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EIA SCOPING & IMPACT ASSESSMENT REPORT AND ENVIRONMENTAL MANAGEMENT PLAN FOR

THE PROPOSED KELP CULTIVATION PILOT PROJECT NEAR LÜDERITZ, KARAS REGION

Prepared for: Kelp Blue Namibia (Pty) Ltd

August 2020

DOCUMENT CONTROL

Report Title	**EIA SCOPING & IMPACT ASSESSMENT REPORT FOR THE PROPOSED KELP CULTIVATION PILOT PROJECT NEAR LÜDERITZ, KARAS REGION**
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EXECUTIVE SUMMARY

1. GENERAL INTRODUCTION

Kelps are members of a group of brown seaweeds which includes the largest of the seaweeds, many of which form large kelp forests in shallow water (mostly <20m depth) on rocky seashores around the world. *Macrocystis* is the largest seaweed in the world, known as 'giant kelp'. In the past there were considered to be 4 species of *Macrocystis*, and the species were separated mostly on the structure of the holdfast. Recent studies have shown that there is only one species of *Macrocystis* in the world (*Macrocystis pyrifera*), and there is in fact very little genetic difference between populations of *Macrocystis* around the world.

Kelp Blue Namibia (Pty) Ltd (i.e. Kelp Blue), a privately owned Company, intends to cultivate and harvest Giant Kelp (*Macrocystis Pyrifera*) at a commercial scale off the coast of southern Namibia.

Prior to full scale commercial 'farming' of Giant Kelp, Kelp Blue intends to first implement a Pilot Project to provide them with further important information and proof of their concept. A location in the vicinity of Lüderitz, Karas region, has been selected for this Pilot Project due to its favourable climatic conditions and fertile marine ecosystem (refer to Figure 1 for the locality map).

As part of its Kelp Cultivation Pilot Project, Kelp Blue proposes to collect fertile sporophylls from various international locations; establish a laboratory for hatching in Lüderitz; develop an initial grow out area of ± 20 hectares (ha); and cultivate and harvest the kelp from three pilot cultivation areas of ± 1 km^2 each (refer to Figure 1 for the locality map of the indicative pilot areas).

This Scoping (including impact assessment) Report summarises the Environmental Impact Assessment (EIA) process being followed for the proposed Kelp Cultivation Pilot Project, near Lüderitz. It includes an assessment of the environmental impacts that the proposed project is likely to have. The proposed management and mitigation measures relating to the proposed project are documented in an Environmental Management Plan (EMP).

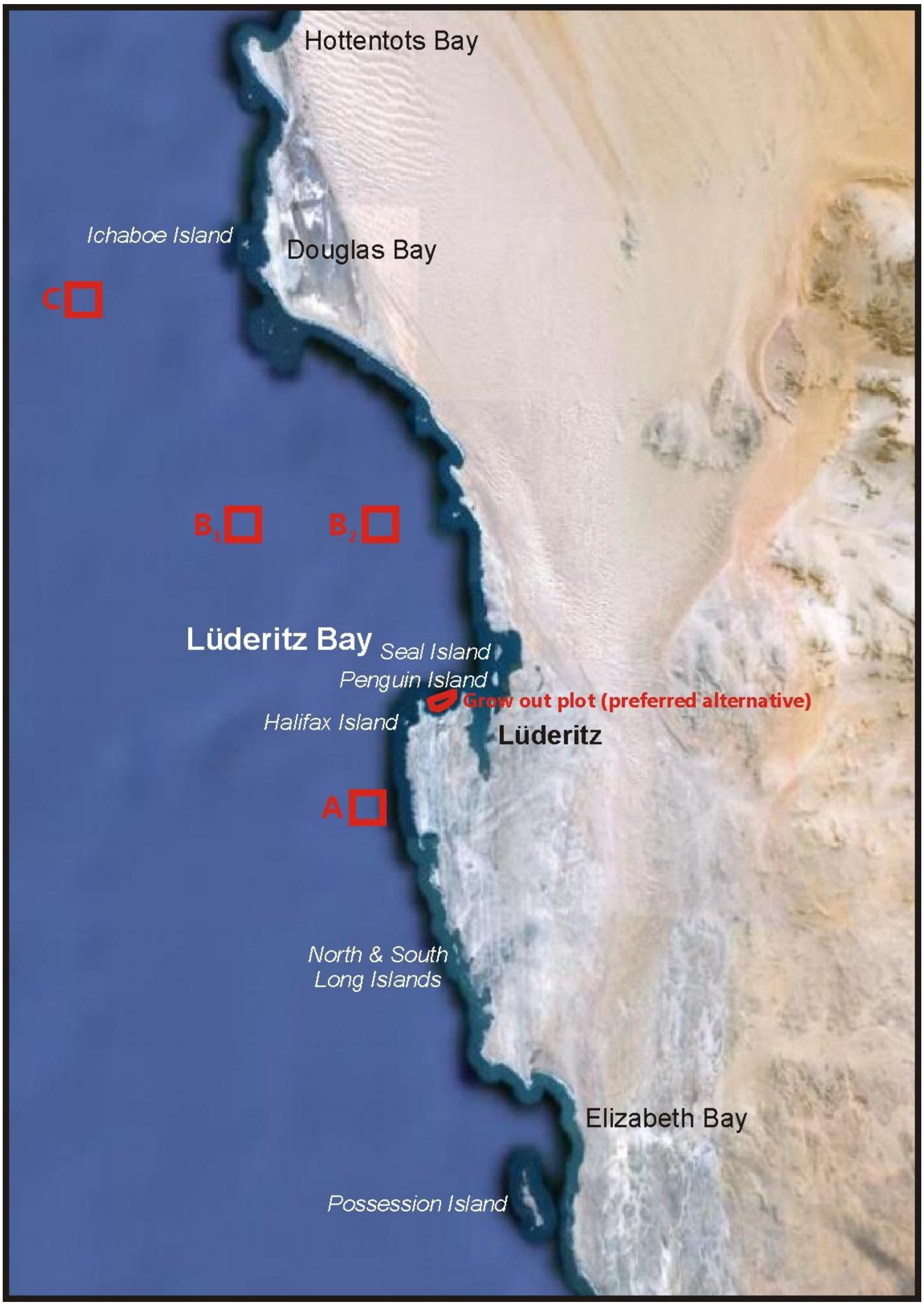

FIGURE 1: PROPOSED KELP GROW OUT AND PILOT AREAS (INDICATIVE - RED LINES)

2. BACKGROUND TO THE BIOLOGY, ECOLOGY AND AQUACULTURE OF KELPS AND THE KELP BLUE PILOT PROJECT MOTIVATION

2.1 Kelp Facts (i.e. Biology & Ecology) and international Kelp cultivation & harvesting activities

The use of seaweeds by humans enjoys a long rich heritage, where people have used seaweeds for thousands of years, and hand-in-hand with modern science, will likely continue to find more uses. Giant Kelp can grow to 50 m long (even probably 70 m or more) in the correct environment, although in some places it is much smaller. It is one of the most widespread marine species globally and is the basis of large kelp forests in many regions. It is one of the fastest growing plants in the world, with growth rates of 50 cm per day reported in optimal conditions.

Like terrestrial forests, kelp forests absorb a lot of carbon dioxide. Seaweed offsetting is not the sole solution to climate change, but it provides an invaluable new tool for a more sustainable future.

In the Benguela upwelling system on the west coasts of Namibia and South Africa there are 3 species of kelp present:

- *Ecklonia maxima* ('sea bamboo') is dominant in South African kelp forests and becomes less prominent northwards. It is not abundant in southern Namibia, and only present to just north of Lüderitz.
- *Laminaria pallida* ('split fan kelp') grows in deeper water (mostly >6m) in the south but becomes more prominent in shallow water in the Northern Cape of South Africa. It is dominant throughout Namibian kelp forests, in shallow water wherever there is open rocky shore, as far north as Rocky Point close to the Angolan border.
- *Macrocystis pyrifera* ('bladder kelp') has never been recorded in Namibia and is rare in South Africa, occurring only at a few wave-sheltered sites over a short stretch of coast in the extreme southwest.

Where there are large forests of *Macrocystis* it has been widely harvested, notably in California and Mexico, Chile, Alaska and New Zealand. *Macrocystis* has been grown in aquaculture almost exclusively from spores. These are seeded onto string systems in land-based 'hatcheries' and grown for a period in tanks with running seawater before the strings are attached to ropes on raft-like structures in sheltered sea embayments. Strings can be seeded direct from sporophylls taken from natural populations of kelp or, alternatively, the microscopic phase (gametophytes) can be cultured and maintained, and later induced to become fertile and seed ropes.

There have been limited research studies in Chile (‘integrifolia’ form) and South Africa (‘angustifolia’ form) on aquaculture of *Macrocystis* from regenerating holdfasts attached to rope systems, with success in producing new uprights and reasonable growth rates. Whether this could be successful in the long-term remains to be demonstrated.

Macrocystis grows most abundantly in nature on relatively sheltered rocky shores but can survive in quite wave-exposed conditions. The nutrient uptake is enhanced by increased wave action, up to a maximum, so it grows faster in somewhat more wave-exposed coastal sites. On the other hand, strong breaking waves can cause considerable frond loss, and some sites with more wave-exposed conditions have very variable kelp forests, with biomass severely reduced by large storms but growing back in between these storms.

As *Macrocystis* is rare in South Africa, and only grows in shallow water, it is possible that competition from the other local kelps is a negative factor, although there is no direct evidence for this. Also, in areas where there are fish which eat kelp, this may have some impact. Most herbivorous fish are in warmer waters. The strepie (*Sarpa salpa*), which does not occur in the Lüderitz area but is very abundant east of Cape Point in South Africa, had to be removed from the Two Oceans Aquarium kelp exhibit in Cape Town, as they were eating the *Macrocystis* but not the other kelps.

In South Africa, *Macrocystis* only grows in sheltered sites, either in small patches in shallow water inside *Ecklonia maxima* forests, or on the lee side of Dassen and Robben Islands. Large *Macrocystis* thrives on sub-Antarctic islands in the middle of very rough seas, but always on the lee side or in sheltered inlets. It is relevant that *Macrocystis* grows at Jacobsbaai, only 10 km from the mouth of Saldanha Bay, but has never been recorded attached in Saldanha Bay itself or in the linked, more sheltered, Langebaan Lagoon.

Inshore coastal seawater in the Lüderitz region is more turbid than in the Southern Benguela, and thus light will likely be limiting to the colonisation of deeper reefs.

The temperature and nutrient conditions are likely to be within the ranges for *Macrocystis* to thrive, but if it did spread to the nearby Namibian coast and attach, it would be likely to only survive on particularly sheltered rocky coastlines. In southwest South Africa it has only colonised a short (ca. 200 km) section of coastline, and is particularly rare, suggesting that contiguous coastlines further north are not suitable for easy colonisation.

2.2 *General motivation for Kelp Blue's proposed Kelp Cultivation Project and the need for the proposed Pilot Project*

Based on considerable research conducted by Kelp Blue into the cultivation of Giant Kelp, the technology in harvesting the kelp, as well as a market analysis of the various products that can be extracted from the kelp, they propose a feasible, commercial scale project for the cultivation of Giant Kelp. The following key considerations were taken into consideration by Kelp Blue in this regard:

- "Kelp is the fastest growing organism on the planet
- It is a keystone species for marine biodiversity
- It is the 2nd biggest source of CO_2 sequestration on the planet
- Provides a source of high value marketable extracts: polyphenols, phlorotannins, mannitol, furfuran, bio-actives, protein, cellulose, hydrocolloids and fertilizer
- It is possible to repeat harvest Giant Kelp every 3 months for at least 7 years without losing virility
- Giant Kelp can be cultivated on artificial substrate
- It grows on rocky sea-beds in cold, transparent nutrient dense water 10 to 40m deep (i.e. in upwelling current systems)".

The following conditions off the coast of Southern Namibia - near Lüderitz, are amongst others considered to be favourable by Kelp Blue for Giant Kelp Cultivation:

- Nutrient-dense upwelling throughout the year;
- low average annual temperatures;
- relatively calm seas,
- favourable solar radiation,
- dryness on land.

Other than the commercial viability of a proposed kelp harvesting project, off the coast of Southern Namibia, Kelp Blue, considers other likely benefits that would emanate from implementing a proposed Kelp cultivation project. These include "establishing a new form of farming, that produces essential goods for humanity in a sustainable/environmentally positive manner, which draw down CO_2, boosts marine biodiversity and boosts fish stocks; as well as Job creation, investment opportunities, research & academia, biodiversity, marine life, fish stocks boosts, eventual scuba diving tourism, etc.".

Prior to full scale commercial 'farming' of Giant Kelp, Kelp Blue intends to first implement a Pilot Project to provide them with further important information and proof of their concept. The Pilot Project will test and confirm the proposed infrastructure design options and associated cultivation activities and compatibility with the marine ecosystems. It will also validate assumptions for growth rates, harvestability of the Giant Kelp, sustainability and costs, as well as monitor environmental effects.

The offshore engineering will therefore be validated and growth and behaviour of several different source cultivars will be assessed by Kelp Blue during the pilot phase. Furthermore, ease of doing business in Lüderitz will be assessed and economic assumptions validated or refined.

The operation and processing of the Giant Kelp Pilot Project would require real estate in the form of a laboratory space/mini-hatchery and workshop & laydown area(s). Temporary storage of the kelp will also be necessary. Kelp Blue Namibia will employ a maximum of approximately 14 permanent people and up to 60 people on a contract (part time basis) during the pilot phase of the project. This will be positive as it would contribute to the local and regional economy.

3. ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

Environmental Impact Assessments (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 in January 2012. The Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) were Gazetted on 6 February 2012.

Prior to the commencement of the proposed Kelp Cultivation Pilot Project activities, an application for an environmental clearance will be submitted in terms of this Act and the associated EIA Regulations to the Ministry of Fisheries and Marine Resources (MFMR), as the competent authority. MFMR will review the application and relevant reports and submit their comments to the Ministry of Environment, Forestry and Tourism (MEFT) for the review and decision.

The above mentioned EIA application and this report focuses only on the proposed Pilot Project. Should Kelp Blue find all relevant aspects of the Pilot Project to be feasible and they plan to proceed with the Commercial Scale Project, a separate EIA (application) process will have to be conducted. The EIA process includes: a screening phase and a scoping phase, which includes an impact assessment and an Environmental Management Plan (EMP) for the proposed Kelp Blue Pilot Project.

The EIA process steps for the prosed Pilot Project is explained diagrammatically in Figure 2 below.

Registered Interested and Affected Parties (I&APs) were provided with the opportunity to comment on this Scoping (including impact assessment) Report. The comment period ended on the 14th of August 2020, where after the Scoping Report and EMP were updated to a final report with due consideration of the comments received, for submittion to the MFMR and the MEFT for decision-making, as described above.

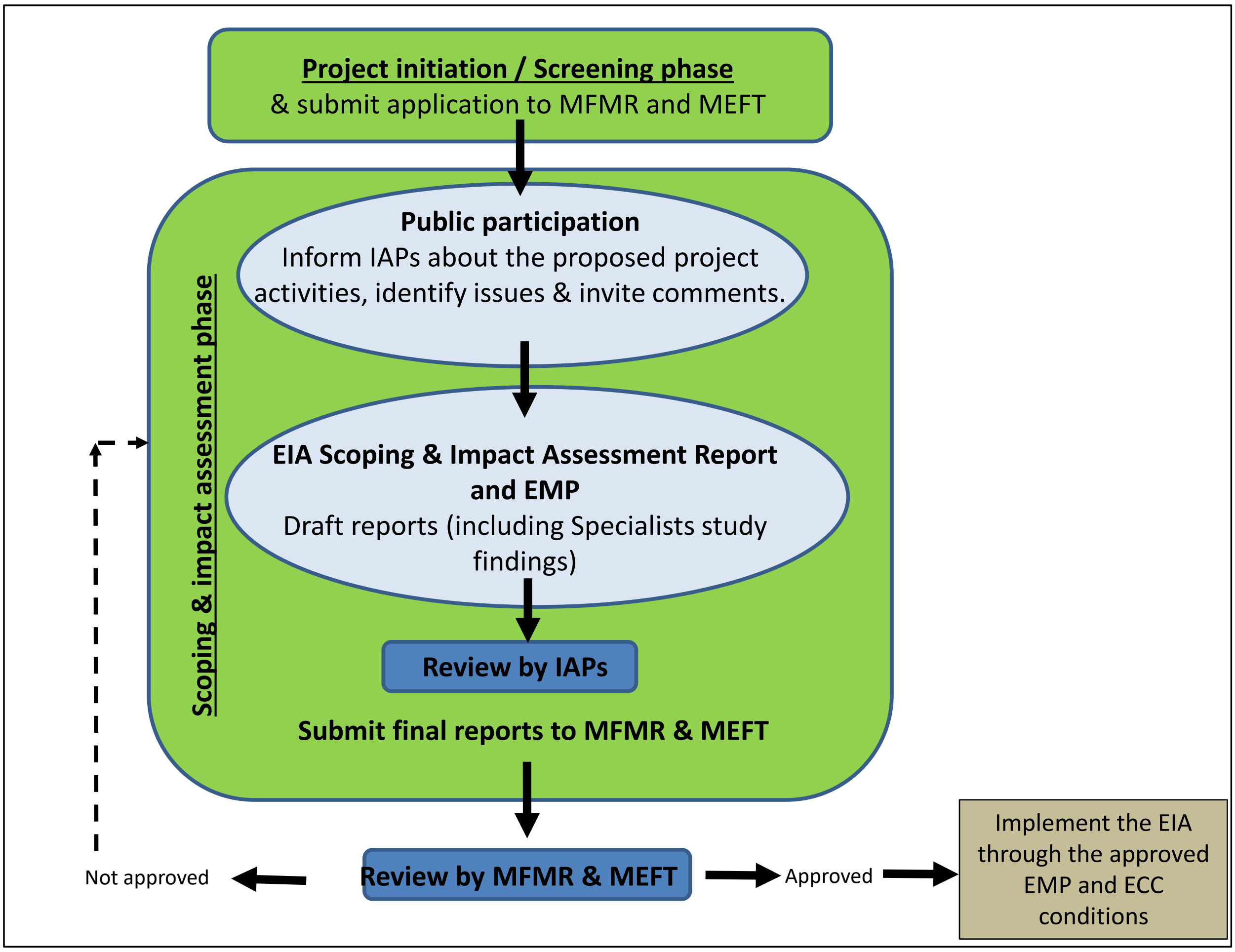

FIGURE 2: THE EIA PROCESS

3.1 EIA Team

Namisun Environmental Projects and Development (Namisun) is an independent environmental consultancy firm appointed by Kelp Blue Namibia to undertake the EIA. Werner Petrick, the EIA project manager has more than twenty-one 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 degree in Environmental Management and is certified as lead environmental practitioner and reviewer under the Environmental Assessment Professionals Association of Namibia (EAPAN).

The Marine Specialist Study was conducted by a team of experts (refer to the Marine Specialist Report [Appendix F] for a summary of their expertise:

- The Marine Specialist Report was prepared by Dr Andrea Pulfrich of Pisces Environmental Services (Pty) Ltd.
- E/Prof John J Bolton's main contribution to this report was to summarise relevant aspects of the biology, ecology and aquaculture of kelps, with special emphasis on Macrocystis.
- Dr Jean-Paul Roux contributed to the marine mammals and turtles parts of the report.
- Dr Jessica Kemper contributed information on seabirds and marine protected areas to the report.
- Dave Japp and Sarah Wilkinson of CapMarine (Pty) Ltd conducted the Fisheries study.

3.3 Steps in the public participation process

The steps that were followed as part of the consultation process are summarised below:

- Namisun notified MEFT and MFMR of the proposed project through a background information document (BID).
- The Application for Authorisation Form was submitted to MFMR (as the Competent Authority) and the Application was registered onto MEFT's online registration system.
- Namisun developed an EIA I&AP database for the Pilot Project. This database is updated as and when required, throughput the EIA process.
- Background Information Documents (BIDs) were distributed via email to relevant authorities and I&APs on the I&AP stakeholder database and copies were made available on request.
- Namisun contacted (telephonically) various key stakeholders to confirm their e-mail addresses to share the relevant information and to arrange for Focus Group meetings. Also, to obtain further input regarding I&APs to be added to the I&AP database.
- The purpose of the BID was to inform I&APs and authorities about the proposed Kelp Blue Pilot Project activities, the EIA process being conducted, possible environmental impacts

and ways in which I&APs could provide input to Namisun. Attached to the BID was a registration and response form, which provided I&APs with an opportunity to submit their names, contact details and comments on the project.

- E-mails were sent to all I&APs on the database and a site notice was placed at the Lüderitz Information Centre, to notify I&APs of the proposed project, the EIA process being following and who to contact for further information requirements. A copy of the e-mail notification and photos of the site notice that were displayed are attached in Appendix B.
- Block advertisements were placed in the Market Watch as part of the following newspaper:
  - The Namibian Sun (11 May and 18 May 2020)
  - Die Republikein (11 May and 18 May 2020)
  - Allgemeine Zeitung (11 May and 18 May 2020)
- Focus group meetings with held with the following Key Stakeholders between 15 May and 5 June 2020:
  - Ministry of Fisheries and Marine Resources in Swakopmund.
  - Five Roses Aquaculture in Lüderitz.
  - JL Marine Merchants in Lüderitz.
  - Ministry of Fisheries and Marine Resources in Lüderitz.
  - Lüderitz Town Council.
  - Macro Fishing in Lüderitz.
  - Hangana Abolone in Lüderitz.
  - Seaflower Whitefish and Novanam in Lüderitz.
  - Seagulls in Lüderitz.
  - LMC Ocean in Lüderitz.
  - Namport in Swakopmund.
  - Ministry of Fisheries and Marine Resources (Mariculture) in Swakopmund.
- A hard copy and electronic (soft) copy of the Draft Scoping and Impact Assessment Report and EMP (including all Appendices) were available for review at the Lüderitz Information Centre from 17 July to 14 August 2020.

- Electronic copies of the Scoping & Impact Assessment Report and EMP (excluding the Appendices) were distributed to all register I&APs and relevant Regulatory Authorities via e-mail.
- Electronic copies of the full report were available on request to Namisun.
- Authorities and I&APs had the opportunity to review the draft report and submit comments in writing to Namisun. The closing date for comments was 14 August 2020.

4. DESCRIPTION OF THE PROPOSED PILOT PROJECT

Kelp Blue Namibia ultimately considers implementing commercial scale Giant Kelp cultivation, which would involve (amongst others) the installation of multiple cultivation arrays anchored between 50 m and 200 m water depth at sea, including installation of seed-lines.

Their proposed Pilot Project will, however, first be implemented to prove various concepts and the feasibility of the commercial scale project, which forms the basis of this report.

Therefore, Kelp Blue intends to implement a kelp cultivation Pilot Project, off shore near Lüderitz, which will broadly involve the follow key activities:

- Collect fertile sporophylls and hatchery activities
- Cultivation
- Harvesting
- Processing

Pilot Project monitoring

3.1 Collection of fertile sporophylls and hatchery activities

Fertile sporophylls will be collected from various international locations, currently under consideration is South Africa, California and Southern Chile with potential further source material from Patagonia, the Falkland Islands, Tristan da Cunha, and Kerguelen Island. The fertile sporophylls will be selected on the basis of healthy, abundant, deep kelp plants in a variety of water movement conditions. The sporophyll blades would be transported cooled to the relevant seaweed culture laboratories where they would be induced to sporulate.

The spores would be hatched and propagated within the relevant culture laboratories before being transported to Kelp Blue's proposed laboratory in Lüderitz in the form of sporophyte concentrations and seeded twine.

The hatchery would require several thousand liters (~ 6 m^3) of seawater per month. The water would, however, be re-circulate in the facility to ensure sterility and stability of temperature and nutrient content. Permanent supply of seawater is therefore not necessary. Seawater treatment processes will consist of UV-filtration and mechanical filtration (and autoclaving), but do not include the introduction of any chemicals except for normal cleaning agents. Some dozens of liters of municipal water (~ 1 m^3) will be used per day, with the addition of trace amounts of iodine, trace amounts of common minerals that mimic seawater composition. A small amount of fresh water for cleaning and washing would also be required.

The seawater and prepared municipal water would be re-circulated within the hatchery. Kelp Blue will apply for a discharge permit from the Ministry of Agriculture Water and Land Reform's (MAWL) - Department of Water Affairs (DWA) and would need to comply to conditions of the permit.

3.2 Giant Kelp Growth (i.e. Cultivation)

Following a further ± two months in the hatchery (i.e. Lüderitz Laboratory), the seeded twine would be wrapped around the horizontal ropes in the grow-out arrays. The initial 'grow-out' will therefore involve a simple horizontal rope suspended between buoys. The-grow out area will be ±20 hectares (0.2 km^2) in size, containing numerous buoy / rope arrays. Kelp Blue intends to develop the grow out area in Shearwater Bay (see Figure 1). Once the cultivars have reached ±150 cm length they will be transferred either one of the three pilot area, described below.

Though Kelp Blue aims for a "one pilot" success, the workplan and budget includes contingent provisions for a second and third pilot, should the first fail in one way or another. Three pilot cultivation areas of ± 1 km^2 each is therefore proposed, as follows (see Figure 1 for indicative locations):

- Pilot Area A: In ±70 m water depth to the south-soutwest of Diaz Point.
- Pilot Area B: Two options, which are both likely feasible (i.e. B1 and B2 in Figure 1), approximately halfway between Ichaboe Island and the Lüderitz Port.
- Pilot Area C: In 150 m water depth to the west-southwest of Ichaboe Island.

The proposed Pilot Areas shown in Figure 1 are all indicative areas and bigger than 1 km^2. The reason being is that the exact location for the pilot areas can only be determined at the time of installing the arrays (i.e. anchoring systems) after surveying the seafloor and Kelp Blue consulting with the diamond mining licence holders (see the EMP in Section 10).

An alternative grow-out area (yellow area in Figure 3) was originally considered by Kelp Blue, which is located in semi-sheltered waters behind Seal Island in the northern bay of Lüderitz. This option was regarded to be less favourable, due to the following reasons:

- The area overlaps with mariculture Farm No. 19 held by another company.
- Abalone ranching is undertake in very close proximity to the proposed kelp Harvesting area. The proposed grow out area is very close the abalone farming areas and that poaching of abalone could become an issue.
- Rock lobster poachers have been reported around Seal and Penguin Islands, which might also pose a risk to Kelp grow out activities.
- There are a few known shipwrecks in the vicinity of Icahboe Island.

Locating the grow-out area in Shearwater Bay would avoid / limit the above mentioned risks, taking further management and mitigation measures provided in the EMP (Section 10) into consideration.

Kelp Blue originally planned one of the Pilot Areas (i.e. area B, yellow outline in Figure 3) in 50 m water depth, to the southwest of Ichaboe Island. This location falls within the Ichaboe Island Rock-Lobster Sanctuaries and overlaps with the lobster fishing areas. Ichaboe Island (amongst others) is further listed as a global IBAs as it regularly support significant numbers of seabirds or waterbirds. Seabirds are also prone to marine oil pollution, particularly flightless African Penguins, and any possible spills from the Pilot Project vessels near Ichaboe Island will cause a risk to these seabirds. Furthermore, there are a few known shipwrecks in the vicinity of Icahboe Island.

Two alternative locations to Option B are being proposed, i.e. B1 and B2 (see Figures 1 and 3). Both these locations are considered feasible, however, the preferred option is B2, i.e. the option closer to shore. The reasons being the following:

- The offshore location (B1) is more exposed to international traffic, i.e. traffic that is likely to have less local knowledge on infrastructure in the water. There is a lot of movement up and down the coast in territorial waters, therefore the risk of any obstruction in the water being hit is high, without proposer planning and suitable management and mitigation measures implemented.

- The inside location (B2) is closer to the port control area, can be more easily demarcated, and more easily controlled by the port.
- Local traffic will be mostly vessels familiar with the area closer to shore and more responsive to port regulations and demarcation, similar what already exists with the mariculture installations. The infrastructure can likely also be more easily maintained when located closer to shore.

The seabed at the location closer to shore (B2) might however be less sandy than the offshore location (B1), which would make this less preferable. A geophysical survey of the seabed needs to be conducted to confirm the conditions (refer to the EMP).

Furthermore, Kelp Blue should consider moving Pilot Plot A further west to avoid interaction with the traffic route heading south.

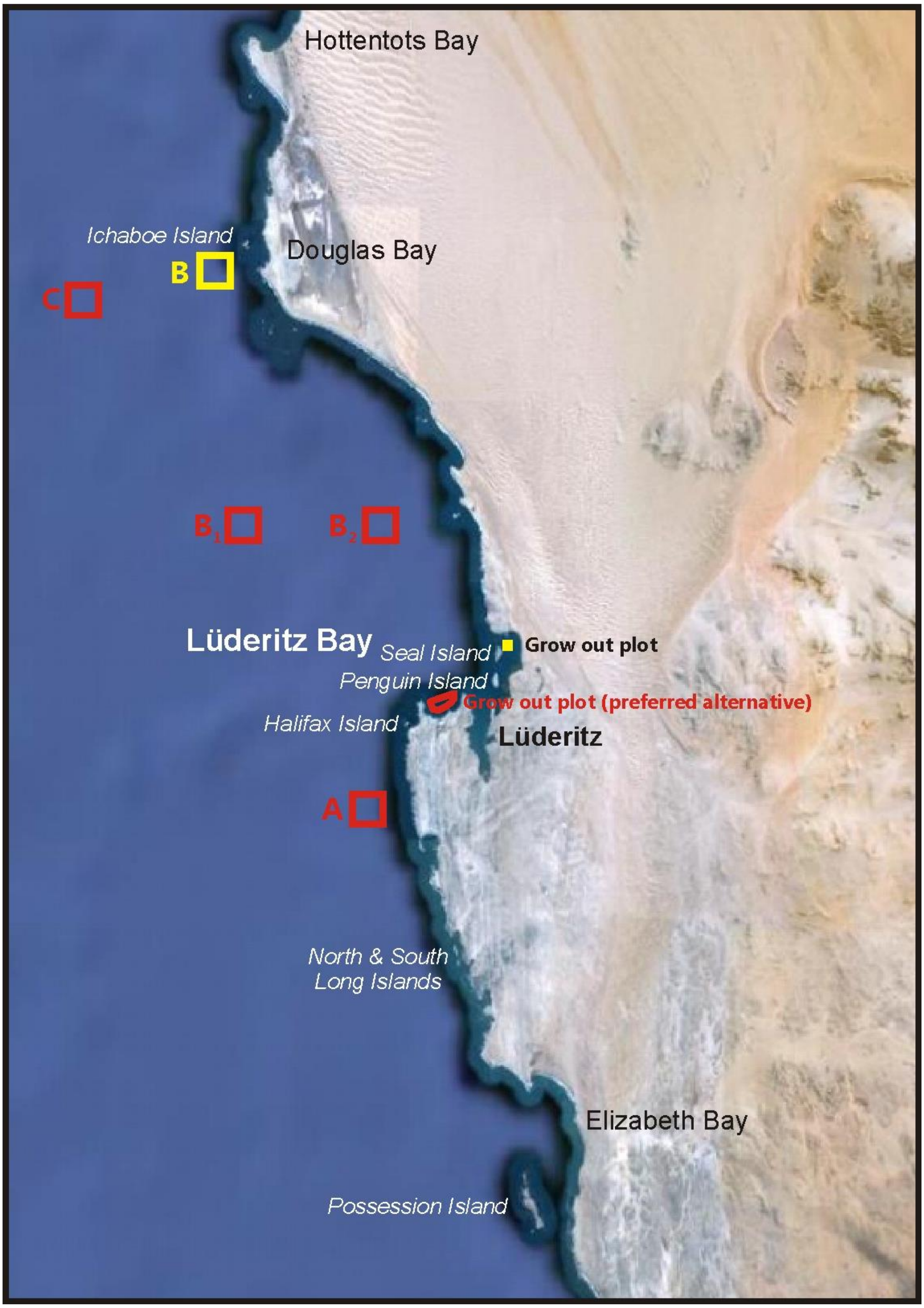

FIGURE 3: ALTERNATIVE KELP GROW-OUT AND INDICATIVE PILOT AREAS (RED OUTLINES ARE THE PREFERRED LOCATIONS: YELLOW OUTLINES WERE ORIGINALLY PROPOSED BY KELP BLUE)

Kelp cultivation requires arrays of artificial substrate in the sea, on which the kelp plants attach and grow. This is typically an array of stiff structures, ropes and buoys. All hard infrastructure will be at 20 m+ depth considering shipping hazards to normal vessels. Various styles of cultivation arrays might be tested during the pilot phase to test different configurations and materials. The arrays are designed as being positively buoyant; and engineered such as to be able to sustain the expected increase in weight as marine growth accumulates. For all the concept designs, a dominant part of the drag forces on the array are transferred to it via the kelp holdfast. Engineering approaches will ensure that the kelp is ripped loose from the array before array failure. With detachment of kelp, the point forces on the arrays would also reduce significantly, thereby avoiding terminal failure and/or loss of the array.

A typical (i.e. schematic) array design is presented in Figure 4.

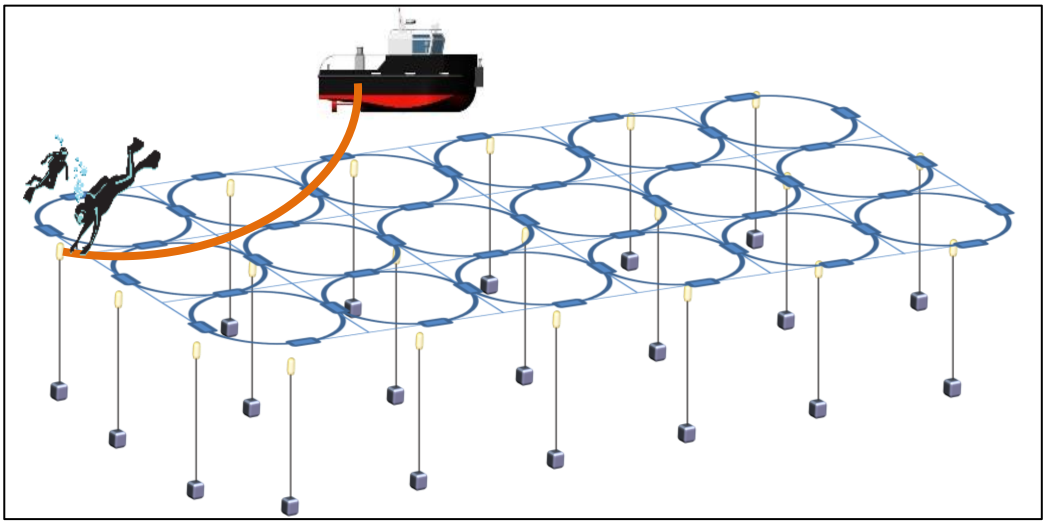

FIGURE 4: TYPICAL (I.E. SCHEMATIC) PILOT CULTIVATION ARRAY DESIGN

The Giant Kelp is expected to grow to full size (occupying the entire 20-25 m of water column above the array) within 6-7 months of out-planting.

3.3 Kelp harvesting

Kelp harvesting will be done with small boats, by divers. The kelp will be cut by hand some 50-100 cm below the surface, loaded onto the vessels (or towed behind the vessels in towing nets) and transported back to Lüderitz. As the cut kelp regenerates within 2-3 months, harvesting can be undertaken every 3-4 months, although growth rates are expected to show some seasonality.

3.4 Processing

A part of the harvest could be sold as fresh leaves to Abalone farms. The remaining harvested kelp will be air dried and milled with a simple commercially available herb or sugar cane grinding mill. The milled kelp from the Pilot Project will be marketed to Namibian farmers as fertilizer/soil improver.

Part of the harvest will be processed experimentally for the extraction of protein, alginate, and cellulose in lab conditions in Lüderitz and at labs in Europe, to establish base quality and physical / chemical properties of the extracts.

The pilot trials will be considered successful if the expected environmental benefits are monitored (and no material adverse impacts identified), and if dry weight yields of greater than 8 tons/ha are achieved within 30% of budget over a 12 month period.

3.5 Pilot monitoring

The purpose of the Pilot Project is to prove that the engineering designs are robust and to evaluate the following:

- Behavior of the structures with growing kelp in ambient (and storm) conditions
- Growth rates of the Giant Kelp
- Cost of the Pilot Project
- Compatibility with the marine ecosystems
- Ease of doing business in Namibia

Further (detailed) environmental monitoring requirements during the Pilot Project implementation phase are presented in the EMP.

5. IDENTIFICATION AND DESCRIPTION OF POTENTIAL ENVIRONMENTAL IMPACTS AND ASSESSMENT FINDINGS

All comments, questions and issues that have been raised throughout the process by authorities and I&APs are provided in Appendix D of this report. The following issues were identified by the Environmental Team, in consultation with various I&APs, as requiring further assessment:

- Potential impacts on the Marine Environment, relating to the following:
    - Biosecurity risks of introducing non-native kelp
    - Biosecurity risks of introducing associated diseases, parasites and biofouling pests to the Benguela;

  - Seawater abstraction and discharges from the land-based hatchery;
  - Disturbance of benthic habitats and associated communities;
  - Disturbance of marine mammals and seabirds;
  - Noise and pollution effects from machinery;
  - Marine mammal and turtle entanglement risks in ropes and buoys;
  - Seabird entanglement in disintegrating rope strands / twine;
  - Habitat creation and/or exclusion and physical presence of floating structures in the pelagic realm;
  - Effects on seawater nutrient chemistry and clarity;
  - Alteration of plankton community structure around arrays;
  - Biodeposition of detritus below the arrays and associated changes to physico-chemical and biological properties of the sediments;
  - Disturbance of seabirds;
  - Biological impacts on fisheries and mariculture stocks and recruitment;
- Unplanned Events, i.e. storm damage and/or loss of arrays; and pollution and accidental spills.
- Heritage impacts (i.e. shipwrecks), and
- Socio-economic impacts, including the following:
  - Interaction with Rock Lobster Fishery and Line-Fishery and potentially impacting their activities; and
  - Hazard to marine traffic and conflict with other users.

The direct ecological effects of a pilot farm for the offshore cultivation of *Macrocystis* are expected to be small, due to the limited size of the operation. Its restricted occurrence in the Southern Benguela suggests that *Macrocystis* is unlikely to become so well established in the natural environment off central Namibia that it may pose a competitive threat to local kelp species. Diseases and pathogens are typically species specific and only develop in the adult crop after many years of intense cultivation. Any negative effects on seabed communities of the placement of the anchor blocks will with time be offset as the blocks will provide an alternative hard substrate to other mobile and sessile benthic species. Being 'ecosystem engineers' the floating *Macrocystis* forests would create their own microecosystem, providing shelter, feeding and nursery areas for a highly diverse associated fauna. By extracting nutrients from the water column, there may however be localised changes in plankton abundance and diversity in the vicinity of the arrays, and changes in sediment properties and benthic communities below the arrays due to biodeposition.

On a limited scale the positioning of the pilot plots may result in conflicts with diamond mining licence holders, vessel traffic and fisheries. As fishing is a high risk industry with many economic constraints, any development that may impact on fishing will increase the risk to both the fishery operations as well as potentially having associated biological impacts to the commercial fish stocks (leading to reduced catch rates).

The design of the arrays and their positioning at ~ 20 m depth should ensure that entanglement by marine fauna would be minimal, with highest risks occurring during installation or in the unlikely event of array failure and loss. It is, however, crucial that materials used in the pilot plots are rigorously tested in order to gauge the wear and tear of the design (and with that the potential for creating entanglement opportunities for marine animals) and the likelihood of losing arrays in rough sea conditions.

