critically however, during the period of tenure of this organisation, several international measures were introduced under the United Nations Convention of the Law of the Sea (UNCLOS). This included the United Nations Fish Stocks Agreement for Highly Migratory Species, and the declaration of the 200 nm EEZ. Since independence, the Namibian government has taken over the management of its fisheries and drastically cut Total Allowable Catch (TAC) levels for key commercial species, which has allowed most fish stocks to recover to maximum sustainable levels (MFMR, August 2004). Namibia has gained international repute for its well-managed fishery and has become an exporter of quality fish products to countries including South Africa, Democratic Republic of the Congo, Mozambique, Spain, Italy and Portugal (MFMR, 2013).

The fishing industry is a cornerstone of the Namibian economy, generating approximately N$10 billion in export revenue (2016) - the second most important forex earner after mining, while it sustains some 16 800 direct jobs (Ministry of Fisheries and Marine Resources, 17 February 2017) - 70% of which are in the hake sector.

Each of these fisheries sectors are covered in the following overview of the current status of Namibian fisheries. Note also, because of the poor data records of these fisheries associated with irregular management, it is only since Namibian independence that attempts have been made to reconstruct the historical catches of these fisheries.

4.2 OVERVIEW OF THE STATUS OF NAMIBIAN FISHERIES SINCE 1990S

The Namibian fishing industry is the country's second largest export earner of foreign currency and the third largest economic sector in terms of contribution to the Gross Domestic Product (GDP). In terms of the value of production, Namibia ranks among the top ten fishing countries globally (Food and Agricultural Organization (FAO): http//www.fao.com.na). Supported by the high productivity of the Benguela upwelling ecosystem, abundant fish stocks have historically typified Namibian waters[4]. Fish resources in upwelling systems are typically high in biomass and relatively low in diversity (relative to non-upwelling environments). Commercial fish stocks, as found in the Benguela system typically support intensive commercial fisheries. Although varying in importance at different times in history, Namibian fisheries have focused on demersal species, small pelagic species, large migratory pelagic fish, linefish (caught both commercially and recreationally) and crustacean resources (e.g. lobster and crabs). Mariculture production is a developing industry based predominantly in Walvis Bay and Lüderitz Bay and surrounds. The main commercial

[3] Wikipedia, February 2017. https://en.wikipedia.org/wiki/Fishing_industry_by_country

[4] Noting that in the ICSEAF period these resources were over-exploited. The northern Benguela (Namibian waters) however remains a highly productive upwelling system resulting in proportionately (to many other countries) abundant commercial fish resources

fisheries, targeted species and gear types are shown in Table and recent TACs are presented in Table 4-2 below. The allocation of TACs and management of each fishing sector is the responsibility of MFMR.

Table 4-1: List of fisheries that operate within Namibian waters, targeted species and gear types used.

Fishery	Gear Type	Targeted Species
Mariculture	Long-lines, rafts	Pacific oysters, European oysters, Black mussel, Seaweed (Gracilaria sp.)
Small pelagic	Purse-seine	Sardine (*Sardinops sagax*), Horse mackerel (*Trachurus capensis*)
Mid-water trawl	Mid-water trawl	Horse mackerel (*Trachurus capensis)*
Demersal trawl	Demersal trawl	Cape hakes (*Merluccius paradoxus, M. capensis*), Monkfish (*Lophius vomerinus)*
Demersal longline	Demersal longline	Cape hakes (*Merluccius paradoxus, M. capensis*)
Large pelagic longline	Pelagic longline	Albacore tuna (*Thunnus alalunga*), Yellowfin tuna (*T. albacares*), Bigeye tuna (*T. obesus*), Swordfish (*Xiphias gladius*), shark spp.
Tuna pole	Pole and line	Albacore tuna
Line-fish	Hand line	Silver kob (*Argyrosomus inodorus*), Dusky kob (*A. coronus*)
Deep-sea crab	Demersal long-line trap	Red crab (*Chaceon maritae*)
Deep-water trawl	Demersal trawl	Orange roughy (*Hoplostethus atlanticus),* Alfonsino (*Beryx splendens*)
Rock Lobster	Demersal trap	Rock lobster (*Jasus lalandii*)

Table 4-1: Total Allowable Catches (tons) from 2009/10 to 2020/21 (supplied by Ministry of Fisheries and Marine Resources, Namibia).

Year	Sardine / Pilchard	Hake	Horse Mackerel	Crab	Rock Lobster	Monk
2009/10	17 000	149 000	230 000	2700	350	8 500
2010/11	25 000	140 000	247 000	2700	275	9 000
2011/12	25 000	180 000	310 000	2850	350	13 000
2012/13	31 000	170 000	310 000	3100	350	14 000
2013/14	25 000	140 000	350 000	3100	350	10 000
2014/15	25 000	210 000	350 000	3150	300	12 000
2015/16	15 000	140 000	335 000	3446	250	10 000
2016/17	14 000	154 000	340 000	3400	240	9800
2017/18	0	154 000	340 000	3400	230	9600
2018/19	0	154 000	349 000	3900	200	9600
2020/21*	0	154 000	349 000	3900	180	9600

Note: Deepwater trawl TAC is currently not applied for Alfonsino and Orange roughy. There is no TAC (output control) for albacore tuna – this is an effort (input) controlled sector with no restriction on catch.

“ *Provisional” noting that fishing rights not yet allocated and current rights and allowable catches subject to extension of 2018/19 allocations

Namibia has only two major fishing ports from which all the main commercial fishing operations are based namely, Walvis Bay and Lüderitz. In central Namibia, the major port is Walvis Bay and it is from this port that the majority of fishing vessels operate. Most of the fishing conducted from this port is, for economic and logistical reasons, directed at fishing grounds in the central and northern part of Namibia and to a lesser extent the southerly fishing grounds towards the South African border. A significant amount of fishing activity also takes place from Lüderitz, from where hake trawlers and longliners operate, as well as a small rock lobster fishery based in southern Namibian waters.

There are currently 116 Namibian-registered commercial fishing vessels. The dominant fleet comprises demersal trawlers that include both large freezer vessels (up to 70 m in length), as well as a smaller fleet of monk trawlers. These vessels fish year round, with the exception of a one month closed season in October, and range the length of the Namibian EEZ. There is a 200 m fishing depth restriction (i.e. no bottom trawling permitted shallower than 200 m). Prior to Namibian independence in 1990, a much larger fleet of trawlers existed, however Namibia now exercises strict effort control and vessel size limits. The only other fleets of significance are the mid-water trawlers that target horse mackerel and the large pelagic tuna long-line vessels. The mid-water fleet was historically uncontrolled and comprised of many large industrial vessels mostly of eastern origin (Ukranian and Russian). Currently these large midwater trawl vessels (mostly >100 m in length) operate in the northern waters of Namibia and are restricted to fewer than 20 vessels.

The large pelagic (tunas and shark) long-line vessels operate broadly in Namibian waters, but unlike the mid-water vessels, concentrate in the south near the South African border targeting the migrations of albacore and yellowfin tuna. The numbers of these vessels varies and is dependent on the seasonal availability of tuna and tuna-like species. The tuna pole (baitboat) vessels are a small fleet[5] and also increase in numbers depending on the number of licenses issued to South African boats. The tuna long-liners are also variable with the number of licenses issued to both Namibian flags and others (mostly Asian) fluctuating annually. The extent and number of these vessels is difficult to ascertain (as they are unpublished), although the actual numbers are limited and are less than the numbers of licensed Namibian boats.

There are few known foreign fishing vessels licensed to fish in Namibian waters, although the majority of the current mid-water fleet have permits to fish under foreign flag registration, but as a rule all licensed fishers must reflag under Namibia. There is a possibility that licenses may have been issued to foreign tuna boats, although these would be few in number and they would be closely monitored by the Namibian compliance units and their Vessel Monitoring System (VMS).

4.3 FISHERIES MANAGEMENT AND RESEARCH

The commercial exploitation of fish stocks is managed by MFMR, which is advised by the Ministry's National Marine Information and Research Centre (NatMIRC) in Swakopmund. TACs are set annually by the Minister on recommendation by an advisory council. Commercial fisheries are represented at industry level by the Confederation of Namibian Fishing Industries, and at fish species sector-specific level by the Midwater Trawling Association of Namibia, the Namibian Hake Association, Namibian Monk and Sole Association, Namibian Tuna and Hake Longlining Association and the Pelagic Fishing Association of Namibia.

MFMR conducts regular research (biomass) surveys for demersal, mid-water and small pelagic species. These surveys are normally fixed at specific times of the year and cover the entire continental shelf from the Angolan to the South African maritime borders. For example the demersal trawl surveys take place in January and/or February over the period of one month. MFMR surveys normally follow fixed transects from inshore to offshore. Surveys have a systematic transect design, with a semi-random distribution of stations along transects designed to statistically optimise the number of stations according to the area of every 100 m depth zone out to 500 m. Transects normally run perpendicular to the coastline are 20-80 nm long and

[5] The baitboat fleet consists of up to 20 Namibian vessels. This is a small number of vessels compared to South Africa. However, because of the variable and migratory nature of tuna, the number of vessels participating in the fishery varies depending on the seasonal and inter-annual availability of tuna. Namibia also licenses South African vessels to optimise the exploitation of these resources when they are available.

are spaced between 20 and 25 nm apart. Most of the sampling stations (trawls) take place during daylight hours.

Swept-area biomass surveys for hake are conducted annually to obtain an index of abundance, determine the geographical distribution and collect biological information of the stock. From 1990 to 1999, these surveys were conducted with the Norwegian R/V *Dr Fridtjof Nansen* (Sætersdal *et al* 1999). Since 2000, Namibian commercial trawlers (using the same trawl gears as that of the *Dr Fridtjof Nansen*) were used for the surveys. Since 2002, the commercial trawler *F/V Blue Sea 1*[6] has been used to conduct these surveys. These surveys are normally carried out over the period of one month during January and February and cover the entire continental shelf from the Angolan to the South African maritime border. The method of abundance estimation from these surveys is based on depth stratification and trawls range in depth from 100 m to 600 m. During trawling the vessel tows the net for a period of 30 minutes at a speed of approximately 3 knots.

Scientific acoustic surveys are carried out between February and March each year to estimate the biomass of small pelagic species (using the survey vessel F/V *Welwitchia*). These surveys cover the Namibian shelf from the coastline to the 500 m depth contour (and up to the 2000 m contour northwards of 18°30´S). The vessel surveys along pre-determined transects that run perpendicular to depth contours (East-West / West-East direction).

4.4 STOCK DISTRIBUTION, SPAWNING AND RECRUITMENT

The distribution patterns for the Namibian commercial stocks are summarised as follows:

- **The sardine stock** ranges along the entire Namibian coast, but in recent years predominantly from 25°S northwards to southern Angola, inshore of the 200 m bathymetric contour. The southern border of this range is demarcated by the Lüderitz upwelling front, a region of cold, upwelled water located off the port of Lüderitz. Historically, spawning occurred continuously from September to April with two seasonal peaks evident – the first from October to December in an inshore area between Walvis Bay and Palgrave Point and the second from February to March near the 200 m isobath between Palgrave Point and Cape Frio (King, 1977). The fishery collapsed in the 1960's and currently the status remains overexploited with a low biomass estimate and a significantly contracted distribution pattern compared to historical levels. The fishery is currently closed after a three-year moratorium was implemented on 01 January 2018 due to a significant population reduction. Scientific studies are underway to ascertain the causes (MFMR 2015 and 15 February 2019). The fishery remains closed (as at May 2021).

- **Cape horse mackerel** occurs predominantly north of 25°S with juveniles present in the inshore regions up to the 200 m isobath and adult horse mackerel populations extending into waters up to 500 m deep. Biomass estimates in this region are mostly low in summer and higher in winter and early spring. Abundance of horse mackerel is, therefore, higher at these times and increases availability of the species to the fisheries exploiting them. Spawning is heaviest in the north between October and March (O'Toole 1977).

- **Albacore tuna, yellowfin tuna, bigeye tuna, shark and swordfish** are large pelagic species with an extensive offshore distribution ranging along the entire Namibian coastline. The abundance of these species has a strong seasonal signal resulting in increased availability to the fisheries targeting them at different periods. For albacore tuna, availability increases from the last trimester (summer) and peaks in the first trimester (late summer to early autumn). Baitboats using pole and line target albacore tuna primarily in southern Namibia in the first trimester (January to March). For the pelagic longline sector targeting yellowfin tuna, bigeye tuna and swordfish, the availability of these target species is highest in the second and third trimesters. It is important to note that weather conditions play an important role in operations within the tuna fisheries (pole and line and long-line). With the onset of summer there is cold water upwelling as a result of increasing south-easterly winds. The

[6] Namibia now also has new research vessel, the *FV Mirabalis* undertaking routine fishery surveys

availability of longfin tuna is associated with this increased biological activity and bait fish (sardine and anchovy) abundance. The longline tuna fishing season peaks two to three months later than the fishery for albacore tuna.

- **Hake** is the most commercially important Namibian fishery. Within the Namibian EEZ the hake stock extends along the entire shelf and slope approximately between the 100 m and 1000 m isobaths. Hake spawn and recruit throughout the year with peaks in spawning thought to occur in early summer (Botha 1980, Olivar *et al*. 1988) along the shelf break off central Namibia.
- **Monkfish** is found along the entire extent of the Namibian coast, with the fishery concentrated between 17°15'S and 29°30'S at depths of 200 m to 500 m. Spawning is irregular and variable and is thought to occur throughout the year (Macpherson 1985) with two separate areas of recruitment recorded between the 100 m and 300 m isobaths off Walvis Bay and Lüderitz (Leslie and Grant 1990).
- **Deep-sea red crab stocks** are distributed predominantly from 23°35'S northwards into Angola within a depth range of approximately 300 m to 1000 m. Spawning takes place throughout the year (Le Roux 1997) on the shallower waters of the continental slope with adult females generally occurring at shallower depths to that of males.
- **Orange roughy** has a discontinuous pattern of distribution along the continental slope with concentrations of fish within four known spawning grounds (within designated Quota Management Areas) within the Namibian EEZ. The species has a short, intense spawning period of about a month from July to August (Boyer and Hampton 2001) during which period individuals aggregate. As a result of overexploitation of the stock(s), the fishery has been closed since 2007; however, the stock is currently being assessed with a view to considering the viability of re-opening the fishery.
- **Rock lobster** is found from 25°S to 28°30'S at depths shallower than 100 m. The depth distribution of adults varies seasonally in response to changes in the concentration of dissolved oxygen in the water. Adults moult during spring (males) and late autumn/early winter (females), with egg hatching peaking in October/November. Fishing activity is greatest over January and February with the number of active vessels declining towards the end of the fishing season in May.

The principle commercial fish species in Namibia undergo a critical migration pattern which is central to the sustainability of the small pelagic and hake fisheries. In Namibian waters, hake spawning commences north of the powerful Lüderitz upwelling centre (27°S) and continues up to the Angola–Benguela Front (16–19°S). Sardines and horse mackerel also spawn in the region between Lüderitz and the Angola–Benguela front. Circulation patterns at depth reveal complex eddying and considerable southward and onshore transport beneath the general surface drift to the north-west (Sundby *et al.* 2001). As eggs drift, hatching takes place followed by larval development. Settlement of larvae occurs in the inshore areas. Sardine spawning peaks 30–80 km offshore during September–October off the central Namibian shelf, with larvae occurring slightly further offshore and recruits appearing close inshore, so there appears to be a simple inshore–offshore movement over the Namibian shelf. Spawning also occurs in mid-summer in the vicinity of the Angola–Benguela Front (Crawford *et al.* 1987). During late summer (December – March) warm water from the Angolan Current pushes southwards into central Namibian waters, allowing pelagic spawning products to be brought into the nursery grounds off central Namibia. There is a high likelihood of substantial offshore transport associated with this convergent frontal region (Shannon 1985).

4.5 DESCRIPTION OF COMMERCIAL FISHING SECTORS AND FISHERIES RESEARCH SURVEYS

4.5.1 Small Pelagic Purse-Seine

The pelagic purse-seine fishery is based on the Namibian stock of Benguela sardine (*Sardinops sagax*) (also regionally referred to as pilchard), and small quantities of juvenile horse mackerel. The purse-seine fishery in Namibia commenced in 1947 following World War II and an increased demand for canned fish. The fishery was the largest by volume of fish landings in the Benguela ecosystem and grew rapidly until 1968, at which time the stock collapsed. Over the period 1960 to 1977, landings of pilchard averaged 580 000 tons per year and fell to a mere 46 000 tons in 1978. Following peak catches of 1.4 million tons recorded in 1968 (Cochrane et al., 2009; refer to Figure 4-3), there was a sharp decrease attributed to stock collapse due primarily to overfishing and environmental perturbations (Boyer et al. 2001). Since independence, Namibia has issued a small TAC of pilchard to sustain the small pelagic sector and to allow land-based factory turnover and in addition, they allow part of this catch to target juvenile horse mackerel (Kirchner et al., 2014). In recent years the resource base has been unable to sustain even these minimal TACs and the fishery has been closed and reopened on an ad hoc basis depending on resource availability. A three-year moratorium was implemented on 01 January 2018 due to a significant population reduction, and extensive scientific studies are underway to ascertain the causes (MFMR 2015 and 15 February 2019). This fishery is currently. Recent landings (2005 to 2017) are shown in Figure 4-4 and monthly trends in landings and catch composition are shown in Figure 4-5 (source MFMR, 2019).

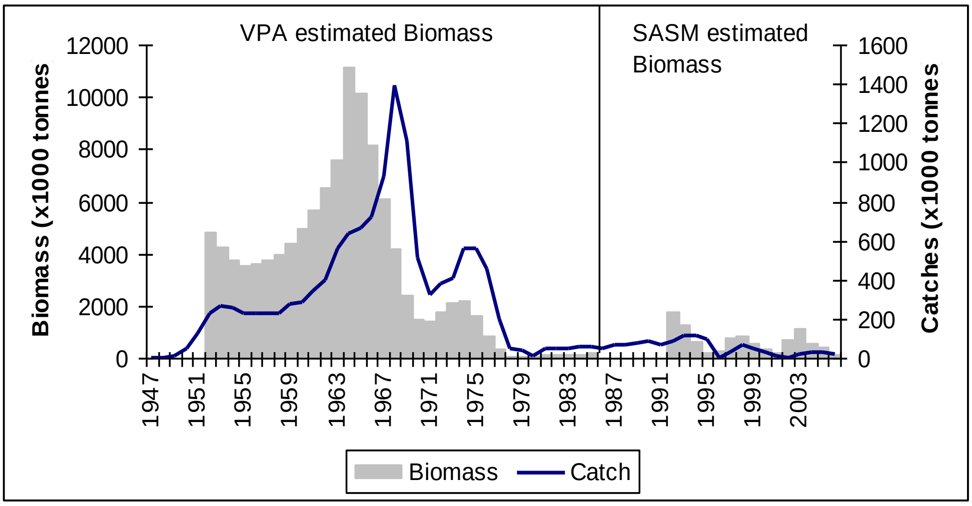

Figure 4-3: Biomass estimates from 1952-1985 of Namibian sardine (Virtual Population Analysis) from 1991-2006 as well as catches taken throughout this period (after Cochrane et al. 2009).

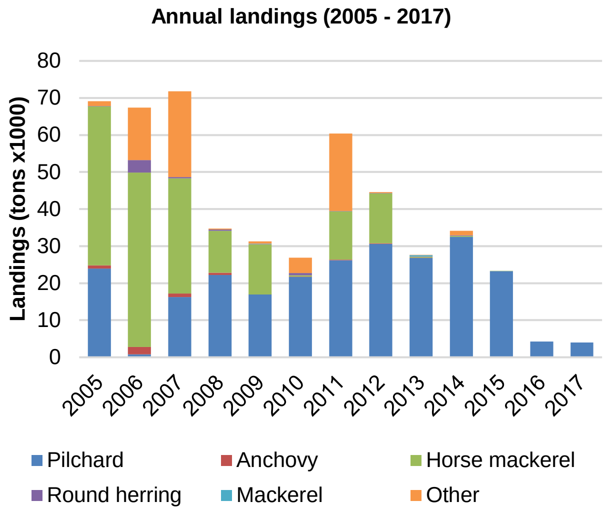

Figure 4-4: Annual landings (tons) of small pelagic species by the purse-seine sector from 2005 to 2017 (Source: MFMR).

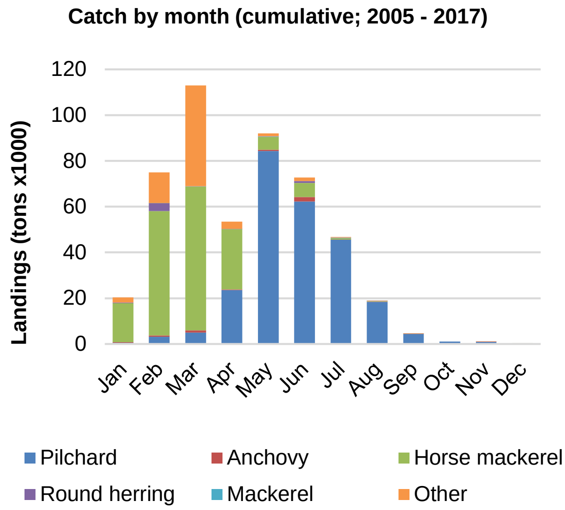

Figure 4-5: Monthly cumulative landings of small pelagic species by the purse-seine sector from 2005 to 2017 (Source: MFMR).

The industry operates from the harbour at Walvis Bay, except for the period 1964-1974 when Lüderitz was used as well. The small pelagic fleet consists of 36 wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 21 m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel will steam around it and encircle it with a large net, extending to a depth of 60 to 90 m (see Figure 4-6 and Figure 4-7). Netting walls surround aggregated fish, preventing them from escaping by diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped on board into the hold of the vessel. It is important to note that after the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered on board and this may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

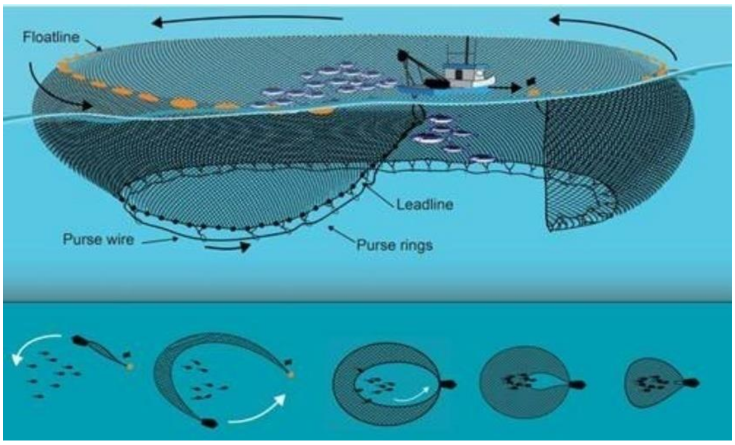

Figure 4-6: Schematic of typical purse-seine gear deployed in the small pelagic fishery (http://www.afma.gov.au/ portfolio-item/purse-seine).