A Precautionary Approach to the offshore cultivation of giant kelp is advised with regard to the scale of any development until such time as the technical, oceanographic and environmental impacts of the pilot project and any future expansion is understood.

In terms of fuel pollution, provision needs to be made to effectively manage even a small fuel spill – especially if it involves heavy fuel oils. Cognisance needs to be taken that the equipment required to contain a spill (booms, assisting vessels, dispersants) is more readily available closer to Lüderitz and that attending to a spill further offshore could prove more of a challenge.

It is Namisun's opinion that the environmental aspects and potential impacts relating to the proposed Kelp Blue Namibia Pilot Project has been successfully identified and assessed as part of this EIA process. Relevant management and mitigation measures have been provided to ensure significant environmental and social impacts are avoided / minimised and positive social impacts enhanced, where relevant. These measures are included in the EMP.

A summary of the assessment findings is presented in Table 1 below.

TABLE 1: SUMMARY OF POTENTIAL IMPACTS ASSOCIATED WITH THE PROPOSED PILOT PROJECT

Potential Impact	Significance	
	Before mitigation	After mitigation
Marine Environment		
Introduction of Non-native Kelp into the Lüderitz area	M	L-M
Introduction of Associated Diseases, Parasites and Pests	L	L
Seawater Abstraction and Discharge at Hatchery	L	L
Disturbance and/or Loss of Benthic Macrofauna	M-H	M
Disturbance of Seabirds during Installation, Operation and Decommissioning	L	L
Habitat Creation and Alteration of Plankton Community	H+	H+
Alteration of Plankton Community	L	L
Biodeposition and Changes to Sediment Properties	L	L
Namibian Islands' Marine Protected Area	L	L
Biological Impact on stocks and stock recruitment	L	L
Noise and Pollution Effects	L	L
Heritage		
Damage to archaeological resources (shipwrecks, etc.)	M-H	L
Socio-Economic		
Interaction with Marine Traffic	M	L
Interaction with the Rock Lobster Fishery	M	L
Interaction with the Line-Fishery	M	L
Interaction with Diamond Mining	M	L
Unplanned Events		
Damage to and Loss of Arrays	M-H	L
Operational Spills and Vessel Accidents	L-M	L

6. WAY FORWARD

The way forward is as follows:

- Submission of the final report (including I&APs' comments) to MFMR and MEFT for their review and decision.

7. ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSIONS

Namisun believes that a thorough assessment of the proposed Pilot Project has been achieved and that an environmental clearance certificate could be issued on condition that the management and mitigation measures in the EMP be adhered to.

Should Kelp Blue find all relevant aspects of the Pilot Project to be feasible and they plan to proceed with the Commercial Scale Project, a separate EIA (application) process will have to be conducted, taking cognisance of the risks identified by the Environmental Team during the execution of the EIA for the Pilot Project.

ACRONYMS AND ABBREVIATIONS

Below a list of acronyms and abbreviations used in this report.

Acronyms / Abbreviations	Definition
BCC-SBA	Benguela Current Commission's Spatial Biodiversity Assessment
BCLME	Benguela Current Large Marine Ecosystem
BID	Background Information Document
BOD	Biological Oxygen Demand
CBD	Convention on Biological Diversity
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CSIR	Council for Scientific and Industrial Research
CV	Curriculum vitae
DEA	Directorate of Environmental Affairs
DNA	deoxyribonucleic acid
EAP	Environmental Assessment Practitioner
EAPAN	Environmental Assessment Professionals' Association of Namibia
EBSA	Ecologically or Biologically Significant marine Areas
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPL	Exclusive Prospecting Licences
FAD	Fish Aggregating Deveice
H2S	hydrogen sulphide
ha	hectare
HAB	Harmful Algal Blooms
HDPE	High-Density Polyethylene
HWS	High Water Spring
IBAs	Important Bird Areas
I&AP	Interested and Affected Parties
IMDH	International Mining and Dredging Holdings
IUCN	International Union for Conservation of Nature
MEFT	Ministry of Environment, Forestry and Tourism
MFMR	Ministry of Fisheries and Marine Resources
ML	Mining Licence
MLA	Mining Licence Area
MME	Ministry of Minerals and Energy
MPAs	Marine Protected Areas
NIMPA	Namibian Islands Marine Protected Area
NGO	Non-Government Organisation
NNE	North-Northeast
NNW	North-Northwest
NOAA	National Oceanic and Atmospheric Administration
PIM	Particulate Inorganic Matter
POM	Particulate Organic Matter
(Pty) Ltd	Proprietry Limited
SACW	South Atlantic Central Water
SAN	South African Navy
sp.	species (singular)
spp.	Species (plural)

SW	Southwest
SWAPO	South West African Peoples Organisation
TAC	Total Allowable Catch
TSPM	Total Suspended Particulate Matter
UNEP	United Nations Environment Program
US	United States
WHO	World Health Organisation
WNW	West-Northwest

1 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

This Scoping (including impact assessment) Report summarises the Environmental Impact Assessment (EIA) process being followed for the proposed Kelp Cultivation Pilot Project, near Lüderitz. It includes an assessment of the environmental impacts that the proposed project is likely to have. The proposed management and mitigation measures relating to the proposed project are documented in an Environmental Management Plan (EMP), see Section 10.

Registered Interested and Affected Parties (I&APs) were provided with the opportunity to comment on this Scoping (including impact assessment) Report (see Section 1.4). The comment period ended on the 14th of August 2020, where after the Scoping Report and EMP were updated to a final report with due consideration of the comments received, for submission to the Ministry of Fisheries and Marine Resources (MFMR) as the Competent Authority and the Ministry of Environment, Forestry and Tourism (MEFT) for decision-making.

1.2 INTRODUCTION TO THE PROPOSED PROJECT

Kelps are members of a group of brown seaweeds which includes the largest of the seaweeds, many of which form large kelp forests in shallow water (mostly <20m depth) on rocky seashores around the world. *Macrocystis* is the largest seaweed in the world, known as ‘giant kelp’. In the past there were considered to be 4 species of *Macrocystis*, and the species were separated mostly on the structure of the holdfast. Recent studies have shown that there is only one species of *Macrocystis* in the world (*Macrocystis pyrifera*), and there is in fact very little genetic difference between populations of *Macrocystis* around the world (Pisces [Bolton], 2020).

Kelp Blue Namibia (Pty) Ltd (i.e. Kelp Blue), a privately owned Company, intends to cultivate and harvest Giant Kelp (*Macrocystis Pyrifera*) at a commercial scale off the coast of southern Namibia.

Prior to full scale commercial ‘farming’ of Giant Kelp, Kelp Blue intends to first implement a Pilot Project to provide them with further important information and proof of their concept. A location in the vicinity of Lüderitz, Karas region, has been selected for this Pilot Project due to its favourable climatic conditions and fertile marine ecosystem (refer to Figure 1 for the regional locality map).

As part of its Kelp Cultivation Pilot Project, Kelp Blue proposes to collect fertile sporophylls from various international locations; establish a laboratory for hatching in Lüderitz; develop an initial grow out area of ± 20 hectares (ha); and cultivate and harvest the kelp from three pilot cultivation areas of ± 1 km^2 each.

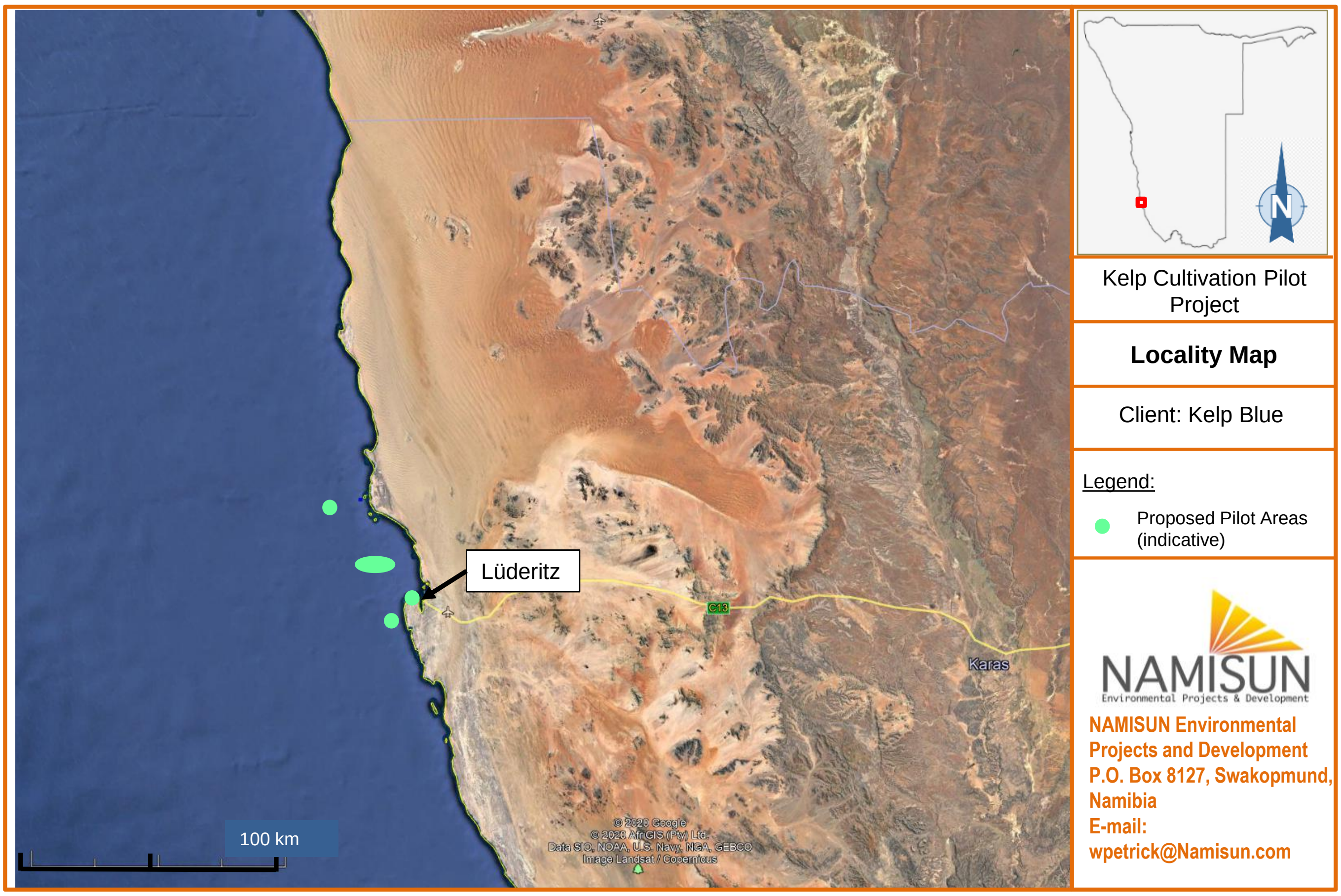

FIGURE 1: REGIONAL LOCATION OF THE KELP BLUE PILOT PROJECT (Ref: Google Earth)

1.3 INTRODUCTION TO THE EIA PROCESS

Environmental Impact Assessments 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 in January 2012. The Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) were Gazetted on 6 February 2012.

Prior to the commencement of the proposed Kelp Cultivation Pilot Project activities, an application for an environmental clearance will be submitted in terms of this Act and the associated EIA Regulations to the Ministry of Fisheries and Marine Resources (MFMR), as the competent authority. MFMR will review the application and relevant reports and submit their comments to the Ministry of Environment, Forestry and Tourism (MEFT).

The above mentioned EIA application and this report focuses only on the proposed Pilot Project. Should Kelp Blue find all relevant aspects of the Pilot Project to be feasible and they plan to proceed with the Commercial Scale Project, a separate EIA (application) process will have to be conducted.

The EIA process includes: a screening phase and a scoping phase, which includes an impact assessment and an Environmental Management Plan (EMP) for the proposed Kelp Blue Pilot Project.

This report is the EIA Scoping and Impact Assessment Report. The main purpose of this report is to provide information relating to the proposed activities and to indicate which environmental aspects and potential impacts have been identified during the process, to assess the potential impacts and to develop effective management and mitigation measures to ensure impacts are avoided or minimised.

Existing information provided by Kelp Blue for the proposed Pilot Project (where available and relevant) was referred to and was further augmented by additional site observations (from Lüderitz), specialist assessments and the results of stakeholder consultation. The potential impacts of the proposed activities (and associated infrastructure and facilities) could therefore be assessed, and the assessment is also included in this report. The potential impacts were cumulatively assessed, where relevant, taking the existing environment and all other relevant activities into consideration.

This EIA Scoping & Impact Assessment Report, together with the EMP (section 10), will therefore provide sufficient information for the MFMR as the Competent Authority and the MEFT to make an informed decision regarding the proposed project, and whether an environmental clearance certificate can be issued or not.

The specialist studies that were conducted as part of this EIA process include the following:

- Marine Ecology and Fisheries Specialist Assessment, including the following specific specialist input:
    - Kelp ecology and biosecurity risks
    - Marine Mammals and Entanglement
    - Seabirds
    - Fisheries
    - Marine ecology & diamond mining interaction

The specialist studies are all included into one consolidated Marine Ecology and Fisheries Specialist Report, included as Appendices F.

In parallel to the EIA process, Kelp Blue is preparing the Aquaculture license application to the Ministry of Fisheries and Marine Resources (MFRM) under the Aquaculture Act, No 18 of 2002.

1.3.1 LIMITATIONS AND ASSUMPTIONS

The following limitations were highlighted by the Marine Ecology Specialist Team. Refer to Appendix F for further details):

- A desk-top approach was followed for the description of the baseline environment.
- The study is based on the project description made available to the specialists at the time of the commencement of the study.
- Potential changes in the marine environment such as sea level rise and/or increases in the severity and frequency of storms related to climate change are not included in the study.

2 BACKGROUND TO THE BIOLOGY, ECOLOGY AND AQUACULTURE OF KELPS AND THE KELP BLUE PILOT PROJECT MOTIVATION (NEED AND DESIRABILITY)

The section below provides background regarding Kelp, in general; international cultivation & harvesting activities; etc. It includes, amongst others, extracts from the Marine Ecology Specialist Report[1] (Appendix F) (input provided by Dr. John Bolton).

Furthermore, the motivation for the proposed Kelp Cultivation Project, off the coast of Southern Namibia is explained in this section, with specific focus on the need for Kelp Blue's proposal to first implement a Pilot Project, before proceeding with a Commercial Scale project.

2.1 KELP FACTS (I.E. BIOLOGY & ECOLOGY) AND INTERNATIONAL KELP CULTIVATION & HARVESTING ACTIVITIES

The use of seaweeds by humans enjoys a long rich heritage, where people have used seaweeds for thousands of years, and hand-in-hand with modern science, will likely continue to find more uses. Giant Kelp can grow to 50 m long (even probably 70 m or more) in the correct environment, although in some places it is much smaller. It is one of the most widespread marine species globally and is the basis of large kelp forests in many regions. It is one of the fastest growing plants in the world, with growth rates of 50 cm per day reported in optimal conditions.

Like terrestrial forests, kelp forests absorb a lot of carbon dioxide. "Seaweed offsetting is not the sole solution to climate change, but it provides an invaluable new tool for a more sustainable future" (Froehlich et al., 2019).

In the Benguela upwelling system on the west coasts of Namibia and South Africa there are 3 species of kelp present:

- *Ecklonia maxima* ('sea bamboo') is dominant in South African kelp forests and becomes less prominent northwards. It is not abundant in southern Namibia, and only present to just north of Lüderitz.
- *Laminaria pallida* ('split fan kelp') grows in deeper water (mostly >6m) in the south but becomes more prominent in shallow water in the Northern Cape of South Africa. It is dominant throughout Namibian kelp forests, in shallow water wherever there is open rocky shore, as far north as Rocky Point close to the Angolan border.

[1] Various references were made in the Marine Specialist Report, which will not be repeated in this report. For the detailed list of references refer to sections 5 and 8 of the Marine Specialist Report (Appendix F).

- *Macrocystis pyrifera* ('bladder kelp') has never been recorded in Namibia and is rare in South Africa, occurring only at a few wave-sheltered sites over a short stretch of coast in the extreme southwest.

Where there are large forests of *Macrocystis* it has been widely harvested, notably in California and Mexico, Chile, Alaska and New Zealand. A major industry in the past was for alginates, which are jelly-forming carbohydrates important in the global colloid industry. Alginate is widely used in industry because of its ability to retain water, and its gelling, viscosifying and stabilising properties. Sodium alginate is used in a wide variety of industries including food (e.g. artificial sausage skins), textiles, printing, and pharmaceuticals. Dental impression material uses alginate for gelling, and it is the main ingredient in indigestion remedies such as Gaviscon®. The major harvesting country currently is Chile where hundreds of thousands of tonnes are harvested each year, mostly for feed in the abalone industry. There are increasing uses of kelps and kelp constituents in a wide variety of industries such as nutraceuticals, functional foods and cosmetics, bioplastics and much research on kelps for biofuel production.

Global annual seaweed aquaculture production is over 30 million tonnes (fresh weight), which in 2016 had a value of US$11.7 billion. Over 99% of this is grown in Asia. Of the top 7 most cultivated seaweeds in the world, two are kelps: the Japanese sugar kelp (*Saccharina japonica*, often known as 'kombu' when used for human food), and wakame (*Undaria pinnatifida*).

Macrocystis has been grown in aquaculture almost exclusively from spores. These are seeded onto string systems in land-based 'hatcheries' and grown for a period in tanks with running seawater before the strings are attached to ropes on raft-like structures in sheltered sea embayments. Strings can be seeded direct from sporophylls taken from natural populations of kelp or, alternatively, the microscopic phase (gametophytes) can be cultured and maintained, and later induced to become fertile and seed ropes. As part of the Marine Biomass Program, Michael Neushul in California "developed about 800 strains of M. pyrifera. Clones were crossed and morphologically distinctive (kelp plants) were produced". Careful cultivation of kelp gametophytes gives more control over the genetics of the product and allows for strain selection.

There have been limited research studies in Chile ('integrifolia' form) and South Africa ('angustifolia' form) on aquaculture of *Macrocystis* from regenerating holdfasts attached to rope systems, with success in producing new uprights and reasonable growth rates. Whether this could be successful in the long-term remains to be demonstrated.

Most sea-based aquaculture in the world takes place in sheltered embayments in East Asia. As far as seaweeds are concerned, in sub-Saharan Africa the only major success story is the cultivation of ca. 9000t per year of the red seaweed Eucheuma in Tanzania (for overseas production of the colloid 'carrageenan'), also in shallow, sheltered inshore systems. Marine aquaculture successes in the Benguela region are either land-based (abalone, and the green seaweed Ulva for abalone feed) or again in sheltered embayments (mussels and oysters). The west coasts of Namibia and South Africa have only very limited areas of sheltered sea conditions where this sort of inshore aquaculture can be practiced. If marine aquaculture is to be done on a large scale, it probably needs to be offshore, which requires considerable engineering input (see sections 5.4 and 7.2) There have been many trials of cultivating *Macrocystis*, but it is currently not produced on a large scale in aquaculture.

Macrocystis grows most abundantly in nature on relatively sheltered rocky shores but can survive in quite wave-exposed conditions. The nutrient uptake is enhanced by increased wave action, up to a maximum, so it grows faster in somewhat more wave-exposed coastal sites. On the other hand, strong breaking waves can cause considerable frond loss, and some sites with more wave-exposed conditions have very variable kelp forests, with biomass severely reduced by large storms but growing back in between these storms.

As *Macrocystis* is rare in South Africa, and only grows in shallow water, it is possible that competition from the other local kelps is a negative factor, although there is no direct evidence for this. Also, in areas where there are fish which eat kelp, this may have some impact. Most herbivorous fish are in warmer waters. The strepie (*Sarpa salpa*), which does not occur in the Lüderitz area but is very abundant east of Cape Point in South Africa, had to be removed from the Two Oceans Aquarium kelp exhibit in Cape Town, as they were eating the *Macrocystis* but not the other kelps.

In South Africa, *Macrocystis* only grows in sheltered sites, either in small patches in shallow water inside *Ecklonia maxima* forests, or on the lee side of Dassen and Robben Islands. Large *Macrocystis* thrives on sub-Antarctic islands in the middle of very rough seas, but always on the lee side or in sheltered inlets. It is relevant that *Macrocystis* grows at Jacobsbaai, only 10 km from the mouth of Saldanha Bay, but has never been recorded attached in Saldanha Bay itself or in the linked, more sheltered, Langebaan Lagoon.

Inshore coastal seawater in the Lüderitz region is more turbid than in the Southern Benguela, and thus light will likely be limiting to the colonisation of deeper reefs.

The temperature and nutrient conditions are likely to be within the ranges for *Macrocystis* to thrive, but if it did spread to the nearby Namibian coast and attach, it would be likely to only survive on particularly sheltered rocky coastlines. In southwest South Africa it has only colonised a short (ca.

200 km) section of coastline, and is particularly rare, suggesting that contiguous coastlines further north are not suitable for easy colonisation.

2.2 General motivation for Kelp Blue's proposed Kelp Cultivation Project

Where kelps have been lost from coastlines due to climate change or direct human action, there are many kelp restoration studies being conducted around the world. Kelp forests are economically essential and are considered critical to the biological health of marine coasts, where they occur. A global study showed that kelp forests are declining in 38% of world regions where they occur. Where they occur naturally kelp forests are a great national asset.

Most of the photosynthetic production in Southern African kelp forests is not directly consumed by animals which eat whole kelp (herbivores) but is released as dissolved or particulate nutrients, much of which is consumed by filter-feeding animals and natural bacterial populations. A significant proportion of kelp material also washes up on coasts, where a large amount is consumed by small invertebrate animals, the latter providing food for shorebirds. It has been shown that considerable amounts of kelp material also contribute to nutrient and energy addition to ecosystems as far as 100s of km from the kelp forest.

Based on considerable research conducted by Kelp Blue into the cultivation of Giant Kelp, the technology in harvesting the kelp, as well as a market analysis of the various products that can be extracted from the kelp, they propose a feasible, commercial scale project for the cultivation of Giant Kelp. The following key considerations were taken into consideration by Kelp Blue in this regard:

- "Kelp is the fastest growing organism on the planet
- It is a keystone species for marine biodiversity
- It is the 2nd biggest source of CO_2 sequestration on the planet
- Provides a source of high value marketable extracts: polyphenols, phlorotannins, mannitol, furfuran, bio-actives, protein, cellulose, hydrocolloids and fertilizer
- It is possible to repeat harvest Giant Kelp every 3 months for at least 7 years without losing virility
- Giant Kelp can be cultivated on artificial substrate
- It grows on rocky sea-beds in cold, transparent nutrient dense water 10 to 40m deep (i.e. in upwelling current systems)".

The following conditions off the coast of Southern Namibia - near Lüderitz, are amongst others considered to be favourable by Kelp Blue for Giant Kelp Cultivation:

- Nutrient-dense upwelling throughout the year;
- low average annual temperatures;
- relatively calm seas,
- favourable solar radiation,
- dryness on land.

Other than the commercial viability of a proposed kelp harvesting project, off the coast of Southern Namibia, Kelp Blue, considers the following to be likely benefits that would emanate from implementing a proposed Kelp cultivation project:

- "Establish a new form of farming, that produces essential goods for humanity in a sustainable/environmentally positive manner, which:
    - Draw down CO_2
    - boosts marine biodiversity
    - boosts fish stocks
- Job creation, investment, research & academia, biodiversity, marine life, fish stocks boosts, eventual scuba diving tourism, etc.".

2.3 THE NEED FOR THE PROPOSED PILOT PROJECT

With reference to section 1.1, prior to full scale commercial 'farming' of Giant Kelp, Kelp Blue intends to first implement a Pilot Project to provide them with further important information and proof of their concept. The Pilot Project will test and confirm the proposed infrastructure design options and associated cultivation activities and compatibility with the marine ecosystems. It will also validate assumptions for growth rates, harvestability of the Giant Kelp, sustainability and costs, as well as monitor environmental effects.

The offshore engineering will therefore be validated and growth and behaviour of several different source cultivars will be assessed by Kelp Blue during the pilot phase. Furthermore, ease of doing business in Lüderitz will be assessed and economic assumptions validated or refined.

The operation and processing of the Giant Kelp Pilot Project would require real estate in the form of a laboratory space/mini-hatchery and workshop & laydown area(s). Temporary storage of the kelp will also be necessary. Kelp Blue Namibia will employ a maximum of approximately 14 permanent people and up to 60 people on a contract (part time basis) during the pilot phase of the project. This will be positive as it would contribute to the local and regional economy.

3 EIA METHODOLOGY

3.1 EIA PROCESS

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

TABLE 1: EIA PROCESS

Objectives	Corresponding activities
Project initiation/screening phase (February – May 2020)	
• Identify environmental aspects and potential impacts internally • Notify the decision making authorities of the proposed project and process • Initiate the EIA Scoping process.	• Project initiation meetings between Kelp Blue and the Environmental Team; review of project information and related studies by the Environmental Team to familiarise themselves with the proposed Pilot Project operations, and baseline environmental conditions. • Identify environmental and social issues. Determine further legal requirements. • Notify MFMR and MEFT (DEA) of the proposed Giant Kelp Pilot Project and submit a background information document (BID). • Submit application for authorisation form to MFMR (Competent Authority) and register the application on MEFT's online system.
Scoping and impact assessment phase (May – August 2020)	
• Identify interested and/or affected parties (I&APs) and develop a Kelp Blue Pilot Project database and involve I&APs in the EIA process through information sharing. • Further identify potential environmental issues in liaison with I&APs.	• Notify government authorities and I&APs of the project and EIA process (telephone calls, e-mails, distribution of BIDs, newspaper advertisements and site notice). Refer to Appendix B. • Interested and affected party (I&AP) registration and comments. • Focus Group and One-on-One meetings with relevant government authorities and I&APs. • Conduct specialist studies.

Objectives	Corresponding activities
• Consider alternatives. • Provide a description of the potentially affected environment. • Assessment of potential environmental impacts associated with the proposed Pilot Project activities. • Develop management and mitigation measures.	• Compilation of Scoping Report (including assessment of impacts) and EMP. • Distribute Scoping Report and EMP to relevant authorities and I&APs for review. • Forward finalised Scoping Report with EMP and I&APs comments to MET for decision making.

The above-mentioned EIA process is explained diagrammatically in Figure 3 below. More details regarding the public participation process is provided in section 2.3.

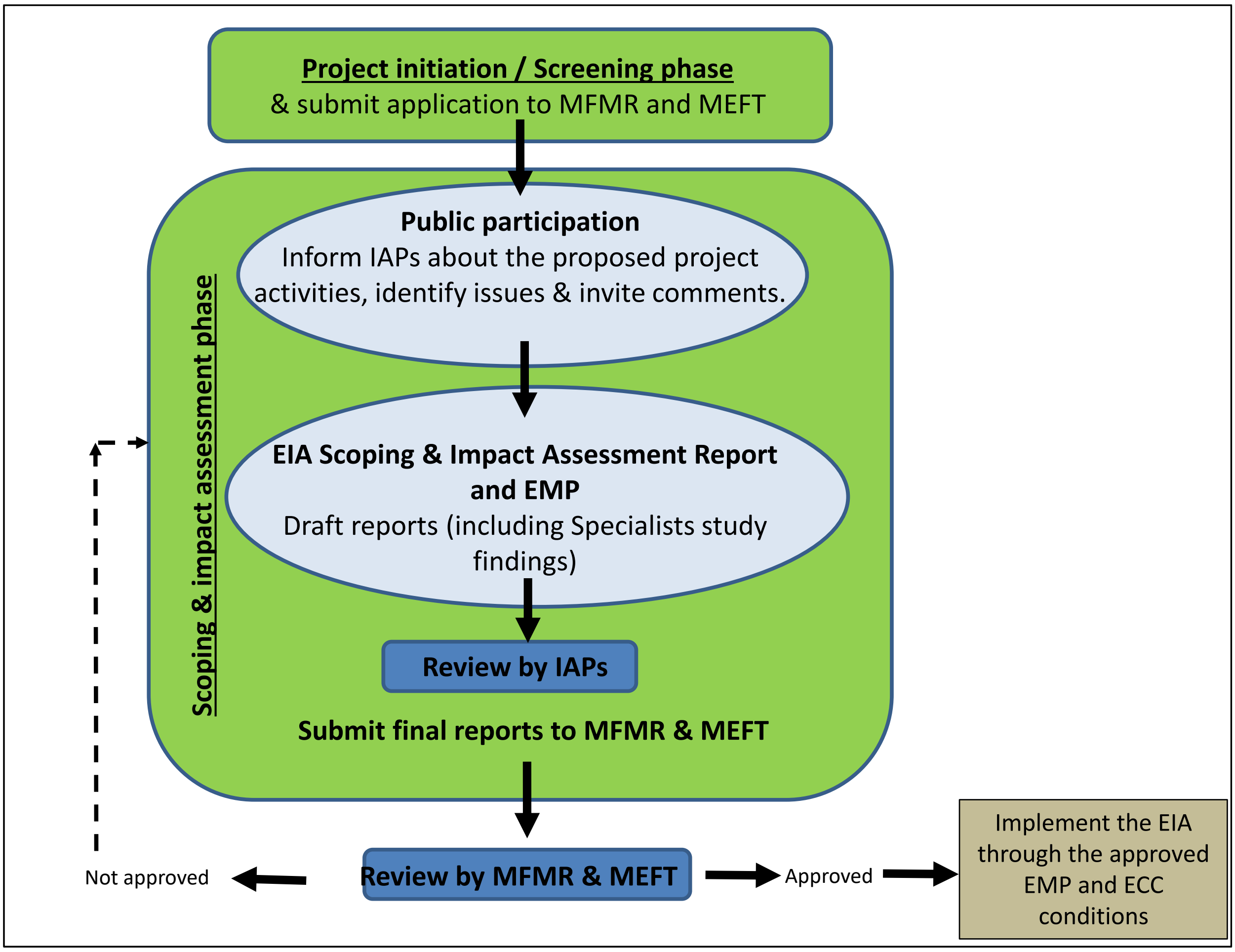

FIGURE 2: THE EIA PROCESS

3.2 EIA TEAM

Namisun Environmental Projects and Development (Namisun) is an independent environmental consultancy firm appointed by Kelp Blue Namibia to undertake the EIA. Werner Petrick, the EIA project manager has more than twenty-one 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 Masters degree in Environmental Management is certified as lead environmental practitioner and reviewer under the Environmental Assessment Professionals Association of Namibia (EAPAN).

The relevant curriculum vitae documentation is attached in Appendix A. The environmental project team for the EIA process relating to the proposed Kelp Blue Pilot Project is outlined in Table 2 below.

TABLE 2: EIA PROJECT TEAM

Team	Name	Designation	Tasks and roles	Company
Project Proponent	Mr Daniel Hooft	Managing Director	Technical input to the EIA Team relating to the proposed project activities Implementation of EIA requirements	Kelp Blue Namibia
	Ms Viviane Kinyaga	Director		
Lead EIA Practitioner	Mr Werner Petrick	EIA project Manager	Management of the EIA process and compilation of EIA report.	Namisun
Specialist investigations	Dr Andrea Pulfrich	Marine Ecology & Fisheries Specialist Study	Marine ecology & diamond mining interaction & consolidate all studies into a single Specialist Report (i.e. main author of Specialist Report)	Pisces Environmental Services (Pty) Ltd
	E/Prof John Bolton		Contributed to Specialist report: Input to aspects of the biology, ecology and aquaculture of kelps, with special emphasis on *Macrocystis*	University of Cape Town Department of Biological Sciences
	Dr Jean-Paul Roux		Contributed to Specialist report: Marine Mammals and turtles and Entanglement study	Private
	Dr Jessica Kemper		Contributed to Specialist report: Seabirds and marine protected areas study	Private
	Mr Dave Japp and Ms Sarah Wilkinson		Contributed to Specialist report: Fisheries study	Capmarine (Pty) Ltd

3.3 INFORMATION COLLECTION

Namisun used various sources to identify both the environmental issues associated with the proposed project and the terms of reference for specialist investigations. The main sources of information for the preparation of the EIA Scoping & Impact Assessment Report include:

- Relevant information relating to the proposed Pilot Project activities and associated infrastructure (provided by Kelp Blue Namibia);
- Kelp Blue Namibia Venture Execution Plan: 2020-2023
- Consultation with the technical (Kelp Blue Namibia) project team;
- Consultation with and input from the specialist team[2];
- Consultation with I&APs/stakeholders;
- Consultation with relevant authorities;
- Google Earth.

3.4 EIA SCOPING & IMPACT ASSESSMENT REPORT

The main purpose of this report is to indicate which environmental aspects relating to the proposed Kelp Blue Pilot Project might have an impact on the environment. Due to reasons mentioned in Section 1.3, these potential impacts could also be assessed, and the findings presented in this report (refer to sections 7 and 8).

Table 3 outlines the Scoping Report requirements as set out in Section 8 of the Environmental Impact Assessment Regulations that were promulgated in January 2012 in terms of the Environmental Management Act, 7 of 2007.

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 EAPs who prepared the report;	Section 3.2 and Appendix A
(b) a description of the proposed activity;	Section 5
(c) a description of the site on which the activity is to be undertaken and the location of the activity on the site;	Sections 5 & 6
(d) a description of the environment that may be affected by the proposed activity and the manner in which the	Sections 6, 8 and 9

[2] Various references were made in the Marine Specialist Report, which will not be repeated in this report. For the detailed list of references refer to sections 5 and 8 of the Marine Specialist Report (Appendix F).

Requirements for a Scoping Report in terms of the February 2012 Regulations	**Reference in Report**
geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed listed activity;	
(e) an identification of laws and guidelines that have been considered in the preparation of the Scoping Report;	Section 4
(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 (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;	Sections 3.5
(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;	Sections 2 and 7
(h) a description and assessment of 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;	Sections 8 and 9
(i) terms of reference for the detailed assessment; and	Section 8 & 9 (However, not applicable due to the fact that this is the final report, which includes an assessment and specialist

Requirements for a Scoping Report in terms of the February 2012 Regulations	Reference in Report
	input. No further assessment is required).
(j) a 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

3.5 Public Participation Process

The public participation process for the proposed Pilot Project is aimed at ensuring that all persons and/or organisations that may be affected by, or interested in, the proposed activities were informed of the project and could register their views and concerns. By consulting with relevant authorities and I&APs, the range of environmental issues to be considered in the study has been given specific context and focus.

Included below is a summary of the people consulted, the process that was followed, and the issues that were identified.

3.5.1 Interested and Affected Parties

A broad list of stakeholders (I&APs) that are relevant to the proposed Kelp Blue Pilot Project is provided below:

- Regulatory authorities (relevant government departments);
- Non-governmental organizations (NGOs);

- Fishing Associations and Companies;
- Mariculture and rock lobster companies;
- Mining companies;
- Other businesses; and
- I&APs that registered on the project.

These stakeholders were informed about the proposed Pilot Project activities and the EIA process, including the public consultation, being conducted.

The full stakeholder database for this project is included in Appendix D of this report.

3.5.2 Steps in the Public Participation Process

The steps that were followed as part of the consultation process are described below.

3.5.2.1 Notification to MEFT and MFMR (May 2020)

- Namisun notified MEFT and MFMR of the proposed project through a background information document (BID).
- The Application for Authorisation Form was submitted to MFMR (as the Competent Authority) and the Application was registered onto MEFT's online registration system.

3.5.2.2 I&AP identification (April - May 2020 and throughout the process)

- Namisun developed an EIA I&AP database for the Pilot Project. This database is updated as and when required, throughput the EIA process. A copy of the I&AP database is attached in Appendix D.

3.5.2.3 Distribution of background information document (BID) and various telephone discussions with I&APs (May 2020)

- BIDs were distributed via email to relevant authorities and I&APs on the I&AP stakeholder database and copies were made available on request (see Appendix B).
- Namisun contacted (telephonically) various key stakeholders to confirm their e-mail addresses to share the relevant information and to arrange for Focus Group meetings. Also, to obtain further input regarding I&APs to be added to the I&AP database.
- The purpose of the BID was to inform I&APs and authorities about the proposed Kelp Blue Pilot Project activities, the EIA process being conducted, possible environmental impacts and ways in which I&APs could provide input to Namisun. Attached to the BID was a

registration and response form, which provided I&APs with an opportunity to submit their names, contact details and comments on the project.

- A copy of the BID is attached in Appendix B.

3.5.2.4 E-MAIL NOTIFICATIONS AND SITE NOTICES (MAY 2020)

- E-mails were sent to all I&APs on the database and a site notice was placed at the Lüderitz Information Centre, to notify I&APs of the proposed project, the EIA process being following and who to contact for further information requirements. A copy of the e-mail notification and photos of the site notice that were displayed are attached in Appendix B.

3.5.2.5 NEWSPAPER ADVERTISEMENTS (MAY 2020)

- Block advertisements were placed in the Market Watch as part of the following newspaper:
    - The Namibian Sun (11 May and 18 May 2020)
    - Die Republikein (11 May and 18 May 2020)
    - Allgemeine Zeitung (11 May and 18 May 2020)
- Copies of the advertisements are attached in Appendix B.

3.5.2.6 KEY STAKEHOLDER AND FOCUS GROUP MEETINGS (MAY – JUNE 2020)

- The following meetings were held with I&APs:
    - Focus Group meeting with Ministry of Fisheries and Marine Resources in Swakopmund on the 15th of May 2020 (minutes of the meeting is attached in Appendix B).
    - Focus Group meeting with Five Roses Aquaculture in Lüderitz on the 25th of May 2020 (minutes of the meeting is attached in Appendix B).
    - Another Focus Group meeting with another person from Five Roses Aquaculture in Lüderitz on the 26th of May 2020 (minutes of the meeting is attached in Appendix B).
    - Focus Group meeting with JL Marine Merchants in Lüderitz on the 26th of May 2020 (minutes of the meeting is attached in Appendix B).
    - Focus Group meeting with Ministry of Fisheries and Marine Resources in Lüderitz on the 26th of May 2020 (minutes of the meeting is attached in Appendix B).

- Focus Group meeting with Lüderitz Town Council on the 27th of May 2020 (minutes of the meeting is attached in Appendix B).
- Focus Group meeting with Macro Fishing in Lüderitz on the 27th of May 2020 (minutes of the meeting is attached in Appendix B).
- Focus Group meeting with Hangana Abolone in Lüderitz on the 27th of May 2020 (minutes of the meeting is attached in Appendix B).
- Focus Group meeting with Seaflower Whitefish and Novanam in Lüderitz on the 28th of May 2020 (minutes of the meeting is attached in Appendix B).
- Focus Group meeting with Seagulls in Lüderitz on the 28th of May 2020 (minutes of the meeting is attached in Appendix B).
- Focus Group meeting with LMC Ocean in Lüderitz on the 28th of May 2020 (minutes of the meeting is attached in Appendix B).
- Focus Group meeting with Namport in Swakopmund on the 3rd of June 2020 (minutes of the meeting is attached in Appendix B).
- Focus Group meeting with Ministry of Fisheries and Marine Resources (Mariculture) in Swakopmund on the 5th of June 2020 (minutes of the meeting is attached in Appendix B).

- The proposed Pilot Project information was presented/shared in the form of a PowerPoint presentation at the above meetings. A copy of the slides is included in Appendix B.

3.5.2.7 COMMENTS AND REPONSES (MAY – JULY 2020)

- Minutes of the meetings and all comments received during the meetings, as well as by email and comment sheets, are attached in Appendix B. A Summary Issues and Response Report is attached in Appendix E.

3.5.2.8 REVIEW OF DRAFT SCOPING & IMPACT ASSESSMENT REPORT AND EMP BY I&APS AND AUTHORITIES (JULY TO AUGUST 2020)

- A hard copy and electronic (soft) copy of the Draft Scoping and Impact Assessment Report and EMP (including all Appendices) were made available for review at the Lüderitz Information Centre from 17 July to 14 August 2020.
- Electronic copies of the Scoping & Impact Assessment Report and EMP (excluding the Appendices) were distributed to all register I&APs and relevant Regulatory Authorities via e-mail (see Appendix B).

- Electronic copies of the full report were available on request to Namisun.
- Authorities and I&APs had the opportunity to review the draft report and submit comments in writing to Namisun. The closing date for comments was 14 August 2020.

3.5.2.9 MFMR and MEFT review of Scoping Report and EMP

Namisun (and the appointed Environmental Specialists) considered the comments from I&APs and Regulatory Authorities after the closing date for comments. Where relevant, the report were updated. A copy of the final report, including authority and I&AP review comments, was delivered to MFMR, who will forward it, with their recommendations, to MEFT for their review and decision.

3.5.3 Summary of comments and issues raised

All comments, questions and issues that have been raised throughout the process by authorities and I&APs are provided in Appendix D of this report. Various IAPs provided positive comments relating to the proposed project.

General questions/comments that were asked pertain to:

- Giant Kelp and what it is used for,
- kelp cultivation and harvesting activities,
- the ownership of Kelp Blue,
- the motivation for the proposed project,
- licencing requirements,
- Namibia / Lüderitz as the preferred location.

A number of concerns / potential negative impacts were also raised, which are further summarised below

- Proposed locations for the pilot areas and specific issues relating to some of these locations, notably the proposed site for the originally planned grow-out area behind Seal Island in the northern bay of Lüderitz and the pilot area southwest of Ichaboe Island.
- Where will the sporophylls come from and why not source them locally?
- Potential disturbance of benthic habitats and associated communities during installation and anchoring of the arrays;
- Biosecurity risks of introducing non-native kelp, its potential spread and associated impacts on the ecosystem;

- Why the Giant Kelp is preferred?
- Potential impacts on rock lobster;
- Potential impact on existing mariculture activities;
- Disturbance of benthic habitats and associated communities during installation and anchoring of the arrays;
- Concerns regarding introduction and spread of pathogens associated with the import of sporophylls;
- Entanglement of seabirds and mammals, etc. with the pilot array infrastructure;
- The specifics of environmental monitoring requirements, during the pilot phase of the project, needs to be developed as part of the EIA process;
- Design of the pilot array infrastructure and the challenges facing the difficult weather (i.e. wind) and sea conditions at Lüderitz;
- Effect on marine traffic (i.e. navigational hazards); and
- Positive and negative socio-economic issues.

4 ENVIRONMENTAL LAWS AND POLICIES

The Republic of Namibia has five tiers of law and a number of policies relevant to environmental assessment and protection, which include:

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

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 mitigate against adverse environmental impacts.

The management and regulation of marine activities falls within the jurisdiction of the Ministry of Fisheries and Marine Resources (MFMR), with environmental regulations guided and implemented by the Department of Environmental Affairs (DEA) within the Ministry of Environment, Forestry and Tourism (MEFT).

The section below summarises the various applicable laws, plans and policies.

4.1 Summary of key legislation applicable to the proposed Pilot Project

In the context of the kelp Blue Namibia Pilot Project, there are several laws and policies currently applicable. The key policy and legislative requirements and guiding principles underpinning the EIA process and requirement for an Aquaculture Licence are outlined below.

4.1.1 Policy and Legal Framework for the EIA

4.1.1.1 Environmental Assessment Policy for Sustainable Development and Environmental Conservation, 1995

Namibia's Environmental Assessment Policy was published in 1995 and provides for the promotion of sustainable development and economic growth while protecting the environment in the long-term. The government recognises, amongst others, that an EIA (termed Environmental Assessment in Policy) is a key tool to further the implementation of a sound Environmental Policy that strives to achieve Integrated Environmental Management. EIAs are required to ensure that the consequences of development projects are considered and incorporated into the planning process. Aquaculture and mariculture activities, as well as the introduction and/or propagation of invasive alien plant and animal species are listed in the policy as activities that require an EIA. This EIA aims to fulfil the requirements of this Policy.

4.1.1.2 ENVIRONMENTAL MANAGEMENT ACT, 2007

The Environmental Management Act (No. 7 of 2007) was promulgated in December 2007 and came into effect in January 2012. The main objectives of this Act are to ensure:

- The careful and timeous consideration of activities that can cause significant effects on the environment;
- Opportunities for timeous participation by I&APs throughout the assessment process; and
- Findings are taken into account before any decision is made in respect of activities.

Section 3(2) of the Act provides a set of principles which give effect to the provisions of the Constitution for integrated environmental management. Decision-makers must take these principles into account when deciding on a proposed project. This Act stipulates that no party, whether private or governmental, can conduct a listed activity without an ECC obtained from the Environmental Commissioner.

4.1.1.3 EIA REGULATIONS 2012

The EIA Regulations 2012, were Gazetted on 6 February 2012 in terms of Section 56 of the Environmental Management Act, 2007 (Government Notice [GN] No. 30). The Regulations provides for, amongst others, the control of certain "listed activities". These listed activities are provided in GN No. 29 and are prohibited until an ECC has been obtained from MET: DEA. The issuing of such ECCs will only be considered by the DEA once there has been compliance with the EIA Regulations 2012. GN No. 30 sets out the procedures and documentation that need to be complied with when undertaking an EIA process.

Listed activities applicable to the proposed Kelp Blue Pilot Project, with corresponding numbers in the Regulations, are summarised below:

"**AGRICULTURE AND AQUACULTURE ACTIVITIES**

7.1 *Construction of facilities for aquaculture production, including mariculture and algae farms where the structures are not situated within an aquaculture development zone declared in terms of the Aquaculture Act, 2002.*

7.2 *The declaration of an area as an aquaculture development zone in terms of the Aquaculture Act, 2002.*

7.8 *The introduction of alien species into local ecosystems.*

INFRASTRUCTURE

10.1 *The construction of-*

(e) any structure below the high water mark of the sea".

4.1.2 Legal Framework relating to Aquaculture activities

4.1.2.1 Aquaculture Act, 2002

The Aquaculture Act (No. 18 of 2002), provides for the regulation and control of aquaculture activities in Namibia; for the sustainable development of aquaculture resources and for related matters. Associated with this Act is the Aquaculture (Licensing) Regulations (2003).

Part V of the Regulations covers the control of disease outbreaks in Namibian waters, specifically disease zoning, emergency disease situations and intra-national movements of live aquatic organisms.

Part VI deals with the protection of the aquatic environment and covers the release and escape of aquaculture products, the discharge of wastes from aquaculture facilities and the introduction and transfer of aquatic organisms.

The other associated Regulations relates to Import and Export of Aquatic Organisms and Aquaculture Products (2010). These Regulations covers the permitting requirements and conditions for the import and export of aquatic organisms. Part II of the regulations stipulates that a risk assessment is required as part of the import permit application. Annexures I and J provide lists of marine aquatic organisms approved for importation, and whose importation is restricted or prohibited, respectively. Marine algae are not specifically covered.

4.1.2.2 Marine Resources Act, 2000 and Regulations relating to the Namibian Islands' Marine Protected Area (NIMPA)

The Marine Resources Act (No. 27 of 2000), provides for the conservation of the marine ecosystem; for the responsible utilisation, conservation, protection and promotion of marine resources on a sustainable basis; and for the control of marine resources for these purposes. It replaces the Sea Fisheries Act 29 of 1992, which in turn replaced the Sea Fisheries Act 58 of 1973. It also replaces the Sea Birds and Seals Protection Act 46 of 1973. The Act came into force on 1 August 2001. Regulations made under previous legislation remain in force, in terms of section 64(2) of the Act.

Part 10 of the Marine Resources Act empowers the Minister to prescribe specific conditions and restrictions regarding closed areas and exclusion zones, applicable to commercial fishing rights, quotas and licenses granted under the Act. In this regard, trawling and longlining is prohibited in waters shallower than 200 m. There are further conditions applicable to hake trawling vessels fishing south of 25° latitude, where the fishing exclusion has been extended to a depth of 300 m. Freezer trawlers fishing in this area, are confined to fishing in depths of 350 m or more (Currie et al. 2008). The Act also provides for the declaration of Marine Protected Areas and fishing areas.

Relevant to this project are the regulations under the Marine Resources Act relating to the Namibian Islands' Marine Protected Area (NIMPA) (No. 316 of 2012). These regulations cover the zonations delineated within the MPA and the restrictions and prohibitions applicable to each zone. Part 5 of the regulations covers restrictions and prohibitions within the NIMPA buffer zone. Those of relevance to the Kelp Blue pilot project and potential full-scale operation are:

- Section 11: Prohibition on kelp-cutting and harvesting of live kelp; and
- Section 13: Obstruction of cetacean pathways.

4.2 Summary of other laws and policies relevant to the Pilot Project

4.2.1 OTHER RELEVANT LEGISLATION

Other legislation relevant to the proposed Pilot Project are summarised in Table 4 below.

TABLE 4: RELEVANT LEGISLATION FOR THE KELP BLUE PILOT PROJECT

YEAR	NAME	Natural Resource Use	Emissions to land	Emissions to water / sea	Emissions to air	Impact on Land use	Impact on biodiversity & protected areas (Marine Environment)	Impact on Archeology	Socio-economic	Marine Traffic	Other
1919	Public Health Act 36 of 1919 (as amended)				X						
1956	Water Act, 1956 (No. 54 of 1956), as amended	X									
1958	Seashore Ordinance 37 of 1958			X			X				
1969	National Monuments Act 28 of 1969							X			
1973	Sea Birds and Seals Protection Act 46 of 1973						X				
1974	Hazardous Substances Ordinance 14 of 1974, and amendments		X	X							
1975	Nature Conservation Ordinance 14 of 1975	X		X			X	X			
1976	Atmospheric Pollution Prevention Ordinance 11 of 1976				X						
1980	Dumping at Sea Control Act (No. 73 of 1980)	X		X			X				
1986	International Convention for the Prevention of Pollution from Ships Act (No. 2 of 1986)	X		X			X				
1990	Territorial Sea and Exclusive Economic Zone of Namibia Act 3 of 1990	X									
1991	Marine Traffic Act (No. 2 of 1981) (as amended by the Marine Traffic Amendment Act (No. 15 of 1991)									X	

NAMISUN

YEAR	NAME	Natural Resource Use	Emissions to land	Emissions to water / sea	Emissions to air	Impact on Land use	Impact on biodiversity & protected areas (Marine Environment)	Impact on Archeology	Socio-economic	Marine Traffic	Other
1991	Prevention and Combating of Pollution of the Sea by Oil Act 24 of 1991			X			X				
1994	Namibian Ports Authority Act (No. 2 of 1994) and Port Regulations									X	X
1996	Nature Conservation Amendment Act (No. 5 of 1996)						X				
2001	The Parks and Wildlife Management Bill of 2001						X				
2003	Pollution Control and Waste Management Bill (3rd Draft September 2003)		X	X	X	X					
2004	National Heritage Act 27 of 2004							X			
2004	Wreck and Salvage Act (No. 4 of 2004)						X	X			
2007	Labour Act, 2007 (No. 11 of 2007)								X		
2013	Water Resources Management Act 11 of 2013	X		X							

4.2.2 RELEVANT POLICIES AND PLANS

Relevant policies and plans currently in force include:

- Namibia Vision 2030
- Fifth National Development Plan, 2017/18 – 2021/22 (NDP5)
- Strategic Plan, 2017/2018 – 2021/2022
- Policy for the Conservation of Biotic Diversity and Habitat Protection, 1994
- National Waste Management Policy (2010)
- National Biodiversity Strategy and Action Plan (NBSAP) 1 and 2 (draft)
- National Agriculture Policy (2015)
- New Equitable Economic Empowerment Framework Policy, 2011
- National Environmental Health Policy (2002)
- SADC Environmental Policy and Regulatory Framework for Mining (2001)
- The National Climate Change Policy of Namibia (September 2010).

4.2.3 INTERNATIONAL LAWS AND CONVENTIONS

International conventions and treaties which have been ratified by the Namibian Government are listed below:

- The Benguela Current Convention (2013)
- The Stockholm Declaration on the Human Environment, 1972
- United Nations Law of the Sea Convention (1982)
- United Nations Framework Convention on Climate Change – UNFCCC, 1992
- United Nations Convention on Biological Diversity (UNCBD), 1992
- Cartagena Protocol on Biosafety to the Convention on Biological Diversity, 2000
- Kyoto Protocol on the Framework Convention on Climate Change, 1997
- Montreal Protocol on Substances that Delete the Ozone Layer, 1987
- Paris Agreement (United Nations Framework Convention on Climate Change), 2016
- Vienna Convention for the Protection of the Ozone Layer, 1985

- African Convention for the Conservation of Nature and Natural Resources (Algeria, 1968) and the revised version (Maputo, 2003)
- Convention on the Conservation of Migratory Species of Wild Animals, also known as the Convention on Migratory Species (CMS) or the Bonn Convention, 1983
- Convention on International Trade of Wild Fauna and Flora Endangered Species, 197) (CITES)
- Memorandum of Understanding (MoU) concerning Conservation Measures of Marine Turtles of the Atlantic Coast of Africa, 1999
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Convention) and 1996 Protocol
- Protocol on the Intervention on the High Seas in Cases of Marine Pollution by substances other than oil, 1973
- Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS)
- Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central and Southern African Region (Abidjan Convention), 1984
- United Nations Law of the Sea Convention, 1982, (UNCLOS)
- Convention concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)
- United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the Protection of the Underwater Cultural Heritage, 2001

5 DESCRIPTION OF THE PROPOSED KELP BLUE NAMIBIA PILOT PROJECT ACTIVITIES

5.1 General project information

5.1.1 Details of the Applicant

Company name:	Kelp Blue Namibia (Pty) Ltd
Contact (responsible) person:	Mr Daniel Hooft
E-mail:	danielhooft@kelp.blue
Business address	PO Box 384, Windhoek 10005 Namibia

5.1.2 Kelp Blue shareholders

Kelp Blue Namibia is a private business registered in Namibia. Currently the Kelp Blue directors are Ms Viviane Kinyaga and Mr Daniel Hooft.

5.1.3 Overview and background to the proposed Kelp Blue Pilot Project

Kelp Blue Namibia ultimately considers implementing commercial scale Giant Kelp cultivation, which would involve (amongst others) the installation of multiple cultivation arrays anchored between 50 m and 200 m water depth at sea, including installation of seed-lines.

Their proposed Pilot Project will, however, first be implemented to prove various concepts and the feasibility of the commercial scale project, which forms the basis of this report.

With reference to sections 2.2 and 6, the following conditions off the coast of Southern Namibia, are amongst others considered to be favorable for Giant Kelp Cultivation: Upwelling throughout the year; low average annual temperatures; relatively calm seas, favorable solar radiation, dryness on land, etc.

Therefore, Kelp Blue intends to implement a kelp cultivation Pilot Project, off shore near Lüderitz, which will broadly involve the follow key activities:

- Collect fertile sporophylls and hatchery activities

↓

- Cultivation

↓

- Harvesting

↓

- Processing

Pilot Project monitoring

The above mentioned key activities and other associated activities and proposed infrastructure requirements are described in more detail in the sections below.

5.2 PROPOSED KELP CULTIVATION PILOT PROJECT ACTIVITIES

5.2.1 COLLECTION OF FERTILE SPOROPHYLLS AND HATCHERY ACTIVITIES

Fertile sporophylls will be collected from various international locations, currently under consideration is South Africa, California and Southern Chile with potential further source material from Patagonia, the Falkland Islands, Tristan da Cunha, and Kerguelen Island. The fertile sporophylls will be selected on the basis of healthy, abundant, deep kelp plants in a variety of water movement conditions. The sporophyll blades would be transported cooled to the relevant seaweed culture laboratories where they would be induced to sporulate.

The spores would be hatched and propagated within the relevant culture laboratories before being transported to Kelp Blue’s proposed laboratory in Lüderitz in the form of sporophyte concentrations and seeded twine.

The collection of sporophylls and laboratory based hatchery is schematically illustrated in the processes flow diagram in Figure 3.

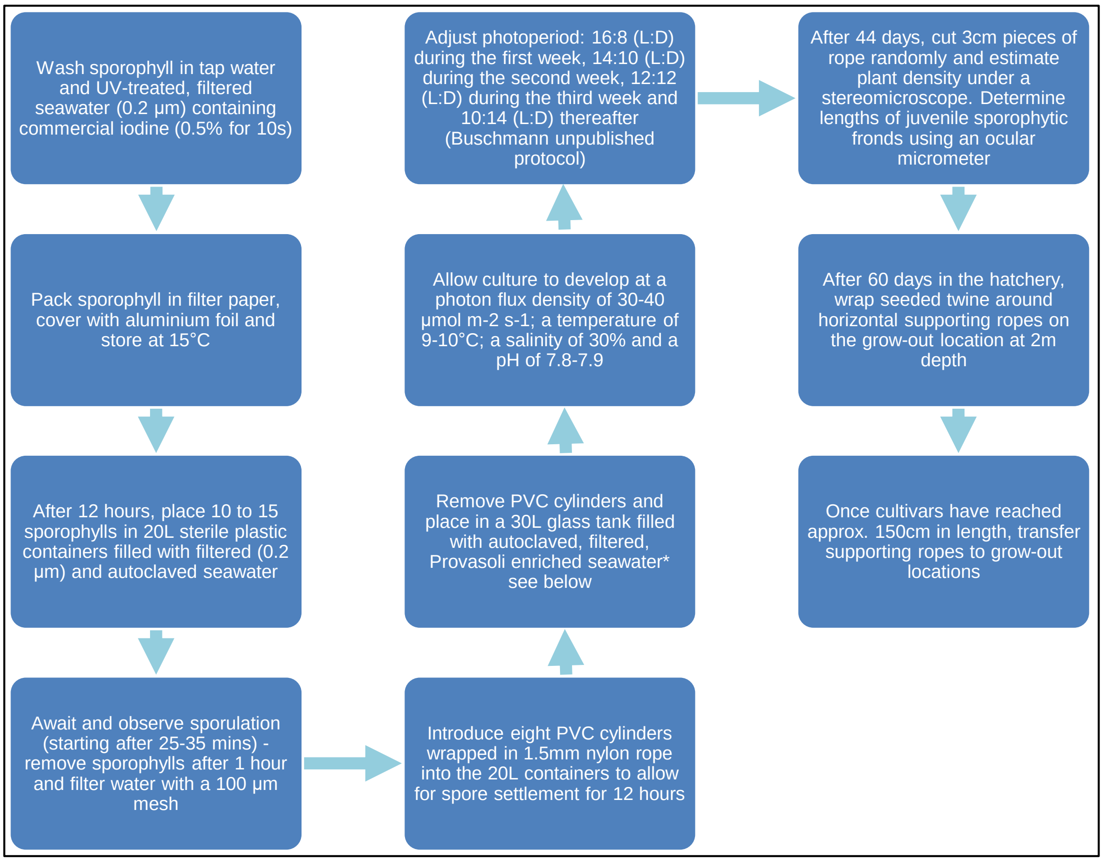

FIGURE 3: SCHEMATIC OF THE COLLECTION OF SPOROPHYLLS AND LABORATORY BASED HATCHERY ACTIVITIES (KELP BLUE, 2020)

“Provasoli’s” solution mimics (in a somewhat concentrated form) the balance of nutrients found in rich upwelling water. “Provasoli’s enriched sweater” preparation is presented in Box 1.

Box 1: Provasoli's enriched sweater" preparation

General purpose marine medium for xenic cultures.

Preparation: add 1 tube (20 mL) of ES-enrichment to 1000 mL of pasteurized, filtered seawater. For ES-enrichment solution, add the following to 100 ml glass-distilled water:

	in 100 ml glass-distilled water
$NaNO_3$	350 mg
Na_2glycerophosphate · 5 H_2O	50 mg
Fe-solution	25 mL
PII metal-solution	25 mL
vitamin B_{12}	10 µg
thiamine	0.5 mg
biotin	5 µg
Tris buffer (Sigma Co.)	500 mg

Adjust to pH 7.8, dispense in tubes (20 mL/tube) and autoclave. Store at 10° C.

Fe-solution:
Dissolve 351 mg of $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$ and 300 mg of Na_2EDTA in 500 mL of de-ionized or distilled water

PII metal solution:

	in 100 ml glass-distilled water
Na_2EDTA	100 mg
H_3BO_3	114 mg
$FeCl_3$ $6H_2O$	4.9 mg
$MnSO_4$ H_2O	16.4 mg
$ZnSO_4 \cdot 7 H_2O$	2.2 mg
$CoSO_4$. 7 H_2O	0.48 mg

5.2.1.1 WATER SUPPLY TO THE LABORATORY

The hatchery would require several thousand liters (~ 6 m^3) of seawater per month. The water would, however, be re-circulate in the facility to ensure sterility and stability of temperature and nutrient content. Permanent supply of seawater is therefore not necessary.

Seawater treatment processes will consist of UV-filtration and mechanical filtration (and autoclaving for fully sterilizing the seawater to ensure no alien spores or lifeforms are cultured), but do not include the introduction of any chemicals except for normal cleaning agents.

Some dozens of liters of municipal water (~ 1 m^3) will be used per day, with the addition of trace amounts of iodine, trace amounts of common minerals that mimic seawater composition (see Box 1).

A small amount of fresh water for cleaning and washing would also be required.

5.2.1.2 DISCHARGES FROM THE LABORATORY

The seawater and prepared municipal water would be re-circulated within the hatchery. If discharged to the sea in order to take in fresh seawater/municipal water, this discharge stream would be compliant with national regulations on discharges into the marine environment. Kelp

Blue will apply for a discharge permit from the Ministry of Agriculture Water and Land Reform's (MAWL) - Department of Water Affairs (DWA) and would need to comply to conditions of the permit (see section 10.6 in the EMP).

5.2.2 Giant Kelp Growth (i.e. Cultivation)

Following a further ± two months in the hatchery (i.e. Lüderitz Laboratory), the seeded twine would be wrapped around the horizontal ropes in the grow-out arrays. The initial 'grow-out' will therefore involve a simple horizontal rope suspended between buoys (see Figure 4). The-grow out area will be ±20 hectares (0.2 km^2) in size, containing numerous buoy / rope arrays. Kelp Blue intends to develop the grow out area in Shearwater Bay (see Figure 5)[3]. Once the cultivars have reached ±150 cm length they will be transferred either one of the three pilot area, described below.

Though Kelp Blue aims for a "one pilot" success, the workplan and budget includes contingent provisions for a second and third pilot, should the first fail in one way or another. Three pilot cultivation areas of ± 1 km^2 each is therefore proposed, as follows (see Figure 5):

- Pilot Area A: In ±70 m water depth to the south-soutwest of Diaz Point.
- Pilot Area B: Two options, which are both likely feasible (i.e. B1 and B2 in Figure 5), approximately halfway between Ichaboe Island and the Lüderitz Port.
- Pilot Area C: In 150 m water depth to the west-southwest of Ichaboe Island.

[3] Whether this alternative grow-out area will be realised is currently not known, with consideration now also being given to applying for one of the mariculture plots in Second Lagoon. Elevated turbidity levels in Second Lagoon would, however, be sub-optimal for the growth of sporlings.

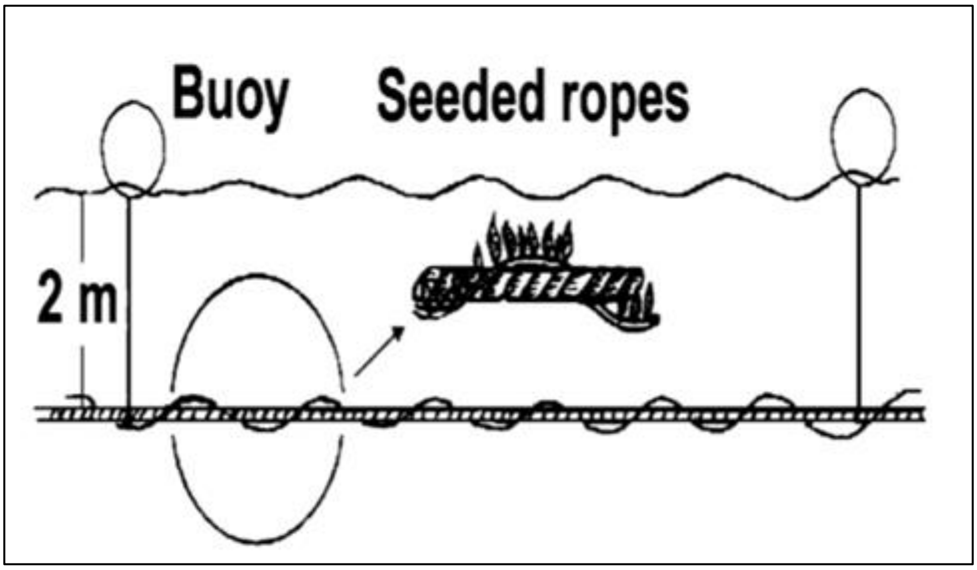

FIGURE 4: SCHEMATIC OF SIMPLE HORIZONTAL ROPE SUSPENDED BETWEEN BUOYS FOR THE INITIAL GROW OUT (KELP BLUE, 2020)

The proposed Pilot Areas shown in Figure 5 are all indicative areas and bigger than 1 km^2. The reason being is that the exact location for the pilot areas can only be determined at the time of installing the arrays (i.e. anchoring systems) after surveying the seafloor and Kelp Blue consulting with the diamond mining licence holders. See the EMP in Section 10.

The Giant Kelp is expected to grow to full size (occupying the entire 20-25 m of water column above the array) within 6-7 months of out-planting.

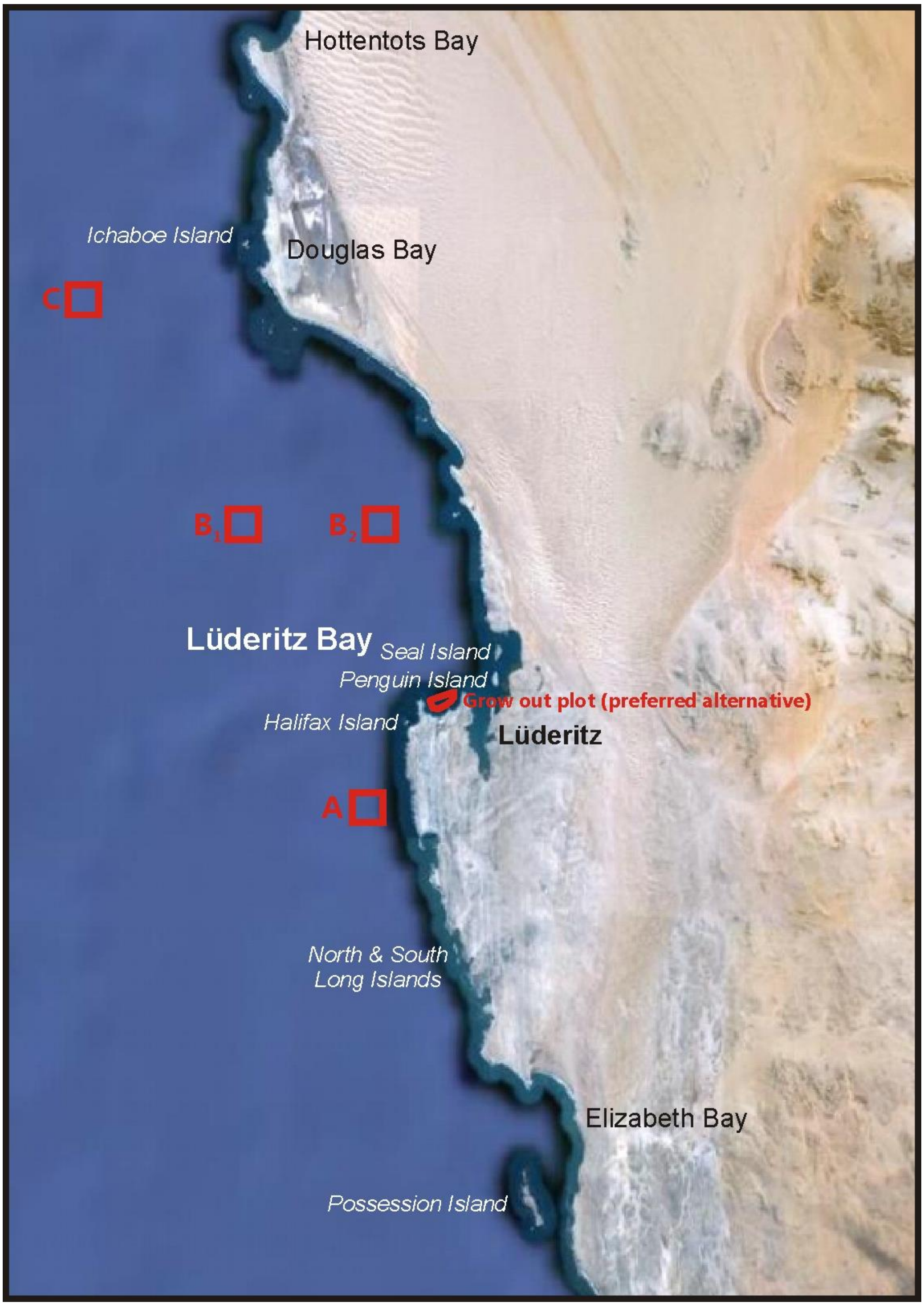

FIGURE 5: PROPOSED KELP GROW OUT AND PILOT AREAS (INDICATIVE RED LINES)

Kelp cultivation requires arrays of artificial substrate in the sea, on which the kelp plants attach and grow. This is typically an array of stiff structures, ropes and buoys. Kelp Blue's array design is stiffer than others to take marine wildlife entanglement issues into consideration (see sections 8 and 9 and minimizes infrastructure at surface, i.e. all hard infrastructure will be at 20 m+ depth considering shipping hazards to normal vessels.

Various styles of cultivation arrays might be tested during the pilot phase to test different configurations and materials. The arrays are designed as being positively buoyant; and engineered such as to be able to sustain the expected increase in weight as marine growth accumulates. For all the concept designs, a dominant part of the drag forces on the array are transferred to it via the kelp holdfast. Engineering approaches will ensure that the kelp is ripped loose from the array before array failure. With detachment of kelp, the point forces on the arrays would also reduce significantly, thereby avoiding terminal failure and/or loss of the array.

Refer to section 5.4 for the description of the material to be used for the arrays. A typical (i.e. schematic) array design is presented in Figure 6.

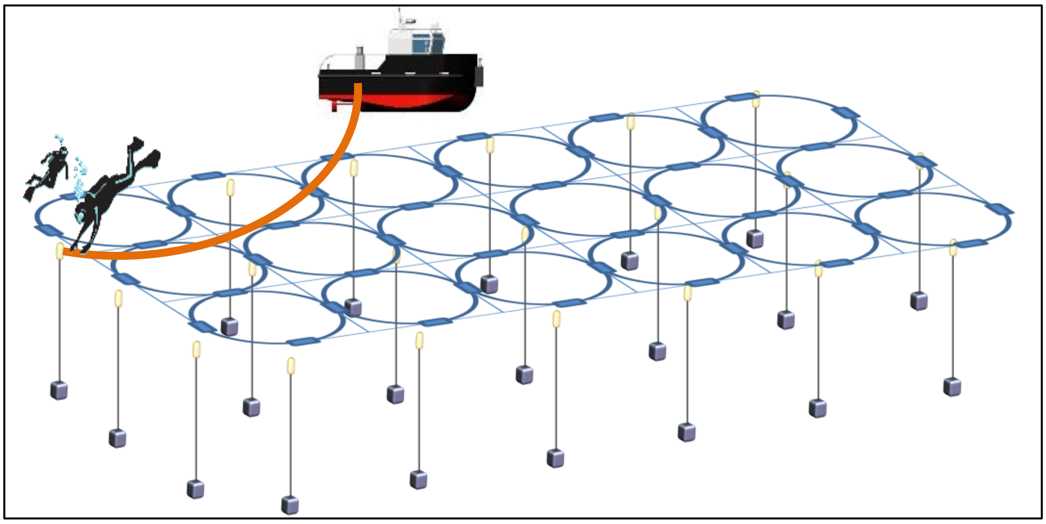

FIGURE 6: TYPICAL (I.E. SCHEMATIC) PILOT CULTIVATION ARRAY DESIGN

Figure 7 provides an illustration of a computer simulation of the pilot array design, with only part of the structure "populated" by kelp in order (a) to see the difference in behavior of the infrastructure with and without kelp.

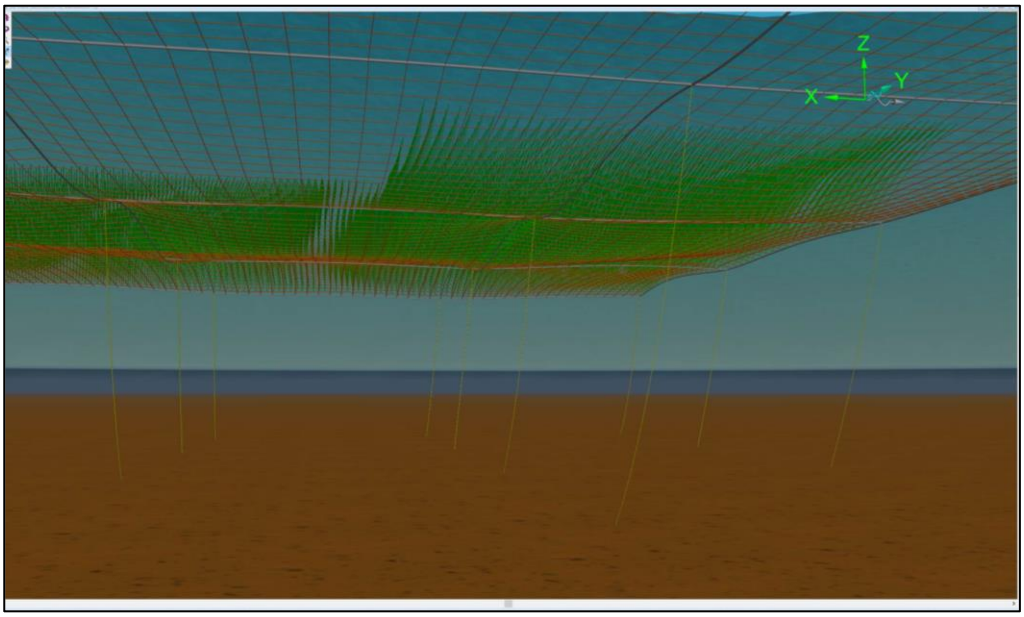

FIGURE 7: COMPUTER SIMULATION OF PILOT ARRAY DESIGN

5.2.2.1 OTHER MARINE GROWTH ON THE ARRAYS

The only feasible means for control of epiphytes and predators of the giant kelp is the bio-controls provided by the naturally developing ecosystem on and around the array. Marine growth will therefore be actively encouraged on the arrays thereby promoting the natural development of an ecosystem on and around the arrays.

Navigation & meteorological buoys will be painted against corrosion and biofouling and may be on occasion cleaned of build-up of marine growth.

No further biofouling mitigation is planned.

5.2.3 KELP HARVESTING

Kelp harvesting will be done with small boats, by divers. The kelp will be cut by hand some 50-100 cm below the surface, loaded onto the vessels (or towed behind the vessels in towing nets) and transported back to Lüderitz. As the cut kelp regenerates within 2-3 months, harvesting can be undertaken every 3-4 months, although growth rates are expected to show some seasonality.

5.2.4 PROCESSING

A part of the harvest could be sold as fresh leaves to Abalone farms. The remaining harvested kelp will be air dried and milled with a simple commercially available herb or sugar cane grinding mill.

The milled kelp from the Pilot Project will be marketed to Namibian farmers as fertilizer/soil improver.

Part of the harvest will be processed experimentally for the extraction of protein, alginate, and cellulose in lab conditions in Lüderitz and at labs in Europe, to establish base quality and physical / chemical properties of the extracts.

The pilot trials will be considered successful if the expected environmental benefits are monitored (and no material adverse impacts identified), and if dry weight yields of greater than 8 tons/ha are achieved within 30% of budget over a 12 month period.

5.2.5 PILOT MONITORING

The purpose of the Pilot Project is to prove that the engineering designs are robust and to evaluate the following:

- Behavior of the structures with growing kelp in ambient (and storm) conditions
- Growth rates of the Giant Kelp
- Cost of the Pilot Project
- Compatibility with the marine ecosystems
- Ease of doing business in Namibia

Further (detailed) Environmental Monitoring requirements during the Pilot Project implementation phase are presented in the EMP (Section 10).

5.2.6 MARINE VESSELS

The following marine vessels will be required:

- Zodiac style vessel for initial environmental monitoring and site selection, and (later) ongoing monitoring, including diver support.
- Temporary vessel support for load-out and deployment of pilot arrays, including seeding on board.
- Possibly different vessel(s) will be required for positioning anchors and buoys for the array.

Kelp Blue's internal market research indicates that the above required vessels are available for short- or long term hire within Namibia.

5.3 ONSHORE BASE / INFRASTRUCTURE

Kelp Blue will rent, purchase, or build suitable facilities for office space and a laboratory / mini-hatchery in Lüderitz.

An appropriate location will be sourced for receipt, secure storage, and assembly of the materials for the pilot trial arrays. The area required is approximately 2000 m^2 and would ideally be adjacent to the sea for convenient loading out of assembled arrays in whole or in part.

5.4 "CONSTRUCTION PHASE" – I.E. ASSEMBLY OF ARRAYS, ANCHORING AT SEAS, LABORATORY SET-UP, ETC.

The construction phase of the Pilot project will involve the following:

- Set up of the laboratory
- Assembly of the pilot array structure
- Transporting the infrastructure off-shore to the pilot locations
- Anchoring of the pilot arrays at sea

The Kelp Blue proposes the following materials for the construction of the cultivation arrays (exact sizes still to be confirmed):

- Anchors: concrete blocks (dimensions still to be confirmed) or screw anchors. Concrete blocks up to 2.5 x 2.5 x 2.5 m are assumed for the assessment).
- Risers: Studlink chain under tension or mooring hawser,
- Frame of the array: ±360 mm steel pipe with a ±10 mm wall thickness, air-filled (which floats) or equivalent HDPE pipe,
- Ropes are 60 mm polyamide (used because it is also almost neutrally buoyant) (or equivalent), installed also under tension, with a 4x4m grid.
- Kelp plants are modelled at a density of every 1.5 m.

The design life of the infrastructure is more than 12 years.

Installation of the grow-out and cultivation arrays will be undertaken by divers and deck hands operating from a fleet of owned or chartered vessels during suitable weather windows.

5.5 EMPLOYMENT

Kelp Blue Namibia will employ approximately 60 employees during the Pilot Project phase, which will be ~20 full time employees and ~40 temporary employments (i.e. temporary contract).

5.6 NON-MINERALIZED (I.E. GENERAL) WASTE

Limited volumes of waste is expected from the construction activities, i.e. ends of rope and welding rods, bits of end steel cuts, etc.

Waste will be separated at source and stored in a manner that there can be no discharge of contamination to the environment. Some waste types will be recycled or reused where possible. Where recycling/re-using is not possible, non-hazardous, non-recyclable waste will be disposed of at the Lüderitz landfill facility. No hazardous waste is expected.

No process waste is expected, i.e. no stream of waste products/materials inherent to the process.

5.7 PROPOSED PILOT PROJECT SCHEDULE

The start date of the Pilot Project phase will be Q1 of 2021, depending on the relevant approvals from MEFT (i.e. ECC) and MFMR (i.e. Aquaculture license). The pilot trials are expected to be conducted over a period of ±12 months.