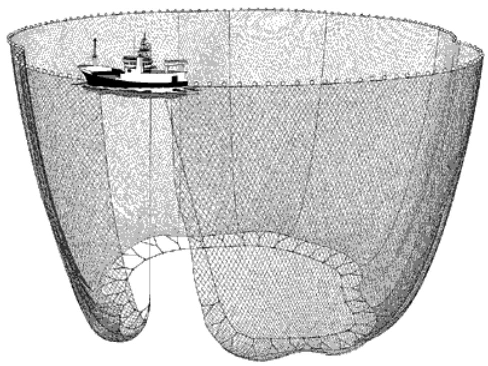

Figure 4-7: Typical configuration of purse-seine gear used to target small pelagic species (http://www.fao.org).

The extent of the stock distribution has effectively contracted since stock collapse, prior to which the historical distribution was throughout the Benguela system. Recent biomass surveys have shown small aggregations of the stock mostly located inshore of the 200 m isobath. The distribution of commercial fishing activity within the Namibian EEZ and in relation to ML 220 is shown in Figure 4-8. The fishery operates northwards of 25°S to the Angolan border primarily inshore of the 200 m depth contour and there is no overlap of fishing grounds with ML 220. The fishery has been closed since 2018 and remains closed (as at May 2021).

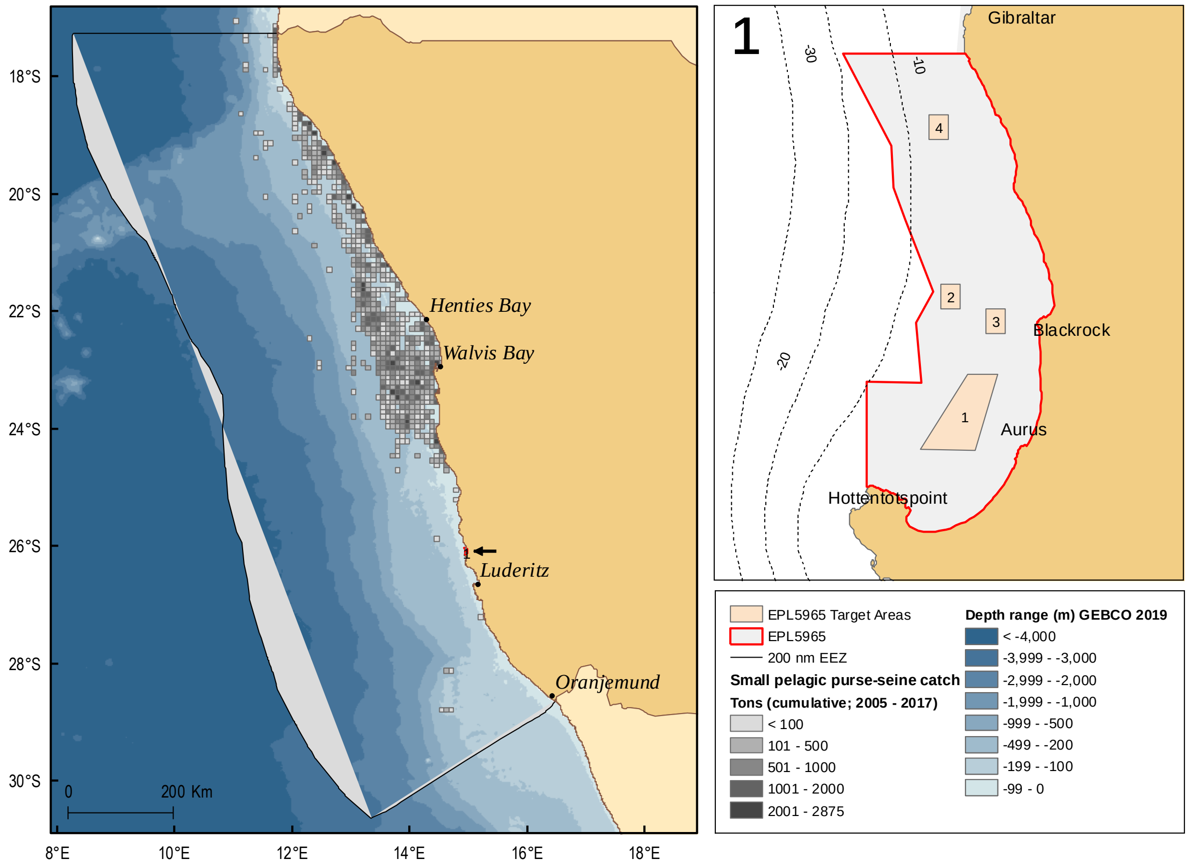

Figure 4-8: Spatial distribution of small pelagic purse-seine catch (2005 – 2017) within the Namibian EEZ and in the vicinity of ML 220 (EPL5965).

4.5.2 Midwater Trawl

The fishery for Cape horse mackerel (*Trachurus capensis*) is the largest contributor by volume and second highest contributor by value to the Namibian fishing industry. The stock is caught by the mid-water trawl fishery (targeting adult horse mackerel) and pelagic purse-seine fishery (smaller quantities of juvenile horse mackerel). The midwater fishery operates using trawls within the water column to catch schools of adult horse mackerel. The catch is either converted to fishmeal or sold as frozen, whole product with landings for the year 2006 valued at N$800 million (MFMR unpublished data in Kirchner *et al.*, 2010). The processing of horse mackerel is an emerging employment creator, as value addition through on-shore fish processing is a key strategy for revenue and job creation under Government's National Development Plan, NDP 5, together with development of mariculture (National Planning Commission, 2016).

The history of the sector in Namibian waters shows initial low catches reported in the early 1960s and a fluctuating but overall increase to a maximum of 600 000 tons in the early 1980s. Since the 1990s landings were on average 300 000 tons per year and the current TAC for horse mackerel is 349 000 tons (2020/21). Figure 4-9 shows the TACs set from 1997 to 2018 for the pelagic and midwater fisheries targeting the Namibian stock of horse mackerel.

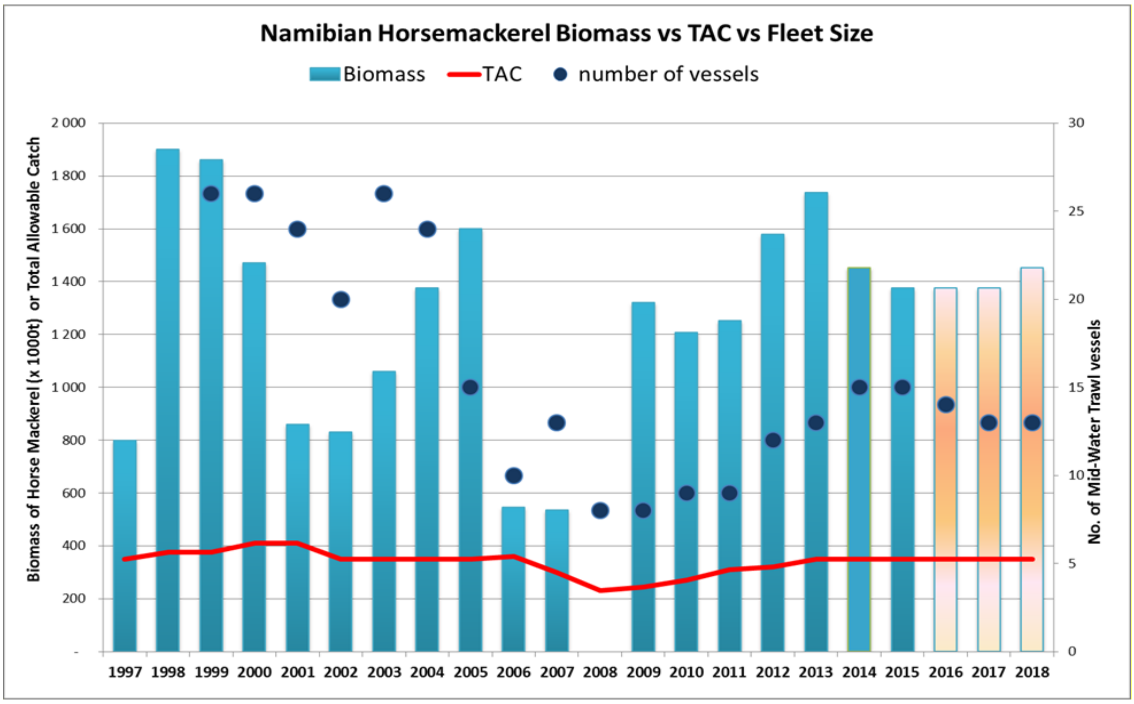

Figure 4-9: Estimated biomass of horse mackerel, TACs set for the mid-water fishery and number of licenced vessels (1997 to 2018).

Prior to independence, the fleet was dominated by various eastern block countries. After independence, the fishery underwent structural changes and it is currently mainly composed of the Russian fleet registered in Namibia but still operated by a foreign crew[7]. The fleet size has decreased since independence from 57 to 22 at present. Of these, only one is Namibian-flagged, although a further eight are based permanently in Namibia. Vessels range in length between 60 m and 120 m. In 2013, 67 rights-holders were registered within the mid-water trawl fishery, with the duration of rights ranging from seven to 15 years. Fishing rights are in the process of being reallocated and have as of yet not been finalised.

The target catch species is meso-pelagic (i.e. found at depths between 200 m and 1000 m above the sea floor (Crawford *et al*. 1987)) and shoals migrate vertically upwards through the water column between dusk and dawn. Mid-water trawlers exploit this behaviour (diurnal vertical migration) by adjusting the depth at which the net is towed (this typically varies from 400 m to just below the water surface). The net itself does not come into contact with the seafloor (unlike demersal trawl gear) and towing speed is greater than that of demersal trawlers (between 4.8 and 6.8 knots). Trawl warps are heavy, ranging from 32 mm to 38 mm in diameter. Net openings range from 40 m to 80 m in height and up to 120 m in width. Weights in front of, and along the ground-rope assist in maintaining the vertical opening of the trawl. To reduce the resistance of the gear and achieve a large opening, the front part of the trawl net is usually made from very large rhombic or hexagonal meshes. The use of nearly parallel ropes instead of meshes in the front part is also a common design. On modern, large mid-water trawls, approximately three quarters of the length of the trawl is made with mesh sizes above 400 mm. A schematic diagram showing the configuration of midwater trawling gear is shown in Figure 4-10.

[7] These are large industrial vessels, primarily of Russian origin, that are flagged as Namibian and must carry a proportion of Namibian crew. The right to fish horse mackerel is only permitted to Namibian nationals who charter these vessels to catch their fish allocations.

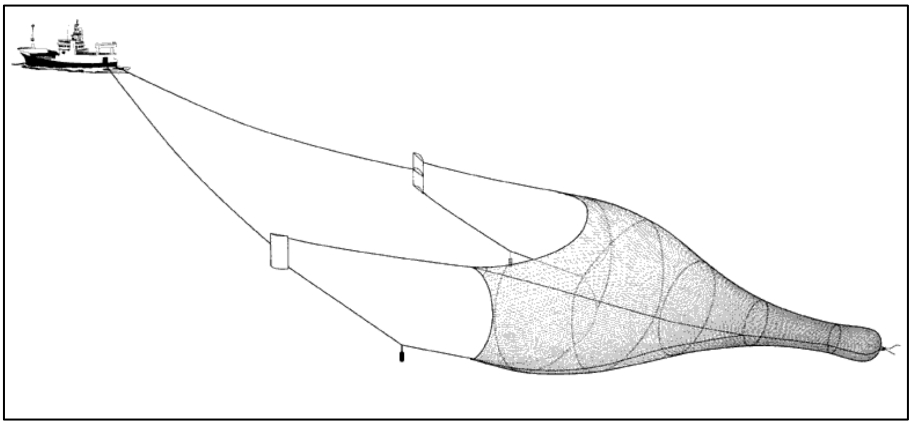

Figure 4-10: Typical gear configuration used during mid-water trawling operations.

The fishery operates year-round with relatively constant catch and effort values by month. The mid-water trawl fleet operates exclusively out of the port of Walvis Bay and fishing grounds extend north of 25ºS to the border of Angola. Juvenile Cape horse mackerel move into deeper water when mature and are fished mostly between the 200 m and 500 m isobaths towards the shelf break. The distribution of horse mackerel-directed fishing grounds in relation to the Namibian EEZ is shown in Figure 4-11. The southern extent of fishing activity is situated 108 km north-west of the ML 220 and there is no overlap.

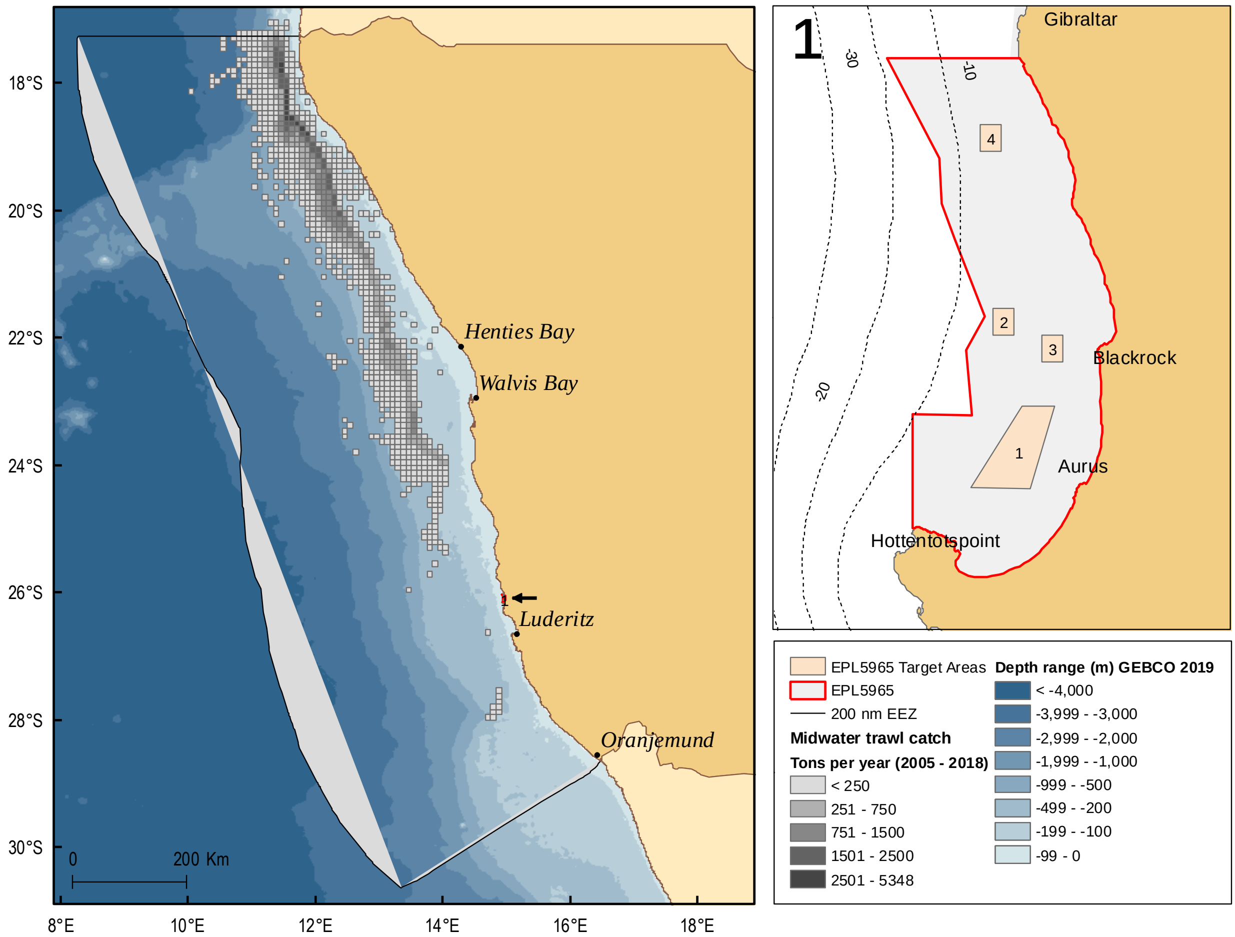

Figure 4-11: Spatial Distribution of Midwater Trawl Catch (2005 – 2018) within the Namibian EEZ and in relation to ML 220 (EPL5965).

4.5.3 Demersal Trawl

The most economically important species in Namibia are shallow-water hake (*Merluccius capensis*) and deepwater hake (*Merluccius paradoxus*). Shallow-water hake is the predominant species, but, because they look very similar, it is difficult to record data separately and the two species are managed as one stock. A proportion of the smaller vessels in demersal trawl fleet target monkfish (*Lophius* spp.), sole and kingklip.

Catches of hake in Namibian waters reached almost 1 million tons in the mid-1970s at the peak of their exploitation (some believe this was a gross underestimated) and was fished by many nations including eastern-block countries, South Africa and Spain (which remains significantly involved in Namibian fisheries). The fishery is currently managed through a TAC, which varies from year to year with a current annual hake TAC of 154 000 tons (2020/21). TACs for hake and monkfish over the period 1991 to 2018 are shown in Figure 4-12. The fishery is active year-round except for a closed period during October each year (see Figure 4-13).

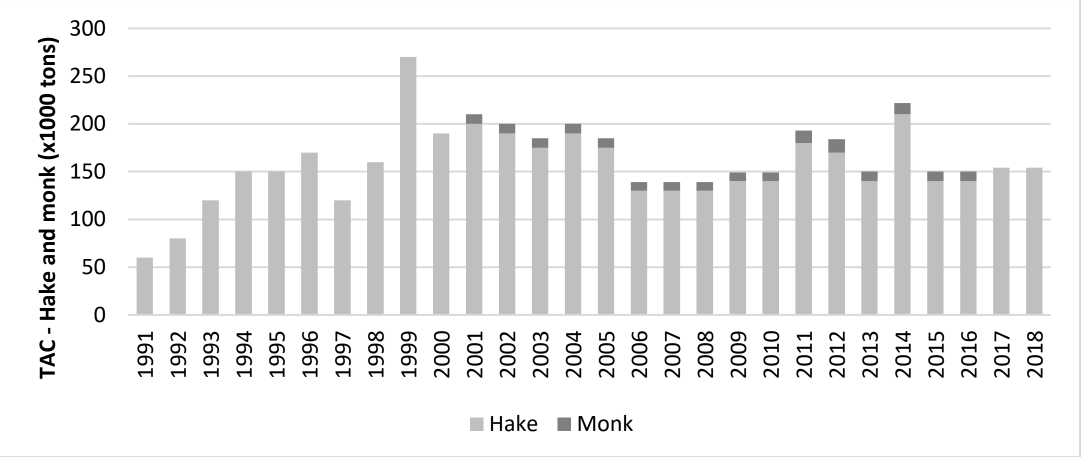

Figure 4-12: Total Allowable Catch set for Hake and Monkfish from 1991 to 2018.

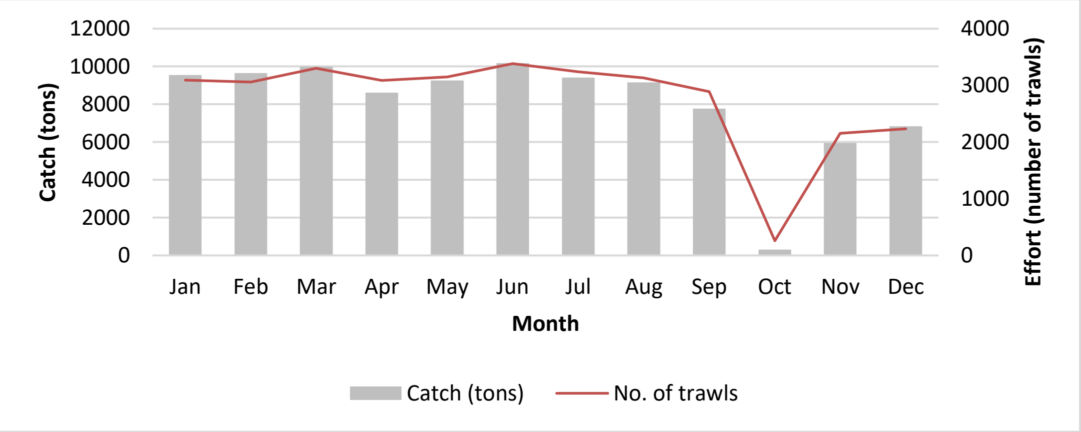

Figure 4-13: Average landings by month reported for wetfish trawlers from 2005 to 2017.

A fleet of 71 demersal trawlers are currently licensed to operate within the fishery. The deep-sea fleet is divided into wetfish and freezer vessels (70:30 ratio is prescribed) which differ in terms of the capacity for the processing of fish offshore (freezers process at sea and wetfish vessel land fish at factories ashore for processing) and in terms of vessel size and capacity (shaft power of 750 – 3 000 kW). Wetfish vessels have an average length of 45 m, are generally smaller than freezer vessels which may be up to 90 m in length. Whilst freezer vessels may work in an area for up to a month at a time, wetfish vessels may only remain in an area for about a week before returning to port (catch is retained on ice). The majority of trawlers operate from the port of Walvis Bay, with fewer vessel operating from Lüderitz.

Trawl gear is towed astern of the vessel and configurations are similar for both freezer and wetfish vessels (refer to Figure 4-14). Typical demersal trawl gear configuration consists of:

- Steel warps up to 32 mm diameter - in pairs up to 3 km long when towed;
- A pair of trawl doors/otter boards (500 kg to 3 tons each);
- Net footropes which may have heavy steel bobbins attached (up to 24" diameter) as well as large rubber rollers ("rock-hoppers"); and
- Net mesh (diamond or square shape) is normally wide at the net opening whereas the bottom end of the net (or cod-end) has a 130 mm stretched mesh.