The steps between license approval and installation of the seeded pilot are illustrated in Figure 8, and expected to take just over 100 days (plus procurement & shipping delay of materials).

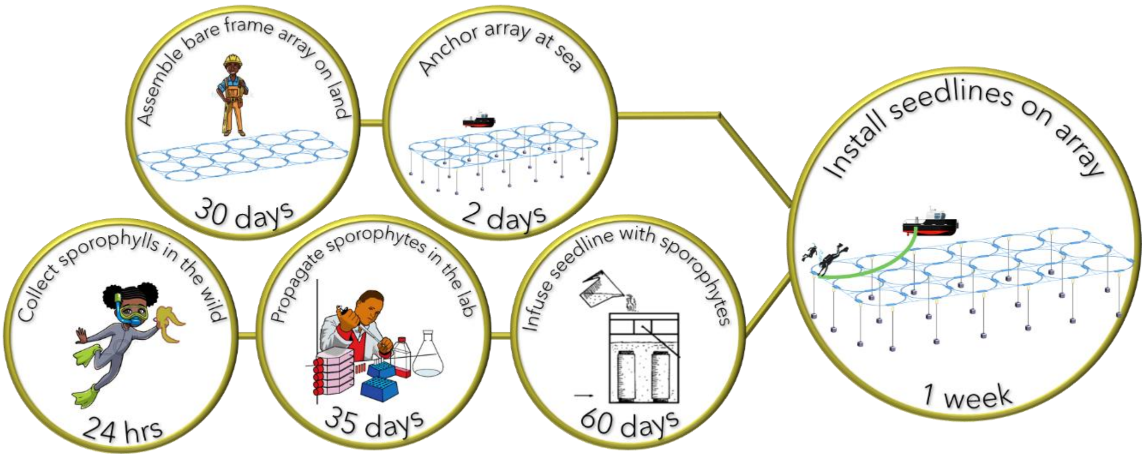

FIGURE 8: ILLUSTRATION OF STEPS BETWEEN LICENSE APPROVAL AND INSTALLATION OF THE SEEDED PILOT ARRAYS

5.8 DECOMMISSIONING PHASE

At a conceptual level, decommissioning can be considered a reverse of the construction phase with the demolition and removal of the majority of infrastructure with activities very similar to those described with for construction.

Being located in the NIMPA, it is critical that the pilot arrays be completely removed at the end of the test phase should the project not prove feasible or at the end of the life span of the structures (estimated at >12 years). Refer to the EMP (section 10) for further requirements.

6 DESCRIPTION OF THE CURRENT/RECEIVING ENVIRONMENT

The Kelp Blue Pilot Project is located near the town of Lüderitz, in southern Namibia in the Karas region, (refer to Figure 1 for the regional setting).

This chapter describes the existing (i.e. baseline) biophysical and human environment and encompasses the coastal zone near Lüderitz and nearshore waters (< 200 m depth) between Spencer Bay and Chameis Bay in southern Namibia. Some of the data presented are, however, more regional in nature, e.g. the wind and wave climate, nearshore currents, etc.

The information presented in the sections below was derived from the following sources:

- Visual observations during site visits by Namisun to Lüderitz.
- Atlas of Namibia
- Google Earth
- The Marine Specialist Study (refer to Appendix F) (Relevant sections were extracted from the above mentioned Specialist study)[4].
- Focus Group Meetings with Key Stakeholders and I&APs (see section 3.5 for details regarding the meetings)
- Information from other EIAs conducted in the area:
    - Final Scoping Report for Total E and P Namibia B.V.'s proposed 3D Seismic Survey in Licence Blocks 2912 AND 2913B, Orange Basin, Namibia (SLR, 2020)
    - Environmental Scoping Report (with assessment) and Environmental Management Plan of LK Mining's Offshore Diamond Exploration Activities on Exclusive Prospecting License 5965 (SLR, 2016) & Archaeological desk assessment by Quaternary Research Services (Kinahan, 2016)

6.1 GEOPHYSICAL CHARACTERISTICS

The information presented in this Section has been sourced from the Marine Specialist Study (Pisces, 2020) (Appendix F).

[4] Various references were made in the Marine Specialist Report, which will not be repeated in this report. For the detailed list of references refer to sections 5 and 8 of the Marine Specialist Report (Appendix F).

6.1.1 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 east of the town, 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. 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.

The coastline of Lüderitz Bay, between North-East Point and Angra Point, alternates between rocky headlands and shallow to deep embayments backed by sandy beaches. The rocky coastline continues ~10 km north of North-east Point before the shoreline becomes dominated by sandy beaches with only occasional rocky promontories. The coastline between Douglas Bay and Hottentots Bay is again rocky, with beaches dominating further north. From Diaz Point southwards to Elizabeth Bay, the coastline is predominantly rocky with prominent beaches at Guano Bay and Grosse Bucht but isolated small beaches in the bays southwards to Elizabeth Bay.

A chain of four rocky islands run from north to south across the mouth of Lüderitz Bay, sheltering North Harbour and Robert Harbour from the open waters of the bay. These are Flamingo, Seal, Penguin and Shark Islands, although the latter has been joined to the mainland by a causeway and harbour quayside. The western and eastern shorelines of Robert Harbour have a relatively steep slope (~1:10), and an irregular alignment, thus forming a submerged rocky valley which runs northward to North Harbour between the eastern shores of Lüderitz Bay and the chain of islands.

The inner shelf is underlain by Precambrian bedrock (also referred to as Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments. Off Lüderitz, the inner shelf sediments are dominated by sand, progressing to muddy sand beyond ~250 m depth (Figure 9). Biogenic muds, which are the main determinants of the formation of low-oxygen waters and sulphur eruptions off central Namibia, occur beyond the 1,000 m contour.

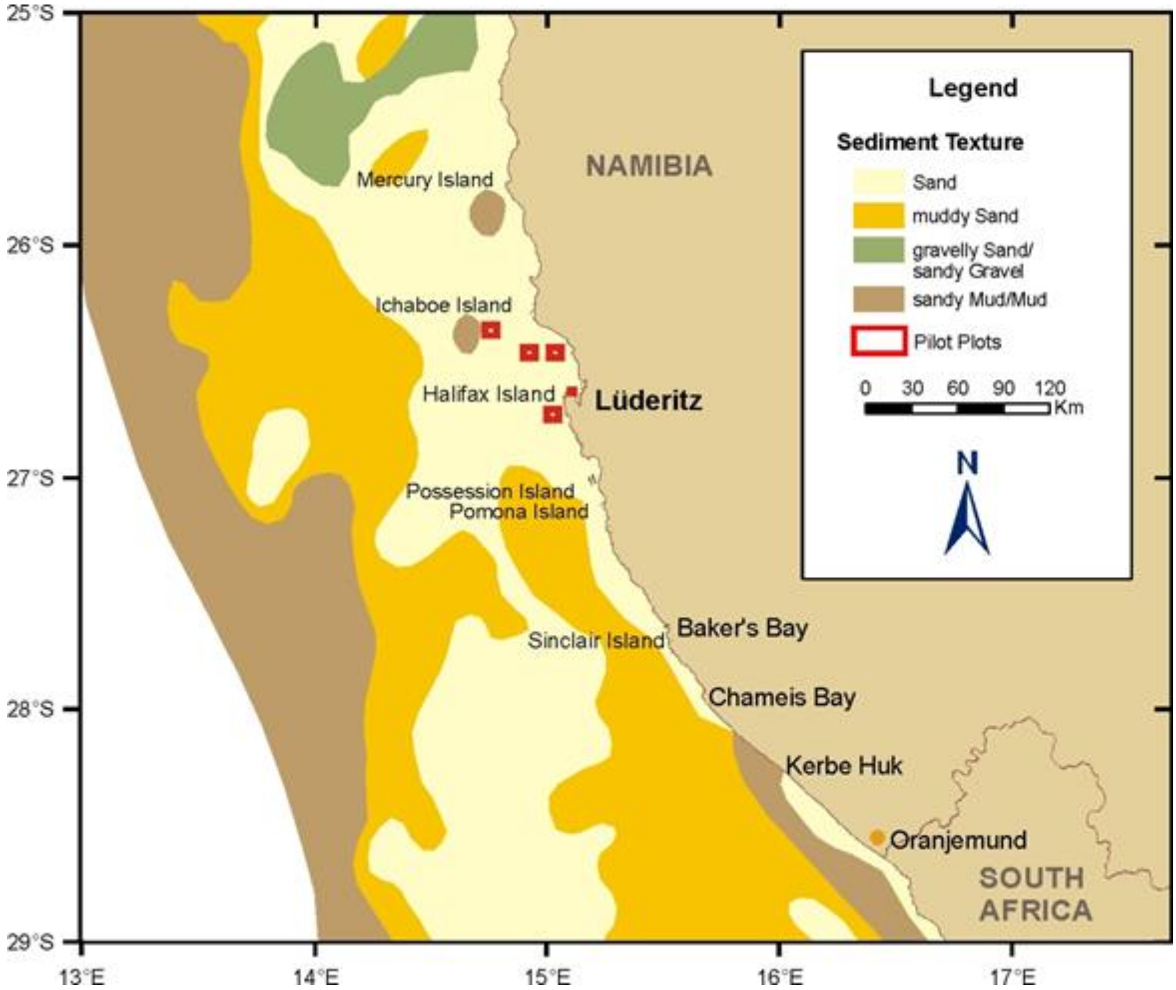

FIGURE 9: THE GIANT KELP PILOT CULTIVATION PLOTS (RED SQUARES – NOT TO SCALE) IN RELATION TO THE SEDIMENT DISTRIBUTION ON THE SOUTHERN NAMIBIAN CONTINENTAL SHELF

6.1.2 BATHYMETRY

Lüderitz Bay is a shallow embayment with water depths east of Diaz Point not exceeding 20 m depth. A bathymetry survey conducted by CSIR in late 2009 indicates the relatively shallow nature of the bay west of the port area, with depths increasing from <5 m in the south of the bay to in excess of 16 m at the entrance to the bay.

Off southern Namibia the continental shelf is variable in width. In the far south off the Orange River the shelf is wide (230 km) and characterised by well-defined shelf breaks, a shallow outer shelf and the aerofoil-shaped submarine Recent River Delta on the inner shelf. It narrows to the north reaching its narrowest point (90 km) off Chameis Bay, before widening again to 130 km off Lüderitz.

The salient topographic features of the shelf include the relatively steep descent to about 100 m, the gentle decline to about 180 m, and the undulating depths to about 200 m. Off Lüderitz the shelf becomes a stepped feature, with a low step having an elevation between roughly 400 - 450 m below mean sea level, making it one of the deepest in the world. The variable topography of the shelf is of significance for nearshore circulation and for fisheries.

6.2 BIOPHYSICAL CHARACTERISTICS

The information presented in this Section has been sourced from the Marine Specialist Study (Pisces, 2020) (Appendix F).

6.2.1 CLIMATE

The climate of the Lüderitz region is arid, and falls within a winter rainfall area, with low, unpredictable rains. Average precipitation per annum in Lüderitz amounts to 22 mm, increasing to 85 mm at Aus further inland. Fog occurs frequently along the coast, decreasing gradually along a coast-inland gradient and seldom extending more than 35 km offshore. Fog occurrence has a seasonal variation, with a frequency of up to 5% in February and March. The duration of fog events is likewise longer in the late summer reaching a peak of up to 135 hours in March, compared to only 45 h in July.

Lüderitz is renowned for its high and constant wind speeds all year round. The coastal area is characterised by strong, predominantly SSE winds throughout most of the year, wind velocities above 30 km/hr occurring with a ~60% frequency, and wind speeds over 36 km/hr have been recorded with 36% frequency. These longshore southerly winds dominate the wind pattern in the area occurring with 77% frequency during summer and 57% frequency during winter. The winds produce coastal upwelling, and play an important role in structuring coastal geomorphology. North-easterly, catabatic bergwinds, however, prevail during the winter months (July to November). These northerly winds are usually moderate, occurring only 8% of the time. On occasion, however, these powerful offshore winds can exceed 50 km/hr, producing sandstorms that considerably reduce visibility at sea and on land. They also have a strong effect on the coastal temperatures, which often exceed 30°C during bergwind periods. In general, however, the prevailing southerly winds and frequent coastal fog moderate the temperatures in the Lüderitz area, temperatures averaging 16°C. Temperatures gradually increase along a coast-inland gradient to 17.7°C in Aus, and 21°C in Keetmanshoop. The coastal area is frost free.

6.2.2 Waves, Large-scale Circulation and Tides

The Southern Namibian Coast is classified as exposed, experiencing strong wave action rating between 13-17 on the 20 point exposure scale. 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.

Lüderitz Bay, is the largest embayment and only natural harbour along the southern Namibian coastline. It is north-facing, and thus sheltered from the predominant southerly and south-westerly swells. Waves entering Lüderitz Bay from the predominant SW sector are refracted and diffracted around the headlands of Diaz Point, Angra Point and Shark Island, and penetrate Robert Harbour from a northerly direction. The eastern shores of Robert Harbour are more exposed to refracted waves than the western section. Furthermore, the irregular alignment of the eastern shores leads to relatively large reflection of incident swell energy, resulting in a scattered wave pattern within the harbour. The local wave heights of the refracted and reflected waves entering the harbour are comparatively low, decreasing southwards. Nonetheless, wave heights of over 0.5 m may occur.

Current velocities outside of Lüderitz Bay in continental shelf areas of the Benguela region typically range between 0.1 – 0.3 m/s. The flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow. Fluctuation periods of these flows are 3 - 10 days, although the long-term mean current residual is in an approximate NW (alongshore) direction. The poleward flow becomes more consistent in the southern Benguela.

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. Surface currents appear to be topographically steered, following the major topographic features. 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.

Within Lüderitz Bay itself, predicted water circulation, identified that currents are mainly tidally driven, and characterised by a strong northward flow occasionally exceeding 0.15 m/s out of the Bay round North-east Point.

In common with the rest of the southern African coast, tides in the study area are 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.

6.2.3 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. Salinities range between 34.5 ppt and 35.5 ppt. Data recorded over a 36-year period at the 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. They show a strong seasonality with lowest temperatures occurring during early spring when upwelling is at a maximum (see section 6.2.4).

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 (see section 6.2.7).

6.2.4 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 on the Namibian coast is in the vicinity of Lüderitz, and upwelling can occur there throughout the year. Several secondary upwelling cells occur off northern and central Namibia, and upwelling in these is perennial. Three upwelling seasons are distinguished in the 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 varies 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. This is mediated by nutrient regeneration from biogenic material in the sediments. 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.

6.2.5 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 The Orange River further south 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. 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. 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 (0.1-0.3 m/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.

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.

In a shallow embayment such as Lüderitz Bay, swell and wind-induced waves and currents result in the constant resuspension of sediments. Consequently, the water within Lüderitz Bay is 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 potentially contributing the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River.

6.2.6 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. 36% 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). 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 section 6.2.7).

6.2.7 Low Oxygen Events

The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system. 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. The distribution of oxygen-poor water is subject to short (daily) and medium term (seasonal) variability in the volumes of oxygen depleted water that develop. 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. 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, 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. While such mass mortalities have been reported from the central Namibian coast, they are uncommon in the area around Lüderitz.

6.2.8 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. This is periodically released from the muds as 'sulphur eruptions', causing upwelling of anoxic water and formation of surface slicks of sulphur discoloured water, and even the temporary formation of floating mud islands. The sulphur events have a strong seasonal cycle being highest between February and April during the seasonal oxygen minimum. Annual variability of sulphur events is also evident being enhanced in years with a lower annual mean of upwelling intensity, decreased oxygen supply associated of bottom waters, and a more southern position of the Angola Benguela Frontal Zone. 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.

Sulphur eruptions have been known to occur off the Namibian coast for centuries, 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 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.

Recently the role of micro-organisms in the detoxification of sulphidic water was investigated during the occurrence of a sulphidic water mass covering 7,000 km^2 of seafloor off the coast of Namibia, when surface waters, however, remained well oxygenated. In the presence of oxygen, sulphide is oxidized and transformed into non-toxic forms of sulphur. An intermediate layer was discovered in the water column, which contained neither hydrogen sulphide nor oxygen. It was established that sulphide diffusing upwards from the anoxic bottom water is consumed by autotrophic denitrifying bacteria that inhabit the intermediate water layer. By using nitrate, the detoxifying microorganisms transform sulphide into finely dispersed particles of sulphur that are non-toxic, thereby creating a buffer zone between the toxic deep water and the oxygenated surface waters. These results, however, also suggest that benthic and demersal animals in coastal waters may be affected by sulphur eruptions more often than previously thought, and that many of these sulphidic events may go unnoticed on satellite imagery as the bacteria consume the hydrogen sulphide before it reaches the surface.

6.3 BIOLOGICAL ENVIRONMENT

The information presented in this Section has been sourced from the Marine Specialist Study (Pisces, 2020) (Appendix F).

Biogeographically the coastline falls into the cool temperate Namaqua Province, which extends from Cape Point up to Lüderitz. The coastal, wind-induced upwelling characterising the Benguela ecosystem, is the principal physical process that shapes the marine ecology of the study area. The coastline of southern Namibia is 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) to develop assessments of their ecosystem threat status and ecosystem protection level (refer to Figure 10). The benthic habitats were subsequently assigned an ecosystem threat status based on their level of protection.

Kelp Blue's proposed Pilot areas for Kelp cultivation fall into the Lüderitz Islands, Lüderitz Inner Shelf and Lüderitz Outer Shelf habitats. Most of the inshore and coastal habitats in the area have been assigned a threat status of 'Least Concern', with the exception of the Lüderitz Outer Shelf habitat, which is considered 'Vulnerable'. The coastline around Lüderitz Bay predominantly comprises rocky shores punctuated by numerous small bays and sandy beaches. Consequently, marine ecosystems comprise a limited range of habitats that include:

- sandy intertidal and subtidal substrates,
- intertidal rocky shores and nearshore reefs,
- mixed shores
- 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.

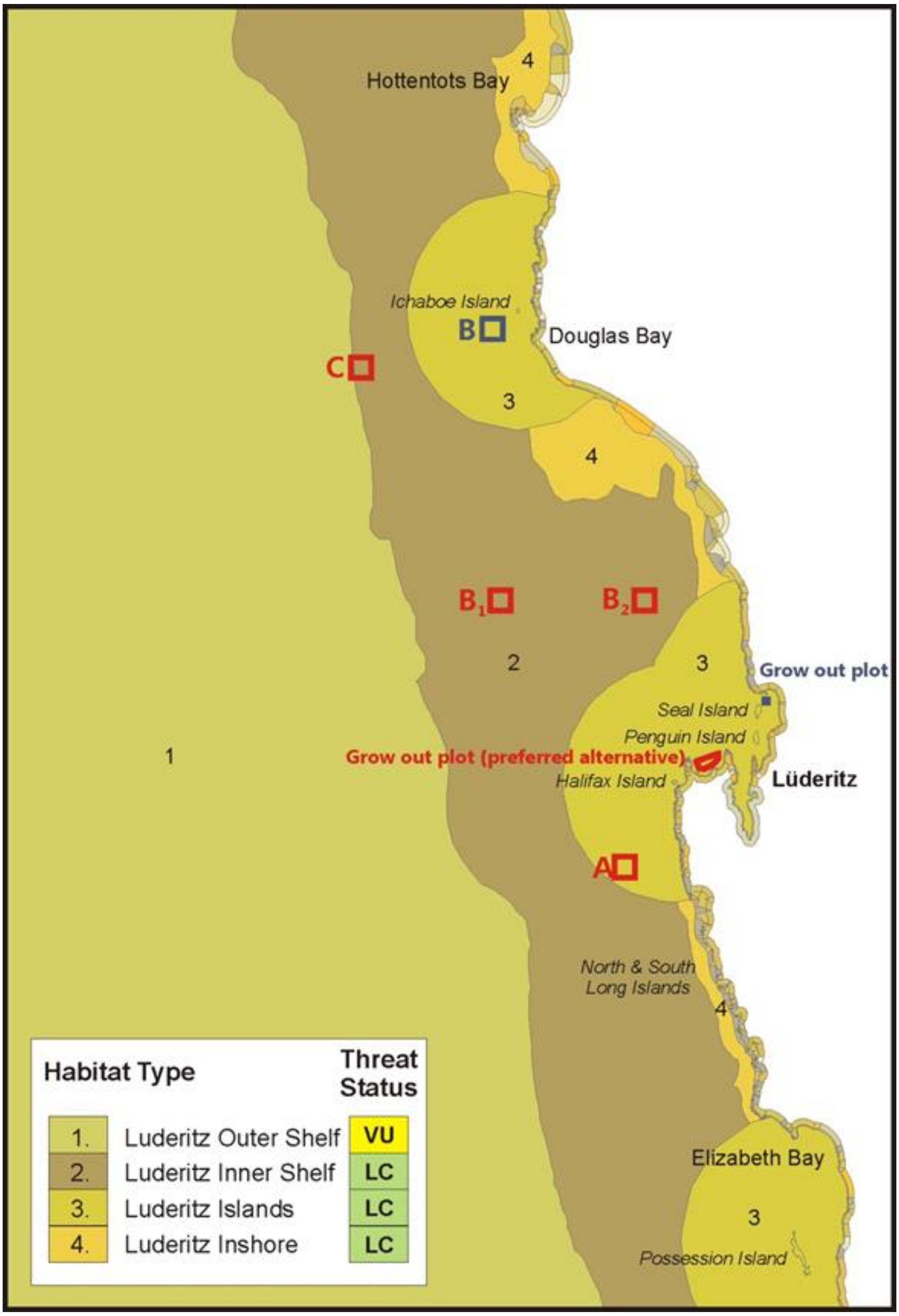

FIGURE 10: THE PROPOSED KELP PILOT CULTIVATION PILOT AREAS (RED POLYGONS – PREFERRED ALTERNATIVES [NOT TO SCALE]) IN RELATION TO THE NAMIBIAN BENTHIC AND COASTAL HABITATS AND THEIR THREAT STATUS. (COASTAL HABITATS ARE NOT LABELLED DUE TO RESOLUTION)

6.3.1 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.

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. There is, however, 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.

Sandy beaches in the *Sperrgebiet* between Oranjemund and Lüderitz have been relatively well studied. In particular, the Elizabeth Bay and Grossebucht beaches have been sampled regularly since 1993. They are biologically similar to those found in the rest of the Namaqua Province, but their pristine nature give them considerable conservation value. For example, whilst many of the beaches in southern Namibia harbour an impoverished fauna due to their reflective nature, the Elizabeth Bay and Grossebucht beaches support a community of great richness in terms of numbers, biomass and species. To date, invertebrate and/or fish fauna have been sampled on numerous beaches in this area.

The macrofaunal communities of sandy beaches are generally ubiquitous throughout the southern African West Coast region, being particular only to substratum type, wave exposure and/or depth zone. Due to the exposed nature of the coastline in the study area, most beaches are of the intermediate to reflective type. The supralittoral zone is situated above the high water spring (HWS) tide level, and receives water input only from large waves at spring high tides or through sea spray. This zone is characterised by a mixture of air breathing terrestrial and semi-terrestrial fauna, often associated with and feeding on kelp deposited near or on the driftline. Terrestrial species include a diverse array of beetles and arachnids and some oligochaetes, while semi-terrestrial fauna include the oniscid isopod *Tylos granulatus*, and amphipods of the genus *Talorchestia*. The intertidal zone or mid-littoral zone has a vertical range of about 2 m. This mid-shore region is characterised by the cirolanid isopods *Pontogeloides latipes*, *Eurydice* (*longicornis*=) *kensleyi*, and *Excirolana natalensis*, the polychaetes *Scolelepis squamata*, *Orbinia angrapequensis*, *Nepthys hombergii* and *Lumbrineris tetraura*, and amphipods of the families Haustoridae and Phoxocephalidae. In some areas, juvenile and adult sand mussels *Donax serra* may also be present in considerable numbers.

The inner turbulent zone extends from the Low Water Spring mark to about -2 m depth. The mysid *Gastrosaccus psammodytes* (Mysidacea, Crustacea), the ribbon worm *Cerebratulus fuscus* (Nemertea), the cumacean *Cumopsis robusta* (Cumacea) and a variety of polychaetes including *Scolelepis squamata* and *Lumbrineris tetraura*, are typical of this zone, although they generally extend partially into the midlittoral above. In areas where a suitable swash climate exists, the gastropod *Bullia digitalis* (Gastropoda, Mollusca) may also be present, surfing up and down the beach in search of carrion.

The transition zone spans approximately -2 to -5 m depth beyond the inner turbulent zone. Extreme turbulence is experienced in this zone, and as a consequence this zone typically harbours the lowest diversity on sandy beaches. Typical fauna include amphipods such as *Cunicus profundus* and burrowing polychaetes such as *Cirriformia tentaculata* and *Lumbrineris tetraura.*

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*, and *Sabellides luderitzii*. The sea pen V*irgularia schultzi* (Pennatulacea, Cnidaria) is also common as is a host of amphipod species and the three spot swimming crab *Ovalipes punctatus* (Brachyura, Crustacea).

In Lüderitz, the transition and outer turbulent zones (or their equivalents) in the bay and lagoon host beds of the red alga *Gracilaria gracilis*, particularly where the seabed is dominated by sandy and muddy sediments. A survey undertaken in 1992 estimated that at that time *Gracilaria* beds in water depths between 1 m and 10 m covered an area of 2.5 km^2 in the lagoon and a further 5.8 km^2 in the Bay system. Biomass of *Gracilaria* peaked at depths between 3-4 m in the lagoon and at 5-6 m in the bay. Although it also occurs in Shearwater Bay, this area was not included in the survey. Densities were highest in Flamingo Bay, North Harbour and inside Seal and Penguin Islands. Beach cast *Gracilaria* formed the mainstay of an important industry in Lüderitz between 1981 and 2010. Beach cast supplies, however, declined steadily during that time suggesting that biomass in the natural beds was decreasing. The decline in *Gracilaria* abundance and biomass has been attributed to numerous factors including changes in sediment structure (fining) within the lagoon and Bay area (the latter possibly due to dredging of the harbour), increasing swell height and declining temperatures or low-oxygen events. Evidence from Saldanha Bay in South Africa, however, suggests that the *Gracilaria* resource can be temporally highly variable and without a follow-up survey of the potential resource in the Lüderitz Bay area, the current state of the resource is difficult to predict.

The surf zone and outer turbulent zone habitats of sandy beaches are considered to be important nursery habitats for marine fishes. However, the composition and abundance of the individual assemblages seems to be heavily dependent on wave exposure. Only five species have been recorded off beaches on the southern *Sperrgebiet* coast, these being 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.

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.

6.3.2 ROCKY INTERTIDAL SHORES

Several studies on the west coast of southern Africa have documented the important effects of wave action on the intertidal rocky-shore community. Specifically, wave action enhances filter-feeders by increasing the concentration and turnover of particulate food, leading to an elevation of overall biomass despite a low species diversity. Conversely, sheltered shores are diverse with a relatively low biomass, and only in relatively sheltered embayments does drift kelp accumulate and provide a vital support for very high densities of kelp trapping limpets, such as *Cymbula granatina* that occur exclusively there. In the subtidal, these differences diminish as wave exposure is moderated with depth.

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.

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.

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. *M. galloprovincialis* has partially displaced the local mussels *Choromytilus meridionalis* and *Aulacomya ater*, and competes with several indigenous limpet species. 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. There is, however, evidence that it has been in South Africa since at least 1992. At the time of its discovery, the barnacle was recorded from 400 km of coastline from Cape Point to Elands Bay in South Africa. It has been reported on rocky shores as far north as Lüderitz in Namibia. 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. Similarly, *C.*

granatina is the dominant grazer on more sheltered shores, also reaching extremely high densities. 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*. 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. 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, but has only recently been recorded from Lüderitz. It now extends along almost the entire West Coast to as far south as Cape Point inSouth Africa. 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. 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. 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. 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.

6.3.3 NEAR- AND OFFSHORE SOFT SEDIMENTS

The benthic biota of soft bottom substrates constitutes invertebrates that live on (epifauna), or burrow within (infauna), the sediments, and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm). The structure and composition of benthic soft bottom communities is primarily a function of water depth and sediment grain size, but other factors such as current velocity, organic content, and food abundance also play a role.

Numerous studies have been conducted on southern Namibian inner shelf benthos, mostly focused on mining impacts. 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.

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.

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. However, studies have shown that shear bed stress - a measure of the impact of current velocity on sediment – oxygen concentration, productivity, organic carbon and seafloor temperature 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. 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.

6.3.4 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.

Rocky subtidal habitats along the southern Namibian coastline and within Lüderitz Bay are dominated by kelp beds *(Laminaria pallida* and *Ecklonia maxim*a). 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 south of 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. 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. 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). 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.).

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.

The whole of the Lüderitz Bay area is a rock lobster (*Jasus lalandii*) sanctuary. 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. Neither commercial nor recreational fisheries are therefore taking place.

6.3.5 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.

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.

On the southern African West coast, for example, semi-exposed to exposed shores influenced by sand are inhabited by the sand tolerant *Choromytilus meridionalis*. 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. Of the intertidal limpets, only *Siphonaria capensis* extends its distribution into regions where sand deposition is a regular occurrence.

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.

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.

6.3.6 MARINE TURTLES

Although only one species breeds on the Namibian shores (the Green turtle, Chelonia mydas in the far north of the Skeleton Coast), five species of marine turtles are known from Namibian waters. Table 5Table 5 details their conservation status.

Of these five species only one, the Leatherback turtle, is known to regularly occur in the inshore habitats where the proposed Pilot Project activities are planned to take place. The large abundance of jellyfish in central and southern Namibian waters makes the region an important feeding ground for Leatherback turtles (a jellyfish specialist predator). These turtles are from three different subpopulations, two of which (Southwest Indian Ocean and Southwest Atlantic ocean) are ranked as critically endangered. 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.

TABLE 5: MARINE TURTLES KNOWN FROM NAMIBIAN WATERS WITH THEIR OVERALL SPECIES CONSERVATION STATUS[5]

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)

All marine turtles outside their rookeries (breeding beaches) face various common threats which include boat strikes, incidental bycatch in fisheries (at least a few Olive ridley turtles have occasionally been recorded in trawl bycatch in Namibia), marine pollution, marine litter and entanglement. Natural mortality (including predation by Killer whales) has also been noted in Namibia for Leatherback turtles.

6.3.7 SEABIRDS

The Namibian coastline sustains large populations of breeding and foraging seabird species, which require suitable roosting, foraging and breeding habitats for their survival. A total of 12 seabird species breed along the southern Namibian coast (refer to Table 6). Most of these species are restricted to areas where they are safe from land predators, and the islands and islets dotted along the southern Namibian coast from Meob Bay in the north to Baker's Bay in the south therefore provide vital breeding habitats. Some species are also able to breed on the mainland coast in inaccessible places. Six of these species are considered globally threatened or near-threatened; nine are considered threatened or near-threatened in Namibia.

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. Information on their exact seasonal distributions and abundances in Namibian waters is generally limited. Highest densities of pelagic

[5] 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.

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.These seabirds forage in open waters, covering vast distances, and feed on a range of fish, krill and squid.

TABLE 6: SEABIRD SPECIES BREEDING ALONG THE NAMIBIAN COASTLINE WITH THEIR NAMIBIAN AND GLOBAL IUCN RED-LISTING CLASSIFICATION[6] AND ENDEMIC STATUS

Species	Namibian listing	Global (IUCN) listing	Endemic status
African Penguin *Spheniscus demersus*	Endangered	Endangered	Southern African breeding endemic
Cape Gannet *Morus capensis*	Critically Endangered	Endangered	Southern African breeding endemic
Bank Cormorant *Phalacrocorax neglectus*	Endangered	Endangered	Southern African endemic (~90% of the global population is in southern Namibia)
Cape Cormorant *Phalacrocorax capensis*	Endangered	Endangered	Southern African near- endemic
Crowned Cormorant *Microcarbo coronatus*	Near Threatened	Near Threatened	Southern African endemic
White-breasted Cormorant *Phalacrocorax [carbo] lucidus*	Least Concern	Least Concern	Widespread
African Oystercatcher *Haematopus moquini*	Near Threatened	Least Concern	Southern African breeding endemic
Kelp Gull *Larus dominicanus*	Least Concern	Least Concern	Widespread
Hartlaub's Gull *Chroicocephalus hartlaubii*	Vulnerable	Least Concern	Southern African endemic
Caspian Tern *Hydroprogne caspia*	Vulnerable	Least Concern	Widespread
Greater Crested (Swift) Tern *Thalasseus bergii*	Least Concern	Least Concern	Widespread
Damara Tern *Sternula balaenarum*	Near Threatened	Vulnerable	Namibian breeding near-endemic

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

[6] Differences between Namibia and global classifications are the result of local population size, and the extent and duration of declines locally.

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, Cape Gannets, which may forage more than 100 km offshore, and African Penguins, which have been recorded more than 60 km offshore in Namibia. Cape Gannets are plunge-divers that can dive from considerable heights, using the momentum of the plunge to reach water depths of more than 10 m. Terns have a similar hunting strategy but don't dive as deeply. African Penguins and cormorants use a pursuit diving strategy to hunt their prey. African Penguins have been recorded to dive to depths of more than 80 m (MFMR unpubl. data), while dive depths up to 47 m have been recorded for Bank Cormorants breeding on Mercury Island. 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.

Small pelagic fish species, including sardine *Sardinops sagax*, anchovy *Engraulis encrasicolus* and round herring *Etrumeus whiteheadi* are the preferred food of African Penguins, Cape Gannets and Cape Cormorants. With the crash of stocks of small pelagic fish in Namibia in the 1970s, these birds have switched to generally less nutritious diets that include the widespread and relatively abundant bearded goby *Sufflogobius bibarbatus*. This lack of suitable prey is also one of the main reasons for the decline in population numbers of these species. Bank Cormorants and Crowned Cormorants tend to forage close to shore, often in kelp beds, where they feed on rock lobster or small fish, including klipfish. Terns feed on a variety of locally available fish, including on juvenile Cape hake *Merluccius capensis* and horse mackerel *Trachurus capensis*. Extending kelp beds and therefore increasing the habitat for prey species associated with kelp beds could be beneficial for bird species such as Bank Cormorants and Crowned Cormorants if these are relatively close inshore and therefore within the feeding ranges of these two species. Other bird species such as Cape Gannets, African Penguins and Cape Cormorants may also benefit from fish attracted to and concentrated in and around kelp beds further offshore, even if these bird species usually do not target kelp beds.

Cormorants, and to a lesser degree African Penguins and gulls, may build elaborate nests that can include kelp and various other seaweeds as nesting material. Cormorants in particular have a tendency to include marine litter. Seabirds are also prone to marine oil pollution, particularly flightless African Penguins.

6.3.8 MARINE MAMMALS

6.3.8.1 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. These three species’ natural habitats coastal habitats comprises extensive kelp beds including *Macrocystis*.

The Cape fur seal (*Arctocephalus pusillus pusillus*), an endemic to the Benguela Current region is an abundant and widespread species particularly on the continental shelf and inshore waters of the region. The species as a whole is ranked “Least concern” as a conservation status by the IUCN. Cape fur seals are resident in the 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.

There are several important breeding colonies along the Namibian coast and particularly in the Lüderitz area. The species is commercially exploited in Namibia with two main concessions along the coast that include the largest colonies in Namibia (Cape Cross north of Swakopmund and Wolf Bay and Atlas Bay colonies just south of Lüderitz). 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. While the Namibian fur seal population as a whole (monitored through aerial surveys of pup production on breeding colonies) seems to have remained relatively stable in the last three decades, the southern Namibian part has declined by about 50% since 1993. The cause of this long term regional decline is probably linked to changes in the regional prey abundance, prey quality and diet composition. While before the development of industrial fishing in the region the northern Benguela food web was dominated by sardine and to a lesser extent anchovy and horse mackerel, many predators had to switch diet to less abundant and less nutritious prey species after the collapse of the sardine stock in the early 1970s. At present the fur seal diet in southern Namibia is dominated numerically by bearded goby, lantern fish and juvenile Cape hake.

Cape fur seal colonies are also important tourist attractions (like at present at Cape Cross and Cape Fria in Northern Namibia). With the future opening to tourism of the Namibian southern coastal national parks, it is envisaged that mainland colonies in the Tsau//Khaeb (Sperrgebiet) like Wolf and Atlas Bay colonies will become the focus of nature-based costal tourism in the area.

Besides the direct commercial exploitation, a relatively small fisheries bycatch mortality rate in the region and the indirect effects of the fishing industry on the food web and fur seal prey abundance and distribution, fur seals are also highly susceptible to entanglement in marine debris and discarded fishing gear. This includes mainly ropes, twine, monofilament lines, netting, and packaging straps. Loose ropes, looped lines and ropes pose a significant entanglement risk for fur seals and should be avoided.

As highly opportunistic and adaptable foragers, fur seals might marginally benefit locally from a large kelp farming project, which could provide a new foraging habitat in their range (through its potential fish aggregating device (FAD) effect). Provided entanglement risks through loose ropes and straps are avoided, no detrimental effect is envisaged for fur seals in the proposed Pilot Project.

6.3.8.2 CETACEANS (WHALES AND DOLPHINS)

The southern African region (including Namibian waters) has a very high diversity of whales and dolphins. 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. (Refer to the Marine Specialist Report [Appendix F] for a list of Cetacean Species known or likely to occur in the Namibia waters). 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. 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. 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. 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 and Mozambique. Southern right whales are seen regularly in Namibian coastal waters (<3 km from shore), especially in the southern half of the Namibian coastline. Right whales have been recorded in Namibian waters in all months of the year, 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. Still rare in Namibian waters, this species has a high value for marine tourism as demonstrated with the development of a multi-million dollars whale watching industry in the Cape Province of South Africa in the last three decades.

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. A recent synthesis of available humpback whale data from Namibia shows that in coastal waters, the northward migration stream is larger than the southward peak supporting earlier observations from whale catches. 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. 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 and it is likely to have increased since this time at about 5% per annum. 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 within the project area in recent years of 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.

Other baleen whales encountered within the project area include a few smaller species (Pygmy right whale, Antarctic and Dwarf minke whales), and the potential impacts of the project will probably be similar or less acute compared to those on larger species but for entanglement issues.

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. 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. 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.

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, and may show a diurnal onshore-offshore movement pattern feeding offshore at night, although this varies throughout the range. 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.

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). An offshore 'form' of common bottlenose dolphins occurs around the coast of southern Africa including Namibia and Angola 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*). Most records in the region originate in a relatively restricted region between 26°S and 30°S. 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. It is possible that the Namibian sightings represent a regionally unique and resident population.

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.

6.4 Biological Resources

The information presented in this Section has been sourced from the Marine Specialist Study (Pisces, 2020) (Appendix F).

6.4.1 Conservation Areas and Marine Protected Areas (MPAs)

The first Marine Protected Area (MPA) in Namibia, the Namibian Islands' Marine Protected Area (NIMPA) was proclaimed on 2 July 2009 under the Namibian Marine Resources Act (No. 27 of

2000). Its main aim is to protect the breeding colonies and foraging habitats of threatened coastal seabirds, as well as key habitats for resident and migratory marine mammals. It also aims to protect spawning and nursery grounds of rock lobster and some fish stocks - and to promote stock recovery.

The NIMPA extends for roughly 400 km, from Meob Bay (24°30´S) in the north, to Chamais Bay (27°57´S) in the south, with an average width of 30 km from the high water mark. Its design is largely based on the foraging ranges of breeding African Penguins. It includes 16 specified islands, islets and rocks, as well as a line fish sanctuary near Meob Bay and a rock lobster sanctuary between Prince of Wales Bay and Chameis Bay. The NIMPA is zoned into four levels of protection, with the islands and their immediate surroundings being afforded the highest conservation status. The regulations pertaining to the NIMPA (Government Gazette 5111, of 31 December 2012) detail which activities are permitted in each of the zones. All three of the currently proposed pilot plots as well as the grow-out plot for the cultivation of Giant Kelp fall within the NIMPA (see Figure 11), with the proposed grow-out area also falling within the Lüderitz Bay rock lobster sanctuary (see below).

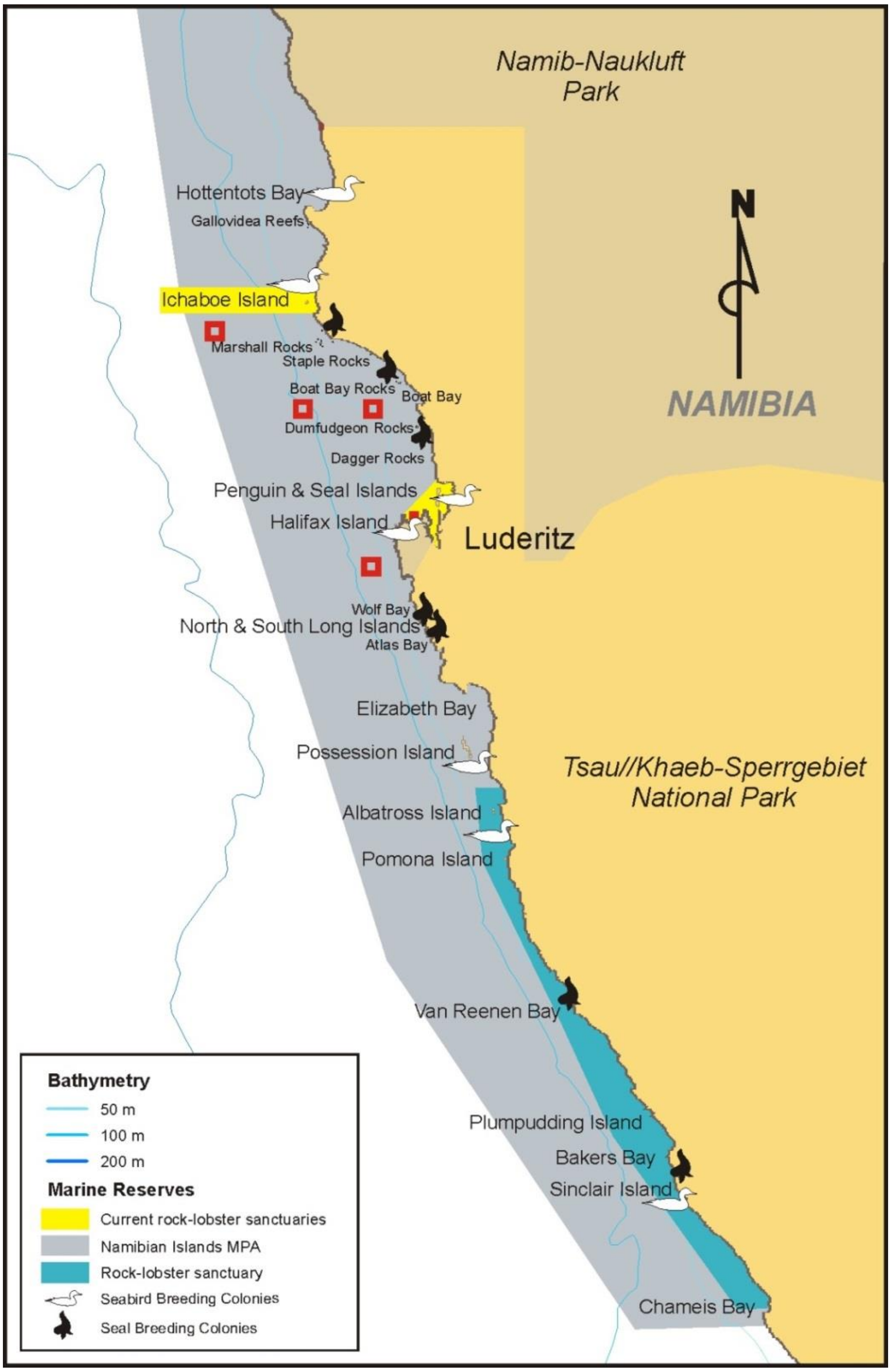

FIGURE 11: THE PROPOSED KELP PILOT LOCATIONS (RED SQUARES) IN RELATION TO THE NAMIBIAN ISLANDS MARINE PROTECTED AREA AND OTHER PROJECT-ENVIRONMENT INTERACTION POINTS

There are a number of smaller conservation areas, namely the Lüderitz Bay and Ichaboe Island Rock-Lobster Sanctuaries and Lüderitz Peninsula. These are described briefly below.

The Lüderitz Bay and Ichaboe Island Rock-Lobster Sanctuaries (see Figure 11 and Figure 12, left) were proclaimed by South Africa in 1939 and 1951, respectively, and subsequently maintained as reserves by the MFMR after Namibian independence. There is no restriction on other activities within these reserves.

The Lüderitz Peninsula has been declared an IUCN category V Protected Landscape/Seascape zone within the context of the Tsau //Khaeb National Park (see below). Although the area has relatively open access for public enjoyment and recreation (Figure 12, right), both the Park's Management Plan and the National Policy on Prospecting and Mining in Protected Areas aim to restrict any future development, prospecting and mining within this zone.

The Sperrgebiet was proclaimed in 1908 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. It extends between latitude 26° in the north and the Orange River in the south, extending inland from the coast for 100 km, covering an area of approximately 22 000 km^2. As diamond mining has remained confined to the narrow coastal strip and along the banks of the Orange River and around Elizabeth Bay, most 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.

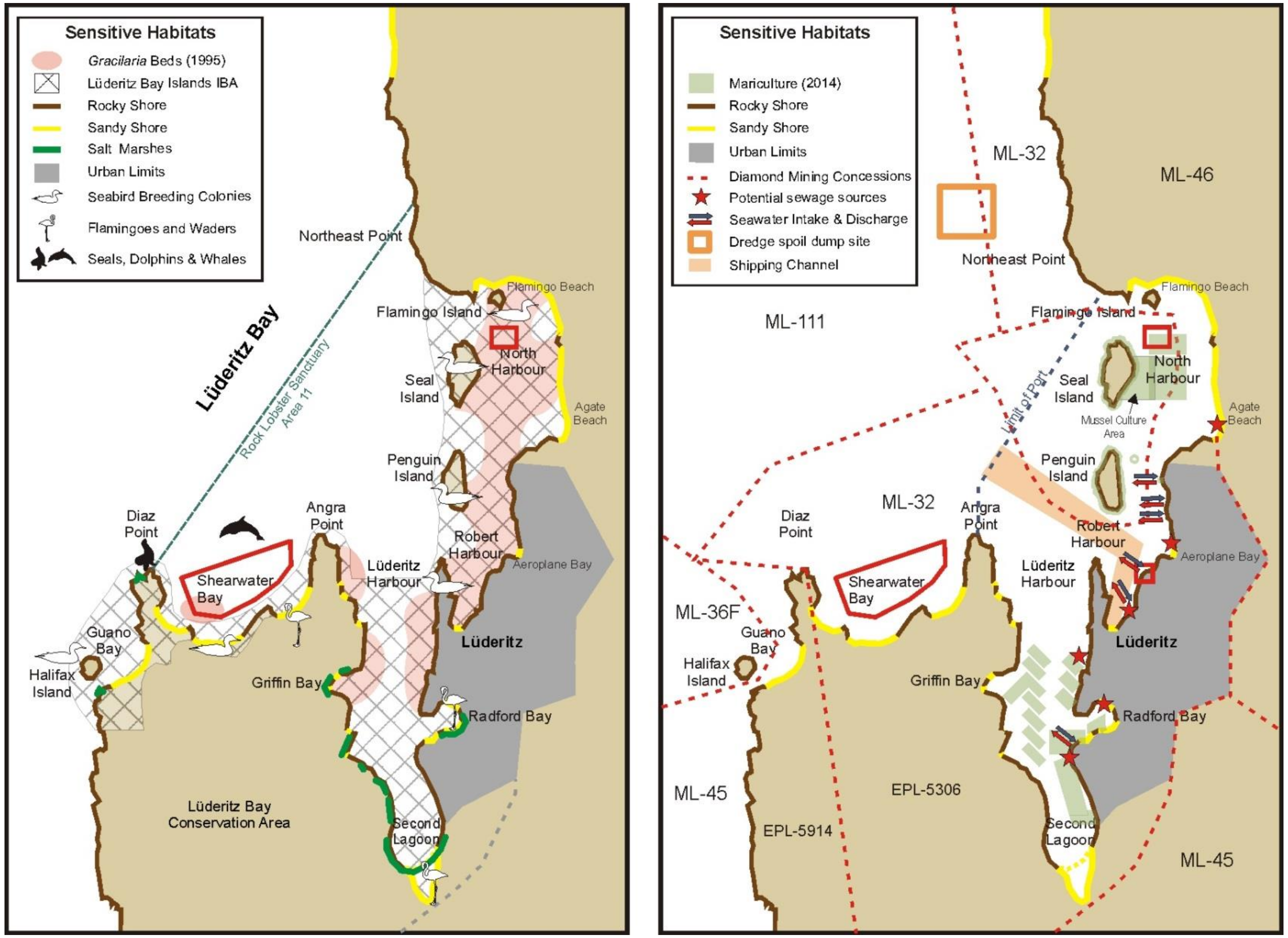

FIGURE 12: THE PROPOSED KELP GROW OUT AREA IN LÜDERITZ BAY (RED POLYGONS) IN RELATION TO PROJECT-ENVIRONMENT INTERACTION POINTS WITH THE NATURAL ENVIRONMENT IN THE BAY (LEFT) AND OTHER USERS (RIGHT). THE PREFERRED ALTERNATIVE IS THE AREA IN SHEARWATER BAY

6.4.2 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 IBAs designated by BirdLife International in Namibia, those located along the southern Namibian coastline and relevant to the planned activities are listed in Table 7.

TABLE 7: 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

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 (Figure 12, left). 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. The proposed grow-out area falls within the Lüderitz Bay Islands IBA – as well as into the proposed Sperrgebiet Marine IBA, together with all three proposed offshore Kelp pilot areas (see Figure 13).

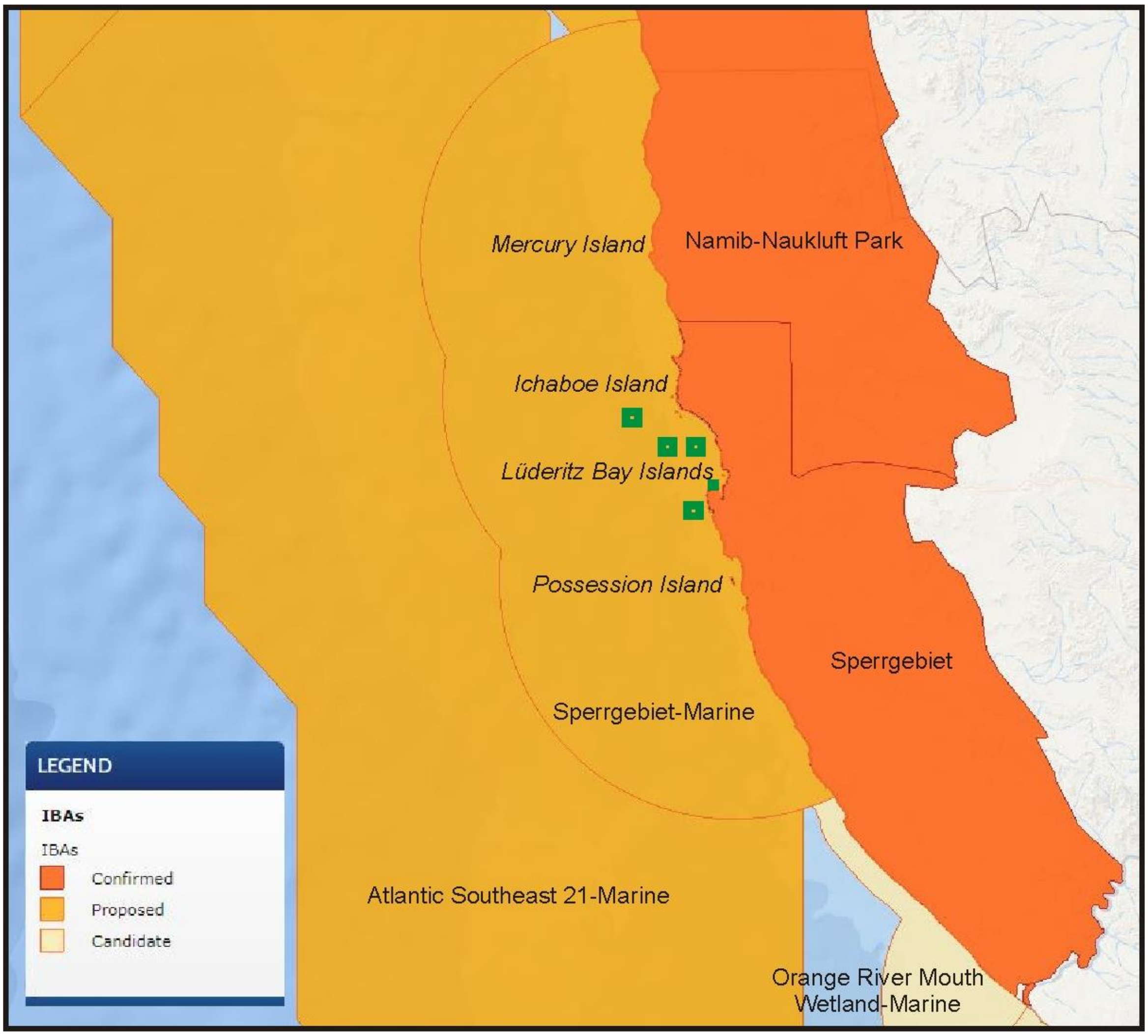

FIGURE 13: THE PROPOSED KELP PILOT AREAS (GREEN SQUARES – NOT TO SCALE) IN RELATION TO CONFIRMED, PROPOSED AND CANDIDATE COASTAL AND MARINE IBAS IN NAMIBIA

6.4.3 ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT AREAS

Ecologically or Biologically Significant marine Areas (EBSAs) are 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. Currently 279 EBSAs have been identified across the world; of these, 11 EBSAs that fall into the BCLME have been recognized by the CBD; an additional nine EBSAs in the region, including trans-boundary EBSAs, have or will be proposed in the near future. In Namibian waters, the Namibian Islands EBSA was initially limited to Mercury, Ichaboe, Halifax and Possession islands, but was recently extended to include the entire NIMPA.

6.5 Heritage

The following is an extract from the Environmental Scoping Report (with assessment) and Environmental Management Plan of LK Mining's Offshore Diamond Exploration Activities on Exclusive Prospecting License 5965 (SLR, 2016) & Archaeological desk assessment by Quaternary Research Services (Kinahan, 2016).

Ichaboe 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 substantial guano deposits. Hottentot Bay, further north, provided a more sheltered anchorage than Douglas Bay adjacent to Ichaboe 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.

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.

Although almost all of the historical evidence is from on-shore contexts it should be emphasized that access to both Hottentot Bay and Ichaboe was exclusively by sea and that the seabed north of Ichaboe and for some distance beyond the Hottentot Bay headland is likely to have significant amounts of wreckage. The large number of vessels involved at Ichaboe (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 8 lists shipwrecks in the records of the Namibia Archaeological Trust:

TABLE 8: RECORDED SHIPWRECKS NEAR ICHABOE ISLAND AND HOTTENTOT BAY

Vessel	Date of loss	Location
Canute	1861	Ichabo Island
Heraclides	1907	Hottentot Bay
Kent	1850	Hottentot Bay
Solingen	1904	Hottentot Bay
Catharina D	1887	west of Hottentot Point
Falke	1883	Ichabo Island
Furus	1896	Ichabo Island

None of the above has been investigated due to restrictions of access to the coast. The *Canute*, *Falke* and *Furus*, or other unknown shipwrecks may lie near or with the proposed Kelp Pilot areas, specifically near Ichaboe Island and could be affected by the anchoring of the arrays.

Archaeological and historical remains on the seabed would be vulnerable to disturbance or destruction in the course of construction of the pilot arrays anchoring.

6.6 SOCIO-ECONOMIC ENVIRONMENT

The information presented in this section has been sourced from the Marine Specialist Study (Pisces, 2020) (Appendix F), however, where relevant, other references are made.

6.6.1 POPULATION DEMOGRAPHICS

6.6.1.1 DEMOGRAPHICS

Lüderitz falls within the !Nami‡Nûs constituency in the ǁKaras Region of Namibia. In 2011, Lüderitz Town supported a total population of 12 537 or 90% of the entire population of the !Nami-Nus Constituency. The local population is largely concentrated in the town, while much of the remaining Constituency is made up of national parks and the Namib Desert. The economically inactive population (persons aged below 15 years and above 65 years of age) account for 32% of the Nami-Nus Constituency, with the majority being comprised of children below the age of 15 years. In general, there is a gender balance across all age groups in the Constituency. (SLR, 2020).

Lüderitz is a formalised urban settlement that support a largely urban population. There is a noted divide between formalised and informal households that are present in Lüderitz. The level of access to basic services for formalised households (i.e. comprised of middle to high-income households) is likely to be good, but highly variable for informal or low-income households. Households located in informal settlement have relatively reduced access to sanitation, waste collection and water. 7% of households in Lüderitz are considered below the poverty line. (SLR, 2020).

6.6.1.2 PUBLIC AND PRIVATE FACILITIES

Lüderitz are largely limited to accommodation, restaurants or take-aways, as well as recreational facilities. These services are likely primarily used by residents of Lüderitz, although there is provision for domestic and international tourism through accommodation, i.e. hotels, bed and breakfasts, etc., as well as the expanded waterfront. (SLR, 2020).

6.6.1.3 EMPLOYMENT AND OCCUPATIONS

Of the total population, 56% was employed in 2011 in the !Nami-Nus Constituency. There is a gender divide in terms of employment, i.e. 4% fewer women being economically active in the !Nami-Nus Constituency. In addition, employment rates for women is 10% lower when compared to men in the areas, with an overall lower labour participation rate for women (of 14% for Lüderitz) when compared to men. The major employers are private businesses or households, which account for 54% of all employment for Lüderitz in 2011.

As the !Nami-Nus Urban constituency support a largely urban population, employment in the commercial or subsistence agricultural sector is minimal and accounts for only around 3.5% of total employment. This shows that the resident population is near exclusively reliant on wage labour for income, which include either formal full-time private employment, government employment or self-employment. Both genders are reliant on private employment or employment by the State. Generally, fewer women are employed in these two major sectors, as 5% fewer women work in the private sector in Lüderitz, while 4% fewer women work in the public sector (SLR, 2020).

6.6.1.4 POVERTY

Poverty mapping undertaken in 2011 (National Planning Commission, n.d.) shows that the Karas Region has a 6.7% poverty rate. This compares positively against the national poverty rate of 26.9% of the total population. At the Constituency level, !Nami-Nus has a poverty rate of 7% (or 970 persons below the poverty line). While this rates favourably against the national rate, it is the second poorest performing constituency in the Karas Region. Agriculture, mining, manufacturing, construction and tourism are the main employers in the Region; however, Lüderitz is far more dependent on commercial fishing (SLR, 2020).

6.6.2 Industries

6.6.2.1 Principal Fisheries

Namibia has one of the most productive fishing grounds in the world, namely the Benguela Current System. As Africa's fourth largest capture fisheries nation behind Morocco, South Africa and Mauritania, Namibia's 200 nautical mile Exclusive Economic Zone (EEZ) supports some 20 different commercially exploited marine species. The two main commercial species (hake and horse mackerel) comprise the primary species of historical importance in Namibia. One other fishery, for sardine, collapsed in the 1970's and has never recovered. Other species of more recent importance include orange roughy, the deepwater crab trap fishery, monk, rock lobster and the large pelagic fisheries for tuna. With the exception of sardine, the majority of sectors are considered by the MFMR to be at optimal harvesting levels and under sustainable management. The allocation of Total Allowable Catches (TACs) and management of each fishing sector is the responsibility of the MFMR.

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. It sustains some 16,800 direct jobs - 70% of which are in the hake sector. Mariculture production is a developing industry based predominantly in Walvis Bay and Lüderitz Bay and surrounds.

Namibia has only two major fishing ports from which all the main commercial fishing operations are based namely, Walvis Bay and Lüderitz. The major port is Walvis Bay and it is from this port that the majority of fishing vessels operate. 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).

A comprehensive description of all the Namibian Fisheries is provided in Appendix 1 of the Marine Specialist Report (see Appendix F). The three fisheries occurring shallower than 200 m depth, included the rock lobster fishery that operates out of Lüderitz, a small linefish fishery that operates mostly out of Walvis Bay, but which has some activity reported in the Lüderitz area, and the small pelagic fishery for sardine. As these are most relevant to the project area they are described briefly below.

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.

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. 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 in January 2018 due to a significant population reduction, and extensive scientific studies are underway to ascertain the causes. This fishery is currently closed and may be reopened at the earliest during January 2021.

The industry operates from Walvis Bay, except for the period 1964-1974 when Lüderitz was also used. The small pelagic fleet consists of 36 wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 21 m to 48 m. Vessels usually operate overnight and return to offload their catch the following day.

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. Commercial fishing activity occurs primarily inshore of 200 m, northwards of 25°S to the Angolan border. The main commercial fishing grounds are situated in the northern Benguela with only the occasional sets made in the southern. The southern fishing grounds are well south of the proposed Kelp Pilot Project area.

Line-Fish

The traditional line fishery is based on snoek (*Thyrsites atun*) with bycatch of yellowtail (*Seriola lalandi*), silver kob (*Argyrosomus inodorus*), dusky kob (*A. coronus*), and shark, which are sold on the local market or exported. The fishery operates mostly northwards of Walvis Bay and within 12 nautical miles (22 km) from the shore. The two commercial components of the linefish sector comprise a fleet of between 10 and 13 ski-boats and a fleet of 26 industrial vessels. Whilst ski-boats fish close to the shore in the vicinity of Swakopmund and Walvis Bay, the industrial vessels fish offshore areas. Commercial operators sell linefish on the local market as well as exporting, largely to South Africa. The sector operates inshore of the 200 m depth contour with the closest fishing activity taking place from the port of Lüderitz. The distribution of linefish catch in in southern Namibia operating out of Lüderitz is shown in Figure 14. Although the spatial definition is not clearly known for the linefish fishery, there is likely spatial overlap with the proposed Kelp Pilot Project areas.

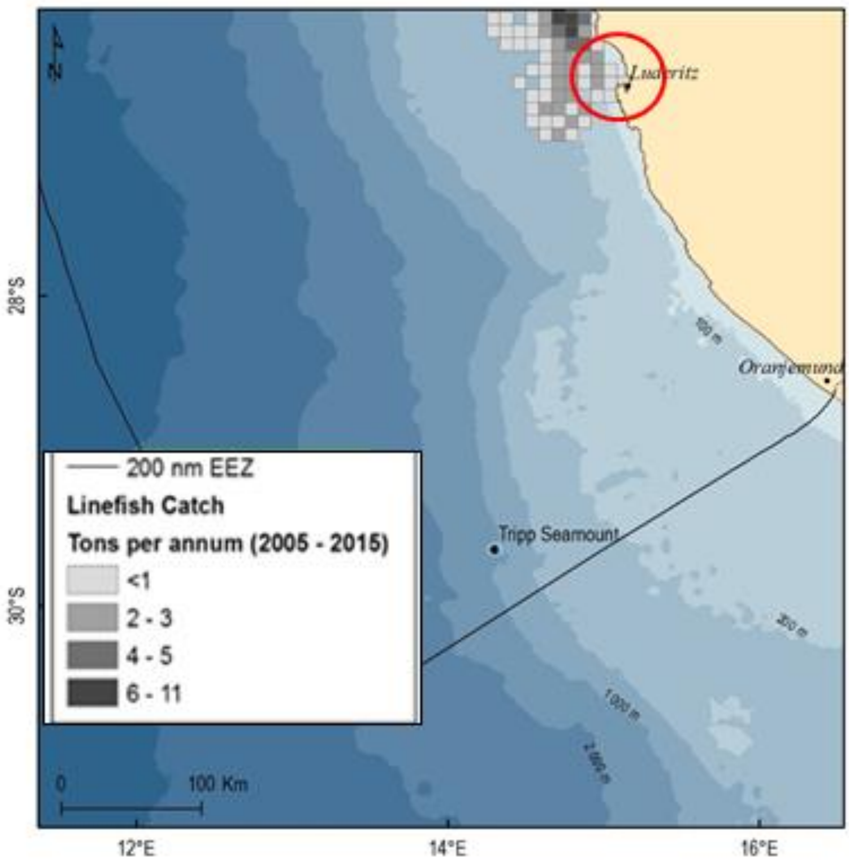

FIGURE 14: SPATIAL DISTRIBUTION OF CATCH TAKEN BY SKI-BOATS OPERATING WITHIN THE LINE-FISH SECTOR ALONG THE SOUTHERN NAMIBIAN COASTLINE

Rock Lobster

The rock lobster *Jasus lalandii* occurs from Cape Cross in Namibia to the east coast of South Africa. In Namibia, significant densities, however, only occur south of Meob Bay from 25ºS to 28º30'S in water depths shallower than 100 m. The spawning cycle of this species is strongly related to its annual moulting cycle. Males moult in spring and mating takes place after the females have moulted in late autumn and early winter. Females carry their eggs until they hatch in October and November, releasing planktonic larvae. These larvae remain in the plankton for a period of months before becoming free-swimming and settling in near-shore rocky areas. Adults generally occur further offshore than juveniles, except in central Namibia where the whole population is periodically forced close to the shore by low-oxygen conditions.

The small but valuable fishery of rock lobster is based exclusively in the port of Lüderitz. Catch is landed whole and is managed using a TAC. Historically, the fishery sustained relatively constant catches of up to 9,000 t per year until a decline in the late 1960s. Table 10 shows the commercial rock lobster TACs since Namibian independence and Figure 15 the historical catches. The TACs have not been filled in recent years with poor catch rates and generally adverse environmental conditions impacting fishing operations.

TABLE 9: TOTAL ALLOWABLE CATCHES OF ROCK LOBSTER (TONS) FROM 2009/10 TO 2018/19

Year	Rock Lobster TAC	Year	Rock Lobster TAC
2009/10	350	2014/15	300
2010/11	275	2015/16	250
2011/12	350	2016/17	240
2012/13	350	2017/18	230
2013/14	350	2018/19	200

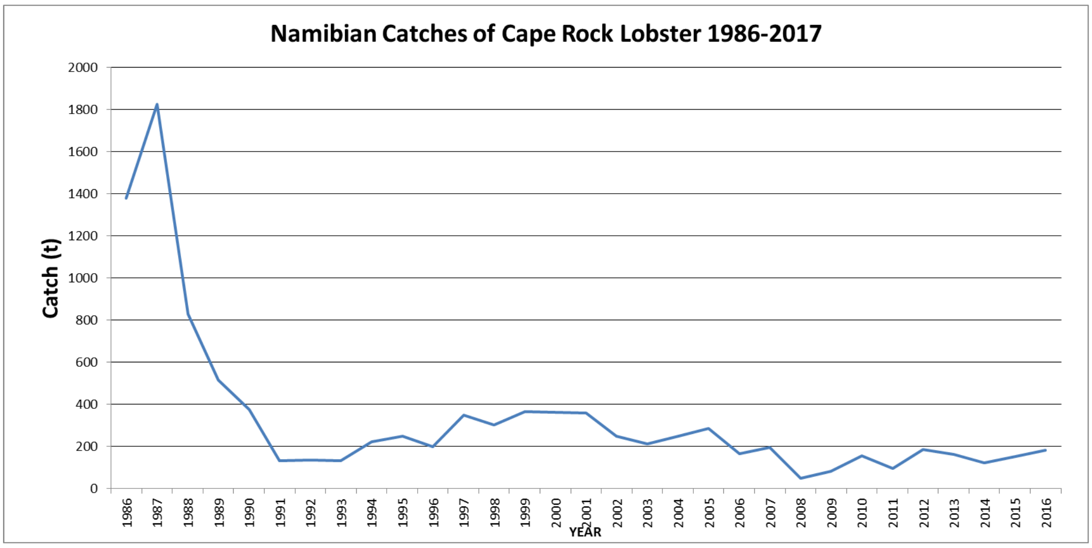

FIGURE 15: MANAGEMENT CATCHES AND TAC OF ROCK LOBSTER IN NAMIBIA FROM 1986 TO 2017

The lobster stock is commercially exploited between the Orange River borders in the south to Easter Cliffs/Sylvia Hill north of Mercury Island (approximately 25°S). The fishery is spatially managed through the demarcation of catch grounds by management area (Figure 16). The catch season is a six-month period with a closed period extending from 1 May to 31 October and highest activity levels experienced over January and February. The spatial distribution of commercial catches in the vicinity of Lüderitz and in proximity to the proposed Kelp Pilot Project areas is provided in Figure 17.

The sector operates in water depths of between 10 and 80 m. 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 (these exact numbers have not been confirmed by MFMR to date). The rock lobster fishing fleet consists of vessels that range 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. Effort is focussed in depths <30 m to the north of Lüderitz, and to a lesser extent south west of Lüderitz Bay.

With the exception of the proposed northern-eastern pilot area (see alternatives in section 7), there is no direct overlap with the lobster fishing areas. The proposed grow-out areas inside Lüderitz Bay fall into Zone 11, which is a proclaimed sanctuary stretching from north of Northwest Point to Diaz Point. These areas may have impacts associated with lobster juvenile settlement and future recruitment.

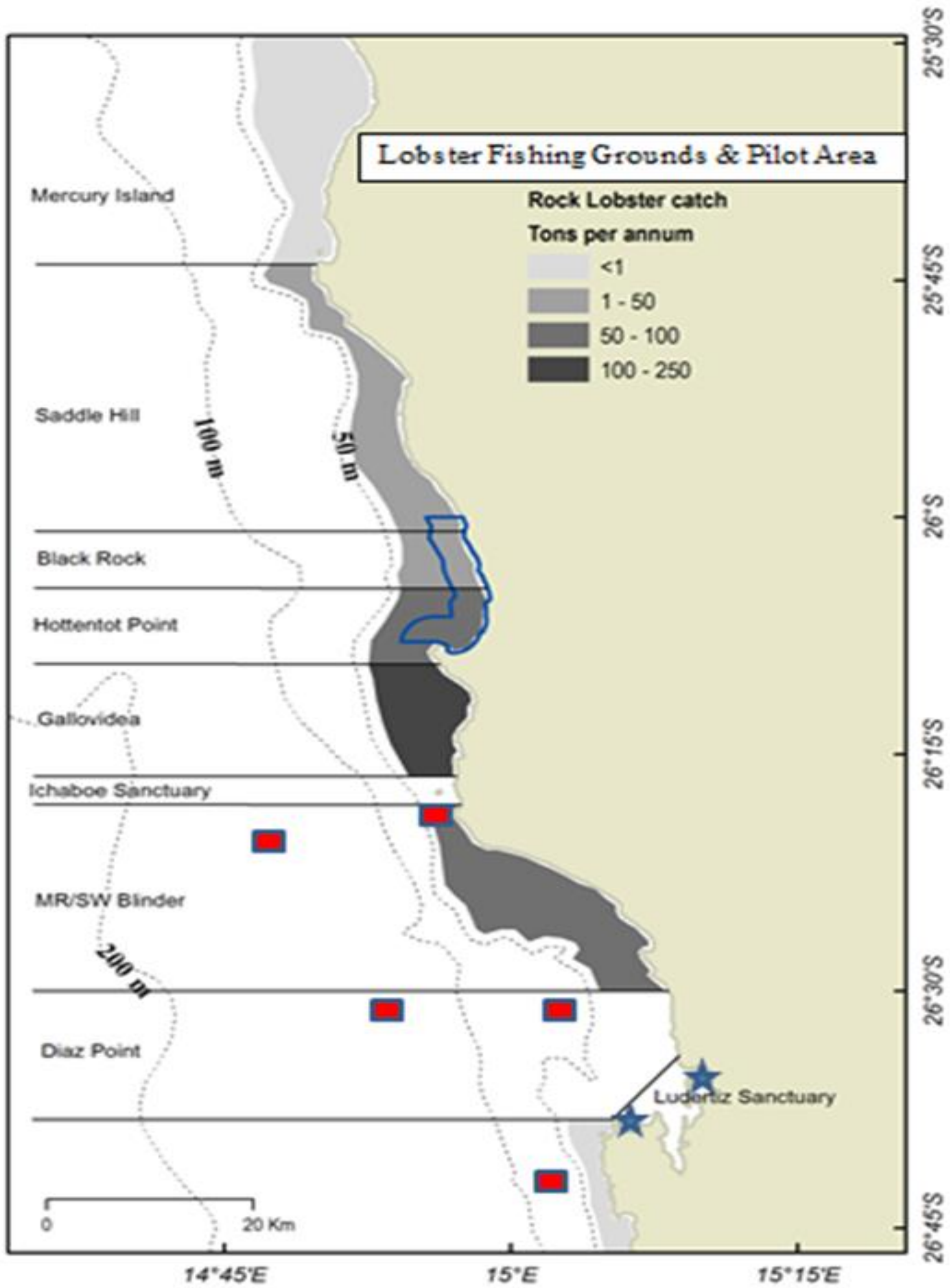

FIGURE 16: THE PROPOSED PILOT KELP AREAS (SQUARES) AND GROW-OUT AREAS (STARS) (INCLUDING THE ALTERNATIVE LOCATIONS [SEE SECTION 7]) IN RELATION TO THE SPATIAL DISTRIBUTION OF COMMERCIAL CATCHES OF ROCK LOBSTER (*JASUS LALANDII*) IN FISHING GROUNDS IN THE VICINITY OF LÜDERITZ. THE 50 M, 100 M AND 200 M ISOBATHS ARE SHOWN.

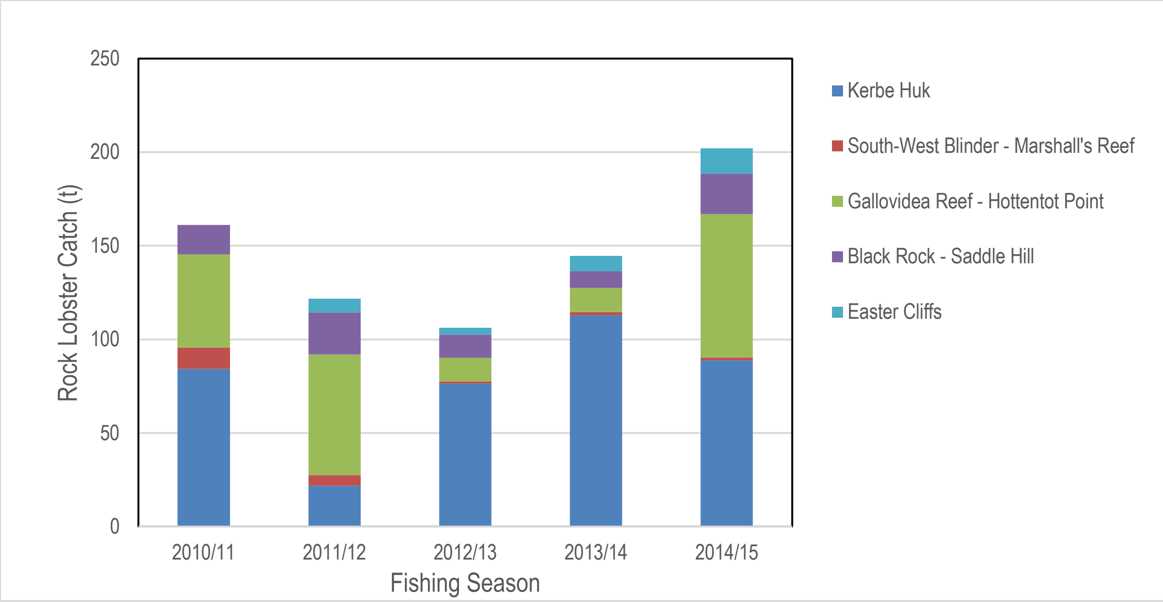

FIGURE 17: NAMIBIAN ROCK LOBSTER CATCH (TONS) BY SEASON AND FISHING GROUND

6.6.2.2 MARICULTURE ACTIVITIES

As a matter of policy, and as outlined in Vision 2030 and the Third National Development Plan, the Namibian government has been promoting the development of aquaculture and mariculture. One of the objectives of the MFMR is to have a fully established aquaculture industry (freshwater and marine aquaculture) by 2030, with deliberate efforts to promote the aquaculture industry being made through the promulgation of the Aquaculture Act, Act 18 of 2002.

There are about 67 aquaculture licence holders in Namibia at present; at least 30 are involved in mariculture. Not all have secured access to a mariculture site, and less than half are currently producing. The Namibian mariculture industry is an export industry developing foreign trade with South Africa, and European countries. Mariculture methods vary but include rafts, suspended long-lines, racks in ponds and onshore flow-through tanks. Commercial marine aquaculture is currently dominated by oyster production in Walvis Bay, Swakopmund and Lüderitz.

The cold, nutrient-rich waters around Lüderitz are ideal for mariculture operations, and following the severe mariculture losses experienced by Walvis Bay in 2008 both existing and new farmers are considering Lüderitz as a more suitable location for investment. NamPort have allocated 20 plots covering a total area 379.7 ha to mariculture. The plots are primarily located in the area between Lüderitz Harbour and Second Lagoon. The shallow subtidal zones around Seal and Penguin Islands and Tiger Reef have been set aside for abalone ranching with further plots located in North Harbour. There is an area for mussel cultivation extending eastwards from the landward side of Seal Island, with application for the longline cultivation of mussels there pending (Faul & Coetzer 2020). A total of 20 plots have been allocated by NamPort, however they currently only have 5 active leases. Numerous applications have, however, recently been submitted for the cultivation of Pacific oyster (*Crassostrea gigas*), Peruvian scallop (*Argopecten purpuratus*), and black mussels (*Mytilus galloprovincialis*).

Mariculture production comprises predominantly oysters (mainly *Crassostrea gigas*), abalone (*Haliotis midae*), rock lobster (*Jasus lalandii*) and mussels (*Mytilus galloprovincialis*). Application to culture the non-native Peruvian scallop (*Argopecten purpuratus)* has also recently been submitted.

The principal role players currently involved in mariculture operations in Lüderitz are Lüderitz Mariculture (Pty) Ltd., Lüderitz Abalone Farming (Pty) Ltd, and Lüderitz Lobster Mariculture (Ocean Grow Namibia) and Rotaq Farming (Pty) Ltd. Their operations are described briefly below.

Lüderitz Lobster Mariculture was started in April 2007 and currently hold various plots for culturing rock lobsters, mussels, oysters and abalone. Their processing facility is located within the NamPort boat yard and comprises holding and purging tanks, which are fed water pumped directly from Second Lagoon and returned to the sea without prior filtration.

Lüderitz Mariculture (Pty) Ltd. (LMC), was started in the early 1990s and grows oysters using suspended trays and anchored nets. The bulk of the company's oyster production (90%) is exported to South Africa with the balance being sold in Namibia. Future objectives are to export the bulk of the farm's production directly to the European markets. Present production is in the region of 125 metric tons annually. Although farming of fresh oysters represents the company's core export product, LMC is presently also experimenting with the farming of mussels and rock lobsters (a joint experimental project with I & J), and is intending to start with a pilot project for Peruvian scallop.