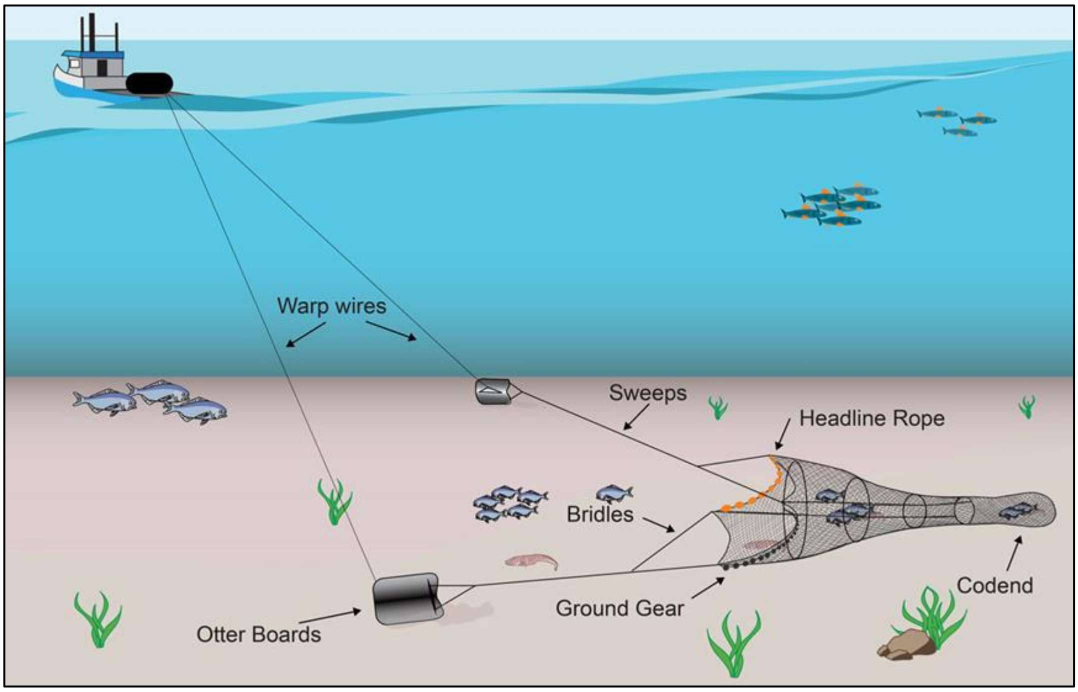

Figure 4-14: Schematic diagram of trawl gear typically used by deep-sea demersal trawlers targeting hake (Source: http://www.afma.gov.au/portfolio-item/trawling

Otter trawling is the main trawling method used in the Namibian hake and monk-directed fisheries. This method of trawling makes use of trawl doors (also known as otter boards) that are dragged along the seafloor ahead of the net, maintaining the horizontal net opening. Bottom contact is made by the footrope and by long cables and bridles between the doors and the footrope. Behind the trawl doors are bridles connecting the doors to the wings of the net (to the ends of the footrope and headrope). A headline, bearing floats and the weighted footrope (that may include rope, steel wire, chains, rubber discs, spacers, bobbins or weights) maintain the vertical net opening. The "belly", "wings" and the "cod-end" (the part of the net that retains the catch) may contact the seabed.

Generally, trawlers tow their gear at 3.5 knots for two to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net opening may be up to 50 m in width and 10 m in height and the swept area on the seabed between the doors may be up to 150 m. The opening of the net is maintained by the vertical spread of the trawl doors, which are in contact with the seafloor. There is a wide range of ground gear configurations used with different companies, vessels and skippers using different combinations that have varied over time, in different grounds and with different fishing strategies relating to market demands. The intention in demersal hake trawling is to have the ground gear in close contact with the seafloor surface and to skim over it rather than to dig into the ground although trawl doors often penetrate up to 150 mm into the seafloor on soft grounds. Footrope protection such as the use of wire in the footrope, bound ropes along the footrope, the addition of rubber disks or rollers (large rollers are considered rock hoper gear or rubber or steel bobbins at regular intervals along the footrope is required, particularly for fishing in hard or irregular ground.

Fishing grounds extend along the entire coastline following the distribution of hake and monkfish along the continental shelf at a depth range of 200 m[8] to approximately 850 m. The total extent of fishing grounds used by the demersal trawl fleet is approximately 78,895 km². Figure 4-15 shows these fishing grounds in relation to the Namibian EEZ and ML 220. The closest fishing activity is situated at the 300 m depth contour at least 50 km from the area and there is no overlap.

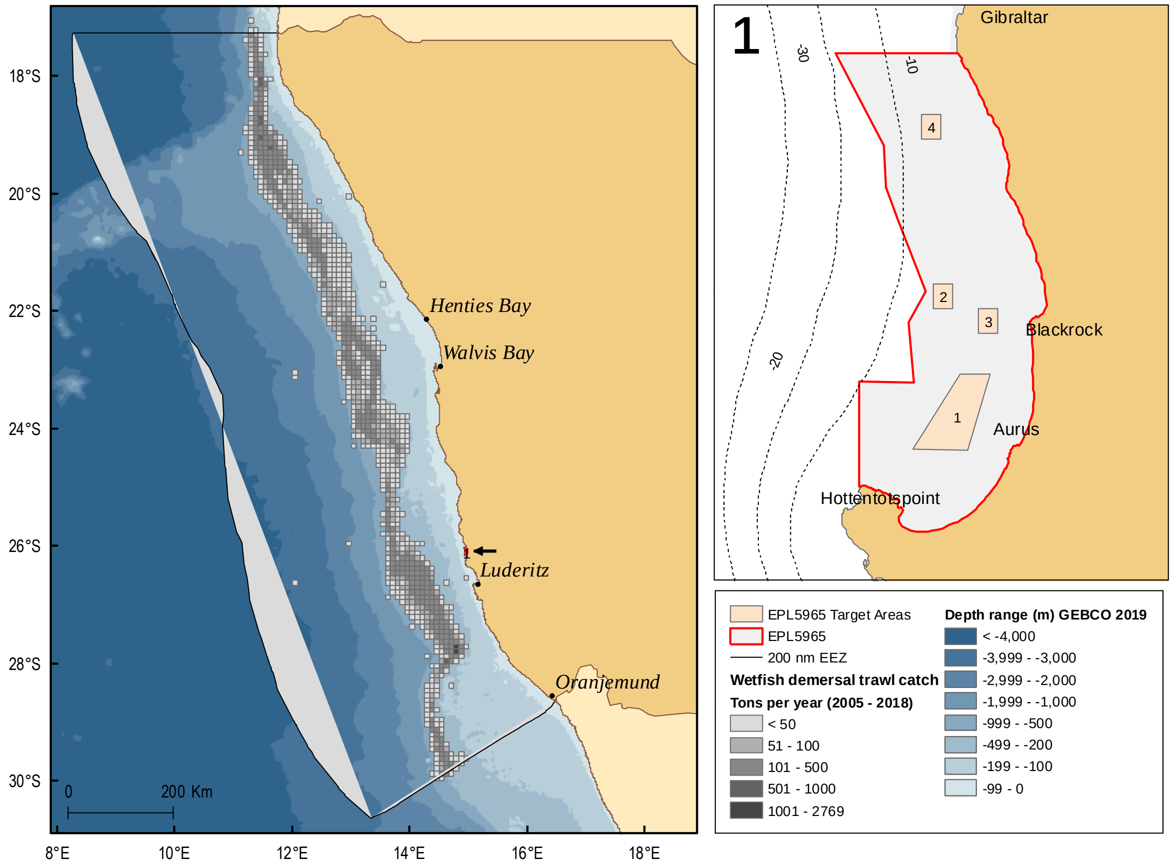

Figure 4-15: Spatial distribution of the catch of hake (2005 – 2018) by demersal trawl vessels in the Namibian EEZ and in relation to ML 220 (EPL5965).

4.5.4 Demersal Longline

Similar to the demersal trawl fishery the target species of this fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. The catch packed unfrozen, on ice, and is landed as either prime quality (PQ) or headed and gutted. A total hake TAC of 154 000 tons was set for 2020/21 but less than 10 000 tons of this is caught by longline vessels. Figure 4-16 shows annual landings recorded by the sector from 2005 to 2018. Vessels operate year-round but operations are particularly low in October (see Figure 4-17).

[8] Namibia has a designated area closed to most "offshore" fishing activities under 200 m water depth i.e. to protect potential spawning areas as well as areas of high juvenile abundance for most demersal species, including hake. Demersal trawling is prohibited in waters shallower than 200 m.

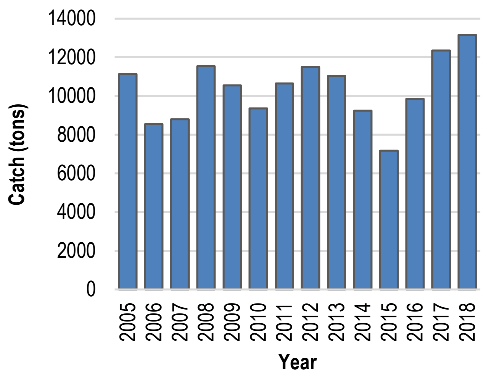

Figure 4-16: Landings recorded for the Namibian demersal long-line sector from 2005 to 2018.

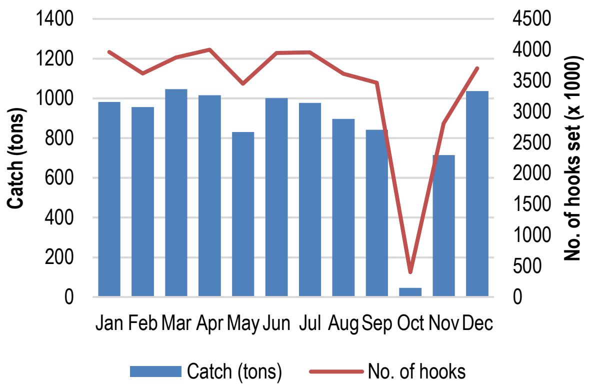

Figure 4-17: Average monthly catch (tons) recorded by the Namibian demersal longline sector between 2005 and 2018.

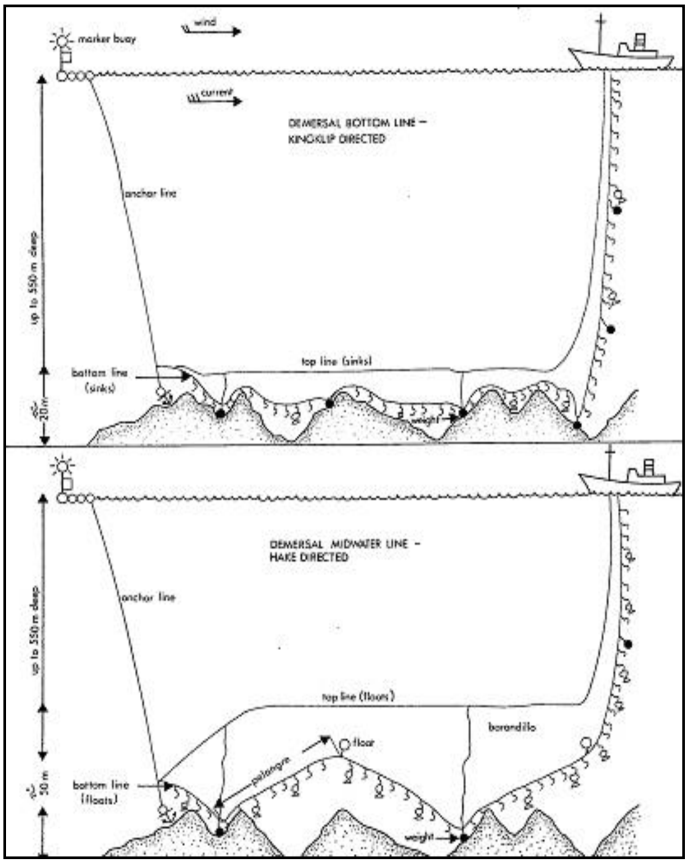

Figure 4-18: Typical configuration of demersal (bottom-set) gear used within the demersal longline fishery (Source: Japp, 1989).

A demersal longline vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor (see Figure 4-18). Steel anchors, of 40 to 60 kg are placed at the ends of each line to anchor it. These anchor positions are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16 mm diameter) is more buoyant than the bottom line, it is raised off the seafloor and minimizes the risk of snagging or fouling. The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically 20 – 30 nautical miles in length. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of 5 – 9 knots. Once deployed the line is left to soak for up to eight hours before retrieval commences. A line hauler is used to retrieve gear (at a speed of approximately 1 knot) and can take six to ten hours to complete. Long-line vessels are similar in size and power to wet-fish trawlers and may vary in length from 18 m to 50 m and remain at sea for four to seven days at a time.

Namibia has a designated area closed to most "offshore" fishing activities under 200 m water depth i.e. to protect potential spawning areas as well as areas of high juvenile abundance for most demersal species, including hake. Longline vessels fish in similar areas targeted by the hake-directed trawling fleet, in a broad area extending from the 200 m to 650 m contour along the full length of the Namibian coastline. Some 18 vessels operate within the sector. Those based in Lüderitz work South of 26°S towards the South African border while those based in Walvis Bay operate between 23°S and 26°S and North of 23°S. Figure 4-19 shows the distribution of catch reported within the Namibian EEZ. The closest fishing activity is situated roughly at the 300 m depth contour at least 50 km from ML 220 and there is no overlap expected.

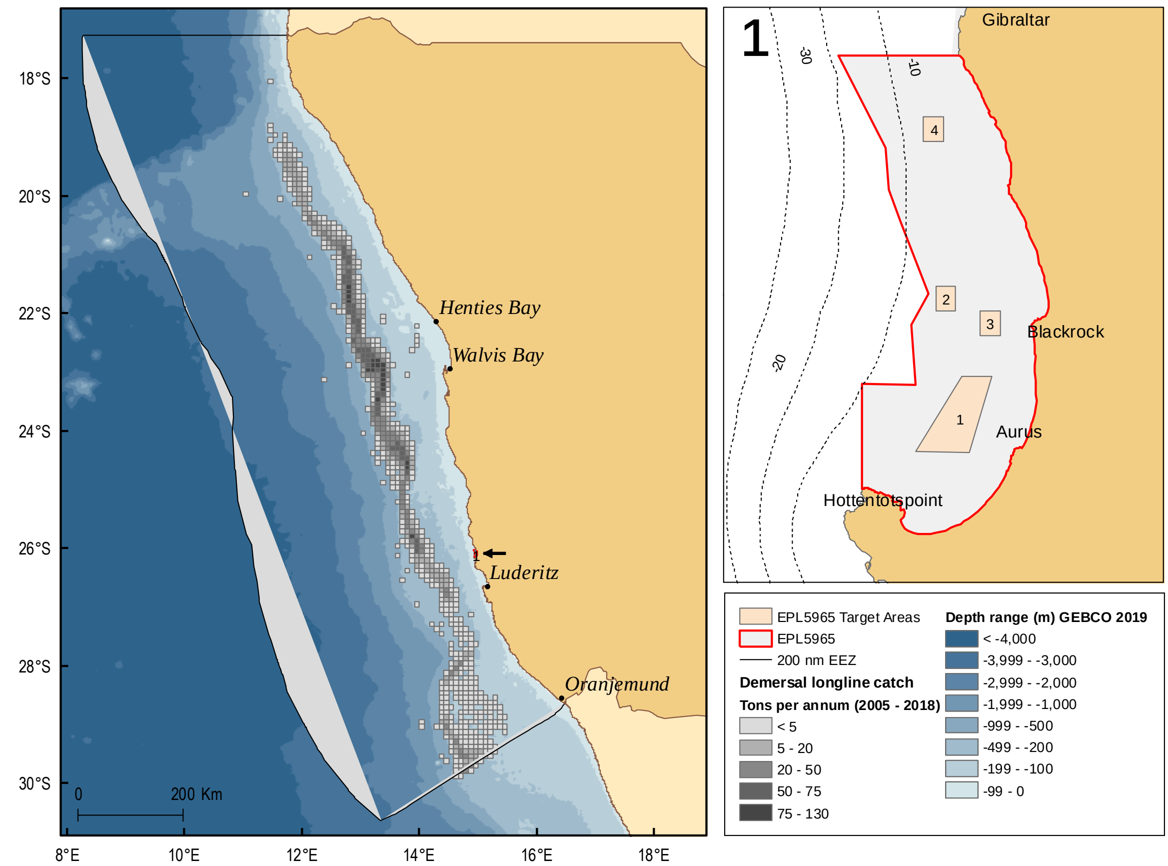

Figure 4-19: Spatial distribution of catch (2005 – 2018) reported by the demersal longline fishery targeting Cape hakes (M. capensis; M. paradoxus) within the Namibian EEZ and in relation to ML 220 (EPL5965).

4.5.5 Large Pelagic Longline

This sector makes use of surface long-lines to target migratory pelagic species including yellowfin tuna (*T. albacares*), bigeye tuna (*T. obesus*), swordfish (*Xiphias gladius*) and various pelagic shark species. Commercial landings of these species by the fishery is variable and Namibian-reported catch from 1992 to 2018 is shown in Figure 4-20 (ICCAT, 2020). There is provision for up to 26 fishing rights and 40 vessels (http://www.mfmr.gov.na/).

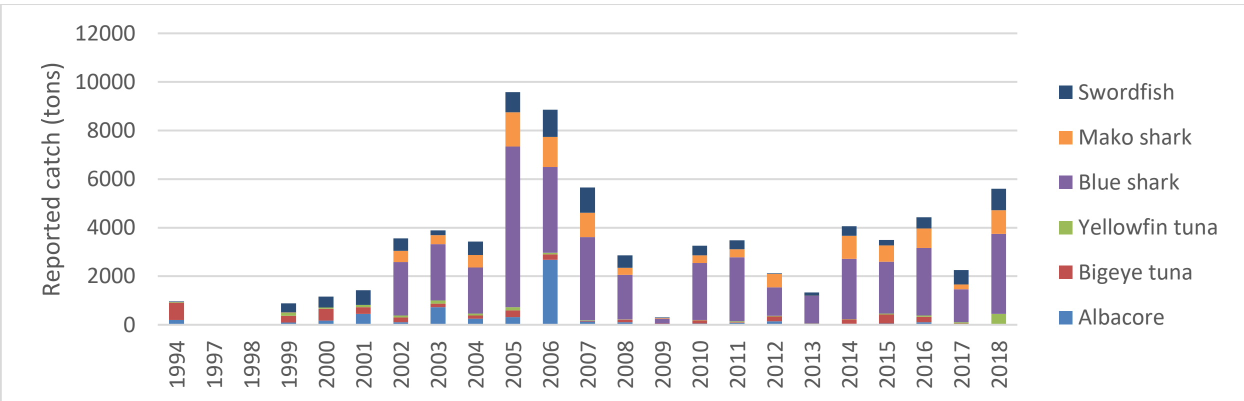

Figure 4-20: Total nominal catch (tons) of species targeted by the Namibian large pelagic longline fishery between 1992 and 2018. Source: ICCAT statistical bulletin, 2020.

Yellowfin tuna are distributed between 10°S and 40°S in the south Atlantic, and spawn in the central Atlantic off Brazil in the austral summer (Penney *et al.* 1992). According to Crawford *et al.* (1987) juvenile and immature yellowfin tuna occur throughout the year in the Benguela system. After reaching sexual maturity they migrate (in summer) from feeding grounds off the West Coast of southern Africa to the spawning grounds in the central Atlantic. Bigeye tuna occurs in the Atlantic between 45°N and 45°S. Spawning takes place in the Gulf of Guinea and in the eastern central Atlantic north of 5°N and it is thought that bigeye tuna migrate to the Benguela system to feed. Swordfish spawn in warm tropical and subtropical waters and migrate to colder temperate waters during summer and autumn months. Tuna are targeted at thermocline fronts, predominantly along and offshore of the shelf break. Pelagic longline vessels set a drifting mainline, up to 50-100 km in length, and are marked at intervals along its length with radio buoys (Dahn) and floats to facilitate later retrieval (see Figure 4-21). Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Between radio buoys the mainline is kept near the surface or at a certain depth by means of ridged hard-plastic buoys, (connected via a "buoy-lines" of approximately 20 m to 30 m). The buoys are spaced approximately 500 m apart along the length of the mainline. Hooks are attached to the mainline on branch lines, (droppers), which are clipped to the mainline at intervals of 20 m to 30 m between the ridged buoys. The main line can consist of twisted tarred rope (6 mm to 8 mm diameter), nylon monofilament (5 mm to 7.5 mm diameter) or braided monofilament (~6 mm in diameter). A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. Refer to Figure 5-19 for a schematic diagram of pelagic longline gear and Figure 4-22 for photographs of an example of vessel, marker buoys and lines. Effort occurs year-round with a slight peak over the period March to May (see Figure 4-23).

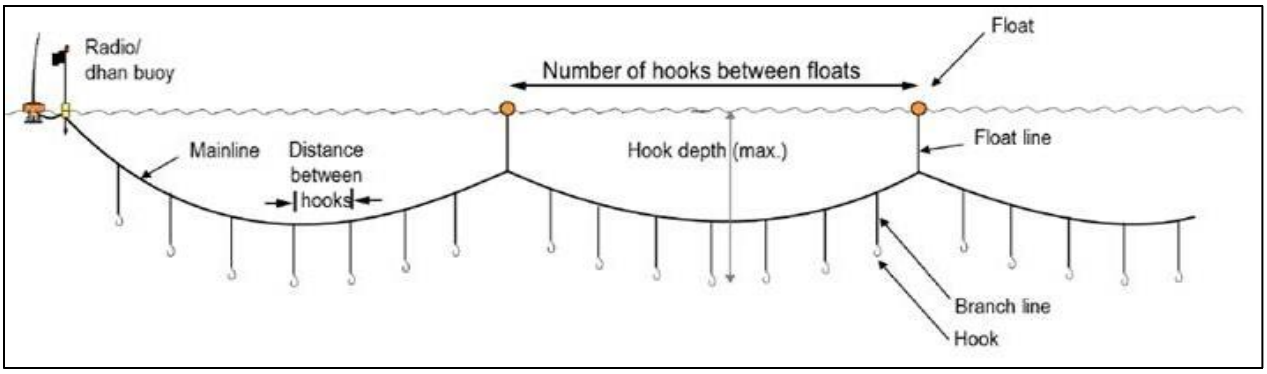

Figure 4-21: Schematic diagram of gear typically used by the pelagic long-line fishery (Source: IOTC ROSS Observer Training Manual, 2015).

Figure 4-22: Photographs showing marker buoys (left), radio buoys (centre) and monofilament branch lines (right) (Source: CapMarine, 2015).

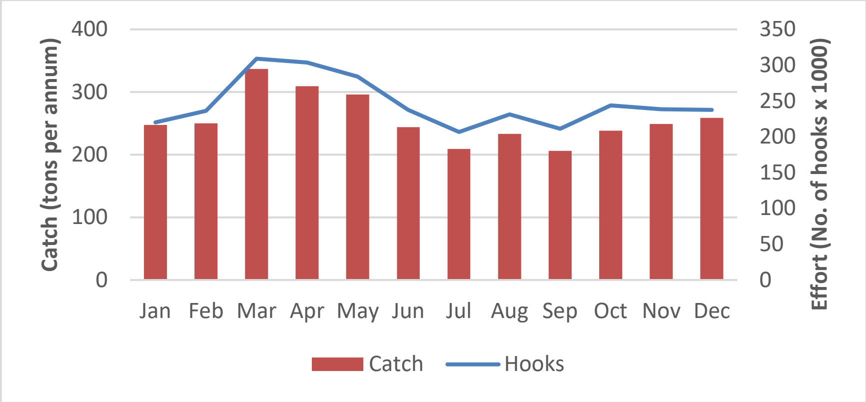

Figure 4-23: Monthly average catch and effort recorded within the large pelagic longline sector within Namibian waters (2003 – 2019).

Longline vessels targeting pelagic tuna species and swordfish operate extensively around the entire coast along the shelf-break and into deeper waters. The spatial distribution of fishing effort is widespread and may be expected predominantly along the shelf break (approximately along the 500 m isobath) and into deeper waters (2 000 m). Because the gear used by this fishery drifts along with surface currents, lines cover a large area during the time that they are deployed. The spatial mapping of the catch and effort used in this assessment is based on the position recorded at the start of line setting and does not take into account the large area covered by the mobile gear before it is retrieved. Figure 4-24 shows the spatial distribution of commercial catches within the Namibian EEZ. Fishing activity is situated least 100 km from ML 220 and there is no overlap.

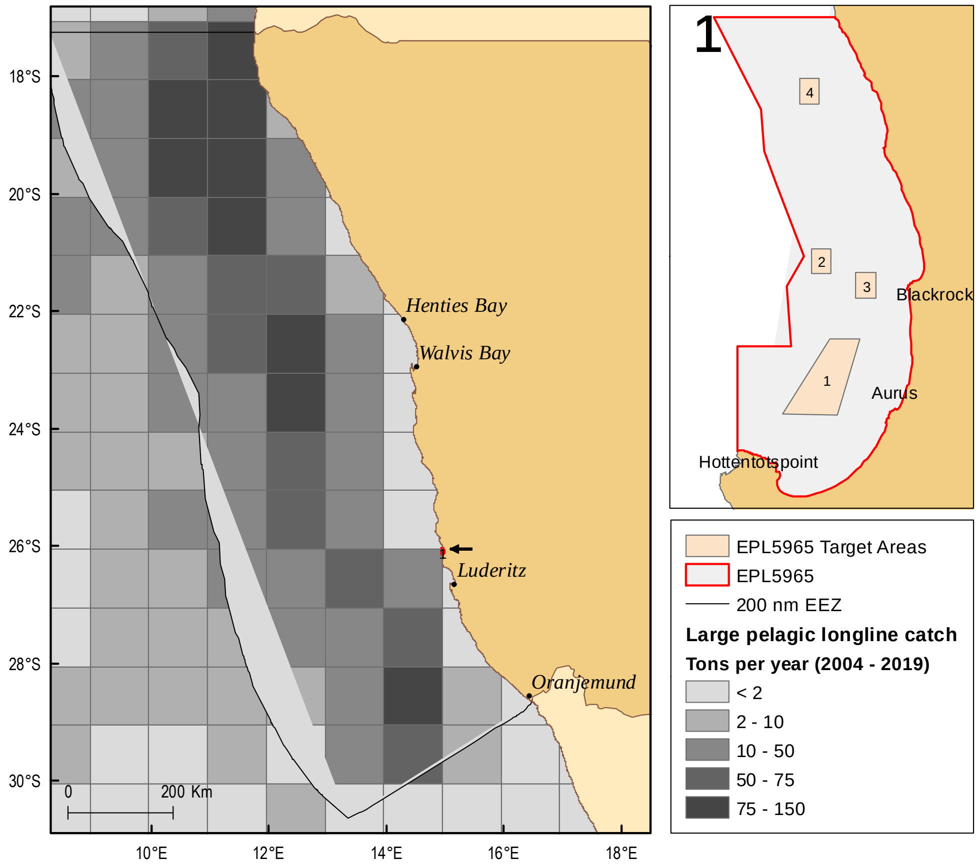

Figure 4-24: Spatial distribution of catch recorded by the pelagic longline fishery within the Namibian EEZ and in relation to ML 220 (EPL5965). Catch is displayed on a 60 x 60 minute grid (average catch per year over the period 2003 to 2019).

4.5.6 Tuna Pole-and-Line

Poling for tuna is predominantly based on the southern Atlantic albacore (longfin tuna) stock (*T. alalunga*) and a very small amount of skipjack tuna (*Katsumonus pelamis*), yellowfin tuna and bigeye tuna. Namibia's quota for tuna and swordfish is allocated by the International Commission for Conservation of Atlantic Tunas (ICCAT), of which Namibia is a member. Catches of albacore tuna for Namibia and South Africa apply to what is referred to as the Atlantic "southern stock" (ICCAT Statistical Bulletin 2012).

Albacore are a temperate species of tuna, favouring subtropical ocean waters of 16° to 20°C (Penney et al 1998). Albacore found in the waters off the coast of southern Africa are proposed to originate from the south Atlantic stock (Penrith 1963, Yeh et al 1996, Penney et al 1998), with some degree of mixing of individuals between the Atlantic and Indian Oceans (Morita 1978, ICCAT Report 2011). Southern albacore migrate annually through their Atlantic distribution range between 10°S and 40°S. Nepgen (1971) noted that juvenile and sub-adult albacore are present in the Benguela region throughout the year. They migrate locally along the west coast feeding at upwelling and topographically induced fronts (Penney et al 1992). The pole-and-line (also referred to as baitboat) and long-line fisheries target albacore that occur in four main areas of the Benguela region: the Vema Seamount off Namibia, Tripp Seamount south of Lüderitz, South Bank south of Hondeklip Bay and the Cape Canyon (Penney et al 1992). Adults of the population occur mostly off Brazil, Argentina and Namibia (Penney et al 1992).

Because of the irregular data availability and dependence on reporting of both South African and Namibian catches to the Regional Fishery Management Organisation (RFMO) (ICCAT) interpretation of catching performance is split between the South African and Namibian data. Overall baitboat catch rate trends exhibit large fluctuations, with a somewhat declining overall trend (ICCAT, 2012). Catch records start from 1960 and climbed steeply in the 1970's and peaked in the late 1990s. Thereafter, catches tapered off to between 6000 tons and 8000 tons per year but have steadily declined since 2009, to below 6000 tons in 2015. In 2016, the estimated Namibian and South African catches were below that of the previous five year (ICCAT, 2018) and in 2018, Namibian catches declined to approximately 874 tons (ICCAT, 2020).

Figure 4-25 shows the total catches of albacore and yellowfin tuna by the South African and Namibian tuna pole ("baitboat") sectors, combined, as well as the relative proportion of the Namibian component of the catch which approximates 20% of the total reported for the two target species.

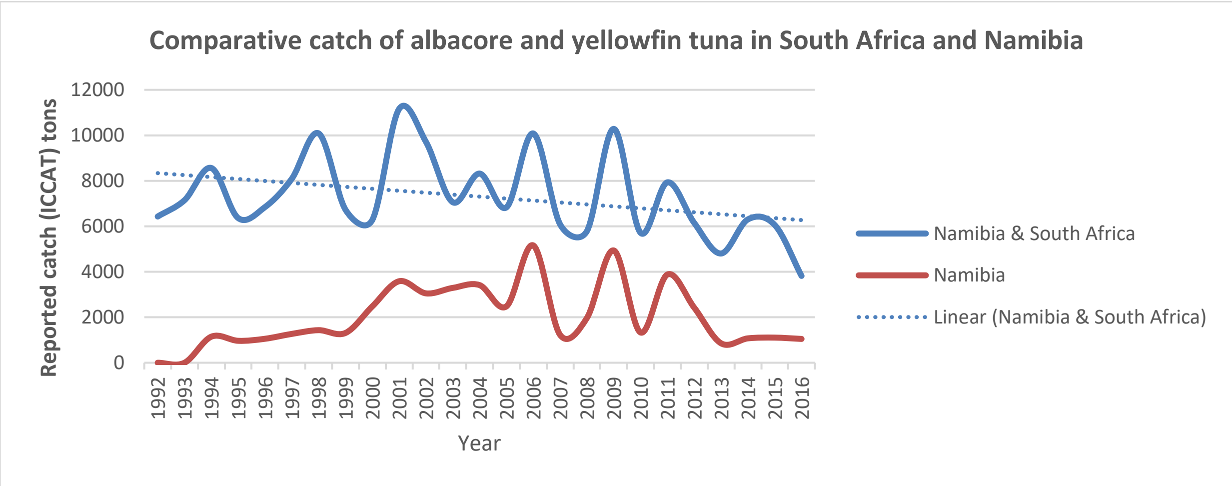

Figure 4-25: Total nominal baitboat and longline catch (tons) of longfin (albacore) and yellowfin tuna reported by South Africa and Namibia between 1992 and 2016. Source: ICCAT statistical bulletin, 2018.

Vessels operating within the fishery are typically small (< 25 m in length). Catch is stored on ice, chilled sea water or frozen and the storage method often determines the range of the vessel. Trip durations average between four and five days, depending on the distance of the fishing grounds from port. Vessels drift whilst attracting and catching pelagic tuna species. Whilst at sea, the majority of time is spent searching for fish with actual fishing events taking place over a relatively short period of time. Sonars and echo sounders are used to locate schools of tuna. At the start of fishing, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface, thereby attracting tuna to the surface. Live bait is flung out to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the 2 to 3 m poles are fitted with a short length of fishing line leading to a hook. Hooked fish are pulled from the water and many tons can be landed in a short period of time. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (see Figure 4-26). The nature of the fishery and communication between vessels often results in a large number of these vessels operating in close proximity to each other at a time. The vessels fish predominantly during daylight hours and as they do not anchor or have any fixed gear in the water, these vessels remain manoeuvrable.

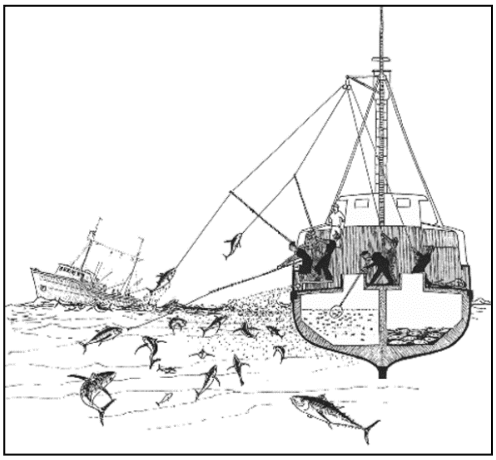

Figure 4-26: Schematic diagram of pole and line operation (www.fao.org/fishery).

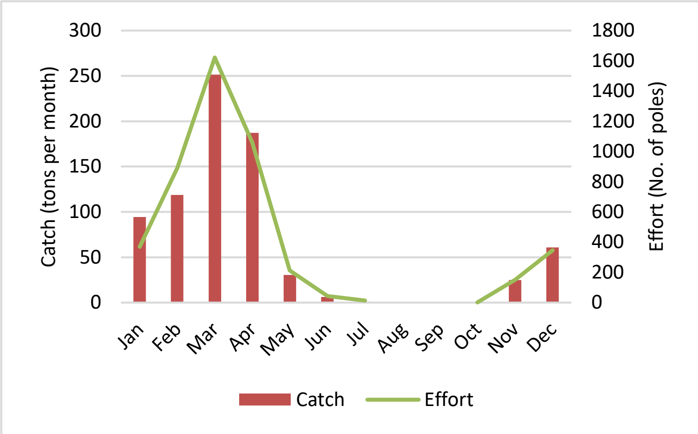

Figure 4-27: Average monthly catch and effort recorded by the tuna pole and line fleet in Namibian waters (2003 – 2019). Source: MFMR, 2020.

Approximately 36 South African pole and line vessels operate under arrangements with Namibian right holders each year, however, the number of active vessels and landed catch have recently shown a decline. As already discussed, the fishery is seasonal with vessel activity mostly between December and May and peak catches in March and April (see Figure 4-27). Effort fluctuates according to the availability of fish in the area, but once a shoal of tuna is located a number of vessels will move into the area and target a single shoal which may remain in the area for days at a time. As such the fishery is dependent on window periods of favourable conditions relating to catch availability.

Aggregations of albacore tuna occur in specific areas, in particular Tripp Seamount which is situated just north of the South Africa/ Namibia maritime border. Catches in this area are variable from year to year, although boats will frequent the area knowing that albacore aggregate around the seamount after migrating through South African waters. The movement of albacore between South Africa and Namibia is not clear although it is believed that the fish move northwards following bathymetric features and generally stay beyond the 200 m depth contour. Figure 4-28 shows the spatial distribution of fishing effort within the Namibian EEZ and in relation to ML 220 (EPL 5965). There is evidence of sporadic catch of albacore in the vicinity, offshore of the 50 m depth contour, but fishing within ML 220 is considered improbable.

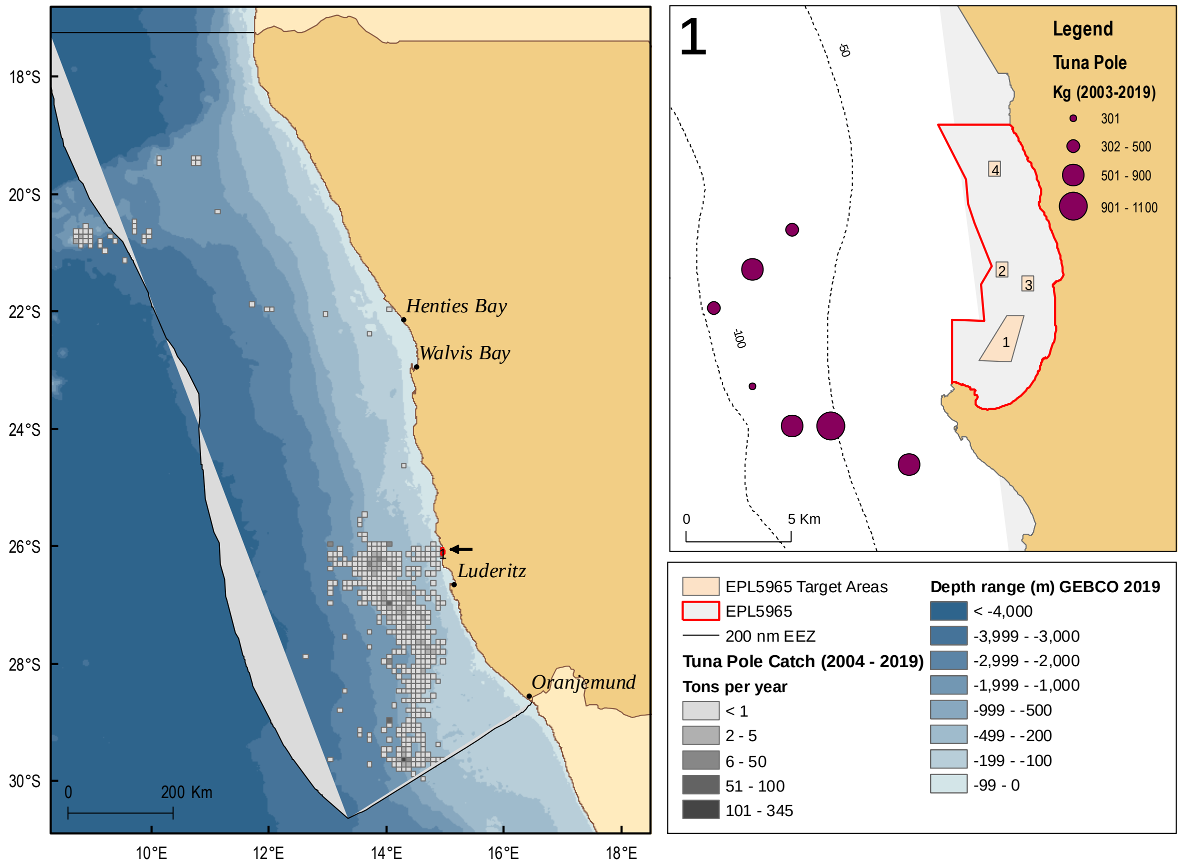

Figure 4-28: Spatial distribution of fishing effort expended by the tuna pole and line fleet (2003 – 2019) within the Namibian EEZ and in relation to ML 220 (EPL5965).

4.5.7 Linefish

The traditional line fishery primarily targets snoek (*Thyrsites atun*) with bycatch of yellowtail, silver kob (*Argyrosomus inodorus*), dusky kob (*A. coronus*), and shark, which are sold on the local market. Snoek availability to the fishery is seasonal. Catches peak in late summer whereafter the fish migrate south into South African waters. The other species caught, such as kob and shark occurs year round, but is in relatively small amounts. Operationally the fishery is limited in extent to Walvis Bay, Swakopmund and Henties Bay and also due to the small size of the boats does not operate much further than 12 nm offshore (i.e. 22 km). There is also a small component of the fishery operating out of Lüderitz in the South. The two commercial components of the linefish sector comprise a fleet of up to 26 small deck boats. Commercial operators sell linefish on the local market as well as exporting regionally to South Africa and Zimbabwe.

Average monthly landings are shown in Figure 4-29 with catches dropping in the mid-winter period with catches increase from spring into summer. This trend is associated with both the availability of snoek and also with weather and sea conditions which make it difficult for the fishery to operate during this time due to the small size of the boats used. The sector operates inshore of the 200 m depth contour and into coastal waters. The spatial distribution of linefish catch within the Namibian EEZ and in relation to ML 220 is shown in Figure 4-30. Fishing activity is reported to the nearest minute (approximately equivalent to one nautical mile) and has been redisplayed at a gridded resolution of 5 nautical miles. There is evidence of fishing activity having taken place across ML 220 with an annual average catch of 1.97 tonnes of snoek. Fishing effort expended within the area amounted to an average of 24 hours, or 40 lines. This is equivalent to 0.06% of the overall snoek landings by the sector.

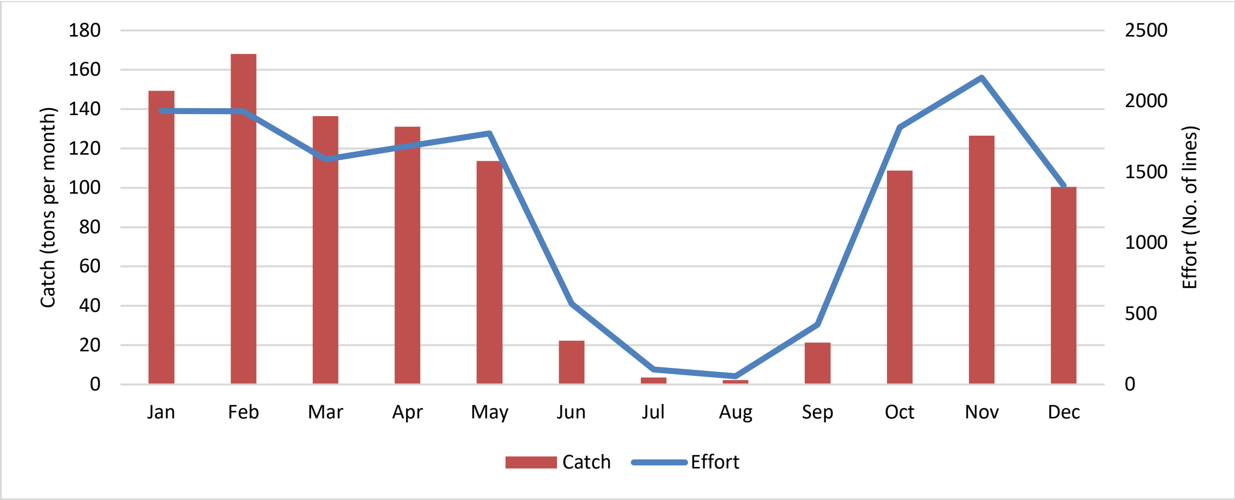

Figure 4-29: Average monthly catch and effort recorded by linefish vessels in Namibian waters (2000 – 2019). Source: MFMR, 2020.

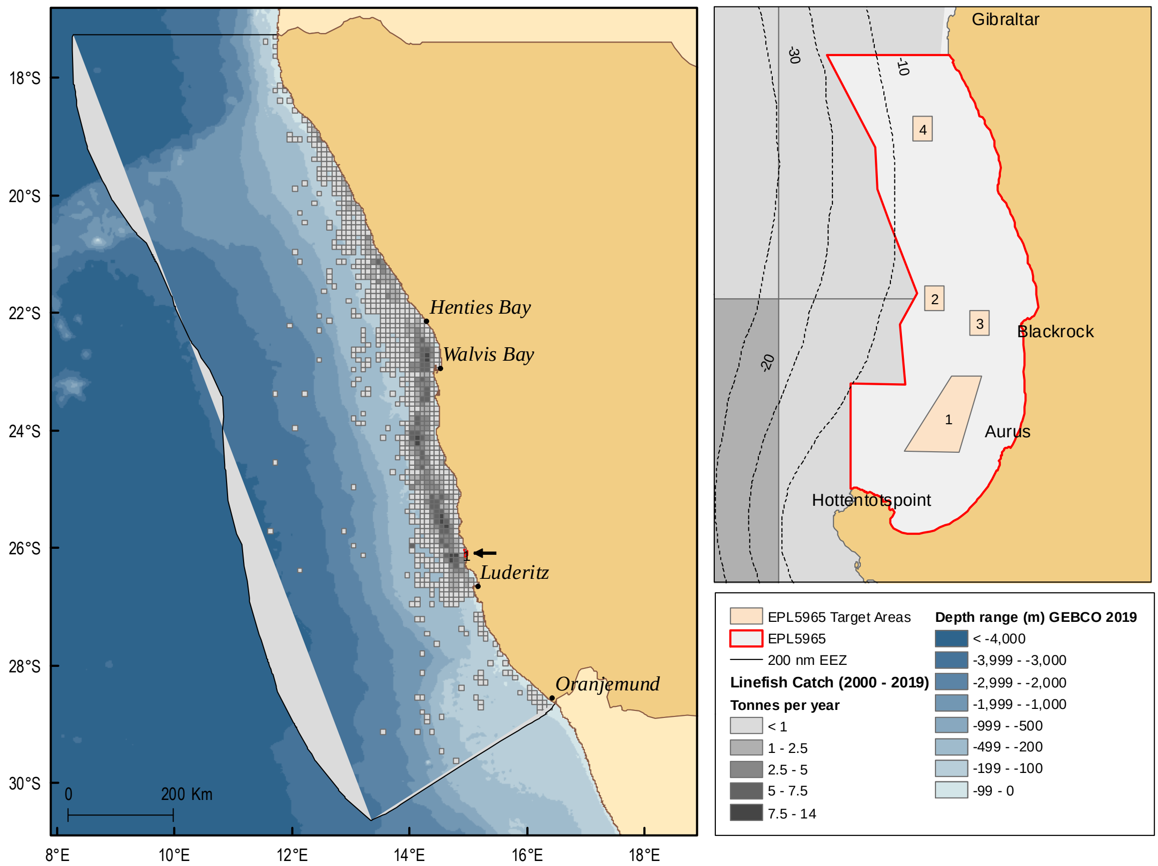

Figure 4-30: Spatial distribution of catch taken between 2000 and 2019 by ski-boats operating within the linefish sector within the Namibian EEZ and in relation to ML 220 (EPL5965).