The abalone mariculture farm was started by Lüderitz Abalone Farming (Pty) Ltd in 2002 and comprises a tank production system located on the eastern shores of Robert Harbour opposite Penguin Island. The farm started with experimental trials in 2004 and by 2009 produced 11 tons of abalone ranging between 70-400 g, which was exported to the Hong Kong as fresh, frozen and canned products. The farm hoped to achieve 80 tons annually, growing to 160 tons per annum in the future. In 2016 the farm was taken over by Hangana Seafoods, with Hangana Abalone inaugurated in September 2018. The enterprise also intends ranching abalone around Penguin and Seal Islands (including Tiger Reef). Feed water for the land-based farm is drawn directly from Robert Harbour and after circulation through the tanks is discharged again into the sea following filtration. Feed for the abalone comprises formulated feed as well as beach-cast kelp collected in the Lüderitz Bay area.

Application for a further abalone ranching venture by Benguella Wealth Farming CC, at ~30 proposed sites between Hottentots Bay and Pomona Island has also recently been submitted.

The *Gracilaria* industry in Lüderitz, which once was the largest source of the agarophytic seaweed *Gracilaria verrucosa* in southern Africa, and the third largest employer in Lüderitz, is no longer operational. The industry was originally based on the collection of beach-cast seaweed between Aeroplane Bay and Flamingo Bay, although beaches near Radford Bay as well as in Shearwater Bay and the Griffith Bay area were also regular collection sites. Dry collected weight of *Gracilaria* descreased steadily from 1,000 tons in the early 1990s, to 300-600 tons between 1991 and 2001 to less than 60 tons in 2010. To supplement the erratic natural beach cast supplies, cultivation of *Gracilaria* on floating rope systems was undertaken in Second Lagoon with an annual production of 280-360 tons, all of which was exported to Japan. Following loss of the raft systems in 2004 and the loss of the Japanese company purchasing the product, the operation was no longer deemed feasible.

Other companies have, however, more recently started collecting dried kelp wrack off the beaches around Lüderitz. As the dry resource was rapidly depleted, the collectors changed to fresh beach cast kelp thereby resulting in conflict with the abalone farm, which had historically collected fresh fronds to supplement the formulated abalone feed.

The one alternative proposed location of the Giant Kelp grow-out area (see section 7) in North Harbour overlaps with mariculture Farm No. 19 held by Chemvet cc. As the area around Seal and Penguin Islands are frequented by rock lobster poachers, the location of proposed grow-out area was moved to Shearwater Bay.

6.6.2.3 PORT OF LÜDERITZ

The Port of Lüderitz became Namibia's first Port after independence. The Namibian Ports Authority (NamPort) took control of Lüderitz Bay in 1995, and is responsible for the operation of the port and its attendant functions (both marine and cargo). The area within which NamPort has jurisdiction stretches east of a line running from Angra Point to North-east Point (Figure 12, right). This includes the foreshore within the port limits, jetties, harbour works and harbour lands vested in the Government of the Republic of Namibia. The port functions as the distribution centre for southern Namibia, focusing primarily on the fishing industry, offshore diamond mining operations, the offshore oil and gas industry, and the export of zinc and manganese ore.

The Port of Lüderitz offers cargo handling and container facilities for importers and exporters. Until recently sulphur has been the main landed cargo, contributing almost half of to the total cargo tonnage landed in 2018/19; the fishing industry contributed only 19% of the annual cargo landed. Zinc and zinc concentrates contributed 76% in freight tonnage to all cargo shipped in 2018/19. Containerised cargo landed amounts to only 4,603 tons in 2018/19, whereas containerised shipped cargo amounts to 54,480 tons in the same period. The port receives on average 727 vessel visits annually. Since September 2019, manganese ore shipments from South Africa are being exported through the Port of Lüderitz. Currently 30,000 tons are being exported per month; this is being increased to 60,000 per month).

Martime Traffic and Navigation

Access into and out of the port is through a channel (shipping separation zone applies as well) as shown in highlight in Figure 18. Movements into and out of the port are strictly controlled by the port authority including larger trawlers and smaller line boats as well as the larger (>50 m) offshore diamond drilling vessels. There are also ongoing oil and gas developments offshore in southern Namibian waters.

Any Kelp Ranching undertaken offshore will require service vessels operating around designated water areas, both offshore and inside the port. Potential interaction with these operations between other users of the sea is demonstrated in Figure 18. Port access into and out of the port is primarily through the channel south of Penguin Island. Shipping movements are controlled by the Port Authority although some freedom of movement can be permitted depending on vessel licensing. Once clear of port precinct, international navigation and maritime legislation applies and there is a likelihood of interaction by the Kelp Ranching activities with maritime traffic moving both inside territorial waters and vessels accessing the port (Figure 18). This will include the regular seasonal movement of rock lobster and linefish vessels in the proposed Kelp Pilot areas offshore.

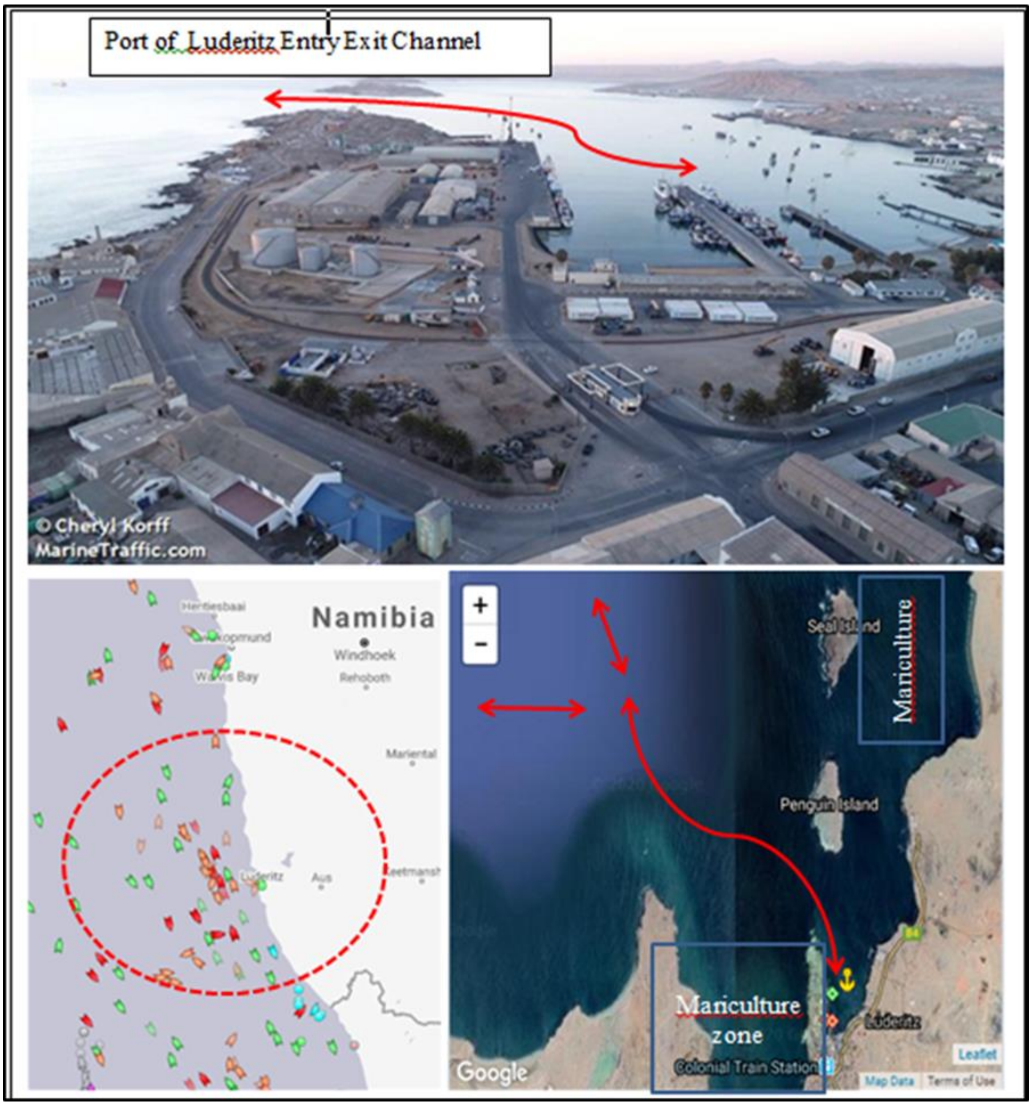

FIGURE 18: OVERVIEW OF THE PORT OF LUDERITZ AND SURROUNDS SHOWING ACCESS POINTS FOR SHIPPING INTO AND OUT OF THE PORT. A SNAPSHOT OF CURRENT VESSEL MOVEMENTS (27 JUNE 2020) IS PROVIDED SHOWING PROXIMITY OF OFFSHORE MARITIME TRAFFIC IN SOUTHERN NAMIBIA AND LUDERITZ.

6.6.2.4 Coastal and Marine Diamond Mining

The Namibian Minerals (Mining and Prospecting) Act (Act 33 of 1992) allows for various types of prospecting and mining licences, issued by the Ministry of Mines and Energy, covering both small-scale and formal activities.

The current offshore marine concessions, established by the Ministry of Mines and Energy under the new mineral legislation, extend virtually the full length of country's coastline from the Orange River to the Kunene. In southern Namibia, the onshore mining licences extend ~5 km offshore, forming a series of narrow concessions along the coast. These are interrupted by 'island concessions', surrounding Namibia's offshore islands. Further offshore, the concessions are irregularly divided into Exclusive Prospecting Licences (EPLs) and Mining Licence Areas (MLAs), in response to applications for specific areas (Figure 19). EPLs are particularly dynamic, as they are valid for three years only, and so the licence holders change regularly, often without having actively undertaken any prospecting or sampling operations in the concession before their leases expire.

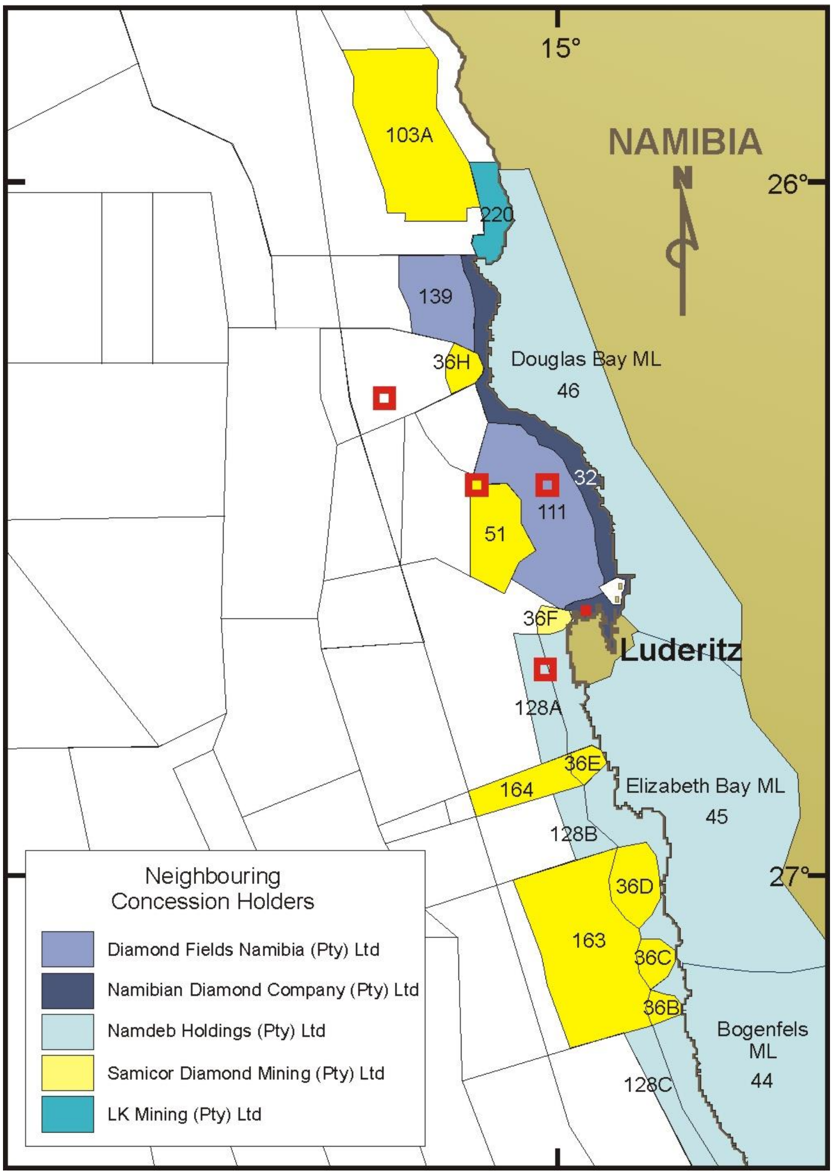

FIGURE 19: THE PROPOSED GIANT KELP PILOT CULTIVATION PLOTS (RED SQUARES) IN RELATION TO DIAMOND MINING LICENCES AND EXCLUSIVE PROSPECTING LICENCES IN THE LÜDERITZ AREA

The marine diamond mining industry is dominated by a few major companies, notably Namdeb Holdings (Pty) Ltd (which operates most of the coastal mining areas), De Beers Marine Namibia (Pty) Ltd (which operates in the Atlantic 1 ML area offshore of Oranjemund), Samicor and Diamond Fields Namibia (Pty) Ltd.

Diamond mining operations in the 10-30 m depth range involve diver-mining contractors working off small, converted fishing boats of between 10 - 15 m in length, with the duration of their activities limited to daylight hours for 3 - 10 diving days per month. Further off-shore remote mining tools (fixed-head trenching tools and airlift dredging systems, rotating drills and seabed crawlers) are used to mine unconsolidated sediments to depths of 120 m. The remote prospecting and mining vessels range from 1,000 - 6,000 gross registered tons, and may be up to 150 m in length. These ships are fully self-contained mining units, with a processing facility on board, potentially able to operate 24-hours a day for 11 months of the year. The only licence area in which mining is currently active is ML-111, where Nutam (International Mining and Dredging Holdings – IMDH) are using seabed crawler technology to mine diamonds on behalf of the concession holder, Diamond Fields Namibia. Vessel-based diver operations undertaken by contractors to Namdeb Holdings operate primarily south of Chameis Bay in ML-43 and ML-44 off southern Namibia. The proposed Plot A for the cultivation of Giant Kelp falls within ML-128A, currently held by Namdeb but with transfer to a new licence holder pending, while the two alternatives for Plot B fall within ML-51 and ML-111 held by Samicor and Diamond Fields Namibia, respecctively. Plot C falls within EPL-8011, for which an application by Sand City Trading Enterprises Seventy Nine CC is pending (MME 2020). The grow-out area in Shearwater Bay falls within ML-32 held by Namibian Diamond Corporation. This concession was last worked about 5 years ago.

6.6.2.5 Other Industries

Following the growing interest in the early 2010s in the exploration of Namibian offshore phosphate resources, a two-year moratorium on marine phosphate mining in Namibia was placed in September 2013. Continued environmental resistance against phosphate mining has resulted in the moratorium never being officially lifted. Nonetheless, interest by foreign companies to develop the Namibian marine phosphate industry has continued, and with the current economic situation renewed pressure is being placed on the Namibian government to grant permission for phosphate mining to go ahead. As part of the proposed mining of marine phosphates in ML-159 off Lüderitz, it was intended to construct a phosphate plant in Lüderitz. The plant was to form part of the proposed development of a new deepwater port at Angra Point. The Strategic Environmental Assessment for the proposed harbour expansion planned to commence in late 2019 has since been put on hold.

Two Exclusive Prospecting Licences (EPLs) have been demarcated on the Lüderitz Peninsula:

- EPL-5306 Mvela Investments: eastern side of Lüderitz Peninsula.
- EPL-5914 (open): western side of Lüderitz Peninsula.

EPL-5306 is currently held by Mvela Investments, a Namibian Small and Medium Enterprise (SME) supplying fertilizers for food production in Namibia to both the private and public sectors.

6.6.3 MARINE RECREATIONAL ACTIVITIES AND COASTAL TOURISM

As most of the area surrounding Lüderitz forms part of the restricted diamond area and the Tsau//Khaeb-Sperrgebiet National Park, land-based recreational activities along this stretch of coast are limited to the Lüderitz Peninsula and to Agate Beach to the north-east of the town. Vessel-based recreational and tourism-related activities include motorised catamaran sight-seeing cruises that visit points of interest in the Bay and at Halifax Island. Fishing trips that target snoek and other linefish are also occasionally offered. Picnic sites and basic braai facilities are found in some of the bays on the Peninsula and along Agate Beach.

Recreational fishing activities require a recreational fishing permits. Activities are similarly limited to rock lobsters in rocky gullies and small bays on the Peninsula caught by snorkelling, or by shore-based or dinghy-based use of hoop nets during the open season (November to April), rock and surf angling. Limited numbers of mussels and limpets may also be collected for personal consumption, subject to being in possession of a valid recreational fishing permit. An annual snoek derby is held in (May), and the Crayfish Festival, usually hosted for several days towards the end of April, has become an event that draws visitors from all corners of Namibia and beyond. (Pisces, 2020).

6.7 CURRENT POLLUTION STATUS OF LÜDERITZ BAY

The information presented in this Section has been sourced from the Marine Specialist Study (Pisces, 2020) (Appendix F).

Marine pollution is generally not an issue in Namibia due to the vastness of uninhabited coastal areas, the absence of coastal agricultural land and the relative low intensity of industrial activities concentrated in few urban centres, particularly in the two harbour towns of Walvis Bay and Lüderitz. In the vicinity of the urban centres both water- and sediment quality is generally poor, as these are located in sheltered bays where flushing rates are reduced. With the proposed expansion of the Port of Lüderitz, the risks of increased pollution in the marine environment from these sources are expected to increase.

Lüderitz Bay receives effluents and contaminants from a number of sources. These range from sewage and industrial pipelines, uncontrolled waste water disposal by the fishing industry, localised organic build-up associated with mariculture activities, through point and diffuse stormwater outfalls, spillages and discharges from shipping in and outside of Robert Harbour, ship repair activities in the port, and atmospheric releases. Anchored vessels and harbour operations also generate localised shore litter. Due to circulation and water exchanges the effect of these on the water bodies in the larger Lüderitz Bay and Robert Harbour will differ. In the mid-2000s there were no municipal or industrial management initiatives and monitoring programmes in place specifically aimed at managing and controlling marine pollution in the Lüderitz area. Consequently, the nature and volumes of untreated effluent that reach the marine environment remains largely unknown, as do the risks posed by these uncontrolled discharges to important marine ecosystems and the health of local inhabitants. At the time of that study there was no law enforcement in place and a lack of the “polluter pays” principle in terms of marine and land-source pollution, particularly outside port limits. There is poor control over re-fueling of anchored vessels and no effective service for collection of rubbish from the foreign midwater fleets anchored outside the Port.

The point source outfalls in Lüderitz Bay are illustrated in Figure 12. Recent issues with high bacterial levels of *Escherichia coli* along the eastern shore of Robert Harbour from the small concrete jetty at the first of the fish processing plants to Agate Beach have been reported. If this issue is not effectively managed by the town council, this could have future implications on the quality of the water abstracted by the various industries along the eastern shores of Robert Harbour.

Namport typically takes water samples at three selected sites prior to, during and after maintenance dredging in the turning circle and west of the channel. Samples taken in 2006 showed that the concentrations of metals in the water in general were low or below the detection limit of the laboratory. No data on trace metal concentrations in sediments for Lüderitz Bay as a whole, could be traced but due to the low level of industrialisation it is safe to assume that there is no significant build up of trace metals in the Bay’s sediments.

Studies investigating trace metal concentrations in sediment samples collected in Robert Harbour have identified that a substantial proportion of the sediments contained trace metal concentrations (particularly Nickel, Cadmium and Mercury) considered to be potentially deleterious to ecosystem health.

The low current velocities in sub-surface flows and correspondingly long flushing periods, suggest that Lüderitz Bay is likely to be vulnerable to organic enrichment. Surficial sediments of core samples taken from within Robert Harbour were found to have a high organic content, attaining a mean maximum of 22.6%.

As the town of Lüderitz has a double oxidation pond system to treat its sewage, no sewage is discharged directly into the bay. However, there are some localities in the town where sewage overflow occasionally occurs resulting in seepage into the sea. The other potential source of sewage is discharge from vessels in the port or anchored in the bay. Due to port regulations this is considered to be a minor contributor of sewage.

The fish factories on the eastern shore of the harbour draw process water from the bay and also discharge effluent into it. The volumes and quality of effluents being discharged by these fish factories were reportedly not controlled or monitored and contain fish scales, oil, blood and offal. Although in 2006 not all factories were connected to the sewage system, plans were underway by the municipality to ensure that all factories would be connected in future thereby reducing uncontrolled discharged with high organic loads into the bay.

Bacterial decomposition of organic matter leads to the development of anoxic conditions near the seabed or in the sediments. Under anoxic conditions, hydrogen sulphide (H_2S) is formed in the seabed by anaerobic bacteria through ongoing anaerobic decomposition processes. Sediments with high H_2S concentrations are characteristically black, foul smelling and toxic to the environment when disturbed. Oxidation of the H_2S released from the sediments strips the dissolved oxygen from the surrounding water column, rapidly creating oxygen-depleted water masses in previous oxygenated areas, and potentially resulting in mass mortalities of marine life. Fish processing wastes in particular, have a high biological oxygen demand (BOD) and can contribute to the degradation of water quality, particularly along the eastern shores of Robert Harbour. Localised areas of organic enrichment also commonly occur below mariculture operations such as mussel rafts or oyster farms, particularly in areas of reduced flushing rates or where sediments are dominated by a high mud fraction.

Harbours and mariculture development zones are a typical place for the introduction of alien species. Ships calling at the port may transport organisms on their hulls or in their ballast waters, which can be released at the port. The introduction of non-native kelp can also via aquaculture as the larvae of exotic species can be introduced through the import of mussel and oyster spat. The structures and materials of suspended cultivations approaches in particular provide ideal habitats that allow fouling organisms to proliferate at high densities. Mariculture farms can therefore act as a 'reservoir' for the further spread of marine pests. Other than the invasive mussels *Mytilus galloprovincialis* and *Semimytilus algosus* and the barnacle *Balanus glandula*, which occur on more exposed rocky shores in the bay, the occurrence of other introduced species in Lüderitz Bay is unknown.

7 ALTERNATIVES

7.1 ALTERNATIVE GROW- OUT AND PILOT AREA LOCATIONS

With reference to section 5.2.2, the initial grow-out area will be ±20 hectares in size, in Shearwater Bay (see red area in Figure 20).

An alternative grow-out area (yellow area Figure 20) was originally considered by Kelp Blue, which is located in semi-sheltered waters behind Seal Island in the northern bay of Lüderitz. This option was regarded to be less favourable, due to the following reasons:

- The area overlaps with mariculture Farm No. 19 held by another company.
- With reference to section 6.6.2.2, abalone ranching is undertake in very close proximity to the proposed kelp Harvesting area. The proposed grow out area is very close the abalone farming areas and that poaching of abalone could become an issue.
- Rock lobster poachers have been reported around Seal and Penguin Islands, which might also pose a risk to Kelp grow out activities.

Locating the grow-out area in Shearwater Bay would avoid / limit the above mentioned risks, taking further management and mitigation measures provided in the EMP (Section 10) into consideration.

Kelp Blue originally planned one of the Pilot Areas (i.e. area B, yellow outline in Figure 20) in 50 m water depth, to the southwest of Ichaboe Island. This location falls within the Ichaboe Island Rock-Lobster Sanctuaries and overlaps with the lobster fishing areas (see sections 6.4.1 and 6.6.2.1). Ichaboe Island (amongst others) is further listed as a global IBAs as it regularly support significant numbers of seabirds or waterbirds. Seabirds are also prone to marine oil pollution, particularly flightless African Penguins, and any possible spills from the Pilot Project vessels near Ichaboe Island will cause a risk to these seabirds. Furthermore, there are a few known shipwrecks in the vicinity of Icahboe Island.

Two alternative locations to Option B are being proposed, i.e. B1 and B2 (see Figure 20). Both these locations are considered feasible, however, the preferred option is B2, i.e. the option closer to shore. The reasons being the following:

- The offshore location (B1) is more exposed to international traffic, i.e. traffic that is likely to have less local knowledge on infrastructure in the water. There is a lot of movement up and down the coast in territorial waters, therefore the risk of any obstruction in the water being hit is high, without proposer planning and suitable management and mitigation measures implemented.

- The inside location (B2) is closer to the port control area, can be more easily demarcated, and more easily controlled by the port.
- Local traffic will be mostly vessels familiar with the area closer to shore and more responsive to port regulations and demarcation, similar what already exists with the mariculture installations. The infrastructure can likely also be more easily maintained when located closer to shore.

The seabed at the location closer to shore (B2) might however be less sandy than the offshore location (B1), which would make this less preferable. A geophysical survey of the seabed needs to be conducted to confirm the conditions (refer to the EMP in section 10).

Furthermore, Kelp Blue should consider moving Pilot Plot A further west to avoid interaction with the traffic route heading south (refer to section 9.3.1 and Figure 22).

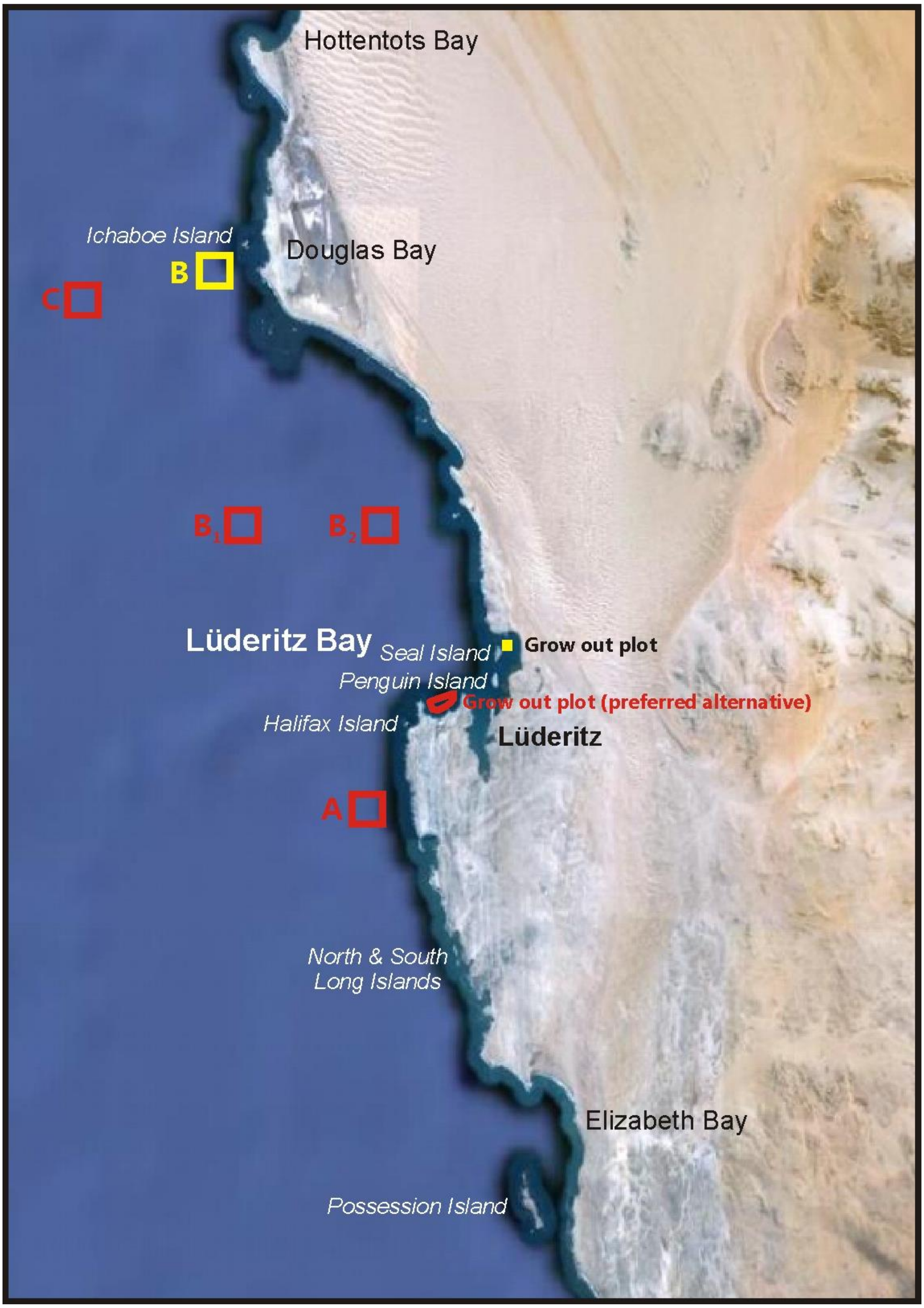

FIGURE 20: ALTERNATIVE KELP GROW-OUT AND PILOT AREAS (RED OUTLINES ARE THE PREFERRED LOCATIONS: YELLOW OUTLINES WERE ORIGINALLY PROPOSED BY KELP BLUE)

7.2 PILOT ARRAY DESIGN OPTIONS

Kelp cultivation requires arrays of artificial substrate in the sea, on which the kelp plants attach and grow. This is typically an array of stiff structures, ropes and buoys.

With reference to section 5.2.2, various styles of cultivation arrays might be tested during the pilot phase to test different configurations and materials. Kelp Blue already considered various design options and included these in computer simulations. Design options being considered by Kelp Blue are presented in Figure 20 and include the following:

A. The preferred option of a buoyant bed frame on tension-leg concrete anchor blocks,

B. submerged weathervaning raft, and

C. conventional hammock design with catenary stockloss anchors.

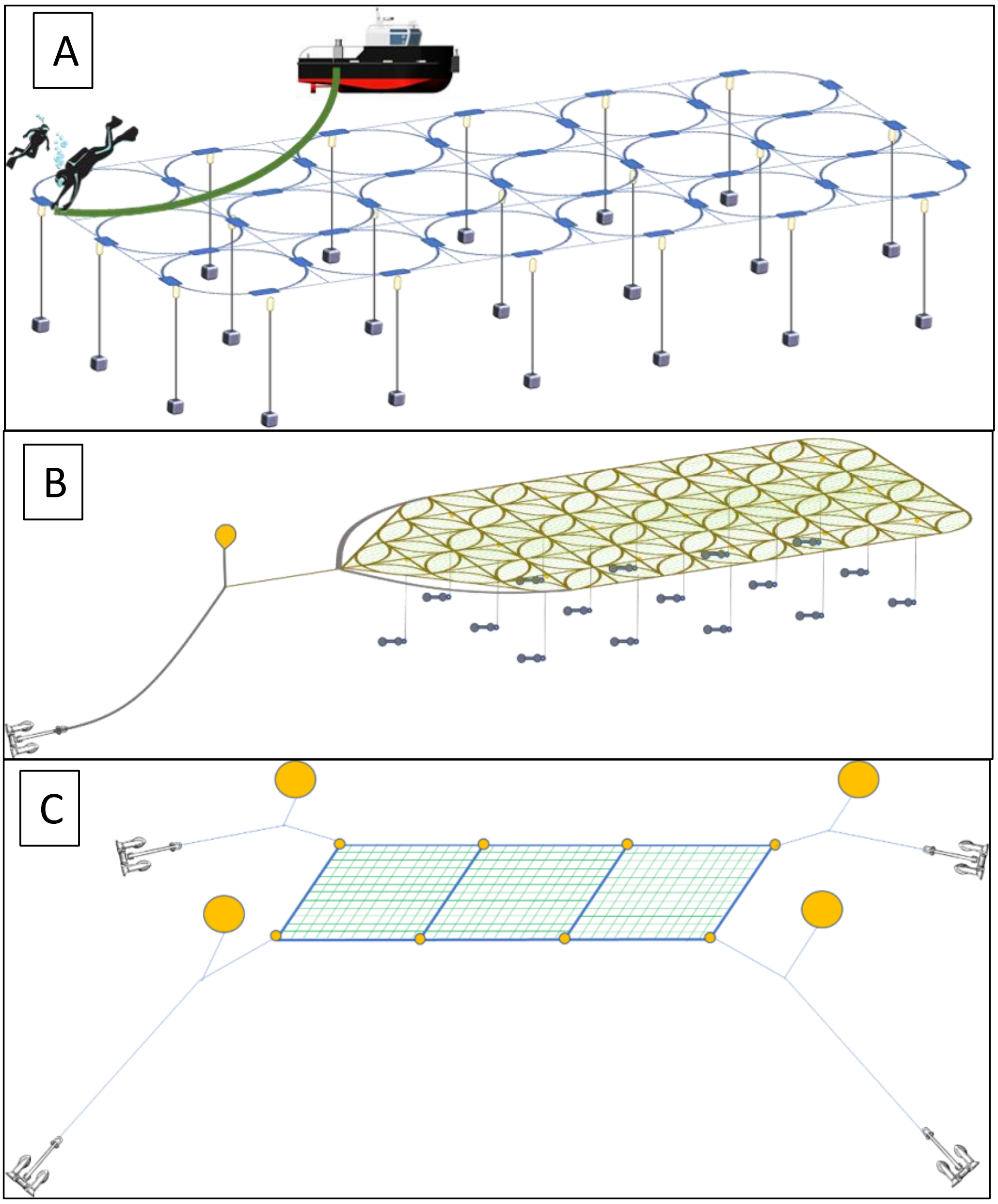

FIGURE 21: ALTERNATIVE CULTIVATION ARRAYS CONSIDERED FOR THE OFFSHORE PILOT PLOTS ARE

One of the key aspect to consider in the final design relates to the entanglement of marine mammals, turtles and sea birds. These potential impacts are further discussed in section 8 and 9.

Materials being considered for the arrays include:

- Rebar steel, pipe steel, studlink chain
- HDPE pipe to provide lateral stiffness (50-200 mm diameter)
- Concrete blocks (with embedded lobster/octopus pots)

- Stockless and other type anchors
- Jute and sisal ropes (6-180 mm)
- Dynema rope (14-120 mm)
- Nylon twine for seeding (1.5-5 mm)
- Bamboo (40-160 mm diameter)
- Marine steel constructed flotation elements including anchor-array bridge harness
- Flotation buoys (extruded recycled plastic HDPE or equivalent)
- Navigational and meteorological buoys (marine steel or HDPE body)

Anoher alternative design being considered by Kelp Blue include more flexible frame materials (HDPE or stiff ropes), which produces a series of dome-shapes which may respond (even) better to wave-forces with less stresses. The design is essentially the same as Option A (Figure 20) but with different material choices.

7.3 HARVESTING OF *MACROCYSTIS* VS *ECKLONIA* OR *LAMINARIA*

The information presented in this Section has been sourced from the Marine Specialist Study[7] (Pisces, 2020) (Appendix F).

The other two west coast kelps are smaller than *Macrocystis* and neither grows to more than ca. 5 m in total length in Namibia.In South Africa, *Ecklonia maxima* rarely grows to 17 m in length (pers. obs.), but then most of the plant length consists of the single, long, rather thin stipe.

The benefit of *Macrocystis* over the other two is in the ability of the whole plant to carry out photosynthetic production, as there are fronds along the whole length of the stipes. The other two species have large fronds at the end of long, single stipes. When the entire frond is cut off a *Laminaria* or *Ecklonia* plant, as in harvesting for abalone feed in South Africa the plant dies, and the stipe and holdfast will eventually rot. When the upper layer of a *Macrocystis* forest (near the surface) is cut off, the lower part of the uprights continues to photosynthesize, and other uprights from the same plant grow up to replace them in the surface canopy. A *Macrocystis* forest (or feasibly a *Macrocystis* raft culture system) can thus be repeatedly harvested, somewhat equivalent to mowing a growing lawn. This is done when natural populations are harvested and

[7] Various references were made in the Marine Specialist Report, which will not be repeated in this report. For the detailed list of references refer to sections 5 and 8 of the Marine Specialist Report (Appendix F).

is not possible with the other two species without selectively cutting off parts of individual fronds leaving some of the frond to regrow, which is extremely labour-intensive.

Kelp aquaculture generally provides only one crop per year (e.g. the sugar kelp), whereas it is potentially feasible to harvest more than once per year from a forest (or raft system) of *Macrocystis*, with plants surviving for a number of years.

It is important to clearly separate the idea of re-harvesting a kelp plant from re-harvesting a kelp forest. A natural *Ecklonia* canopy in a local kelp forest takes around 2.5 years to be replaced when it has been harvested by cutting off the entire tops of the plants, as is mostly done when harvesting for abalone feed in South Africa. This is because the plants that are cut will die and will not grow new fronds. They thus need to be replaced at the surface by new plants. In South Africa, even though the canopy cover is replaced by new plants in about 2.5 years, it takes up to 4.5 years for the other organisms which are attached to kelps in a healthy kelp forest to grow back. It is, thus, not advisable to harvest the same area of natural kelp forest more often than every 4.5 years or so (there is also evidence from Norway on harvesting a *Laminaria* forest, which makes a similar finding. The same plants can be re-harvested if only the upper portions of fronds are cut. This is done to a small extent in harvesting *Ecklonia* for abalone feed in South Africa. It is extremely labour intensive and cannot be done mechanically on a large scale. It is done in a minority of cases, for abalone feed, as the farmers are only interested in the fronds, not the stipes. They are allowed to harvest 10% per annum of the kelp forest biomass in a particular ‘Concession Area’ in South Africa. Harvesting only fronds means that all their harvest can be used as feed. *Laminaria* was once harvested in Lüderitz for a cosmetic product, by cutting only the distal part of the fronds (furthest away from the holdfast), which then grow back. This was again very labour intensive and was only possible for a high-value final product.

There is a history in Lüderitz of commercial aquaculture of the red seaweed *Gracilaria* in the lagoon. For a number of years, this was the only successful commercial *Gracilaria* aquaculture in Sub-Saharan Africa but was discontinued over a decade ago. *Gracilaria* grows very differently from kelps. In sheltered lagoons (Lüderitz and Langebaan/Saldanha in South Africa) it grows loosely trapped in sand and sediment, without producing spores. This makes for easy aquaculture, as a handful can be attached to a rope raft and in a few weeks it will grow into a large mass of seaweed. If you take a piece of kelp of any of the three species mentioned and tie it to a rope in the sea, it may survive for a while, but will not grow (unless it is an entire plant). The exception to this, as mentioned, is the holdfast of some forms of *Macrocystis* (such as the ‘angustifolia’ form in South Africa and the ‘integrifolia’form in Chile.

Most forest-forming kelps are perennial (individual plants surviving for a number of years) although there are populations of *Macrocystis* in Chile which have been reported to be annual (growing newly from spores each year).

7.4 THE "NO-GO" OPTION

The assessment of this option requires a comparison between the alternative of proceeding with the proposed Giant Kelp Pilot Project, with that of not proceeding with the proposed project.

With reference to sections 2.2 and 2.3, Kelp Blue propose a feasible, commercial scale project for the cultivation of Giant Kelp, with a number other key considerations and potentially positive aspects, including the fact that Kelp draws down CO_2; it is a keystone species for marine biodiversity; Giant Kelp can be harvested repeatedly, relatively frequently; etc. Other potential positive socio-economic impacts include job creation, investment, research & academia, etc.

Without the implementation of the Pilot Project, the required testing will not be achieved to confirm the proposed infrastructure design options and associated cultivation activities and compatibility with the marine ecosystems. It will also not allow Kelp Blue to validate assumptions for growth rates, harvestability of the Giant Kelp, sustainability and costs, as well as monitor environmental effects.

Should the proposed Kelp Pilot project, however, not proceed, the situation would remain as is and the potential negative environmental impacts associated with the project as addressed in Sections 8 and 9 would not occur.

8 IDENTIFICATION AND DESCRIPTION OF POTENTIAL ENVIRONMENTAL IMPACTS

8.1 ASPECT AND IMPACT IDENTIFICATION

Table 10 provides a summary of all the construction and operational activities/facilities; the environmental aspects and the potential impacts associated with the proposed Kelp Pilot Project.

The decommissioning objectives and requirements of the proposed Pilot Project facilities will be in line with the specifications laid out in the EMP.

The relevance of the potential impacts ("screening") are also presented in the tables below to determine which aspects need to be assessed in further detail (Section 8 of this report).

TABLE 10: ENVIRONMENTAL ASPECTS AND POTENTIAL IMPACTS ASSOCIATED WITH THE PROPOSED PILOT PROJECT ACTIVITIES

ACTIVITY / INFRASTRUCTURE	ENVIRONMENTAL ASPECTS & POTENTIAL IMPACTS	RELEVANCE (SCREENING) OF POTENTIAL IMPACT
Construction / set up: • Set up of the laboratory • Assembly of the pilot array structure on land	• Use of machinery, vehicles, equipment, etc. that can spill hydrocarbons causing pollution on land.	Limited machinery & equipment will be used during the laboratory establishment and assembly stage. Kelp Blue does not intend to construct a laboratory but to equip an existing building in Lüderitz. The chance for significant hydrocarbon spillages is unlikely. The related management and mitigation measures are stipulated in the EMP (refer to sections 10). No further Assessment is required.
	• Noise from machinery and equipment causing disturbance to third parties.	Limited machinery & equipment will be used during the assembly stage. The exact location for the assembly still needs to be determined and relevant third parties cannot be identified at this stage. The construction phase will be of relatively short duration and management and mitigation measures as stipulated in the EMP would further assist in avoiding / minimizing noise impacts. No further Assessment is required.
	General activities, offices and buildings, domestic waste generation: • Emissions to land, impact on biodiversity, environmental degradation and nuisance impacts.	Limited volumes of waste is expected from the "construction activities". Waste will be separated at source and stored in a manner that there can be no discharge of contamination to the environment. Some waste types will be recycled or reused where possible. Where recycling/re-using is not possible, non-hazardous, non-recyclable waste will be disposed of at the Lüderitz landfill facility. No hazardous waste is expected. No process waste is expected, i.e. no stream of waste products/materials inherent to the process. The related management and mitigation measures are stipulated in the EMP (refer to section 10). No further Assessment is required.

Construction / set up: • Transporting the infrastructure off-shore to the grow out area and pilot locations • Anchoring of the pilot arrays at sea • Development of the grow out area and pilot arrays • Use of marine vessels	Potential heritage impact: Destruction of shipwrecks.	With reference to section 6.5, there are a number of known shipwrecks in the vicinity of Icahboe Island, which could be affected by the anchoring of the arrays. Archaeological and historical remains on the seabed would be vulnerable to disturbance or destruction in the course of construction of the pilot arrays anchoring. The potential impacts on the heritage (i.e. shipwrecks) have been qualitatively assessed in section 9.
	• Disturbance of benthic habitats and associated communities during installation and anchoring of the arrays. • Disturbance of marine mammals and seabirds during installation of the arrays. • Noise and pollution effects (Marine ecology) from machinery required during array installation. • Marine mammal entanglement risks in ropes and buoys.	A number of potential impacts on the marine environment, associated with the development of the Kelp grow-out and pilot areas (and associated activities), were identified (also by various I&APs during the Key stakeholder meetings and Focus Group meetings. The potential impacts on the Marine Environment have been assessed in more detail in section 9.
• Collection of fertile sporophylls from various international locations	• Biosecurity risks of introducing non-native kelp. • Biosecurity risks of introducing associated diseases, parasites and biofouling pests to the Benguela.	The potential impact of introducing non-native kelp was one of the key issues raised by the Environmental Team as well as at most of the Key Stakeholder meetings and Focus Group meetings. Furthermore, the risks of introducing associated diseases, parasites and biofouling pests to the Benguela ecosystem was raised by various stakeholders. These potential impacts have been assessed in more detail in section 9.

• Hatchery activities	• Seawater abstraction and discharges from the land-based hatchery.	
• Giant Kelp Grow out • Kelp growth / cultivation at pilot areas	• Marine mammal and turtle entanglement risks in ropes and buoys. • Seabird entanglement in disintegrating rope strands / twine. • Habitat creation and/or exclusion and physical presence of floating structures in the pelagic realm. • Effects on seawater nutrient chemistry and clarity. • Alteration of plankton community structure around arrays. • Biodeposition of detritus below the arrays and associated changes to physico-chemical and biological properties of the sediments. • Noise and pollution effects from machinery required during array maintenance.	A number of potential impacts on the marine environment, associated with the Kelp grow / cultivation activities and the use of marine vessels, were identified (also by various I&APs during the Key stakeholder meetings and Focus Group meetings. The potential impacts on the Marine Environment have been assessed in more detail in section 9.

	• Disturbance of seabirds during operations, including during array maintenance. • Biological impacts on fisheries and mariculture stocks and recruitment. • Fishery operational impacts including navigation (rock lobster and line fisheries).	
• Kelp Harvesting • Use of marine vessels	• Noise and pollution effects from machinery required during kelp harvesting. • Hazard to marine traffic and conflict with other users (e.g. fisheries and diamond mining). • Fishery operational impacts including navigation (rock lobster and line fisheries). • Disturbance of seabirds.	A number of potential impacts on the marine environment, associated with the Kelp Harvesting activities and the use of marine vessels, were identified (also by various I&APs during the Key stakeholder meetings and Focus Group meetings. The potential impacts on the Marine Environment have been assessed in more detail in section 9.
• Unplanned events	• Storm damage and/or loss of arrays. • Pollution and accidental spills.	The potential impacts associated with unplanned events were further assessed. Refer to Section 9.

Kelp processing on land	Noise from kelp processing activities. Increase in disturbing noise levels (nuisance) to third parties.	The activities associated with the kelp processing on land is not expected to create significant noise or dust. The exact location for the assembly still needs to be determined and relevant third partiers cannot be identified at this stage. Management and mitigation measures as stipulated in the EMP would further assist in avoiding / minimizing noise impacts. No further Assessment is required.
	Dust and odors from kelp processing (drying and milling) activities. Nuisance impact to third parties.	
	General operational activities / employees generating domestic waste. • Emissions to land, impact on biodiversity, environmental degradation and nuisance impacts.	Limited volumes of waste is expected from the processing activities. Waste will be separated at source and stored in a manner that there can be no discharge of contamination to the environment. Some waste types will be recycled or reused where possible. Where recycling/re-using is not possible, non-hazardous, non-recyclable waste will be disposed of at the Lüderitz landfill facility. No hazardous waste is expected. The related management and mitigation measures are stipulated in the EMP (refer to section 10). No further Assessment is required.
Socio-economic: Employment	Employment of people (positive impact) • Impacts to local, regional and national economy. • Jobs creation and skills development.	With reference to section 5.5, Kelp Blue Namibia will employ approximately 60 employees during the Pilot Project phase, which will be ~20 full time employees and ~40 temporary employments (i.e. temporary contract). With the high unemployment numbers in the region (and country) this will be a positive impact. Locals will, (mainly) be employed, where possible, for all the Pilot Project activities. This will provide short term benefits to some of the locals. The related management and mitigation measures are stipulated in the EMP (refer to section 10). No further Assessment is required.

Socio-economic: Impact on other industries	• Fishery operational impacts including navigation (rock lobster and line fisheries).	A number of potential impacts on other users of the marine environment near Lüderitz, associated with the Kelp Harvesting activities and the use of marine vessels, were identified (also by various I&APs during the Key stakeholder meetings and Focus Group meetings). The potential impacts on other industries have been assessed in more detail in section 9.
	• Hazard to marine traffic and conflict with other users (e.g. fisheries and diamond mining).	

With reference to Table 10 above, the following issues were identified as requiring further assessment.

- Potential impacts on the Marine Environment, relating to the following:
  - Biosecurity risks of introducing non-native kelp;
  - Biosecurity risks of introducing associated diseases, parasites and biofouling pests to the Benguela;
  - Seawater abstraction and discharges from the land-based hatchery;
  - Disturbance of benthic habitats and associated communities;
  - Disturbance of marine mammals and seabirds;
  - Noise and pollution effects from machinery;
  - Marine mammal and turtle entanglement risks in ropes and buoys;
  - Seabird entanglement in disintegrating rope strands / twine;
  - Habitat creation and/or exclusion and physical presence of floating structures in the pelagic realm;
  - Effects on seawater nutrient chemistry and clarity;
  - Alteration of plankton community structure around arrays;
  - Biodeposition of detritus below the arrays and associated changes to physico-chemical and biological properties of the sediments;
  - Disturbance of seabirds;
  - Biological impacts on fisheries and mariculture stocks and recruitment;
- Unplanned Events, i.e. storm damage and/or loss of arrays; and pollution and accidental spills.
- Heritage impacts (i.e. shipwrecks), and
- Socio-economic impacts, including the following:
  - Interaction with Rock Lobster Fishery and Line-Fishery and potentially impacting their activities; and
  - Hazard to marine traffic and conflict with other users.

Refer to Section 9 of this report for an assessment of the above mentioned issues.

9 IMPACT ASSESSMENT

The environmental aspects that require further assessment (as identified in Section 8 of this Scoping Report) relate to various aspects regarding the Marine Environment; unplanned events; heritage issues (i.e. shipwrecks), and socio-economic issues relating to the potential impacts on other industries and marine traffic.

The activities that are summarised in this chapter are linked to the descriptions provided in Sections 5 and 8 (Table 10). This section must further be read in the context of the baseline conditions described in Section 6.

Management and mitigation measures to address the identified (potential) impacts are presented in the EMP (refer to section 10).

Both the criteria used to assess the impacts and the method of determining the significance of the impacts are outlined in Table 11, Table 12 and Table 13.

This method complies with the Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) EIA regulations. Table 11 provides the impact assessment criteria and the approach for determining impact consequence (combining nature and intensity, extent and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Table 12 and Table 13 respectively. The interpretation of the impact significance is given in Table 11. Both mitigated and unmitigated scenarios are considered for each impact.

The potential impacts are cumulatively assessed, where relevant, taking the existing environment and all other activities and facilities associated with the proposed Giant Kelp Pilot Project into consideration.

TABLE 11: 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.

TABLE 12: DETERMINING THE CONSEQUENCE

DETERMINING THE CONSEQUENCE					
INTENSITY OF IMPACT = LOW					
DURATION	VH	Moderate	Moderate	High	High
	H	Moderate	Moderate	Moderate	Moderate
	M	Low	Low	Low	Moderate
	L	Low	Low	Low	Moderate
INTENSITY OF IMPACT = MODERATE					
DURATION	VH	Moderate	High	High	High
	H	Moderate	Moderate	High	High
	M	Moderate	Moderate	Moderate	Moderate
	L	Low	Moderate	Moderate	Moderate
INTENSITY OF IMPACT = HIGH					
DURATION	VH	High	High	Very High	Very high
	H	High	High	High	Very High
	M	Moderate	Moderate	High	High
	L	Moderate	Moderate	High	High
INTENSITY OF IMPACT = VERY HIGH					
DURATION	VH	Very high	Very High	Very High	Very high
	H	High	High	Very High	Very high
	M	High	High	High	Very High
	L	Moderate	High	High	Very High
		L	M	H	VH
		EXTENT			

TABLE 13: DETERMINING THE SIGNIFICANCE

DETERMINING THE SIGNIFICANCE					
PROBABILITY	VH	Moderate	High	High	Very high
	H	Moderate	Moderate	High	Very high
	M	Low	Moderate	High	High
	L	Low	Low	Moderate	High
		L	M	H	VH
		CONSEQUENCE			

9.1 Potential Impacts on the Marine Environment

With reference to Table 10, the various activities relating to the proposed Pilot Project pose various risks (i.e. potential impacts) to the marine environment. Each of these potential impacts (i.e. "issues") are separately considered and assessed in the sections below.

The information in this section was sourced from the Marine Specialist Study[8] (Pisces, et al, 2020) included in Appendix F.

9.1.1 ISSUE: Introduction of Non-Native Kelp into the Lüderitz Area

9.1.1.1 Introduction

Invasive Potential of Macrocystis

The distinction between 'introduced' and 'invasive' is important. There are different scientific definitions, but here an introduced species (sometimes called an alien species) is considered to be one that is not native to a specific location. An invasive species is an introduced species that has a tendency to spread to a degree believed to cause damage to the environment, human economy or human health. Bringing *Macrocystis pyrifera* to Lüderitz for aquaculture might potentially introduce the species to ecosystems in Namibia, but not to the Benguela system, as it already grows in the southern Benguela in South Africa. Most marine introductions are not invasive. For example, there are almost 100 marine documented marine species introductions into South Africa, but only a few would be considered invasive with the above definition. Most species that are recorded as invasive are considered so because of damage to the environment (changing ecosystems), although these may become economically beneficial. An example of this is the Mediterranean mussel *Mytilus galloprovincialis*, which is invasive on South African rocky shores, but there is a mussel aquaculture industry based on this invasive species in Saldanha Bay.

Macrocystis grows in most oceans of the world, with major exceptions in the North Atlantic and Western Pacific (in most of the Indian Ocean, the sea is too warm). Aquaculture trials have been carried out in the past in both these major ocean regions. *Macrocystis* aquaculture trials took place, apparently successfully, in the early 1970s in Brittany, France for alginate. This was discontinued due to worries from scientists about ecological and other impacts of the potential introduction of *Macrocystis* onto the coastline. The project was terminated in

[8] Various references were made in the Marine Specialist Report, which will not be repeated in this report. For the detailed list of references refer to sections 5 and 8 of the Marine Specialist Report (Appendix F).

response to these concerns, plants in the sea were removed, and there have been no reports of escapees.

Macrocystis was brought from Mexico into China for aquaculture purposes in 1978, and again in 1982, as gametophyte cultures. Aquaculture was carried out for many years, with the kelp used for abalone feed, alginate, and human food. This recently ceased due to problems with plant fitness (possibly inbreeding depression) but may be resumed in the future.

To summarise, various attempts have been made to cultivate *Macrocystis* in Brittany, France and in China, the latter commercially for several years. There is no available evidence that *Macrocystis* has been introduced into natural ecosystems thus far in either of these regions, and no reports of *Macrocystis* being invasive.

The Japanese kelp *Undaria pinnatifida* is a major resource in East Asia (wakame in Japan), and one of the major aquaculture crops in the world. It is also an invasive kelp species, sometimes considered one of the 'world's worst' marine invaders. It has been introduced into several world regions, by the oyster industry or in ballast water of ships, but it was also grown deliberately in Brittany, France in the 1980s. It has spread into natural ecosystems throughout Europe, is still spreading, and is also established in New Zealand, Tasmania, and Argentina. It is now harvested commercially in a number of places where it was introduced. In a review of the invasions of *Undaria*, Epstein and Smale (2017) concluded: "Although not yet conclusive, *Undaria* may cause some.

<u>Can Macrocystis Grow Naturally in Namibia?</u>

The large-scale (biogeographic) distribution of seaweeds is usually considered to be controlled mostly by seawater temperature regime, correlated with maximum and minimum monthly mean seawater temperatures in a region. The inshore monthly mean temperatures are in a very narrow range in the main Benguela upwelling regions, being between 11 and 15°C throughout the year from Lüderitz to Sea Point (west coast of the Cape Peninsula, South Africa). As might be expected from this, the animal and plant species present in inshore marine rocky shore ecosystems of southern Namibia are closely similar to those in the north and central west coast of South Africa. Thus, almost all species which grow on rocky shores in Lüderitz also grow on the west coast of South Africa. *Macrocystis pyrifera* is an exception to this, with its limited distribution in the southern Benguela.

The other two main factors, which have been linked with *Macrocystis* presence or absence are nutrients and wave action. There is some link between the two, as very sheltered conditions can inhibit nutrient uptake in seaweeds. It has been shown that the rippling on the fronds of *Macrocystis* is an adaptation to increase turbulence over the frond surface, increasing uptake of nutrients in conditions with low water movement. In most marine systems, including the Benguela, major nutrients for kelp growth are negatively correlated with temperature – the lower the temperature the more nutrients (especially nitrogen, the major nutrient limiting to seaweed growth). There is some evidence that even if the temperature range is conducive for *Macrocystis* to grow and reproduce, in some global regions the kelp can be seasonally nutrient limited. This seems unlikely in the Lüderitz inshore region, where the upwelling is less seasonal than in the Southern Benguela.

As *Macrocystis* is rare in South Africa, and only grows in shallow water, it is possible that competition from the other local kelps is a negative factor, although there is no direct evidence for this. Also, in areas where there are fish which eat kelp, this may have some impact. Most herbivorous fish are in warmer waters. The strepie (*Sarpa salpa*), which does not occur in the Lüderitz area but is very abundant east of Cape Point in South Africa, had to be removed from the Two Oceans Aquarium kelp exhibit in Cape Town, as they were eating the *Macrocystis* but not the other kelps.

In South Africa, *Macrocystis* only grows in sheltered sites, either in small patches in shallow water inside *Ecklonia maxima* forests, or on the lee side of Dassen and Robben Islands. Large *Macrocystis* thrives on sub-Antarctic islands in the middle of very rough seas, but always on the lee side or in sheltered inlets. It is relevant that *Macrocystis* grows at Jacobsbaai, only 10 km from the mouth of Saldanha Bay, but has never been recorded attached in Saldanha Bay itself or in the linked, more sheltered, Langebaan Lagoon.

Inshore coastal seawater in the Lüderitz region is more turbid than in the Southern Benguela, and thus light will likely be limiting to the colonisation of deeper reefs.

In summary, the temperature and nutrient conditions are likely to be within the ranges for *Macrocystis* to thrive, but if it did spread to the nearby Namibian coast and attach, it would be likely to only survive on particularly sheltered rocky coastlines. In southwest South Africa it has only colonised a short (ca. 200 km) section of coastline, and is particularly rare, suggesting that contiguous coastlines further north are not suitable for easy colonisation.

9.1.1.2 Assessment of impact

Nature and intensity, duration of impact & geographical extent

The marine flora and fauna of intertidal and shallow subtidal rocky habitats in the cool temperate Namaqua Province are ubiquitous to the southern African West Coast. Species associated with rocky substrates around Lüderitz therefore also occur in the southern Benguela. *Macrocystis pyrifera* is an exception to this, occurring in a few patches in sheltered water along only 200 km of coastline between Cape Point and Cape Columbine in South Africa. *Macrocystis* is therefore rare in southwestern South Africa and although it has been there for many years (at least since 1942) it has not spread further north. As it already grows in the Southern Benguela, albeit geographically distant from Lüderitz, it could thus not be considered as being 'introduced' into the Benguela Ecosystem should it become established on rocky habitats around Lüderitz. Evidence of *Macrocystis* introductions for aquaculture in other parts of the world (China and France), however, indicate that it has not spread into natural ecosystems and there are no reports of it being invasive.

As it grows most abundantly in nature on relatively sheltered rocky shores, it is only likely to become established over the long term in similar ecological environments to shores where the species grows in South Africa. This could include sheltered bays such as Lüderitz or in the lee of islands. However, as the inshore waters along the Namibian coastline are naturaly turbid, it is likely that the colonisation of deeper reefs will be light limited. Should *Macrocystis* spread from the arrays into the natural ecosystem, this is likely to occur only over the medium to long term as spores do not survive to more than a few metres from the parent. Long-distance dispersal would be reliant on the distribution of rafts of dislodged floating kelp following storm damage of an established forest.

As it already exists in the Southern Benguela, the establishment of *Macrocystis* in the natural ecosystem is considered of medium intensity as the ecosystem would continue to function but in a slightly modified way. Should it occur, establishment would only be effective over the medium- to long-term. Although its dispersal from the pilot plots via rafting may be regional, where it does establish, it is likely to remain highly localised in isolated suitable sites limited by environmental factors, such as excess wave action, water turbidity and ecological interactions with native species.

Consequence

The determining consequence can thus be considered MODERATE for the unmitigated scenario and LOW to MODERATE for the mitigated scenario.

Probability

As the temperature and nutrient conditions in the proposed project area are likely to be within the ranges for *Macrocystis* to thrive, it is POSSIBLE that the species may become introduced to ecosystems in Namibia.

SIGNIFICANCE

The significance of the impact is thus rated as **MODERATE** for the unmitigated scenario and **LOW to MODERATE** for the mitigated scenario. Cumulative impacts to marine communities are not expected.

Tabulated summary of the assessed impact – Introduction of Non-Native Kelp into the Lüderitz area

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M**	**M-H**	**M**	**M**	**M**	**M**
Mitigated	**L**	**M-H**	**L**	**L-M**	**M**	**L-M**

9.1.1.3 Management and Mitigation Measures

No mitigation is possible other than the no-project alternative.

It is recommended that the potential long distance dispersal of *Macrocystis* by rafting be modelled with satellite-tracked drifters or using oil spill dispersal modelling software (e.g. MIKE 21/3). Such a dispersal study should be undertaken prior to start-up of the pilot phase and once the pilot plot locations have been finalized to gain a better understanding of where along the coast the kelp could potentially establish following dislodgement during storms given the correct environmental conditions. The outcome of such a study would also provide an indication of the most appropriate stretches of coast to monitor.

Monitoring requirements are included in the EMP (see section 10.7).

9.1.2 ISSUE: INTRODUCTION OF ASSOCIATED DISEASES, PARASITES AND PESTS

9.1.2.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

A major concern of biosecurity in all aquaculture is the potential for diseases of the crop itself. In areas of high density seaweed culture, disease outbreaks and production losses are thought to occur as a consequence of nutrients deficiency brought about by over-production. Most cooler temperate regions, outside of upwelling areas, tend to have very low nutrient levels in the water during summer, due to depletion by phytoplankton and lack of replacement from below. In such areas nutrient replenishment typically only occurs during seasonal (mainly winter) storms. Diseases are thus typically noted only after many years of cultivation, and as they are generally species-specific, they can subsequently be managed. Due to the year-round nutrient availability in the Lüderitz upwelling cell, disease outbreaks in the project area as a consequence of nutrient deficiency is highly unlikely.

A further potential impact is the possibility of large-scale aquaculture affecting the genetics of natural populations. As there is no local natural population of *Macrocystis* in Namibia, a pilot *Macrocystis* aquaculture project is therefore unlikely to affect natural seaweed populations by genetic change.

When transporting pieces of tissue taken from the sea to the laboratory, sporophylls would need to be chosen not to have obvious infestations of other organisms. Biosecurity measures would need to include some sort of surface sterilisation of sporophylls before spore release. Spores are also washed with sterile seawater before the seeding of strings, to prevent any contamination of cultures.

In seaweed laboratory culture, particular care must be taken to prevent contamination with other algae as this can damage seaweed cultures and lead to failure. Aquaculture seedstock production thus has very specific biosecurity procedures to ensure success of the operation. The production of such laboratory seedstock is thus much less likely to introduce pathogens than the transport of adults or pieces of adult tissue.

Considering the novelty of the proposed *Macrocystis* aquaculture, the establishment of diseases in the crop itself would be expected only over the medium- to long-term, and as diseases are typically species specific, the impact would remain localised to aquaculture plots in the vicinity of Lüderitz and not spread to other kelp species occurring naturally in the ecosystem. Considering the short period of the pilot phase (two years) it is unlikely that diseases will manifest or become evident over this period.

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Consequence

The determining consequence can thus be considered LOW to MODERATE.

Probability

Considering that the crop would have been generated under laboratory conditions subject to strict biosecurity procedures it is considered UNLIKELY that diseases and pathogens would be transmitted into the natural ecosystem in Namibia through the introduction of sporophyte concentrations and seeded twine.

SIGNIFICANCE

The significance of the impact is thus rated as **LOW**. Should diseases, parasites and pests be introduced, the impact would be considered NEGATIVE, although likely being species specific it would affect the aquaculture only and not the natural ecosystem. Cumulative impacts to marine communities are not expected.

Tabulated summary of the assessed impact – Introduction of Associated Diseases, Parasites and Pests

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**M-H**	**L**	**L-M**	**L**	**L**
Mitigated	**L**	**M-H**	**L**	**L-M**	**L**	**L**

9.1.2.2 MANAGEMENT AND MITIGATION MEASURES

- Ensure strict biosecurity controls are in place in all laboratory and culture facilities.
- Monitor the developing crop regularly for any sign of disease or parasites.
- Refer to the EMP in section 10.

9.1.3 ISSUE: SEAWATER ABSTRACTION AND DISCHARGE AT HATCHERY

9.1.3.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

The sporophyte concentrations and seeded twine will be held in the proposed laboratory and hatchery in Lüderitz. Seawater required in the hatchery will be pumped from the bay and undergo mechanical and UV-filtration and autoclaving (sterilisation). Although a permanent supply of seawater will not be necessary, several thousand litres of seawater will be required per month. Some dozens of liters of municipal water will also be used per day, with the addition of trace amounts of iodine, trace amounts of common minerals that mimic seawater composition.

This water would re-circulate in the facility to ensure sterility and stability of temperature and nutrient content. No chemicals other than normal cleaning agents will be added. If discharged to the sea in order to take in fresh seawater, this seawater and prepared municipal water would be compliant with national regulations on discharges into the marine environment (see section 10.6 for permit requirements).

The intake of feed-water directly from the ocean could result in loss of marine species as a result of impingement and entrainment. Impingement refers to injury or mortality of larger organisms (e.g. fish, jellyfish) that collide with and are trapped by intake screens, whereas entrainment refers to smaller organisms that slip through the screens and are taken into the plant with the feed-water. Impingement mortality is typically due to suffocation, starvation, or exhaustion due to being pinned up against the intake screens or from the physical force of the rakes used to clear screens of debris. The significance of impingement is related primarily to the location of the intake structure (which is currently unknown) and is a function of intake velocity. The reduction of the average intake velocity of the feed-water to ~0.1 - 0.15 m/s, which is comparable to background currents in the ocean, will allow mobile organisms to swim away from the intake under these flow conditions. Various engineering design options exist to reduce and change the direction of the intake water velocity, allowing fish and other mobile species to react more quickly to the velocity change and escape the intake system.

Planktonic organisms common in the Benguela region are likely to be prevalent in the surface waters of the project area. Plankton typically shows substantial temporal and spatial variations in species abundance, diversity and productivity, with most species having rapid reproductive cycles. Due to these circumstances it seems unlikely that the abstraction of seawater at the Kelp Blue laboratory and hatchery facilities will have a substantial negative effect on the ability of plankton organisms to sustain their populations. The entrainment of eggs and larvae from common invertebrate and fish species will also unlikely adversely affect the ability of these populations to reproduce successfully.

As numerous fish processing facilities and the abalone farm also abstract seawater from Robert Harbour, impingement and entrainment effects will be cumulative over time. It has been suggested that the removal of particulate matter from the water column where it is a significant food source, may affect the productivity of coastal ecosystems. The effects of this are, however, difficult to quantify. Compared to the seawater abstraction by other users in the bay, the feed-water requirements for the Kelp Blue hatchery are not substantial. The effects of this abstraction on the potential reduction in the particulate food source for the particle-feeding benthic macrofauna or flamingos in Robert and North Harbours would be difficult to quantify and is likely insignificant. The loss of marine species through impingement and entrainment is deemed of low intensity, highly localised and of short duration due to the rapid turn-over of plankton populations ensuring that any effects are quickly reversible.

Consequence

The determining consequence can thus be considered LOW.

Probability

Although impingement and entrainment are most likely, the probability of it affecting plankton communities in the bay is low.

SIGNIFICANCE

The significance of the impact is thus rated as **LOW**. Despite the installation of screens and adjustment of intake velocities, entrainment of particulate matter is unavoidable and no further direct mitigation is deemed feasible.

Depending on the location of the hatchery, the greater concern to Kelp Blue should be the feed water quality as there have been recent reports of high bacterial levels in the seawater on the eastern shores of Robert Harbour. Every care should thus be taken in selecting a suitable site for the development of the laboratory and hatchery facilities, and ensuring that feed water is properly treated before use in the hatchery.

Cumulative impacts to marine communities are expected over the medium- to long-term.

Tabulated summary of the assessed impact – Seawater Abstraction and Discharge at Hatchery

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**L**	**L**	**L**	**L**	**L**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

9.1.3.2 MANAGEMENT AND MITIGATION MEASURES

- Ensure installation of screens on the end of the intake pipe, or the use of a screen box or shroud.
- Adjust peak intake velocities to <0.15 m/s.

- Abstracted seawater must be treated as outlined in Annexure H of the Regulations relating to the Import and Export of Aquatic Organisms and Aquaculture Products (2010).
- Effluents released from the hatchery facility must comply with the discharge permit conditions issued by MAWL and requirements requirements outlined in Annexure H of the Regulations relating to the Import and Export of Aquatic Organisms and Aquaculture Products (2010).
- As an alternative, the seawater and municipal water effluents could be blended to reduce salinity and discharged into the town sewage system.
- Refer to the EMP in section 10.

9.1.4 ISSUE: DISTURBANCE AND/OR LOSS OF BENTHIC MACROFAUNA

9.1.4.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

Installation of the arrays will involve the setting of a large number of anchors in up to 80 m water depth. Each anchor comprises a concrete block up to 2.5 x 2.5 x 2.5 m with a rebar skeleton and an octopus/lobster pot embedded, for affixing the chain. Screw anchors are also being considered and while these would have a smaller environmental footprint, they would not provide the alternative substrates for colonizing by benthic fauna. Based on the array design provided by Kelp Blue, this would involve up to 45 anchor blocks per array, which would disturb and alter a total area of some 280 m^2 of seabed (assuming 2.5 x 2.5 x 2.5 m blocks). The anchor blocks will sink into the soft unconsolidated seabed sediments crushing or smothering any infauna in the footprint. In the event of the base landing on relatively hard bottom, epifauna present in the anchor block footprint will likewise be crushed.

Physical disturbance of the seabed from installation and anchoring of the arrays would result in a range of effects at various spatial and temporal scales. These are discussed below.

Up to 45 anchor blocks may be required to maintain position of each floating array. In setting the anchors, benthic epifauna and infauna are likely to be crushed, and in subsequent potential tensioning or dragging of the anchors and anchor chains, macrofauna will be disturbed, thereby resulting in a reduction in benthic biodiversity. The potential area of seabed disturbed will vary with the number of anchors used, the proportion of anchor chain that lies on the seabed prior to tensioning, the forces applied during positioning and tensioning and the substrate type. Where anchor blocks are dragged into position in unconsolidated sediments, the impacts resulting from these activities generally include the displacement of seabed materials, and the generation of impact depressions and scars, and possibly sediment mounds/ridges. Damage to organisms in the impact depressions and scars is likely to primarily affect soft-bodied species as some molluscs and crustaceans may be robust enough to survive. This in turn may have indirect effects on higher order bottom feeding consumers through direct loss of benthic prey items.

The duration of impact depressions and sediment displacement mounds vary and are dependent upon the nature of the sediments and the durability of the cohesive masses at the seabed surface. Observations of anchor scars and mounds in the northern North Sea suggest that under those conditions anchor disturbance may persist for 2-10 years. In an investigation of natural recovery of the seabed following diamond mining activities off Namaqualand it was reported that anchor scars not persisting for more than 2 years in unconsolidated sediments. Persistence of scars and anchor depressions in the Kelp Blue pilot areas would likely be of similar duration.

If, however, the arrays are anchored over hard ground, boulder fields or reef outcrops, physical damage to the reef structure or the inversion of boulders on the seabed may result, causing damage or loss of epifauna living on the rock or boulder surface through the physical crushing of relatively immobile / sedentary species. Some of the impacted biota may be long-lived and fragile, and recovery of such communities may only occur over the medium-term.

The significance of the effects on the impacted species will depend on the extent of the habitat types disturbed relative to the total available area of that particular habitat type. The overall distribution of the species affected and the degree of disturbance should also be considered. Deep reefs and other hard ground habitats in particular may support fragile, structurally complex species that in turn provide habitat for other species. Many of the cold water corals, gorgonians and sponges typical of such habitats are long-lived and slow-growing and recovery from disturbance is thus only expected over the medium term. Of particular relevance on the shelf area inshore of the 200 m depth contour are numerous slow-growing and potentially vulnerable species of seapen, which have been recorded from unconsolidated sediments beyond 75 m depth.

Once the concrete anchors have been set, the affected seabed areas around the blocks would with time be recolonised by benthic macrofauna. The rate of recovery/re-colonisation depends largely on the type of community that inhabits the affected benthic habitats, the extent to which the community is naturally adapted to high levels of disturbances, the sediment character (grain size) and physical factors such as depth and exposure (waves, currents). Recolonisation takes place by passive translocation of animals during storms or sediment influx from nearby unaffected areas, active immigration of mobile species, and immigration and settlement of pelagic larvae and juveniles.

Artificial structures (e.g. harbours, mariculture rafts and concrete anchor blocks) have been reported to enhance populations of jellyfish by providing the hard substrata required by jellyfish polyps for growth. Enhancing local jellyfish production in the area would be seen as a negative impact but due to the abundance of rocky subtidal reefs in the area, the impact should it occur is highly unlikely to be measurable. Following the decline of small pelagic fisheries in the late 1960s, two jellyfish species (*Chrysaora fulgida* and *Aequorea forskalea*) have become established as a major component of the Northern Benguela ecosystem, with jellyfish biomass estimated to exceed that of finfish by a factor of four. Swarms of these jellyfish have hampered fishing activities by physically clogging and subsequently bursting trawl nets and spoiling catches, caused mass mortalities of cage-cultured finfish and interfered with decapod culture and cause localised problems to the offshore diamond mining industry by blocking the suction systems on the drill heads used to mine marine sediments.

The ecological recovery of the disturbed seafloor is generally defined as the establishment of a successional community of species, which progresses towards a community similar in species composition, population density and biomass to that previously present. In general, communities of short-lived species and/or species with a high reproduction rate (opportunists) recover more rapidly than communities of slow growing, long-lived species. Opportunists are usually small, mobile, highly reproductive and fast growing species and are the early colonisers. Re-colonisation by such species starts rapidly after a disturbance, and species numbers may recover within periods of only a few weeks. The unconsolidated sediments on the Lüderitz Inner Shelf, and Lüderitz Inshore, are generally dominated by such short-lived macrofaunal communities. Therefore, provided the sediment characteristics of the impacted area are not dramatically altered, recovery of such communities following disturbance would be expected within 5 years.

Conversely, more stable habitats (characterised by coarser sediments) are typified by large, often burrowing, slow growing and long-lived species. As long-lived species need longer to re-establish the normal age and size structure of the population, biomass often remains reduced for several years.

It must be kept in mind, however, that re-colonisation is a site specific process, with the recovery time and resulting community structure being dependent not only upon sediment characteristics, but also local hydrodynamic conditions and depth. In deep water benthic community recovery rates are appreciably slower than in shallower areas subject to strong swell or current effects. At depths excess of 1,000 m, re-colonization of disturbed seabeds to conditions similar to undisturbed areas is thought to take decades. In contrast, recovery of shallow water (<30 m depth) sandy seabed communities occurs within 1 year.

The impacts on benthic communities of anchor deployments would be of moderate to high intensity and, in the case of unconsolidated sediments, endure over the short-term as recolonisation would occur rapidly from adjacent undisturbed sediments. For hard ground and boulder fields the impact may, however, persist over the medium term.

Consequence

The determining consequence can thus be considered LOW to MODERATE in the unmitigated scenario and LOW in the mitigated scenario.

Probability

The probability of impacts occurring is definite in the unmitigated scenario and most likely in the mitigated scenario.

SIGNIFICANCE

The potential impacts on benthic organisms of anchoring the arrays is consequently deemed to be of **MODERATE** (unconsolidated sediments) to **HIGH** (hard grounds) significance without mitigation.

Tabulated summary of the assessed impact – Disturbance and/or Loss of Benthic Macrofauna

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M-H**	**L-M***	**L**	**L-M**	**VH**	**M-H**
Mitigated	**M**	**L***	**L**	**L-M**	**H**	**M**

* Low (Short term) = unconsolidated sediments; Moderate (Medium term) = hard grounds

9.1.4.2 MANAGEMENT AND MITIGATION MEASURES

- Undertake a survey of the seabed at the pilot sites using geophysical (e.g. side-scan sonar, multibeam echo sounder) or remote visual (Remotely Operated Vehicle-mounted video) techniques to determine the distribution of seabed sediments and to identify any significant topographic features (e.g. rocky outcrops) or vulnerable habitats (e.g. hard grounds). The seabed survey should cover an area well in excess of the array spread thereby enabling flexibility in final positioning.

- If significant topographic features or vulnerable habitats are detected within the anchor spread area, the final position of the array should be adjusted to avoid such sensitive seabed features or habitats.
- Refer to the EMP in section 10.

9.1.5 ISSUE: DISTURBANCE OF SEABIRDS DURING INSTALLATION, OPERATION AND DECOMMISSIONING

9.1.5.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

Seabirds can easily be disturbed, but the degree to which such a disturbance can cause a bird to react depends on the species, the nature of the disturbance and the location of the disturbance. At a densely packed seabird breeding colony, for example, human presence and movement, or overflying aircaft can cause panic among nesting birds. Some species such as Cape Cormorants are easily stressed and may abandon their nests *en masse*. Other seabird species may react differently, e.g. by assuming a defensive stance and protecting their nest contents (e.g. penguins) or by temporarily leaving their nest and returning a short while later (e.g. gulls and oystercatchers). Sometimes a disturbance can have a ripple effect, with agitated birds causing a panic in other species nesting nearby. This is typically the case when nesting Kelp Gulls are disturbed; their frantic, raucous reactions in turn cause other birds to leave their nests – often providing an opportunity for gulls to then raid unguarded nests for eggs and small chicks. Similarly, birds roosting on islands are prone to disturbance and may easily take flight or, in the case of penguins flee into the water if disturbed. The NIMPA recognises the sensitivity of seabird breeding colonies to human disturbance, and access to the seabird breeding islands is therefore strictly controlled.

At sea, disturbance by human activities is likely to be less of a factor than at breeding localities. Seabirds in the general area around Lüderitz Port are habituated to the movements and noises generated by shipping traffic and other sources of disturbance such as mariculture activities. Further offshore, where seabirds tend to be more widely dispersed than at their breeding colonies (unless feeding in dense clouds in the wake of a fishing vessel), disturbance impacts should be minimal. The use of bright light sources at night could cause some birds to become disorientated and/or blinded and could lead to birds colliding with the vessel or infrastructure that is being assembled.

The disturbances (vessel movement, noise, use of artificial lighting) likely to be generated by installation / decommissioning activities at the grow-out zone and the three pilot plots will be localized and temporary, and although some disturbance to seabirds is possible, it is likely to be of LOW intensity and should not lead to any significant changes in seabird behavior or cause any direct or indirect physical harm. Similarly, disturbance caused to seabirds by operational activities is likely to be of LOW intensity.

Consequence

The determining consequence can thus be considered LOW.

Probability

The probability of impacts occurring is definite in the unmitigated scenario and most likely in the mitigated scenario.

SIGNIFICANCE

Although negative, the impact is therefore considered to be of **LOW** significance.

Cumulative impacts of disturbance to seabirds would be from other activities in the project area, such as vessel traffic, general port activities and mariculture operations.