4.5.8 Deepsea Crab

The Namibian deep-sea crab fishery is based on two species of crab namely spider crab (*Lithodes ferox*) and red crab (*Chaceon maritae*). The fishery commenced in 1973 with a peak in catches of 10 000 tons in 1983. Catches remained high during the 1980s between 5000 tons and 7000 tons. Following heavy exploitation by foreign fleets during this period, catch rates dropped significantly and have averaged at approximately 2000 tons in 1997 and have been steadily increasing since then. The TAC for 2020/21 has been set at 3900 tons (see Figure 4-31).

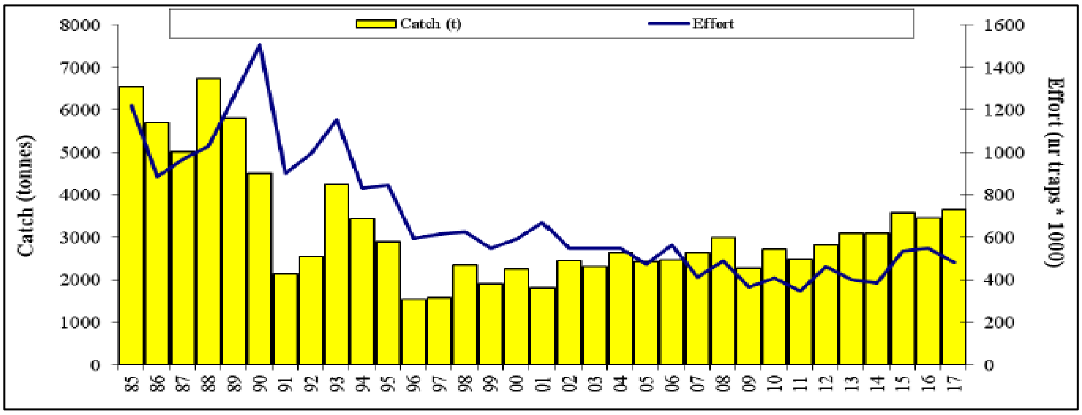

Figure 4-31: TACs set for red crab (C. maritae) from 1985 to 2017[9].

The distribution of red crab extends from ~5°S to just South of Walvis Bay and the commercial fishery operates in grounds extending northwards of 23°S and into Angolan waters (Figure 4-33). There is a minimum operational depth of 400 m set for the fishery, which sets traps at depths of up to 1200 m. The fishery is small, with only two vessels currently operating from the port of Walvis Bay. Vessels are active year-round but with relatively low fishing effort from November to February.

Method of capture involves the setting of a demersal longline with a string of approximately 400 Japanese-style traps (otherwise known as "pots") attached to each line (Figure 4-32). Traps are made of plastic and dimensions are approximately 1.5 m width at the base and 0.7 m in height. They are spaced 15 m apart and typically baited with horse mackerel or skipjack. The line is typically 6000 m in length and weighted at each end by a steel anchor. A surface buoy and radar reflector mark each end of the line via a connecting dropper line that allows retrieval of the gear. Up to 1200 traps may be set each day (or two to three lines) and are left to soak for between 24 and 120 hours before being retrieved.

Fishing grounds within the Namibian EEZ and in relation to ML 220 are shown in Figure 4-33. Grounds are situated at least 450 km from the area and there is no overlap.

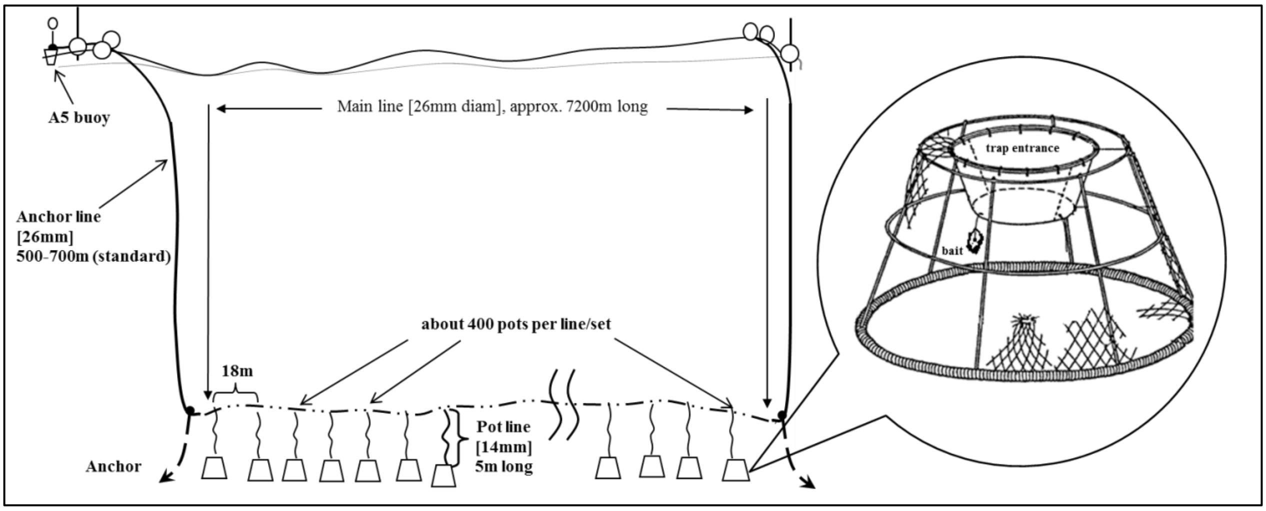

Figure 4-32: Schematic diagram of the gear configuration used by the deep-sea crab fishery (SEAFO, 2018).

[9] Benguela Current Commission (2018) : Report of the Regional Demersal Working Group meeting 10-14 Dec. 2018.

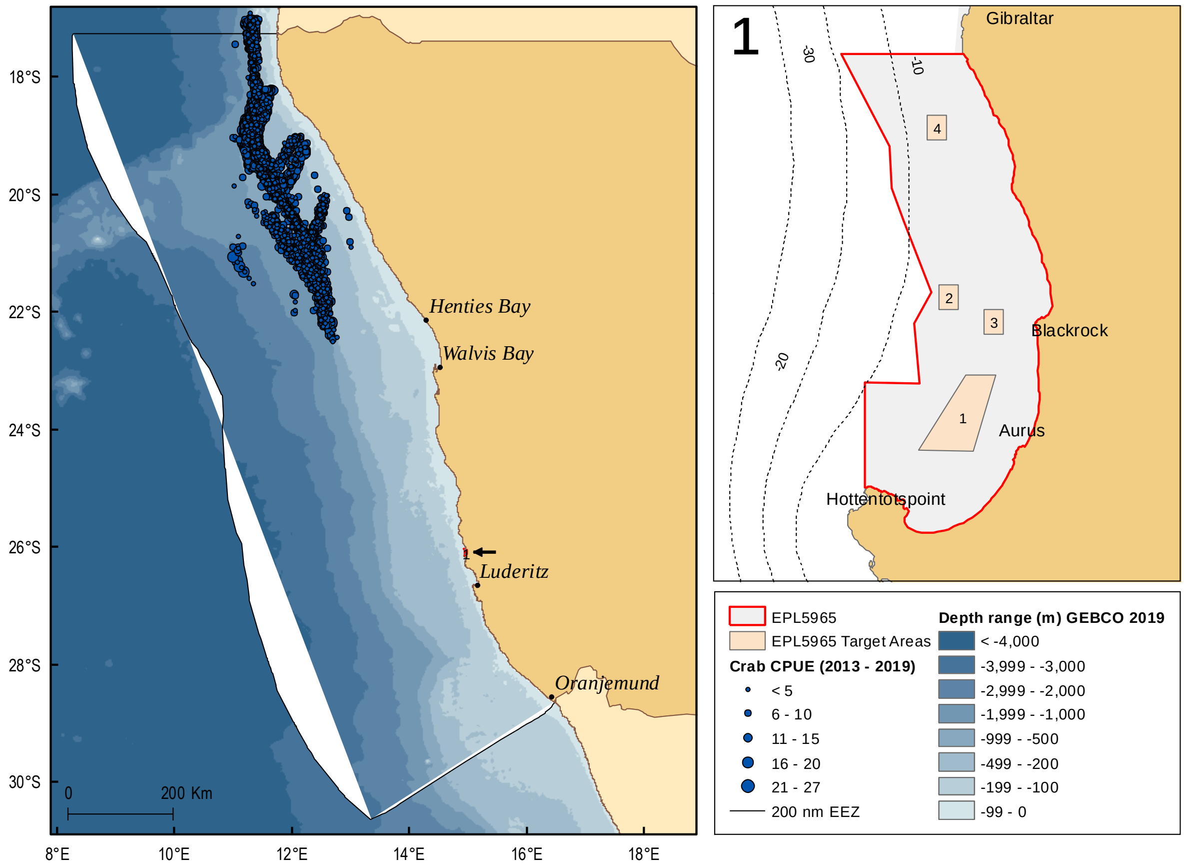

Figure 4-33: Spatial Distribution of catch taken by the Deep-Sea Crab Fishery (2013 – 2018) within the Namibian EEZ and in relation to ML 220 (EPL5965).

4.5.9 Deep-Water Trawl

The deep-water trawl fishery is a small but lucrative fishing sector directed at the outer Namibian shelf from 400 m to 1500 m water depth targeting orange roughy (*Hoplostethus atlanticus*) and alfonsino (*Beryx splendens*). Both species are extremely long-lived and aggregate densely, leading to high catch rates. General aggregations of the stock occur between June and August. Fishable aggregations are usually found on hard grounds on features such as seamounts, drop-off features or canyons (Branch, 2001). Off Namibia orange roughy has a restricted spawning period of less than a month in late July, when spawning takes place in dense aggregations close to the bottom in small areas typically between 10 and 100 km^2 in extent (Boyer and Hampton 2001b). The fishery uses a similar gear configuration to that used by the demersal hake-directed trawl fishery. Alfonsino is taken primarily as a bycatch in the orange roughy fishery, although after the collapse of the orange roughy stock, the deep-water trawl boats continued to fish for alfonsino (which is a species more widely distributed than orange roughy and also are not as closely associated with bottom substrate). However, with the demise of the orange roughy, the economic incentives to fish in deep-water was lost and as a result alfonsino catches also effectively stopped.

The fishery is split into four Quota Management Areas (QMA's) referred to as "Hotspot", "Rix", "Frankies" and "Johnies" and TACs are set for each specific QMA. Fishing grounds were discovered in 1995/1996 and total catches reached 15500 tons in 1997. At this point catch limits were set (see Figure 4-34) and effort was limited to five vessels. Following a steep decline in biomass levels, the TAC was decreased from 12 000 tons in 1998 to 1875 tons in 2000. By 2007 the number of vessels had dropped to one and total catches declined to 270 tons. The fishery has ceased commercial operations due to stock collapse however, the stock is currently being assessed with a view to considering the viability of re-opening the fishery. Research surveys are undertaken in July each year by MFMR to assess the status of the resource.

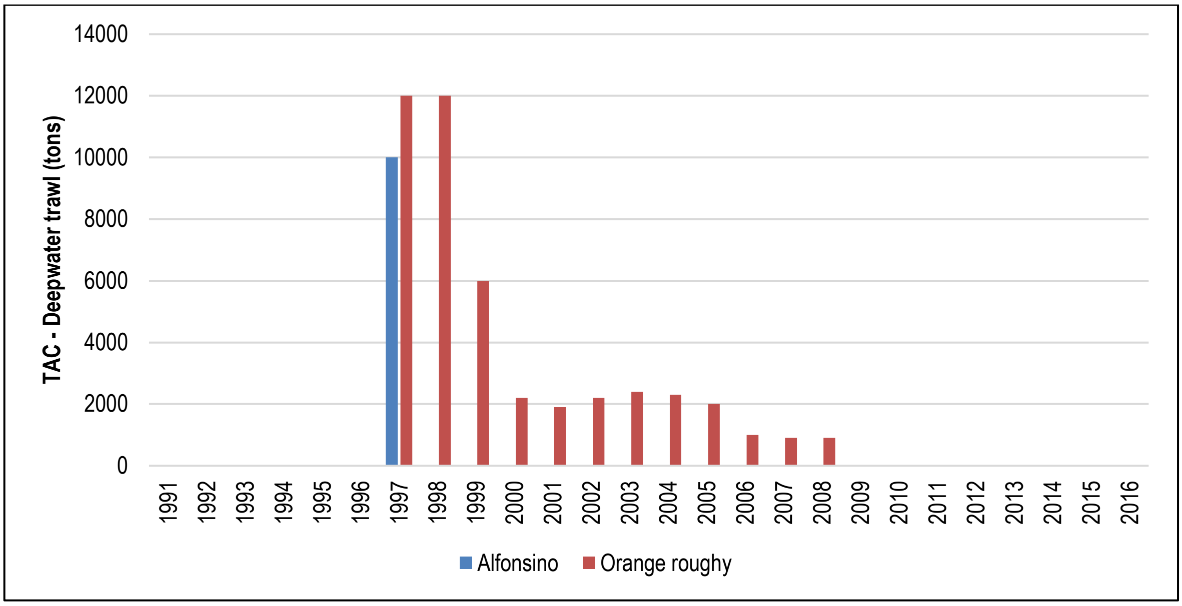

Figure 4-34: TACs issued for Orange Roughy (H. atlanticus) and Alfonsino (B. splendens), Targeted by the Namibian Deep-Water Trawl Fishery.

MFMR conducts annual acoustic and swept-area surveys on all indicated orange roughy grounds. These scientific surveys are aimed at determining the biomass of the stock which enables advice on possible re-opening of the fishery. During these surveys, trawl gear is towed at a speed of approximately 3.5 knots along the depth contour. The default is to trawl in a northern direction, but if the stratum border is crossed during the towing by doing this, the towing course is selected to the south. The duration of each trawl is targeted for maximum 30 minutes on the seabed. Recent orange roughy biomass surveys have been undertaken using the MV *Pemba Bay* which is a commercial vessel operated by a Spanish company through the National Fishing Corporation (FISHCOR). The vessel is a 48 m factory stern trawler, with 907 GRT and 1496 HP. The trawl net is based on the standard New Zealand 'Arrow' rough bottom trawl, with cut-away lower wings. Sweep and bridle lengths of 100 m and 50 m, respectively. A 'rock-hopper' footrope was used with 21"rock-hoppers. The net had a 5-6 m headline height when towed at an average speed of about 3.5 knots. Wingspread is estimated at 15 m.

Table 5-3 shows the stock biomass estimates within all four management areas.

Table 4-2: Biomass estimates of orange roughy from acoustic and swept-area surveys conducted within all three QMAs (adapted from MFMR, 2019[10])

QMA	Biomass estimate (tons)							
	2004	2005	2006	2007	No data	2016	2017	2018
QMAs: All Total Biomass	9 874	9 710	7 395	11 370	ANS	26 221	17 713	26 928

ANS Area not surveyed *Behaviour of orange roughy did not permit acoustic assessment

The location of the QMAs within the Namibian EEZ and in relation to ML 220 are shown in Figure 4-35. The closest QMA, Johnies, is situated at least 97 km from the area and there is no overlap.

[10] MFMR (2019): Survey of the Orange Roughy Stock: Cruise Report No 1/2018 (Survey No. 201801: 10 – 27 July 2018). Orange Roughy Research, Demersal Subdivision. National Marine Information and Research Centre (NatMIRC), Swakopmund.

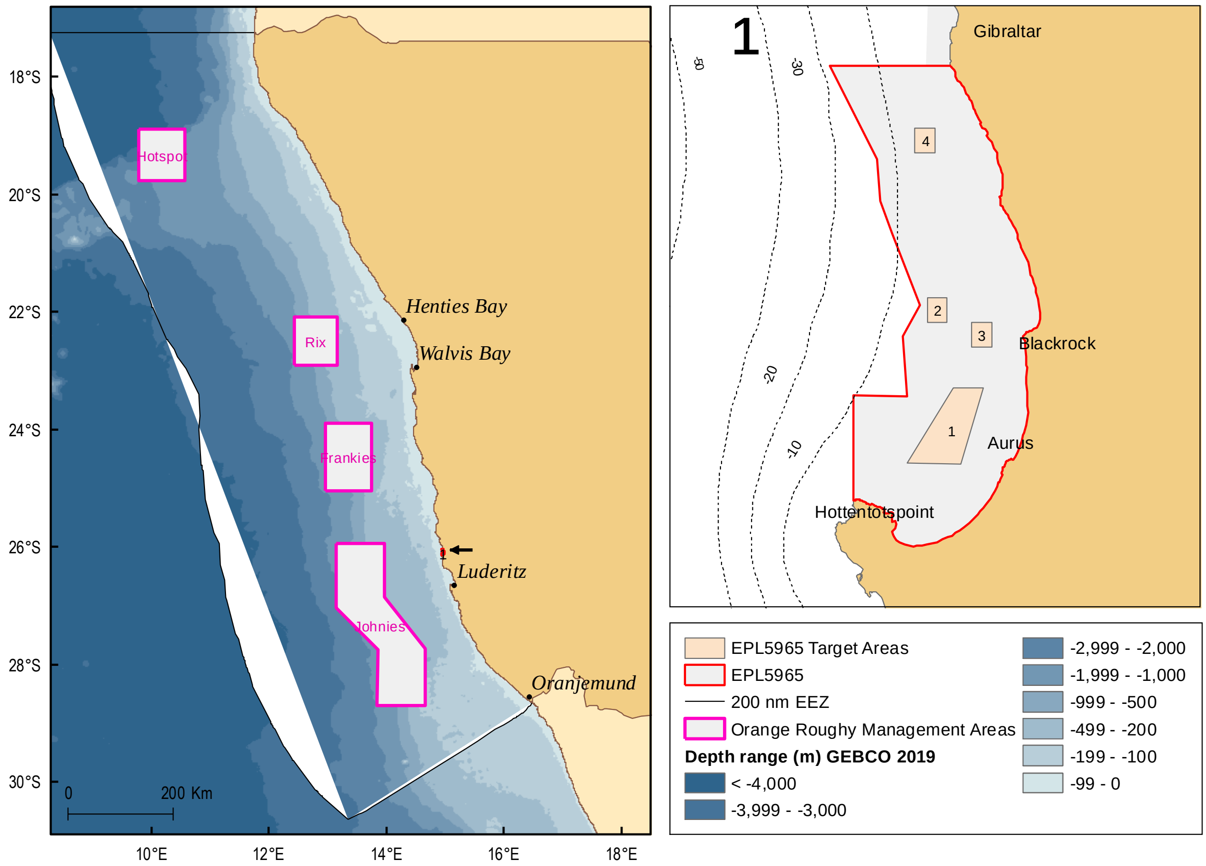

Figure 4-35: Management Areas Used by the Deep-Water Trawl Fishery (1994–2007) within the Namibian EEZ and in relation to EPL5965.

4.5.10 Rock Lobster

The small but valuable fishery of rock lobster (*Jasus lalandii*) is based exclusively in the port of Lüderitz. Within Namibian waters, the lobster stock is commercially exploited between 28°30'S and 25°S from the Orange River border in the south to Easter Cliffs/Sylvia Hill north of Mercury Island. Catch is landed whole and is managed using a TAC. Historically, the fishery sustained relatively constant catches of up to 9000 tonnes per year until a decline in the late 1960s. Figure 4-36 shows the commercial rock lobster catches from 1986 to 2019. The TAC for the 2020/21 was set at 180 tonnes, remaining unchanged from the previous season and a reduction from 200 tonnes TAC set during 2018/19. The TACs have not been filled in recent years with poor catch rates and generally adverse environmental conditions impacting operations. The industry lands between 50% and 80% of the total TAC each season.

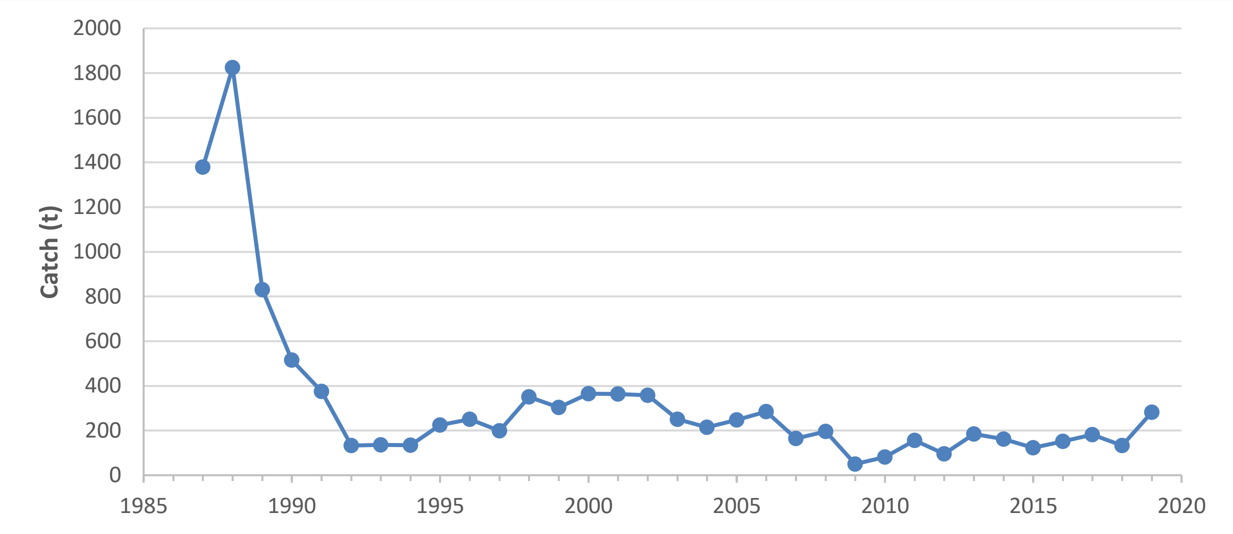

Figure 4-36: Management Catches of rock lobster in Namibia from 1986 to 2019 (Source: FAO catch statistics).

The Namibian Rock Lobster fishery is a seasonal fishery that conventionally occurs from the start of November to the end of April the following year. There is a closed period extending from 01 May to 31 October each year. The fishery is delineated by a commercial fishing zone starting just north of Sylvia Hill all the way to the Orange River Mouth along the southern coast of Namibia. The fishery is spatially managed through the demarcation of catch grounds by management area (refer to Figure 4-37 for map of management areas). Fishing locations from this fishery are not referenced by GPS data, but by the easily recognized features along the coastline. Fishing operations occur at various depths but are mainly limited to the 2-40m depths, and rarely exceed 50m. Effort is reported by management zone an as the number of traps deployed per 24-hour period (termed a “trap day”). Catch reported in kilograms.

Figure 4-38 shows the Far North, North, Central and South fishing areas which are further separated into 16 management zones including two sanctuary areas. Figure 5-36 shows the aggregated rock lobster catch by zone. ML 220 coincides with the Black Rock (Zone 5) and Hottentot Point (Zone 6) management zones situated within the North Fishing Area. Mining Area 1, Target Areas 2 and 3 are situated within Management Zone 6 (Hottentot Point) which yielded an average of 17.2 tonnes of lobster per year over the period 2005 to 2016. Target Area 4 is situated within Management Zone 5 (Black Rock) which yielded an average of 18.8 tonnes of lobster per year. Rock lobster catch within ML 220 amounts to 22.2% of the overall national rock lobster catch landed by the sector. Fishing in the Hottentot Point and Black Rock areas takes place from January to April.

Fishing is directed over reef areas or within a limited distance (several metres) from these hard grounds. Baited traps consisting of rectangular metal frames covered by netting, are deployed from small dinghy’s and delivered to larger catcher reefers to take to shore for processing. The number of active vessels correlates to the allocated quota each season with between 16-29 vessels active. The fleet consists of vessels ranging in length from 7 m to 21 m, setting traps usually in the late morning and allowed to soak overnight before being retrieved the following morning.

Although the proposed mining and areas targeted for resource development are located within the depth range targeted for rock lobster, they are situated in areas of unconsolidated sediment which are therefore unlikely to coincide with grounds targeted by the fishery. While the proposed areas inside the bay are unlikely to overlap with the fishery or operations, these areas may have impacts associated with lobster juvenile settlement and future recruitment.

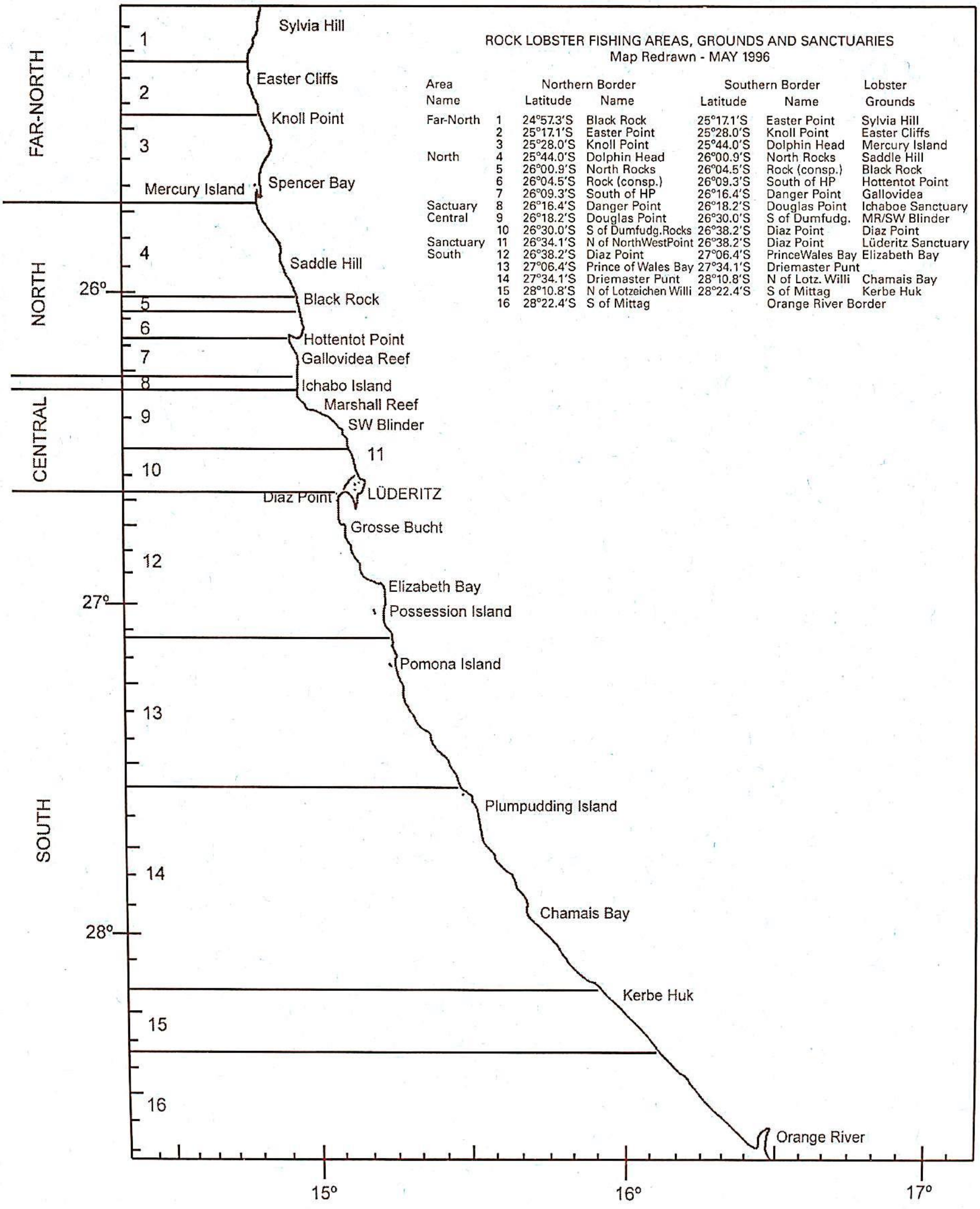

Figure 4-37: Fishing areas and management zones demarcated for the Namibian rock lobster fishery.

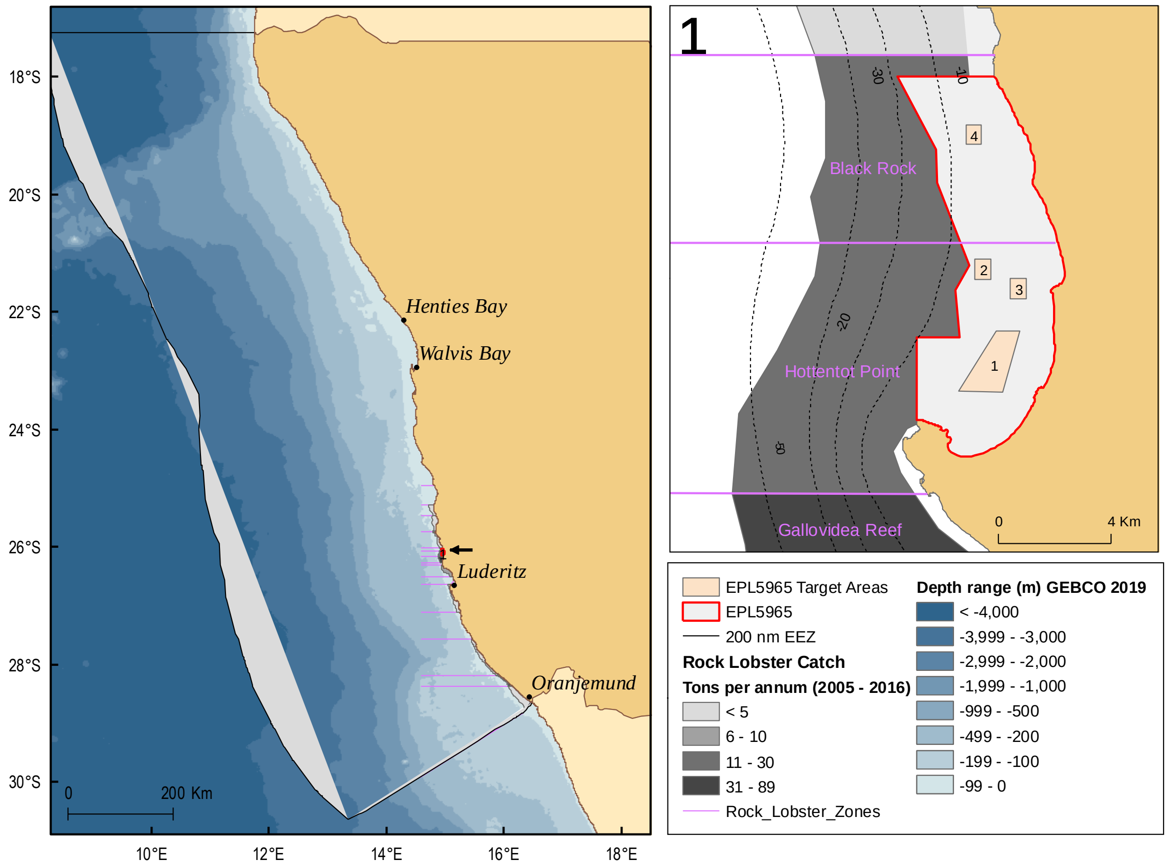

Figure 4-38: Spatial Distribution of Rock Lobster Catch (2005 – 2016) within the Namibian EEZ and in relation to ML 220 (EPL5965).

5. ASSESSMENT

5.1 NOISE EMISSIONS

5.1.1 Description of Impact

The presence and operation of the survey vessel will introduce a range of underwater noises into the surrounding water column that may potentially contribute to and/or exceed ambient noise levels in the area. The survey vessel would be equipped with a medium- to high-frequency multi-beam echo sounder (MBES), low- to high-frequency sub-bottom profiler and medium- to high-frequency side scan sonar.

The likely geophysical survey equipment and its source frequencies and source noise levels are provided in the project description (section 2.1).

A description of the acoustic impacts on marine fauna of the current project activities is provided by Pulfrich (2021).

Sources of anthropogenic noise in the ocean include vessel traffic, multi-beam sonar systems, seismic acquisition, underwater blasting, pile driving, and construction. Elevated noise levels could impact marine fauna by:

- Causing direct physical injury to hearing or other organs, including permanent (PTS) or temporary threshold shifts (TTS) in hearing;
- Masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals and sounds produced by predators or prey); and

- Causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding areas.

A review of the literature and guidance on appropriate thresholds for assessment of underwater noise impacts are provided in the 2014 Acoustical Society of America (ASA) Technical Report *Sound Exposure Guidelines for Fishes and Sea Turtles* (ASA, 2014)[11]. The ASA Technical Report includes noise thresholds for mortality (or potentially mortal injury) as well as degrees of impairment such as TTS or PTS. Separate thresholds are defined for peak noise and cumulative impacts (due to continuous or repeated noise events) and for different noise sources (e.g. explosives, seismic airguns, pile driving, low- and mid-frequency sonar). As surveys using the MBES, sub-bottom profiling and side scan sonar sources have much lower noise emissions compared with seismic airgun sources, no specific considerations have been put in place in developing assessment criteria for these.

Whereas experiments have been carried out to define the levels of sound that cause mortality, injury or hearing damage; it is more difficult to determine the threshold levels that cause behavioural effects, which are likely to take place over wider areas. Reactions of fish to different types of anthropogenic sounds have been reviewed by Hawkins et al. (2015), who concluded that more information is required on the effects of man-made sounds on the distribution of fishes and their capture by different fishing gears as effects differ across species, fishing ground and habitat type.

Due to the more deleterious effects of loud, low frequency sounds such as those emitted in seismic surveys, research has focused on these effects. Due to the paucity of research into the effects of geophysical survey tools on fish and crustaceans and their related fisheries, effects are inferred by comparing the sounds that these organisms produce and are capable of detecting, and evidence of noise thresholds that can cause them harm or disturbance such that their fishery might be affected.

In general terms, sound sources that have high sound pressure and low frequency will travel the greatest distances in the marine environment. Conversely, sources that have high frequency will tend to have greater attenuation over distance due to interference and scattering effects (Anon 2007). It is for this reason that the acoustic footprint of sonar survey tools is considered to be much lower than that of deeper penetration low frequency seismic surveys that are used for petroleum exploration and in addition have lower sound pressure levels. The proposed multibeam survey produces frequencies between 10 kHz and 200 kHz (ultrasonic), with source sound levels in the order of 221dB re 1 μPa at 1m. Research into the effects of these multibeam swath bathymetry on fish and other fisheries-relevant organisms is lacking. However, as the frequencies produced fall well outside of the range of hearing of most marine fish, it is assumed to have little impact on fisheries. Furthermore, the intensity of such high-frequency sound attenuates rapidly, meaning that any potential effects of the sound will be localised to near their source. The soft start capacity of this technology may encourage animals capable of detecting high frequencies to move out of the range of the sound.

Urchins exposed to three hours of one-second sweeps of 100 – 200kHz at 145 and 160 dB re 1μPa (within the range of multibeam echosounders) showed signs of physiological stress (Vazzana et al 2020.) This suggests that invertebrates may be sensitive to high frequency sound, which might cause ecosystem effects on fisheries. However, urchins are less mobile than fish and crustaceans, which may be able to avoid noise disturbance, especially if soft-starts are used.

Sub-bottom profilers include a variety of survey techniques that produce sound ranging from low frequencies (boomer, sparker and sleeve-gun systems) to medium frequencies (chirp and IXSEA) and ultrasonic frequencies (Innomar and Parametric systems). The low frequency techniques are capable of soft starts. Lower frequencies have the potential to travel large distances underwater and may interfere directly with fish and crustacean sound detection.

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[11] See also: Hawkins, A.D., Pembroke, A.E. and A.N. Popper. 2014. Information gaps in understanding the effects of noise on fishes and invertebrates. Rev Fish Biol Fisheries (2015) 25:39-64

Marine organisms tend to be able to detect sounds that fall within the range produced by their species, prey or predators. High frequency, ultrasonic sound (>20kHz) sound is less commonly produced by marine animals. Some cetaceans and mantis shrimps produce ultrasonic sound and there is evidence that some fish species are capable of detecting it.

Bottom profiling has been proposed – this type of equipment would emit an acoustic pulse at frequencies ranging from 0.4 to 30 kHz and typically produces sound levels in the order of 200-230 db re 1µPa at 1m. This frequency range coincides with the hearing range of fish and crustaceans (refer to Table 5-1). The proposed multibeam survey produces frequencies between 10 kHz and 200 kHz (ultrasonic), with source sound levels in the order of 221dB re 1 µPa at 1m. Similarly, a typical side scan sonar emits a an ultrasonic pulse with frequencies ranging from 50 to 500 kHz and sound levels in the order of 220-230 db re 1µPa at 1m. These frequencies fall well outside of the range of hearing of most marine fish; however, members of the genera *Alosa* and *Brevoortia* (shads and menhadens) have shown specialisations that enable them to detect ultrasound. The American shad (*Alosa sapidissima*) is an example of a clupeoid species that shows a behavioural response to ultrasonic frequencies. American shad have been reported to respond with changes in schooling behaviour at 200-800Hz and 25-150 kHz (Velez, 2015). Behavioural responses have also been shown by blueback herring (*Alosa aestivalis*) at a sonar frequency range of 110 kHz to 140 kHz at sound levels above 180 dB re 1 Pa (peak) (Nestler *et al*. 1992, in Popper *et al*., 2014).

Table 5-1: Known hearing frequency and sound production ranges of various fish taxa (Pulfrich 2020 adapted from Koper & Plön 2012; Southall et al. 2019).

Taxa	Order	Hearing frequency (kHz)	Sound production (kHz)
Shellfish	Crustaceans	0.1 – 3	
Snapping shrimp	*Alpheus/ Synalpheus* spp.		0.1 - >200
Ghost crabs	*Ocypode* spp.		0.15 – 0.8
Fish	Teleosts		0.4 – 4
Hearing specialists		0.03 - >3	
Hearing generalists		0.03 – 1	
Sharks and skates	Elasmobranchs	0.1 – 1.5	Unknown

5.1.2 Impact Assessment

The noise generated by the acoustic equipment utilized during bottom profiling falls within the hearing range of most fish, and at sound levels of between 200 to 230 dB re 1 µPa at 1 m, will be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels (Findlay 2005). Similarly, the sound level generated by mining operations fall within the 120-190 dB re 1 µPa range, with main frequencies between 3 – 10 Hz. The noise generated by mining operations thus falls within the hearing range of most fish, and depending on sea state would be audible for several kilometres around the vessel before attenuating to below threshold levels.

The noise emissions from the geophysical sources are highly directional, spreading as a fan from the sound source, predominantly in a cross-track direction. Based on the rapid attenuation of high-frequency sound in the ocean, the spatial extent of the impact of noise on catch rates is expected to be localised.

Based on the location of fishing grounds of the various fisheries sectors in respect to ML 220, the sound generated during mining and survey activities would be expected to attenuate to below threshold levels before reaching fishing grounds. However, in the case of the linefish and rock lobster fisheries, the spread of sound into fishing grounds may affect catch rates. The impact on these sectors is assessed to be of low consequence and overall low significance. No mitigation measures are possible, or considered necessary for the generation of noise by the geophysical survey methods proposed in the current project. The impact is considered to be highly reversible – any disturbance of behaviour that may occur as a result of survey noise would be temporary (refer to Table 5-2).

Table 5-1: Impact of Survey Noise on Catch Rates.

1	IMPACTS OF MULTIBEAM, BOTTOM PROFILING, SIDE-SCAN SONAR AND MINING ACTIVITIES ON FISHERIES CATCH	
	PRE-MITIGATION IMPACT	**RESIDUAL IMPACT**
TYPE OF IMPACT	INDIRECT	INDIRECT
NATURE OF IMPACT	NEGATIVE	NEGATIVE
CONSEQUENCE	LOW	LOW
INTENSITY	MODERATE	MODERATE
EXTENT	LOCAL	LOCAL
DURATION	SHORT-TERM	SHORT-TERM
SIGNIFICANCE	LOW linefish, rock lobster	LOW linefish, rock lobster
PROBABILITY	POSSIBLE (survey activities) UNLIKELY (mining activities)	POSSIBLE (survey activities) UNLIKELY (mining activities)
CONFIDENCE	MEDIUM	MEDIUM
REVERSIBILITY	FULLY REVERSIBLE Any disturbance of behaviour, auditory “masking” or reductions in hearing sensitivity that may occur as a result of survey noise below 220 dB would be temporary.	
LOSS OF RESOURCES	NEGLIGIBLE	
MITIGATION POTENTIAL	LOW	
CUMULATIVE POTENTIAL	No cumulative impacts as a result of the mid- to high-frequency sonars, sampling or mining activities are anticipated, although cumulative impacts of general anthropogenic ocean noise is likely	

5.2 EXCLUSION FROM FISHING GROUND

5.2.1 Description of Impact

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), a vessel that is engaged in surveying is defined as a “vessel restricted in its ability to manoeuvre” which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. In addition to a statutory 500 m safety zone, a vessel operator would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond.

While the survey and sampling vessels are operational at a given location, a temporary 500 m operational safety zone around the unit would be in force, i.e. no other vessels (except the support vessels) may enter this area. A vessel conducting marine sampling operations would typically operate on a 3 or 4 anchor spread with unlit anchor mooring buoys. For the duration of operations a coastal navigational warning would be issued by the South African Navy Hydrographic Office (SANHO) requesting a 500 m clearance from the survey and mining vessels. The safety zones aim to ensure the safety both of navigation and of the project vessel, avoiding or reducing the probability of accidents caused by the interaction of fishing boats and gears and the survey and mining vessels.

The exclusion of vessels from entering the safety zone poses a direct impact to fishing operations in the form of loss of access to fishing grounds or displacement of fishing effort into alternative fishing grounds.

An overview of the Namibian fishing industry and a description of each commercial sector is presented in Sections 4.1 and 4.5, respectively. The affected fisheries sectors have been identified based on the extent of overlap of fishing grounds with ML 220. The linefish and rock lobster sectors have historically operated within the area and are currently active.

The sensitivity of a particular fishing sector to the impact of the safety / exclusion zone would differ according to the degree of disruption to that fishing operation. The current assessment considers this to be related to the availability of alternative fishing grounds and the likelihood that activity can be relocated away from the affected area (the safety / exclusion zone) into alternative fishing areas.

5.2.2 Impact Assessment

The exclusion of vessels from entering the safety zone around a vessel engaged either in survey or mining activities poses a direct impact to fishing operations in the form of loss of access to fishing grounds.

Boat-based fishing for linefish takes place within ML 220. Although most of the fishing effort is centred offshore of the 100 m depth contour, snoek is targeted in nearshore waters over the period February to June. There is evidence of fishing activity having taken place across the mining licence area which yielded an average of 1.97 tonnes of snoek per year. Fishing effort expended within the area amounted to an average of 24 hours, or 40 lines per year. The potential impact of displacement of fishing operations is considered to be local in extent and of short-term duration. The consequence of the impact on the sector is expected to be low and, due to the low probability of occurrence, of overall low significance.

Rock lobster is targeted by a fleet of vessels based exclusively in the port of Lüderitz. ML 220 coincides with the Black Rock (Zone 5) and Hottentot Point (Zone 6) management zones which yielded an average of 17.2 tonnes of lobster per year over the period 2005 to 2016 – this is equivalent to 22.2% of the total landings recorded by the sector. Effort within ML 220 is seasonal, from January to April. Fishing takes place on rocky grounds at a water depth of between 2-40 m. As the proposed mining and target areas are situated in areas of unconsolidated sediment, the probability of these areas coinciding with preferred fishing grounds is considered to be low. The potential impact of displacement of fishing operations is considered to be local in extent and of short-term duration. The consequence of the impact on the sector is expected to be moderate and, due to the low probability of occurrence, of overall low significance.

Mitigation

A process of notification and information-sharing should be followed with the rock lobster and linefish associations. The required safety zones around the survey and sampling vessels should be communicated via the issuing of Daily Navigational Warnings for the duration of the mining operations through the South African Naval Hydrographic Office and broadcast by Lüderitz radio.

The linefish sector targets snoek in close proximity to ML 220 over the period February to June. Timing of the survey and mining activities to avoid this fishing period would eliminate the impact on the sector.

The rock lobster sector operates within ML 220 during the period January to April. Timing of the survey and sampling activities to avoid this fishing period would eliminate the impact on the sector.

Table 5-3: Impact of Temporary Exclusion of Fishing Operations.

3	IMPACTS OF EXCLUSION OF FISHERIES DURING SURVEY AND MINING OPERATIONS	
	PRE-MITIGATION IMPACT	RESIDUAL IMPACT
TYPE OF IMPACT	DIRECT	N/A
NATURE OF IMPACT	NEGATIVE	N/A
CONSEQUENCE	LOW	N/A
INTENSITY	LOW (linefish) MODERATE (rock lobster)	N/A
EXTENT	LOCAL	N/A
DURATION	SHORT-TERM	N/A
SIGNIFICANCE	LOW	NO IMPACT
PROBABILITY	UNLIKELY	N/A
CONFIDENCE	MEDIUM	N/A
REVERSIBILITY	FULLY REVERSIBLE	
MITIGATION POTENTIAL	HIGH	
CUMULATIVE POTENTIAL	Some cumulative impacts can be anticipated but not expected to raise the significance rating.	

6. CONCLUSIONS

Of the commercial fisheries assessed, the rock lobster and linefish sectors could be impacted by the survey and sampling activities proposed by LKM. The rock lobster fishery focusses its efforts in depths <40 m across targeted fishing areas within the Black Rock and Hottentot Point Management Zones. As the proposed geophysical surveys will be conducted at depths less than 40m, there may be an overlap with commercial fishery during the fishing season from January to April. The fishery is likely to be affected by the presence of the survey vessel and equipment running along pre-selected survey lines. Similarly, the fishery could be temporarily excluded from fishing grounds during mining operations due to a 500 m exclusion zone that would be maintained around the vessel. The potential impact of the proposed exploration activities on the fishery would thus be localised but is expected to be of overall low significance. The spread of project-induced sound into the surrounding water column was assessed to have an impact of low overall significance on the linefish and rock lobster sectors. A ranking of low negative significance is translated in the impact assessment methodology as having no influence on the decision to implement the project. Timing survey and sampling operations to avoid the period January to April is suggested as a mitigation measure that could eliminate the impact on the fishery.

The following measures are proposed in order to minimise disruptions to the fishing indsustry:

- Prior to the commencement of each phase of the project, the Namibia Rock Lobster Association and MFMR should be informed of the pending activity and the likely implications for the affected fishing sectors and research surveys via an informational Notice to Mariners;
- Daily Coastal Navigational Warnings should be issued for the duration of the surveying and sampling operations through the South African Naval Hydrographic Office (SANHO) and daily notifications should be issued by Lüderitz radio;
- A daily electronic reporting routine should be circulated, informing affected parties (i.e. fishing industrial bodies and MFMR) of the survey activity and expected date of completion as well as recorded fisheries interactions; and
- Where activities should be scheduled to avoid seasonal rock lobster activity within the area.

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22nd April 2021

ASECcc
P.O. Box 40386
Windhoek
Namibia

For attention: Alexandra Speiser

ARCHAEOLOGICAL DESK ASSESSMENT OF PROPOSED ML 220, //KHARAS REGION, NAMIBIA

John Kinahan, Archaeologist
P.O. Box 22407
Windhoek
Namibia

DECLARATION

I hereby declare that I do:

(a) have knowledge of and experience in conducting assessments, including knowledge of Namibian legislation, specifically the National Heritage Act (27 of 2004), as well as regulations and guidelines that have relevance to the proposed activity;

(b) perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

(c) comply with the aforementioned Act, relevant regulations, guidelines and other applicable laws.

I also declare that I have no interests or involvement in:

(i) the financial or other affairs of either the applicant or his consultant

(ii) the decision-making structures of the National Heritage Council of Namibia.

PLEASE NOTE: The purpose of this report is to assist the client in gaining consent under the National Heritage Act (27 of 2004) to proceed with mining activities at specific locations as defined herein. The report and its contents, specifically maps and other illustrations, may not be abstracted, distributed or used for any other purpose by the client, the National Heritage Council of Namibia or any other party and remain the copyright of the author.

John Kinahan, Archaeologist

EXECUTIVE SUMMARY

An archaeological desk assessment was carried out for ASECcc on behalf of LK Mining (Pty) Ltd, focussing on the proposed Mining Licence (ML) 220 at Hottentot Bay, located approximately 60km north of Lüderitz in the //Kharas Region of Namibia. Archaeological records from previous studies in the surrounding area, as well as historical documentary sources were reviewed as a basis of inference to determine the likelihood that seabed mining operations would damage or disturb sites or materials protected under the National Heritage Act (27 of 2004). On the basis of the available record it is concluded that Hottentot Bay is a site of considerable historical importance and that it probably contains significant underwater cultural heritage remains and that these could be threatened by sea-floor diamond exploration and mining operations.

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1. INTRODUCTION

1.1 Background

LK Mining (Pty) Ltd has applied for a Mining Licence (ML) (ML 220) to MME, which will only be granted once the ECC has been obtained. ML 220 is located approximately 60km north of Lüderitz in the //Kharas Region of Namibia and within the Marine Protected Area of the Namibian coast[1]. The proponent wishes to carry out seabed mining for diamonds and has lodged an application (Application ML 220) to convert the lease to a Mining Licence, having delineated a resource area in which mining would be carried out using a small dredge pump vessel. The potential resource area extends from the shallow water to the midwater parts of the bay at a depth of approximately 45mbsl.

Mineral exploration and mining operations require an Environmental Clearance Certificate to be issued in terms of the Environmental Management Act (2007), and ASECcc has been appointed by LK Mining to carry out an environmental assessment (EA). Archaeological remains, including those in Namibia are protected under the National Heritage Act (2004) and National Heritage Regulations (Government Notice 106 of 2005). Exploration and mining projects are therefore subject to archaeological assessment and ASECcc has accordingly appointed the undersigned, J. Kinahan, archaeologist, to carry out this assessment.

1.2 Terms of Reference

The desk assessment reported here is intended to identify from existing field survey data and historical records sensitive archaeological sites that could be affected by ongoing exploration and proposed mining activities on the proposed ML 220. Archaeological assessment forms the basis of recommended management actions to avoid or reduce negative impacts, as part of the environmental assessment. The study is intended to satisfy the requirements of the relevant legislation and regulations, in which the process of review and clearance may require further, or different mitigation measures to be adopted if required by the National Heritage Council.

Specifically, the archaeological assessment addresses the following issues:

1. The identification and assessment of potential impacts on archaeological/heritage resources arising from the ongoing exploration and proposed mining activities.

[1] The coastline adjacent to the proposed ML 220 lies with both the Tsau-/Khaeb National Park (former Sperrgebiet, or Diamond Area 1) and the Namib Sand Sea World Heritage Site.

2. The identification and demarcation of sensitive archaeological/heritage sites requiring special mitigation measures to eliminate, avoid or compensate for possible destructive impacts.
3. Formulation and motivation of specific mitigation measures for the project to be considered by the authorities for the issuance of clearance certificates.
4. Specification of permit requirements as related to the removal and/or destruction of heritage resources.

1.3 Assumptions & Limitations

Archaeological desk assessment is based on existing data from surveys and excavations carried out in the course of previous work in the same general area as the proposed project. Where detailed information is available these data are used as a basis of inference pending further field survey should the authorities deem it necessary.

On the basis of previous studies and cumulative field records it is possible to predict the likely occurrence of further archaeological sites with varying accuracy, and to present a general statement (see 3. Environmental & Archaeological Setting, below) of the local archaeological site distribution and its likely sensitivity. In the case of the proposed ML 220 historical records of shipping activity related to the 19th century "Guano Rage" provide an additional source of information. However, it is necessary to caution the proponent that hidden, or buried archaeological or palaeontological remains, as well as remains lying on the seabed might be exposed as the project proceeds. It is for this reason that the proponent is advised to adopt the Chance Finds Procedure set out in Appendix 3.

The following assessment is based on cumulative archaeological data abstracted from the accessions register of the National Museum of Namibia, the records of the Namib Desert Archaeological Survey, and on the results of various site investigations carried out by the undersigned to assist mining, infrastructure and other projects to comply with the environmental and heritage conservation laws of Namibia. The assessment also draws on information presented in a provisional EIA Report[2] compiled by LK Mining (Pty) Ltd.

2. LEGAL REQUIREMENTS

The principal instrument of legal protection for archaeological/heritage resources in Namibia is the National Heritage Act (27 of 2004). Part V Section 46 of the Act prohibits removal, damage, alteration

[2] LKM (2019), section 1: Description of the proposed offshore diamond mining activities EPL 5965 (Application ML 220).

or excavation of heritage sites or remains. Section 48 *ff* sets out the procedure for application and granting of permits such as might be required in the event of damage to a protected site occurring as an inevitable result of development. Section 51 (3) sets out the requirements for impact assessment. Part VI Section 55 Paragraphs 3 and 4 require that any person who discovers an archaeological site should notify the National Heritage Council. Heritage sites or remains are defined in Part 1, Definitions 1, as "any remains of human habitation or occupation that are 50 or more years old found on or beneath the surface".

Of particular relevance to the proposed activities on ML 220, Section 57 (1) of the Act defines as historic shipwrecks and shipwreck objects, "the remains of all ships that have been situated on the coast or in the territorial waters or the contiguous zone of Namibia for 35 years or more are historic shipwrecks for the purposes of this section." Also relevant here, Section 57 (4) (a) (i) notes that "a place where the remains of a ship are located [may] be declared a protected place; or (ii) an article associated with a ship [may] be declared a protected object". Section 57 (4) (b) states that "a provisional protection order [may] be made in relation to a place where an article or articles appearing to be the remains of a ship are located".

However, it is important to be aware that no specific regulations or operating guidelines have been formulated for the implementation of the National Heritage Act in respect of archaeological assessment. However, archaeological impact assessment of mining projects has become accepted practice in Namibia during the last 25 years, especially where project proponents need also to consider international guidelines. In such cases the appropriate international guidelines are those of the World Bank OP/ BP 4.11 in respect of "Physical Cultural Resources" (R2006-0049, revised April 2013). Of these guidelines, those relating to project screening, baseline survey and mitigation are the most relevant.

Archaeological impact assessment in Namibia may also take place under the rubric of the Environmental Management Act (7 of 2007) which specifically includes anthropogenic elements in its definition of environment. The List of activities that may not be undertaken without Environmental Clearance Certificate: Environmental Management Act, 2007 (Govt Notice 29 of 2012), and the Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Govt Notice 30 of 2012) both apply to the management of impacts on archaeological sites and remains whether these are considered in detail by the environmental assessment or not.

3. ENVIRONMENTAL & ARCHAEOLOGICAL SETTING

The proposed ML 220 lies mainly within Hottentot Bay, extending approximately 15km north of the bay and up to 3km offshore. The lease also includes the waters extending over a radius of approximately 3km from the northern point of the Hottentot Bay headland. The seabed within the lease area lies mainly at a depth of less than 30mbsl. The coastline consists of unconsolidated aeolian sands with an extensive lagoon deposit to the south, and relatively little rock outcrop other than the Hottentot Bay headland, Black Rock near the northern end of the bay, and Neglectus Island, a small rock within the bay itself. These outcrop features are primarily Mokolian pre- and syntectonic biotite-rich augen gneisses, with some very large intrusive hydrothermal quartz veins. Almost entirely devoid of vegetation other than desert succulent species, the shoreline has no freshwater sources other than a weak spring at Anigab, about 10km inland of Douglas Bay. Such conditions severely limited both historical and pre-colonial human settlement.

The southern Namib coastline has been affected by successive changes in sea level driven by global climatic changes[3]. The Last Glacial Maximum, ending about 12 000 years before present, saw sea levels at least 100m below present mean sea level with the shoreline approximately 20km due west of its current position. An early Holocene stillstand at present mean sea level was briefly disturbed following global warming during the mid-Holocene Optimum, in which sea level rose by approximately 3m between 7 300 and 6 500 years before present, falling to current levels at 4 200 years before present after a series of eustatic fluctuations around a mean of approximately 1masl[4]. During the mid-Holocene lea level rise, the Hottentot Bay headland of today became an offshore island, adding to the available roost and nesting sites for pelagic seabirds such as Ichabo Island. The Hottentot Bay bird

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[3] Corvinus, G. 1983. *The Raised Beaches of the West Coast of South West Africa/Namibia: An Interpretation of their Archaeological and Palaeontological Data.* Forschungen zur Allgemeinen und Vergleichenden Archäologie, 5, München: C.H. Beck; Deacon, J. & Lancaster, N. 1988. *Late Quaternary palaeoenvironments of southern Africa.* Oxford: Oxford University Press. Kinahan, J. 2021. *Namib: the archaeology of an African desert.* Windhoek, University of Namibia Press.

[4] Compton, J. 2006. The mid-Holocene sea-level highstand at Bogenfels Pan on the southwest coast of Namibia. *Quaternary Research* 66: 303–10; Compton, J. 2007. Holocene evolution of the Anichab Pan on the south-west coast of Namibia. *Sedimentology* 54: 55–70; Kinahan, J. & Kinahan, J.H.A. 2016. Post-Pleistocene archaeology and geomorphological processes on the Namib Desert coast of southwestern Africa. *Journal of Island and Coastal Archaeology* 12 (1): 65–77; Kinahan, J.H.A. & Kinahan, J. 2009. 'A thousand fine vessels are ploughing the main...' Archaeological traces of the nineteenth century 'Guano Rage' on the south-western coast of Africa. *Australasian Historical Archaeology* 27: 43–54.

colonies would have been abandoned when sea level dropped and the sites became vulnerable to terrestrial predators.

On the basis of seafloor morphology[5], wave-cut terraces have been identified throughout the proposed ML 220, at -12, -14, -20 & –26mbsl, and to the west of the area at –30mbsl and –31m. These terraces are assumed to represent approximately fifteen significant sea-level still stands at specific depths in the range of -20 to -100 mbsl. Thus, due to sea-level fluctuations in the Quaternary, there are multiple terraces; some seafloor platforms may contain a single terrace, while others consist of a number of closely-spaced terraces with little discernible topographic separation between them.

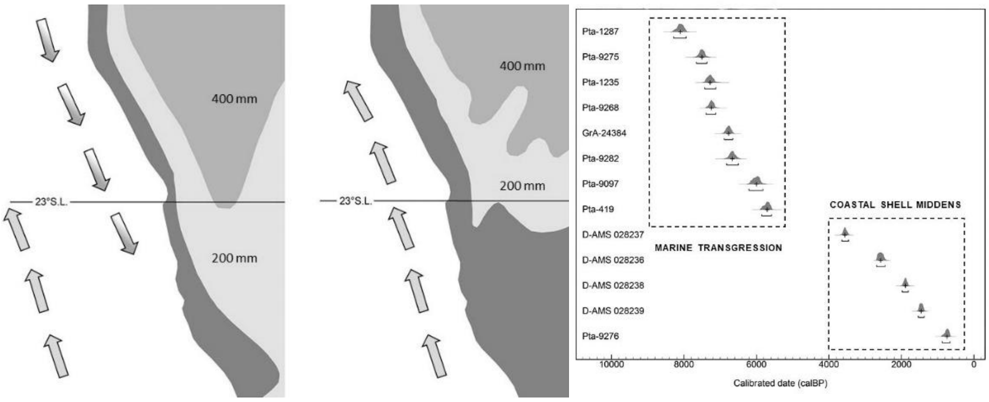


Figure 1: Shifts in ocean currents along the southern Namib coastline and the dating of the mid-Holocene marine transgression, followed by the accumulation of coastal shell middens.

Figure 1 summarizes the effect of mid-Holocene global warming which weakened the northward-flowing Benguela Current, allowing a southward intrusion of the warm equatorial Angola Current. The dating of the mid-Holocene marine transgression is shown to fall roughly between 8 000 and 5 000 years before present after which cold Benguela conditions were restored on the Namib coast, bringing a recovery of the high nutrient littoral fauna. This served as an important human subsistence resource and the late Holocene is associated with an increasing number of shell middens on the Atlantic shore of southern Africa[6]. Offshore upwelling cells appear to coincide with major shell midden

[5] Data from *LK Mining: Geotechnical & Exploration Report for Marine Diamond Concession EPL 5965, Hottentots Bay, Namibia.* (no date).

[6] Jerardino, A., Klein, R.G., Navarro, R., Orton, J. & Horwitz, L. 2013. Settlement and subsistence patterns since the terminal Pleistocene in the Elands Bay and Lamberts Bay areas. In Jerardino, A., Malan, A. & Braun, D. eds *The Archaeology of the West Coast of South Africa.* Cambridge Monographs in African Archaeology 84: 85–108;

accumulations of which the most spectacular occur at Elizabeth Bay. The scarcity of water at Hottentot Bay may explain the general scarcity of shell middens there[7].

Sub-fossil accumulations of marine shell at Hottentot Bay provide direct evidence for the influence of the mid-Holocene marine transgression on the littoral fauna. These shell accumulations occur as strandlines on the margins of the tidal lagoon that developed between the mainland and the Hottentot Bay headland, and include species such as the mollusc *Lutraria lutraria*, and the bivalve *Solan capensis*, which do not occur on the Namib coast under normal Benguela Current conditions[8]. Similarly, fragments of oyster (probably *Saccostrea* spp.), which also do not occur under present conditions, have been dated to 7,600 years ago at Langewandt, and 6,700 years ago at Reutersbrunn, both to the north of Hottentot Bay[9].

Evidence of precolonial settlement in the vicinity of Hottentot Bay appears to date to within the last 4 000 years, as suggested by the palaeoclimatic data and fluctuations in sea level. The most abundant archaeological evidence from Hottentot Bay is very recent, dating to within the last two hundred years, much of it relating to the highly profitable "Guano Rage" which involved hundreds of vessels jostling for anchorage at Ichabo Island and involving thousands of diggers between 1843 and 1845[10]. Due to insecure anchorage, bad weather and the unseaworthiness of many guano carriers, there were several vessels lost in the vicinity of Ichabo Island. Figure 3 shows a contemporary sketch of the crowded conditions at Ichabo Island at the height of the "Guano Rage". Vessels lost included several that came to grief at Hottentot Bay where ships would sometimes seek sheltered anchorage. One of these vessels, suspected to be the barque *Kent,* lost in 1850[11] is still visible on the southern shore of Hottentot Bay (Figure 4)[12].

Jerardino, A. & Navarro, R. 2018. Large-scale hunter-gatherer exploitation of marine resources in South Africa, Part 1: 'Kreefbaai C' Megamidden, Lamberts Bay area. *South African Archaeological Bulletin* 73: 93–107.

[7] One of the few examples being located at -26.14578S 14,93459E

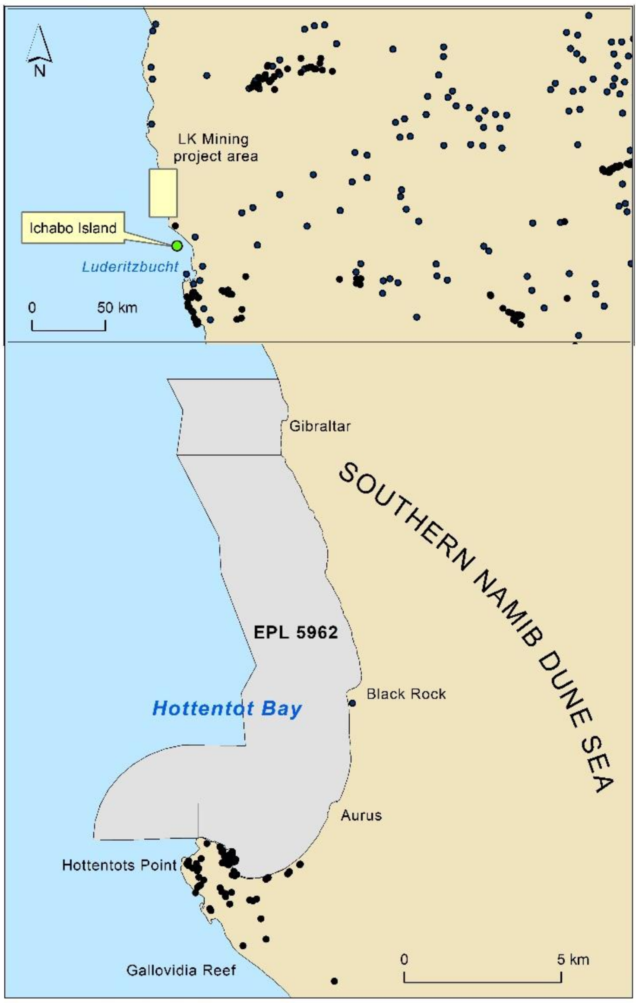
[8] Branch, M. & Branch, G. 1981. *The Living Shores of Southern Africa.* Cape Town: Struik.

[9] Vogel, J.C. & Visser, E. 1981. Pretoria radiocarbon dates II. *Radiocarbon* 23 (1): 43–80.

[10] Kinahan, J.H.A. & Kinahan, J. 2009. 'A thousand fine vessels are ploughing the main...' Archaeological traces of the nineteenth century 'Guano Rage' on the south-western coast of Africa. *Australasian Historical Archaeology* 27: 43–54.

[11] Located at -26.4296S 14.95486E

[12] These are among a total of 48 known shipwrecks on the southern Namib coastline.



Cartography: J. Kinahan, March 2021

Figure 2: The location of the proposed ML 220 at Hottentot Bay, indicating major topographic features and the distribution of known archaeological sites on the mainland. Other than the suspected wreck of the *Kent* still visible on the southern shores of Hottentot Bay, the exact location of other vessels reported as lost is not known (see Table 1).

Table 1 lists the known shipping losses from this part of the coast and is headed by the suspected store ship of Bartholemeu Diaz which caught fire and sank in 1488, possibly in Hottentot Bay, although this has not been verified. The list includes at least six guano carriers from which it is possible that some wreckage may have drifted into Hottentot Bay. Another six vessels are confirmed lost at Hottentot Bay and it is possible that their wreckage lies within the area of the proposed ML 220. The on-shore activities of diggers during the "Guano Rage" included burial of the dead, mainly at Douglas Bay, and it appears that there was frequent trading contact as well some conflict with indigenous communities. Items that were most probably acquired through this trade have been found as much as 100km inland in the Awasib Mountains[13].

When the guano deposits on Ichabo were exhausted in 1845, attention turned to the much smaller and less valuable deposits which accumulated on the Hottentot Bay headland during the mid-Holocene Optimum when it was effectively an offshore island. Here, an on-shore digger's camp was established and occupied intermittently until 1850 during which time an exploration shaft was sunk on a prominent hydrothermal quartz vein to assess its potential for mining copper[14]. The Hottentot Bay venture was short-lived and attention shifted to Sandwich Harbour where a fish processing enterprise was established in the second half of the 19th century[15]. It was only towards the mid-20th century that there was renewed interest in Hottentot Bay when it became a major source of crayfish, processed at a factory of which the ruins can still be seen[16]. During the last few decades Hottentot Bay became a focus of diamond exploration and dredging operations, with some temporary on-shore facilities being established.

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[13] Kinahan, J. & Kinahan, J.H.A. 2006. Preliminary report on the late Holocene archaeology of the Awasib-Gorrasis Basin complex in the southern Namib Desert. *Studies in the African Past* 5: 1–14.

[14] Kinahan, J. & Kinahan, J. 2002. *Baseline Environmental Assessment of Hottentot Bay on the Sperrgebiet coast of Namibia*. Commissioned by Hottentot Bay Investments cc.

[15] Kinahan, J.H.A. 1991. The historical archaeology of nineteenth century fisheries at Sandwich Harbour on the Namib coast. *Cimbebasia* 13: 1–27.

[16] QRS 38. *Interim Report on Hottentot Bay Environmental Baseline Study*. Commissioned by Hottentot Bay Investments cc (Namibia) (2002). John and Jill Kinahan.

Table 1: List of vessels lost in vicinity of Ichabo Island and Hottentot Bay[17].

Vessel	Date lost	Notes
unnamed	1488	Burned and sank Hottentot Bay
Guernsey Lily	17/05/1844	Guano carrier, lost Ichabo Island
Orion	1845	Guano carrier, lost Ichabo Island
Ann Mondell	28/02/1845	Guano carrier, lost Ichabo Island
Kate	27/10/1845	Ran aground north of Ichabo Island
Daphne	23/11/1845	Guano carrier, lost Ichabo Island
Sverige	5/05/1873	Ran aground, Ichabo Island
Byron	1/08/1893	Lost at Ichabo Island
Eurus	13/03/1896	Guano carrier, lost Ichabo Island
Kent	5/07/1850	Ran aground in Hottentot Bay
Canute	03/1861	Lost at Ichabo Island
Clara & Florence	7/08/1873	Lost in storm, Hottentot Bay
Solingen	4/11/1904	Ran aground, possibly Hottentot Bay
Heraclides	26/10/1907	Lost in Hottentot Bay
Sea Spray	1950	Ran aground in Hottentot Bay
St. John	15/06/1956	Wrecked at Hottentot Bay
Malagas	2009	Ran aground in Hottentot Bay

In summary, there is valuable palaeoenvironmental evidence from Hottentot Bay relating to late Pleistocene and mid-Holocene sea level changes. The evidence from Hottentot Bay has been studied in detail and the most important results have been published, although it is possible that some follow-up investigations will be carried out. Detailed archaeological surveys of the coastline north of Douglas Bay and in the vicinity of Hottentot Bay have located and documented all the major sites, including those relating to 19th century guano mining activities. On-shore surveys and archival searches have been carried out to determine the likely extent of shipping losses in and around Hottentot Bay. However, no underwater surveys have yet been carried out. The coastline around Hottentot Bay has a known potential for palaeoenvironmental and archaeological research, while there is unconfirmed evidence that the in-shore seabed within the bay would have important marine archaeological remains.

[17] Based on information furnished by Mr Gunter von Schumann, Windhoek.

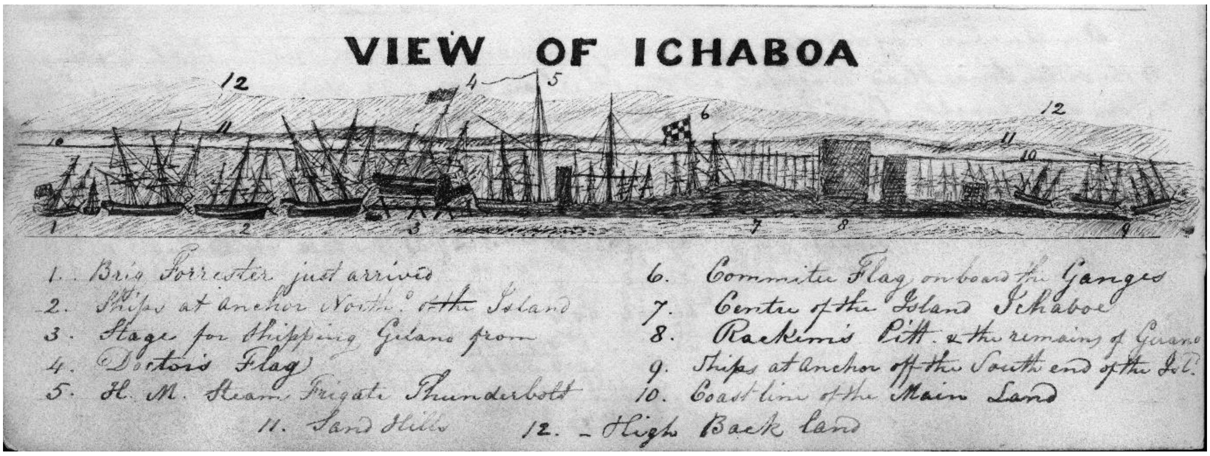

Figure 3: Sketch showing ships riding at anchor while collecting guano at Ichabo Island in 1845, viewed from the south-west. From the log of the American brig *Forrester*, January 1845 no. 508, reproduced by courtesy of Mystic Seaport Museum, Judy Beisler Photo no. 93-5-60, Mystic Seaport, Mystic, Connecticut.

Figure 4: Timbers suspected to be of the barque *Kent*, lost in 1850, protruding from the sand at Hottentot Bay

4. ASSESSMENT

The most likely impact of seabed diamond exploration and mining in the proposed ML 220 on sites and materials protected under the National Heritage Act (27 of 2004) would be damage through inadvertent disturbance and possible destruction in the course of mechanical exploration and mining activities. This impact could seriously compromise in particular the underwater cultural heritage resources of Hottentot Bay, bearing in mind that damage to archaeological sites is essentially irreparable. The consequences of such impacts must be considered as permanent. However, it is not possible to assess the likelihood of such impacts with any degree of certainty, given that do inspection of the seabed within the lease area has been carried out. The following assessment must therefore be treated as tentative.

Assessment of seabed diamond exploration and mining in the proposed ML 220 on sites and materials protected under the National Heritage Act (27 of 2004) is based on the criteria in Appendix 1 which sets out the approach for determining impact consequence (combining nature and intensity, extent and duration) and impact significance (the overall rating of the impact). Following the criteria for ranking the NATURE & EXTENT of potential impacts, the project (without mitigation) is likely to have a **Very High (VH+) Negative Impact**. The EXTENT of this impact would be **Low (L)** in that its direct effect would be within the lease area itself, but since the maritime archaeological heritage of the lease area is considered to the national heritage the extent can be considered as **High (H)**. As with all impacts on archaeological sites, the DURATION is considered to be **Very High (VH)**, or permanent. Given the historical importance of the lease area site and the documentary record of shipping losses there the PROBABILITY of the impact is considered to be **High (H)**. On the basis of the assessment criteria set out in Appendix 1, the SIGNIFICANCE of the impacts is negative and should be considered as either **Moderate (M)** or **High (H)**, if mitigation is applied (see 5. Recommendations). The consequence and significance of these impacts is potentially highly negative given the information at hand.

5. RECOMMENDATIONS

Of particular relevance to the proposed activities on the proposed ML 220, are Section 57 (1) of the Act and Section 57 (4) (a) (i) which notes that “a place where the remains of a ship are located [may] be declared a protected place; or (ii) an article associated with a ship [may] be declared a protected object”. Section 57 (4) (b) furthermore states that “a provisional protection order [may] be made in relation to a place where an article or articles appearing to be the remains of a ship are located”. The available information on shipping losses in the ML 220 area indicates a high likelihood of maritime heritage at Hottentot Bay, although this remains to be confirmed.

It is therefore recommended that:

a. The National Heritage Council should consider declaring Hottentot Bay a protected place in terms of Section 57 of the National Heritage Act (27 of 2004), subject to independent assessment of maritime heritage based on direct and geophysical survey of the area concerned.
b. Survey and assessment should be carried out by a qualified and experienced maritime archaeologist under a permit issued by the National Heritage Council. Contact details for a suitably experienced professional are provided in Appendix 2.
c. Given that the proponent has an existing exploration licence for EPL 5962, the project EMP should adopt the Chance Finds Procedure attached here as Appendix 3, so that in the event that buried archaeological remains which are not visible to surface survey may be handled in accordance with the provisions of Part V Section 46 of the National Heritage Act (27 of 2004).

Appendix 1: Impact Assessment Criteria

IMPACT assessment criteria		
SIGNIFICANCE determination	**Significance = consequence x probability**	
CONSEQUENCE	**Consequence is a function of:** • **Nature and Intensity of the potential impact** • **Geographical extent should the impact occur** • **Duration of the impact**	
Ranking the NATURE and INTENSITY of the potential impact		
Negative impacts		
Low (L)	The impact has no / minor effect/deterioration on natural, cultural and social functions and processes. No measurable change. Recommended standard / level will not be violated. (Limited nuisance related complaints).	
Moderate (M)	Natural, cultural and social functions and processes can continue, but in a modified way. Moderate discomfort that can be measured. Recommended standard / level will occasionally be violated. Various third party complaints expected.	
High (H)	Natural, cultural or social functions and processes are altered in such a way that they temporarily or permanently cease. Substantial deterioration of the impacted environment. Widespread third party complaints expected.	
Very high (VH)	Substantial deterioration (death, illness or injury). Recommended standard / level will often be violated. Vigorous action expected by third parties.	
Positive impacts		
Low (L) +	Slight positive effect on natural, cultural and social functions and processes Minor improvement. No measurable change.	
Moderate (M) +	Natural, cultural and social functions and processes continue but in a noticeably enhanced way. Moderate improvement. Little positive reaction from third parties.	
High (H) +	Natural, cultural or social functions and processes are altered in such a way that the impacted environment is considerably enhanced /improved. Widespread, noticeable positive reaction from third parties.	
Very high (VH) +	Substantial improvement. Will be within or better than the recommended level. Favourable publicity from third parties.	
Ranking the EXTENT		
Low (L)	Local (confined to within the project concession area and its nearby surroundings).	
Moderate (M)	Regional (confined to the region, e.g. coast, basin, catchment, municipal region, district, etc.).	
High (H)	National (extends beyond district or regional boundaries with national implications).	
Very high (VH)	International (Impact extends beyond the national scale or may be transboundary).	
Ranking the DURATION		
Low (L)	Temporary/short term. Quickly reversible. (Less than the life of the project).	
Moderate (M)	Medium Term. Impact can be reversed over time. (Life of the project).	
High (H)	Long Term. Impact will only cease after the life of the project..	
Very high (VH)	Permanent	
Ranking the PROBABILITY		
Low (L)	Unlikely	
Moderate (M)	Possibly	
High (H)	Most likely	
Very high (VH)	Definitely	
SIGNIFICANCE Description		
	Positive	**Negative**
Low (L)	Supports the implementation of the project	No influence on the decision.
Moderate (M)	Supports the implementation of the project	It should have an influence on the decision and the impact will not be avoided unless it is mitigated.
High (H)	Supports the implementation of the project	It should influence the decision to not proceed with the project or require significant modification(s) of the project design/location, etc. (where relevant).
Very high (VH)	Supports the implementation of the project	It would influence the decision to not proceed with the project.

Appendix 2: Recommended maritime archaeologist

Vanessa Maitland, MARITIME ARCHAEOLOGIST

Elandskraal, Western Cape

Cell: 082 490-4066

E-mail: vanessa@cocojams.co.za

ASAPA (Association of Southern African Professional Archaeologists) Member No: 326

EDUCATION

1986 Hill College — Port Elizabeth
- Matriculated

1987-1988 University of Cape Town — Cape Town
- BA – First & Second Year

1992-1993 University of Witwatersrand — Johannesburg
- Completed BA, majored in Archaeology and Jewish Studies
- Other subjects studied include: Anthropology, Geology, Classical Civilizations, Hebrew, History, Biblical Archaeology

1996 University of Witwatersrand — Johannesburg
- BA Honours – Archaeology

2010 - 2012 NAS/SAHRA/IZIKO — Cape Town
- NAS I, II & III: Underwater Survey and Fieldwork Courses
- Iziko Waterlogged Artefact Conservation Course

2010 University of Witwatersrand — Johannesburg
- ARCGIS Course

2011 University of Witwatersrand — Johannesburg
- GRASS & QGIS Course

2013-2019 University of South Africa — Pretoria
- Masters Degree in Maritime Archaeology

ARCHAEOLOGICAL EXPERIENCE

Archaeological excavations at:
- Border Cave, KZN (Stone Age Archaeology)
- The Castle, C.T. (Historical Archaeology)
- Roosfontein Shelter, F.S. (Stone Age Archaeology)
- Rose Cottage Cave, F.S. (Stone Age Archaeology)
- de Hoop, Mpumalanga (Stone Age Archaeology)
- Nettleton Dump, JHB (Historical Archaeology)
- Modderfontein Railway Dump, JHB (Historical Archaeology)

- Stone Age Site near Maun, Botswana. (Stone Age Archaeology)
- Bulhoek, Eastern Cape (Historical Archaeoology)
- Site Archaeologist on the *County of Pembroke* wreck (Maritime Archaeology)
- Site Archaeologist on the *Karin* wreck site (Maritime Archaeology)
- Survey of Robben Island wrecks (Maritime Archaeology)
- Survey of "The Barrel Wreck", Table Bay (Maritime Archaeology)
- Survey of *Odd* wreck site, Durban (Maritime Archaeology)
- Scoping Report, Berths 203-5 & Salisbury Island, Durban Harbour
- Underwater HIA, Berths 203-5 & Sand Winning Sites, Durban Harbour
- Underwater HIA and Land HIA, Pier 1, Durban Harbour
- Platberg Mission Station (Historical Archaeology)
- Inhambane (Mozambique) Slave Wreck Project Magnetometer Survey
- Bloubergstrand, Cape Town Slave Wreck Project Magnetometer Survey
- Senegal, African Slave Wreck Project Magnetometer Survey & Training
- Ilha de Mozambique Slave Wreck Project Magnetometer Survey & Training
- Durban, SAPREF Pipeline Desktop & Magnetometer Survey
- Cape Recife, Port Elizabeth WWTW Desktop, Magnetometer Survey & diver searches
- Cape Recife, Port Elizabeth Wreck Mapping
- False Bay, Cape Town Desalination Desktop, Magnetometer Survey & diver searches
- Hermanus, Western Cape; Magnetometer Survey and diver searches for Neptune Divers
- Port of Ngqura, Port Elizabeth; Magnetometer Survey

WORK EXPERIENCE

1987–1988 First Bowrings — Gauteng
Data Capturer
- Vacation work.

1989–1991 Dryflora — Gauteng
Owner

1990–1992 Charlotte Firbank-King — Gauteng
Researcher

1993–2003 C.F.K. Fine Art & Publishing cc. — Gauteng
Co-owner & Manager

2004 Subtech Diving & Marine — Port Elizabeth
Admin Assistant & Archaeological Advisor
- Research on unknown wreck site
- Compiling interim reports on *County of Pembroke* wreck site

2007-2008 Independent Consultant — Port Elizabeth

Site Archaeologist

- Diving and collecting data on *County of Pembroke* wreck site
- Liasing with Bayworld re curation of artefacts
- Research
- Archaeological reports

2009 Independent Consultant Durban

- Diving and collecting data on "Anomaly 27" wreck site
- Liasing with SAHRA regarding site

2010 Independent Consultant Durban

Site Archaeologist

- Fieldwork and research on the *Karin* ("Anomaly 27") wreck
- Archaeological report on the *Karin*
- NAS (Nautical Archaeology Society) I course on Robben Island
- NAS II course on Robben Island
- NAS III (1st & 2nd Module) course on Robben Island
- Editing and co-authoring NAS II group report
- Organising and training at NAS I (Durban) Course

2011 Independent Consultant Durban

Site Archaeologist

- Fieldwork and tutor on NAS II Robben Island Course
- Fieldwork and tutor on NAS II Durban Course
- Heritage Scoping Report for the Proposed Developments at the Container Terminal at the Port of Durban for CSIR

2012 Independent Consultant Durban

Site Archaeologist

- Fieldwork and tutor on NAS II Robben Island Course
- Fieldwork on "The Barrel Wreck" for Masters degree
- Underwater HIA for Berth 203-5 & Sand Winning Areas at Durban Harbour for Nemai Consulting

2013 Independent Consultant/ACHA Durban

Maritime Archaeologist

- Underwater HIA and Land HIA, Pier 1, Durban Harbour
- Registered for Masters at UNISA
- Fieldwork at Bulhoek – Free State

2014 ACHA Durban

Maritime Archaeologist

- Fieldwork at Platberg Mission Station – Free State
- Inhambane (Mozambique) Slave Wreck Project Magnetometer Survey
- Underwater HIA for Pier 1 at Durban Harbour for Jeffares & Green

2015 ACHA Durban

Maritime Archaeologist

- Bloubergstrand, Cape Town Slave Wreck Project Magnetometer Survey
- HIA for Pier 1 at Durban Harbour for Jeffares & Green
- Tutor WITS MUCH Field School - Durban
- Fieldwork at Platberg Mission Station – Free State
- Site Archaeologist at KZN Children's Hospital – Durban
- Project Director Transnet MUCH Project

2016 ACHA Durban
Maritime Archaeologist

- Senegal, African Slave Wreck Project Magnetometer Survey and Training
- Ilha de Mozambique, African Slave Wreck Project Magnetometer Survey and Training
- Fieldwork at Platberg Mission Station – Free State
- Saldanha Bay shipwreck research for Dr Jonathan Sharfman
- Site Archaeologist at KZN Children's Hospital – Durban
- Maritime Heritage Desktop Survey for Umgeni Water Amanzi's proposed construction of desalination plants at: Lovu River & Tongaat – KZN
- Maritime Heritage Desktop Survey for Ibhubesi Gas Project
- MUCH Heritage Display for Transnet's Maritime School of Excellence Graduation
- Project Director Transnet MUCH Project

2017 ACHA/Independent Consultant Cape Town
Maritime Archaeologist

- Project Director Transnet MUCH Project
- Ilha de Mozambique, African Slave Wreck Project Magnetometer Survey
- UHIA and Magnetometer Survey, Richard's Bay Floating Dock
- UHIA and Magnetometer Survey, Hitachi Water Remix Project
- Statement on Maritime Structures, Gansbaai and Still Bay
- SAPREF UHIA and Assessment of ROV Survey
- UHIA, De Beers, West Coast Concessions

2018 ACHA/Independent Consultant Cape Town
Maritime Archaeologist

- SAPREF Magnetometer Survey, Durban
- Magnetometer and Diver Survey for CoCT on Monwabisi and Strandfontein Desalination Sites, Cape Town
- UHIA, Magnetometer and Diver Survey for NMBM Outfall Pipes, Cape Recife, Alogoa Bay
- UHIA, Alexkor, West Coast Concessions
- Wreck Mapping for for NMBM Outfall Pipes, Cape Recife, Alogoa Bay
- Ilha de Mozambique, African Slave Wreck Project Magnetometer Survey

2019 ACHA/Independent Consultant Knysna

- SAPREF Magnetometer Survey, Durban

- Wreck Mapping for for NMBM Outfall Pipes, Cape Recife, Alogoa Bay
- HIA for Buccara-Africa's Noetzie Helipad and Walkway Development

2020 ACHA/Independent Consultant Knysna

- Hermanus, Western Cape Magnetometer Survey and Diver Searches for local dive company, Neptune Divers
- Port of Ngqura Desktop Assessment, Magnetometer Survey and Diver Searches

OTHER QUALIFICATIONS & EXPERIENCE

- NAUI Dive Master
- Commercial Diver Class IV
- CRM Field Director – ASAPA
- CRM Accreditation – Amafa

Appendix 3: Chance Finds procedure

Areas of proposed development activity are subject to heritage survey and assessment at the planning stage. These surveys are based on surface indications alone, and it is therefore possible that sites or items of heritage significance will be found in the course of development work. The procedure set out here covers the reporting and management of such finds.

Scope: The "chance finds" procedure covers the actions to be taken from the discovery of a heritage site or item, to its investigation and assessment by a trained archaeologist or other appropriately qualified person.

Compliance: The "chance finds" procedure is intended to ensure compliance with relevant provisions of the National Heritage Act (27 of 2004), especially Section 55 (4): *" a person who discovers any archaeological …. object ……must as soon as practicable report the discovery to the Council".* The procedure of reporting set out below must be observed so that heritage remains reported to the NHC are correctly identified in the field.

Responsibility:

Operator	To exercise due caution if archaeological remains are found
Foreman	To secure site and advise management timeously
Superintendent	To determine safe working boundary and request inspection
Archaeologist	To inspect, identify, advise management, and recover remains

Procedure:

Action by person identifying archaeological or heritage material

a) If operating machinery or equipment stop work

b) Identify the site with flag tape

c) Determine GPS position if possible

d) Report findings to foreman

Action by foreman

a) Report findings, site location and actions taken to superintendent

b) Cease any works in immediate vicinity

Action by superintendent

a) Visit site and determine whether work can proceed without damage to findings

b) Determine and mark exclusion boundary

c) Site location and details to be added to project GIS for field confirmation by archaeologist

Action by archaeologist

a) Inspect site and confirm addition to project GIS

b) Advise NHC and request written permission to remove findings from work area

c) Recovery, packaging and labelling of findings for transfer to National Museum

<u>In the event of discovering human remains</u>

a) Actions as above

b) Field inspection by archaeologist to confirm that remains are human

c) Advise and liaise with NHC and Police

d) Recovery of remains and removal to National Museum or National Forensic Laboratory, as directed.