Tabulated summary of the assessed impact – Disturbance of Seabirds during Installation, Operation and Decommissioning

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**L**	**L**	**L**	**M**	**L**
Mitigated	**L**	**L**	**L**	**L**	**M**	**L**

9.1.5.2 MANAGEMENT AND MITIGATION MEASURES

- Limit any activities that could create a disturbance in the vicinity of the seabird islands, including loud, sudden noises.
- No islands may be accessed, except to retrieve lost gear that may have washed up on an island. In this case permission must be sought from the MFMR Lüderitz office.
- Refer to the EMP in section 10.

9.1.6 ISSUE: ENTANGLEMENT RISKS

9.1.6.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

Seabirds

Cormorants, and to a lesser degree African Penguins and gulls, may build elaborate nests that can include kelp and marine litter such as washed up rope-strands and bits of fishing lines in their nests, which subsequently pose an entanglement risk to them and their chicks. Seabird entanglement in marine litter, particularly in fishing gear such as drifting pieces of lost, discarded or torn sections of netting or "ghost nets" and fishing line, but also other items such as loose rope strands or fish box straps, is a global issue.

Primary entanglement occurs when a seabird gets caught in marine litter at sea. Depending on the severity of entanglement and the size of the marine litter the bird the bird may be incapacitated to varying degrees. It could be completely incapacitated and drown almost immediately, or it could be only partly incapacitated and continue to survive, at least for some time, but may experience difficulties in flying, walking, diving or feeding. Secondary entanglement occurs when birds collect pieces of marine litter either from the water surface or washed up on the shore and incorporate them into their nests. This then poses an entanglement risk for the nesting birds and their chicks for the duration of the nest being used and possibly in subsequent breeding attempts if the nest is reused, or nest material recycled for other nests.

Apart from targeted studies on accidental seabird bycatch in longline and trawl fisheries, the incidence of seabird entanglement in marine litter along Namibia's coast has been poorly documented. Anecdotal observations of direct entanglements are scarce and include reports of Crowned Cormorants entangled in discarded bits of gillnetting, as well as Kelp Gulls and African Penguins entangled in fishing lines discarded by recreational anglers. During a routine bird census in 2008, an examination of Crowned Cormorant nests found that 13 of the 29 examined nests (45%) contained marine litter - mostly rope strands, fishing line and plastic packaging. Similar levels of marine litter have found in Cape Cormorant nests on Penguin and Seal islands.

Potential entanglement of seabirds in array material would be of low to moderate intensity, restricted to a local scale and, depending on the biodegradable properties of the materials to be used, persist over the short-term but potentially enduring over the long-term.

Marine Turtles and Marine Mammals

Entanglement in marine litter, discarded or active fishing gear, mariculture and other marine artificial installations (including mooring lines) are a recognised significant global threat to many species of conservation concerns including marine turtles and marine mammals. Floating loose ropes, twine, monofilament lines, netting, and packaging straps, particularly if they form loops can snare animals like fur seals, marine turtles and cetaceans. Floating or buoyed lines from lobster traps or mariculture farms to heavy anchor spread of large mining vessels have been involved in serious entanglement incidents in the region involving all group sizes of animals from immature fur seals, to large baleen whales (and turtles).

While many entanglement incidents on marine turtles involve marine litter and discarded fishing gear (ropes, monofilament lines, plastic debris etc.) entanglement in mariculture operations is not unusual. In Lüderitz Bay in the last two and a half decade at least three mature Leatherback turtles were found entangled in mariculture installations in the bay (two in ropes and twine of the *Gracilaria* seaweed farm, and one in an oyster farming operation) (Kemper & Roux pers. obs.). One animal was cut free and released (albeit with cut injuries) while the other two had drowned before being discovered. In addition, another large Leatherback turtle (with a tag from Gabon) was found seriously entangled in a polyprop rope (from a lobster trap) on the southern Namibian lobster fishing ground and was successfully released. These local examples highlight the potential risks of entanglement of marine turtles when floating ropes or lose twine arrays are used in such operations.

As reported from other parts of the world, southern right whales are particularly affected by boat strikes (as they are slow swimmers) and entanglement in marine debris and fixed fishing gear like gill nets, crab pots and lobster trap lines and buoys, as well as mooring lines of mariculture operations. Despite the present low population size in southern Namibian waters, several serious entanglement incidents were noted in the past two decades which illustrate this potential risk. A right whale was found by a service vessel badly entangled in a looped and buoyed anchor steel hawser from a diamond dredging operation. The whale could not be freed and after the cable was cut it is assumed that the animal succumbed after being let go with steel cable loops wrapped though the mouth, around the body and the tail stock. In another incident a right whale in poor condition was disentangled from several loops of polyprop ropes off Cape Town. The buoy attached to the rope was marked and identified as a rock lobster trap rope from a Namibian vessel operating out of Lüderitz. It is not known if this animal survived. Several other whales were observed temporarily entangled in lobster trap ropes along the southern Namibian coast but were reported to have managed to free themselves.

Locally there are known incidents of humpback whales getting temporarily entangled in rock lobster traps ropes and buoys. hese did not seem to have resulted in mortalities. However several humpback whales mortalities were documented in False Bay near Cape Town as results of similar entanglements in ropes of squid pots.

Baleen whales may approach dense kelp beds near the surface but usually do not swim through them. The artificial kelp beds created by the project will therefore probably create a barrier to local movements of these animals. In all likelihood the whale will swim around the kelp bed and array with limited impact as long as the arrays are sufficiently set apart to leave enough space for the animal to navigate around them (e.g. do not funnel the travelling whale towards dangerous areas close to the shore or very shallow exposed areas).

The mooring lines and blocks forming part of the kelp cultivation arrays were identified as a potential entanglement risk only for the largest species in the area (baleen whales). The risk of such animals getting trapped and/or entangled under the structure would be much reduced if those were of large diameter (or chain) and under constant tension and spaced out so an animal can easily navigate through them (i.e. the spacing should be considerably larger than the maximum body length of the animals (i.e. 25 m for fin whales)).

Any rigid structure of the submerged raft itself (pipes or high diameter ropes under tension) should pose a minimal entanglement threat. Any possibility of loose ropes or twine of any diameter used in the structure would increase entanglement risk to animals in a wide range of sizes and therefore should be avoided.

The kelp growing from the submerged raft would not pose any significant risk of entanglement as the species of concern would either avoid the kelp forest on the surface (large baleen whales) or are adapted to local kelp beds (smaller dolphin species and fur seals).

Potential entanglement of turtles and marine mammals in arrays would be of moderate to high intensity, restricted to local scale and persist over the medium-term.

Consequence

The determining consequence of entanglement of seabirds and Marine Turtles & Marine Mammals is rated as MODERATE in the unmitigated scenario and LOW in the mitigated scenario.

Probability

The probability of impacts occurring on seabirds is POSSIBLE. The probability of impacts occurring on Marine Turtles & Marine Mammals is POSSIBLE or MOST LIKELY (surface buoys) in the unmitigated scenario and unlikely in the mitigated scenario.

SIGNIFICANCE

The significance of impacts to seabirds and Marine Turtles & Marine Mammals is **MODERATE** in the unmitigated scenario and **LOW** in the mitigated scenario.

Cumulative impacts of seabird entanglement from other sources in the project area, such as marine litter posing entanglement risks stemming from port activities and mariculture operations. Entanglement through other sources adds additional mortality risk, especially for long-lived, threatened species.

Tabulated summary of the assessed impact – Entanglement Risks relating to seabirds

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L-M**	**L-H**	**L**	**M**	**M**	**M**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

Tabulated summary of the assessed impact – Entanglement Risks relating to Marine Turtles and Marine Mammals

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M-H***	**M**	**L**	**M**	**M-H****	**M**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

* Species specific   ** Surface buoys

9.1.6.2 MANAGEMENT AND MITIGATION MEASURES

Seabirds

- Materials used for the arrays in the grow-out area and the three pilot plots should be "seabird-friendly". Nylon twine used for seeding kelp in the grow-out area should not be too thin to minimize the risk of it (a) breaking off the array and drifting off, and/or (b) forming dense balls that could increase an entanglement risk. Seeding twine should be wrapped tightly around ropes, remain under tension and not become loose and form loops that could trap seabirds diving through the array.

- Choose twine and rope material carefully. Materials to be used should (a) be thick enough to limit tangling into shapes in which seabirds could become entangled and (b) not be prone to produce loose strands that break off easily.
- Ensure regular inspection of arrays / seeding ropes and prompt replacement of damaged ropes / twine before they become an entanglement hazard.

Marine Turtles and Marine Mammals

- All mooring hawsers, rope arrays and ropes to floats should be rigid or under constant tension.
- Install navigational warning devices (e.g. buoyed radar reflectors) marking the outer boundaries of the arrays. These should be of a design which ensures constant tension or preferably rigid links to the raft ("pencil buoys").
- Space mooring lines / blocks to be placed more than 25 m apart.
- Refer to the EMP in section 10.

9.1.7 ISSUE: HABITAT CREATION AND ALTERATION OF PLANKTON COMMUNITY

9.1.7.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

Being 'ecosystem engineers' large kelps such as *Macrocystis* create their own ecosystem around themselves wherever they thrive. An offshore aquaculture operation that provides a suitable substratum near the surface for macroalgal attachment and growth would thus create its own microecosystem, providing shelter, feeding and nursery areas for a highly diverse number of associated fauna. The pelagic ecosystem typically supporting microscopic floating phytoplankton would therefore be locally altered to one dominated by large attached seaweeds, which in turn would provide a substrate for colonisation by benthic organisms typically associated with reef habitats in the photic zone. By providing a three-dimensional habitat, kelp farms would thus effectively increase biological complexity in the otherwise structureless seawater column thereby benefitting a diversity of mobile fauna (e.g. invertebrates and fish).

Similarly, concrete anchor blocks placed on the seabed to keep the array in position, will provide an alternative hard substrate to other mobile and sessile benthic species. Although information on the importance of physical structures associated with suspended aquaculture on the seafloor is lacking, there is considerable information on the importance of structures used as artificial reefs to enhance specific areas for fisheries species. An increase in the abundance of lobsters at a mussel aquaculture site in eastern Canada was due to the presence of anchor blocks and not to mussel fall-off. Direct interactions of cultivated kelp forests with rock lobsters are unknown but could entail enhanced larval lobster settlement within the kelp forest by creating a new potentially favourable habitat for young life stages thereby potentially increasing the recruitment success to local stocks. If the kelp arrays are placed in areas of unconsolidated sediments, the bottom structures would also provide considerable surface area for the settlement of sessile organisms not normally found on soft sediment bottoms. Diverse fouling communities may thus develop on these structures, thereby increasing the biomass below the culture site.

As algae function at a lower trophic level and use dissolved nutrients (mainly nitrates, phosphates, silicon) for growth, their potential effect on the water column is nutrient extraction, with a possible knock-on effect of reduced nutrient availability for natural phytoplankton populations and other algae species thereby potentially affecting patterns of nutrient recycling and secondary productivity. With the development of the offshore kelp forests, primary productivity would shift locally from supply by phytoplankton to supply by macroalgae. This will affect food chains, by inhibiting the development of phytoplankton-consuming zooplankton, which in turn serve as a food source to small pelagic shoaling species (e.g. anchovies, sardines, horse mackerel), but enhancing filter-feeding invertebrates (e.g. mussels, barnacles) which consume released kelp particles. The floating forest is likely to function as a fish aggregating device, attracting both mobile and sessile invertebrates, as well as herbivorous and predatory fish species. These in turn may attract higher order consumers such as seabirds and marine mammals.

Kelps supported by floating arrays in the offshore environment would compete with phytoplankton for the available dissolved nutrients, and in the area of the rafts much of the nutrients available would be cycled through the kelps rather than phytoplankton. Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, upwelling in the area around Lüderitz can occur throughout the year suggesting that nutrient availability in surface waters is unlikely to be limited. Furthermore, phytoplankton typically shows substantial temporal and spatial variations in abundance and productivity, and as substantial proportions are lost to the seabed annually, it is unlikely that the presence of a localised floating kelp forest would have noticeable effects on the primary productivity of phytoplankton.

This effect of acting as nutrient sinks has led to extensive research into the bioremediation potential of culturing algae in integrated systems, particularly in conjunction with finfish farms. Seaweed cultivation has, however, been effectively used to improve water clarity by reducing suspended solids through decreased flow velocity, turbulence and sediment resuspension within a kelp farm.

The modification of the pelagic habitat through the localised establishment of offshore kelp forests can therefore be considered a positive impact of medium intensity. During the pilot phase, the modification of the environment would persist in the medium-term arrays would remain in place for the approximate seven-year harvestable lifespan of the adult kelps, but would remain highly localised to the area of the pilot plots.

Potential alteration of plankton communities due to uptake of nutrients by the kelp forests would be considered of low intensity. Any alteration of nutrient regimes around the array would be short-term due to the high variability in upwelling occurrence and strength. The consequence can thus be considered LOW as the alteration of plankton communities beyond the site specific scale is unlikely during the pilot phase of the project.

Consequence

The determining consequence relating to habitat creation can thus be considered Moderate (positive) and for Alteration of Plankton Community LOW (negative).

Probability

Localised habitat creation would definitely occur.

SIGNIFICANCE

The significance of the impact relating to habitat creation is thus rated as **HIGH** (positive) and for Alteration of Plankton Community the significance of the impact is thus rated as **LOW**. The impact would be considered NEUTRAL, as it would affect the aquaculture plots only and not the natural ecosystem.

Cumulative impacts to marine communities are not expected.

Tabulated summary of the assessed impact – Habitat Creation

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M**	**M**	**L**	**M+**	**H**	**H+**
Mitigated	**M**	**M**	**L**	**M+**	**H**	**H+**

Tabulated summary of the assessed impact – Plankton Communities

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**L**	**L**	**L**	**L**	**L**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

9.1.7.2 MANAGEMENT AND MITIGATION MEASURES

- No mitigation other than the no project alternative is feasible.
- Refer to the EMP in section 10 for monitoring requirements.

9.1.8 ISSUE: BIODEPOSITION AND CHANGES TO SEDIMENT PROPERTIES

9.1.8.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

Kelp forests release a lot of material in the form of dissolved organic matter and particulate organic matter as older fronds disintegrate. Larger portions of frond systems or even entire plants can be lost during high swells or storms. This lost material contributes to the food webs in numerous marine ecosystems; from the neighbouring water column and sea floor, to the seabed and coastal ecosystems that receive the rafts of detached kelp wrack. The discussion below focusses primarily on the seabed effects from the offshore floating arrays, both from the sedimentation of organic-rich, kelp-derived particles as well as the deposition and accumulation of fine-grained particles (faeces and pseudo-faeces), and of the live bivalves and other biota attached to the arrays and the kelps themselves. It is based largely on information on biodeposition below mussel cultivation rafts, which due to the production of pseudofaeces and faeces, will be significantly higher than that expected below a kelp array. Similar principles would apply, however, and as a large volume of literature is available compared to that on biodeposition below kelp farms, this will be referred to where relevant.

With the increased availability of particulate organic matter within and around the kelp forest, heavy biofouling by filter-feeding bivalves, barnacles, ascidians and hydroids on the array structures, floats and ropes, and the kelp and kelp holdfasts can be expected. While these will be effective in reducing the amount of biodeposition reaching the seabed, drop-off of the biofouling organisms themselves can contribute substantially to the biodeposition below the array. Biofouling discards from mussel culture operations in Saldanha Bay, South Africa, have been estimated as amounting to ~12.5 tons per ha of culture rafts. Whereas some of the biofouling organisms and discards would be consumed by predators and scavengers attracted to the farm, there is an increased risk of the development of areas of hypoxia or anoxia under the arrays as a result of the increased discards. Mussel drop-off and biofouling organisms have been reported to create reef-like habitats beneath mussel farms thereby locally altering the composition and abundance of benthic organisms. Fouling of shellfish farms (in particular) has become recognised as a significant threat to the aquaculture industry, as population explosions of biofouling species can result in substantial crop losses. This needs to also be be considered in the case of kelp farms.

The degree to which biodeposits will accumulate in the vicinity of an array will be a function of four factors, namely 1) the rate of biodeposit production, 2) initial dispersal below the arrays, 3) the redistribution on the sediment surface *via* creep, saltation and/or resuspension, and 4) the rate of biodeposit decay. This deposition can lead to enrichment of the seabed sediments beneath the arrays due to the high organic content of the deposited particles, with concomitant effects on the benthic communities due to changes in the physico-chemical properties of the sediments.

The degree to which effects of the kelp farms on the seabed manifest, and the capacity of the environment to disperse and assimilate the biodeposition will be dependent on site-specific environmental characteristics (e.g. depth, current speeds and directions, existing benthic habitat, wave climate, phytoplankton abundance). In areas of strong water currents, localised sedimentation and accumulation of organic matter would be reduced, and oxygen delivery to the sediments increased, thereby allowing for more efficient mineralisation of organic material and a reduced chance of sediment hypoxia. Increased organic matter may in fact have the effect of enhancing infaunal abundance and promoting the recruitment and abundance of sessile invertebrates and fish, although benthic impacts through the release of dissolved and particulate matter by the seaweed biomass have been reported. Farms located in deep water and areas of stronger water currents would therefore have depositional footprints that are less intense and more widely dispersed. For example, modelling of depositional footprints for mussel cultivation sites in more energetic environments or greater water depth found effects extending beyond 250 m from the farm boundary. Although the seabed beyond the effects footprint may also be exposed to farm-derived materials, the environment is expected to have the capacity to assimilate these without measurable ecological changes.

Detritus originating from fouling epibiota attached to the array structures or the kelp themselves would also contribute to increased sedimentation, either where fouling organisms reach high densities on arrays and fall to the seabed naturally or because of deliberate defouling by farm operators. Live shellfish, shell material and associated fouling biota would settle directly beneath the array and are typically confined within 10 m of marine farming structures. These may act as settlement sites for benthic fauna thereby increasing local rugosity and enhancing the development of hard substrate communities.

Assuming that farms would be operational over the medium- to long-term, increased biodeposition from the kelp arrays and associated physico-chemical changes to sediment properties below the array is deemed of low intensity within the immediate vicinity of the farm, with impacts persisting for at least as long as the farm is in operation (medium-term).

Consequence

The determining consequence can thus be considered LOW.

Probability

Biodeposition and changes to sediment properties are POSSIBLE.

SIGNIFICANCE

The overall significance of the impact is considered **LOW**. Recovery of the sediment properties following removal of the farms are assumed to be site specific and relatively rapid once farming ceases.

Cumulative impacts to sediments and associated communities below the arrays are not expected.

Tabulated summary of the assessed impact – Biodeposition and Changes to Sediment Properties

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**M**	**L**	**L**	**M**	**L**
Mitigated	**L**	**M**	**L**	**L**	**M**	**L**

9.1.8.2 MANAGEMENT AND MITIGATION MEASURES

- No mitigation measures other than the no project alternative are deemed feasible or necessary.
- Monitoring requirements are however included in the EMP (see section 10.7).

9.1.9 ISSUE: NAMIBIAN ISLANDS' MARINE PROTECTED AREA

9.1.9.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

Both the proposed grow-out area and pilot plots are located within the buffer zone of the Namibian Islands' Marine Protected Area (NIMPA). Although no restrictions regarding the total area permitted for aquaculture have been specified in the NIMPA regulations, restrictions governing various fisheries, diamond mining and the potential obstruction of cetacean pathways by erect structures, fixed moorings and lines are covered. Seaweed farming is often considered as the least environmentally damaging form of aquaculture, offering a number of ecosystem services. Nonetheless, as habitat-creators seaweeds do alter the marine environment in which they are cultivated having effects both on the water column and the benthos. Such impacts within a MPA need to be considered.

At the pilot scale such impacts in the NIMPA are deemed of low intensity and highly localised, persisting for at least as long as the farm is in operation (medium-term), and for the anticipated relatively short period required for rehabilitation after decommissioning.

Consequence

Any effects of the pilot project on the NIMPA are consequently considered to be of LOW consequence.

Probability

Although localised habitat changes within the NIMPA are POSSIBLE, effects on the NIMPA as a whole are unlikely.

SIGNIFICANCE

The overall significance of the impact is thus considered **LOW**.

Cumulative impacts to the NIMPA of the pilot project are not expected.

Tabulated summary of the assessed impact – Namibian Islands' Marine Protected Area

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**M**	**L**	**L**	**L**	**L**
Mitigated	**L**	**M**	**L**	**L**	**L**	**L**

9.1.9.2 Management and mitigation measures

- No mitigation measures other than the no project alternative are deemed feasible or necessary.

9.1.10 ISSUE: Biological Impact on stocks and stock recruitment

9.1.10.1 Assessment of impact

Nature and intensity, duration of impact & geographical extent

Many marine species depend on healthy ecosystems to sustain their life history strategies. For the main commercial offshore fisheries, inshore areas and bays act as nurseries for the settlement and grow-out of juveniles. In southern Namibia this includes hake, monk, small pelagic species, linefish and crustaceans (lobster in particular). Anthropogenic inputs, including mariculture development, disturbance of seabed (habitat) and many other environmental factors create stress on ecosystems that can eventually lead to alteration of the ecosystem. Such alterations can include disruption of recruitment and survival of spawn and juveniles. Generally marine systems have proven resilient to these changes. Scale and duration combined with persistence are however critical factors. Relatively small anthropogenic impacts are expected to have low impacts on established commercial fisheries, while large-scale impacts would be expected to have greater potential to disrupt stock recruitment. Globally, when uncertainty is high as to the impacts of an activity (such as the commercial removal of fish or "mortality"), the Precautionary Principle is applied. This approach (also called the Precautionary Approach) suggests a conservative management strategy, at least until there is greater confidence in the understanding of the effects of a particular impact.

The proposed kelp cultivation Project is currently following this precautionary approach through limiting initial development to only a few small pilot areas (i.e. implementing the Pilot Project first). Nevertheless there still remain many uncertainties such as the introduction of an alien species and the physical disturbance of fish nursery areas and habitat alteration.

Based on the scale of the proposed pilot phase of kelp cultivation, the intensity of any impacts on the main commercial stocks or their nursery areas is considered, highly localised to the areas of the arrays and persisting over the medium-term (life time of the pilot project).

Consequence

The consequence can thus be considered LOW as long as the scale of the development is contained to small areas or until such time there is greater understanding of the long-term effects on the ecosystem and possible impacts of recruitment to the main commercial fisheries in the region are better understood.

Probability

Disturbance of recruitment of commercially important species is POSSIBLE in the unmitigated scenario.

SIGNIFICANCE

The overall significance of the impact is considered **LOW**.

Cumulative impacts are only expected for larger-scale operations (not part of the scope of this EIA).

Tabulated summary of the assessed impact – Biological Impact on stocks and stock recruitment

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**M**	**L**	**L**	**M**	**L**
Mitigated	**L**	**M**	**L**	**L**	**L**	**L**

9.1.10.2 Management and mitigation measures

- Apply the precautionary principle to the development of the offshore kelp farms by managing the scale of future operations conservatively thereby avoiding potential irreversible impacts over large areas of the NIMPA.
- Implement systematic monitoring of the ecosystem using reliable ecosystem indicators.
- Refer to the EMP in section 10.

9.1.11 ISSUE: Noise and Pollution Effects

9.1.11.1 Assessment of impact

Nature and intensity, duration of impact & geographical extent

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. 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 can thus be expected to interfere directly or indirectly with such activities thereby affecting the physiology and behaviour of marine organisms. The cumulative impact of increased background anthropogenic noise levels in the marine environment is an ongoing and widespread issue of concern, as such sound sources interfere directly or indirectly with the animals' biological activities. The magnitude of the effects will, however, depend on the hearing thresholds of the receptor, these varying substantially among faunal groups and between species. 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.

In offshore areas, natural ambient noise will vary considerably with weather and sea state, ranging from about 80 to 120 dB re 1 µPa for the frequency range 10 – 10k Hz. 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. 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. With the vessel traffic into and out of the Port of Lüderitz, the natural ambient noise in the bay is likely to be comparatively high. The vessels used during array installation and maintenance, as well as during harvesting would contribute to the noise in the environment. The resistance offered to the current by the arrays and anchor spreads, as well as the kelps themselves are also likely to generate underwater noise although the sound levels are difficult to predict.

Noise generated by vessels required during the installation and maintenance of the arrays and harvesting of the kelp would be considered of low intensity as it would not result in physiological injury of marine fauna, although it may lead to temporary behavioural changes in marine mammals and diving seabirds when in close proximity. The noise would persist over the short-term only, when vessels are operational, and be highly localised.

During array installation, chartered vessels will transit between the pilot plot areas and Lüderitz. Operational discharges from such vessels include deck drainage, sewage, water from machinery spaces, ballast water, food (galley) wastes, detergents and cooling water. The discharge of wastes to sea could create local reductions in water quality, both during transit to and within the pilot areas. Deck and machinery space drainage may result in small volumes of oils, detergents, lubricants and grease, the toxicity of which varies depending on their composition, being introduced into the marine environment. Sewage and gallery waste will place a small organic and bacterial loading on the marine environment, resulting in an increased biological oxygen demand. Litter, such as building material packaging accidentally blowing overboard could, depending on the nature of the litter, constitute an entanglement risk.

These discharges will result in a local reduction in water quality, which could impact marine fauna in a number of different ways: 1) physiological effects due to ingestion of or soiling by hydrocarbons, detergents and other waste, 2) increased food sources for opportunistic feeders, and 3) increased predator - prey interactions due to the increased food source, and 4) entanglement.

Operational discharges from vessels used for the installation and maintenance of arrays and the harvesting of kelp would be considered of low intensity as they would result in highly localised reductions in water quality. Rapid dilution would ensure that any effects would persist over the very short-term only when vessels are operational.

Consequence

The determining consequence is considered LOW.

Probability

Behavioural changes in marine mammals and diving seabirds in response to the vessel noise are POSSIBLE. Physiological effects on marine fauna of operational discharges are UNLIKELY.

SIGNIFICANCE

The overall significance of the impact is considered **LOW**.

Cumulative impacts to marine fauna are not expected.

Tabulated summary of the assessed impact – Noise and Pollution Effects

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**L**	**L**	**L**	**L-M**	**L**
Mitigated	**L**	**L**	**L**	**L**	**L-M**	**L**

9.1.11.2 MANAGEMENT AND MITIGATION MEASURES

- Ensure that operational discharges are undertaken in a manner consistent with good international industry practice and in compliance with the applicable requirements in

MARPOL 73/78, regardless of the size of the vessel, , and in compliance to the local legislation.

- Ensure that all wastes generated on board are stored in dedicated, clearly labelled, containers (bins, skips, etc.) and frequency removed to a licenced land-fill site.
- Refer to the EMP in section 10.

9.2 Heritage Impact Assessment

This qualitative assessment is based on the baseline information presented in section 6.5, referring to the Archaeological desk assessment by Quaternary Research Services (Kinahan, 2016) for LK Mining's EIA for Offshore Diamond Exploration Activities on Exclusive Prospecting License 5965 (SLR, 2016).

9.2.1 ISSUE: Damage to Archaeological Resources (Shipwrecks, etc.)

9.2.1.1 Assessment of Impact

Nature and intensity, duration of impact & geographical extent

The array design would involve up to 45 anchor blocks per array, which would disturb and alter a total area of some 68 m^2 of seabed. Impact on archaeological sites or sites and material protected under the National Heritage Act (27 of 2004) resulting from the Kelp Pilot Project activities would primarily take the form of physical destruction or disturbance with a high probability of physical destruction due to the placement of the anchor blocks on the shipwrecks and other archaeological and historical remains on the seabed.

Archaeological and historical remains on the seabed would be vulnerable to disturbance or destruction.

Loss of resource is of moderate to high severity in the unmitigated scenario. The duration is permanent and therefore very high in the unmitigated scenario. The extent of the impacts is within site boundary, i.e. local.

Consequence

The determining consequence can thus be considered MODERATE to HIGH in the unmitigated scenario and LOW in the mitigated scenario.

Probability

The probability of impacts occurring is POSSIBLE in the unmitigated scenario due to a number of known shipwrecks and other archaeological and historical remains on the seabed, specifically near Ichaboe Island.

SIGNIFICANCE

The potential impacts on heritage (i.e. shipwrecks, etc.) is consequently deemed to be of **MODERATE** to **HIGH** in the unmitigated scenario and **LOW** in the mitigated scenario.

Tabulated summary of the assessed impact – archaeological resources (damage to shipwrecks, etc.)

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M-H**	**VH**	**L**	**M-H**	**M**	**M-H**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

9.2.1.2 MANAGEMENT AND MITIGATION MEASURES

- Undertake a survey of the pilot sites to determine if there are any shipwrecks and other archaeological and historical remains on the seabed.
- Consult a qualified Archaeologist to confirm most appropriate survey and to advice on the survey results.
- If significant archaeological shipwrecks / remains are found within the anchor spread area, the final position of the array should be adjusted to avoid such sensitive remains features or habitats.
- In the event that archaeological resources are discovered during the installation of the arrays or during the harvesting activities, a chance find emergency procedure will be implemented.
- Refer to the EMP in section 10.

9.3 SOCIO-ECONOMIC

With reference to Table 10, the various activities relating to the proposed Pilot Project pose various risks (i.e. potential impacts) to other industries / users of the Marine Environment.

Each of these potential impacts (i.e. “issues”) are separately considered and assessed in the sections below.

The information in this section was sourced from the Marine Specialist Study[9] (Pisces, et al, 2020) included in Appendix F.

9.3.1 ISSUE: INTERACTION WITH MARINE TRAFFIC

9.3.1.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

As Namibia’s second largest port (to Walvis Bay), Lüderitz services mostly the fishing and mining industry as well and supporting a growing mariculture industry. It is managed through the Namibian Port Authority and as with all international ports, must comply with Namibia’s commitments to the International Maritime Organisation.

Access into and out of the port is through a channel (shipping separation zone applies as well. Movements into and out of the port are strictly controlled by the port authority, including larger trawlers and smaller line boats as well as the larger (>50 m) offshore diamond drilling vessels, although some freedom of movement can be permitted depending on vessel licencing. There is also ongoing oil and gas developments offshore in southern Namibian waters.

Once clear of the port precinct, international navigation and maritime legislations apply. An increase in maritime activity and movement of vessels associated with the development of the kelp cultivation project in and around the Port Precinct will occur leading to interactions with maritime traffic moving both inside territorial waters and vessels accessing the port. This will include the regular seasonal movement of rock lobster and linefish vessels transitting the proposed kelp pilot areas as well as diamond-mining vessels and ships heading south to international destinations (refer to Figure 22). The development of the pilot project offshore with fixed structures in the ocean will generate both increased movement of service vessels and present navigation obstructions. The planned grow-out area in Shearwater Bay will also require operational space and will result in additional (to current) maritime traffic posing increased risk of collisions and operational spills.

Any pilot plots located in the shipping lanes or restricting vessel traffic in inshore and offshore waters would be of moderate intensity. Vessel interactions and restrictions in navigation would

[9] Various references were made in the Marine Specialist Report, which will not be repeated in this report. For the detailed list of references refer to sections 5 and 8 of the Marine Specialist Report (Appendix F).

remain highly localised around the pilot plots, but would persist over the medium-term (for the length of the project).

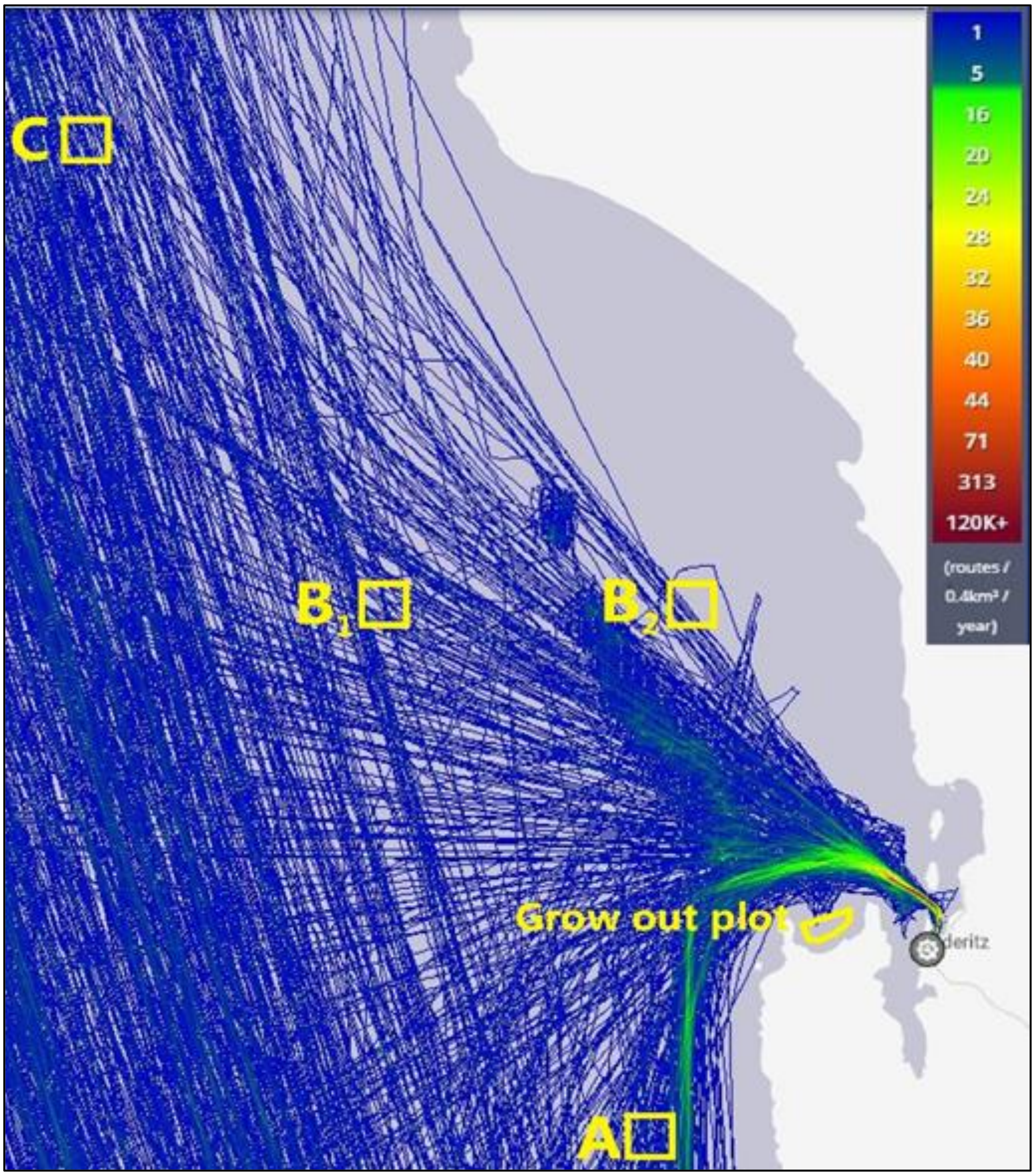

FIGURE 22: SHIPPING TRAFFIC DENSITY IN THE NEARSHORE REGIONS AND OFFSHORE OF LÜDERITZ IN RELATION TO THE PROPOSED PILOT PLOTS

Consequence

The determining consequence is considered MODERATE.

Probability

The interaction between project-specific vessels, pilot plots and other maritime traffic is MOST LIKELY

SIGNIFICANCE

The overall significance of the impact is thus considered **MODERATE** in the unmitigated scenario and **LOW** in the mitigated scenario.

Cumulative impacts on vessel traffic are expected.

Tabulated summary of the assessed impact – Interaction with Marine Traffic

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M**	**M**	**L**	**M**	**H**	**M**
Mitigated	**L**	**M**	**L**	**L**	**M**	**L**

9.3.1.2 MANAGEMENT AND MITIGATION MEASURES

- Ensure that normal maritime traffic rules are followed at all times and that Port Authority conditions are applied.
- Negotiations around usage of water area and the exact location of grow-out and pilot areas is the mandate of the Port and Namibian transport authorities.
- Ensure that suitable navigational warning devices (e.g. buoyed radar reflectors) are installed to mark the outer boundaries of the arrays.
- Prior to array installation inform the Namibian Ports Authorities and the SAN Hydrographic Office at Silvermine to put out Radio Navigation Warnings throughout the operational period, and to publish particulars of the array locations in the Notices to Mariners.
- Consider moving Pilot Plot A further west to avoid interaction with the traffic route heading south.
- Refer to the EMP in section 10.

9.3.2 ISSUE: INTERACTION WITH THE ROCK LOBSTER FISHERY

9.3.2.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

Rock lobster fisheries use small vessels and carry traps which are deployed and recovered over the side of the boat. Traps are typically set in water depths as shallow as 10 m but also out to depths of 50 m. As lobsters avoid sandy areas unless undergoing seasonal migrations, traps are set on hard or rocky grounds. The establishment of offshore kelp farms could overlap with the preferred water depth of lobster trap fishers, as well as over their preferred substrate. Depending on their proximity to lobster grounds, the pilot plots may also create space and navigation issues between vessels, which will pose a risk to normal navigation. The pilot plots may also require the establishment of exclusion areas around the arrays, thereby potentially resulting in user conflict.

As the fishery is well established, any pilot plots located in rock lobster fishing areas that may restrict access to the fishery resource would be of moderate intensity. Although any interactions would remain highly localised in isolated fishing target areas, the impact would persist over the medium-term (for the length of the project).

Consequence

The determining consequence is considered MODERATE in the unmitigated scenario.

Probability

The interaction between rock lobster operations and the specific location of each pilot area is POSSIBLE.

SIGNIFICANCE

The overall significance of the impact is thus considered **MODERATE** in the unmitigated scenario and **LOW** in the mitigated scenario.

Cumulative impacts are only expected if the pilot areas permanently exclude the trap fishery.

Tabulated summary of the assessed impact – Interaction with the Rock Lobster Fishery

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M**	**M**	**L**	**M**	**M**	**M**
Mitigated	**L**	**M**	**L**	**L**	**L**	**L**

9.3.2.2 MANAGEMENT AND MITIGATION MEASURES

- Consult with the rock-lobster fishing industry before finalising the position of the arrays to ensure there is no conflict between array location and potential fishing target areas.
- Refer to the EMP in section 10.

9.3.3 ISSUE: INTERACTION WITH THE LINE-FISHERY

9.3.3.1 ASSESSMENT OF IMPACT

Nature and intensity, duration of impact & geographical extent

Linefish fisheries use small vessels and are mobile units, fishing extensively in the nearshore areas (generally within the 200 m depth contour) and expected to range no more than 50 nautical miles from Lüdertiz. Fishing location is variable depending on target species. Mobile species such as snoek are expected to range widely and catching location (shoals) will therefore be variable. When targeting groundfish, locations are expected to be regular and established historically. Pilot sites for kelp cultivation are expected to exclude linefishers from established ground-fishing areas when they overlap but would only have minimal impact when targeting mobile (pelagic) species. As the kelp forests may function as fish aggregating devices positive effects may occur for the linefishery, although the economic benefits of this are unlikely.

As the linefishery is well established, any pilot plots located in fishing areas that may restrict access to the fishery resource (particularly targetting ground fish) would be of moderate intensity. Although any interactions would remain highly localised in isoloated fishing target areas, the impact would persist over the medium-term (for the length of the project).

Consequence

The determining consequence is considered MODERATE in the unmitigated scenario.

Probability

The interaction between linefishing operations and the specific location of each pilot area POSSIBLE.

SIGNIFICANCE

The overall significance of the impact is thus considered **MODERATE** in the unmitigated scenario and **LOW** in the mitigated scenario.

Cumulative impacts are only expected if the pilot areas permanently exclude the the line fishery.

Tabulated summary of the assessed impact – Interaction with the Line-Fishery

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M**	**M**	**L**	**M**	**M**	**M**
Mitigated	**L**	**M**	**L**	**L**	**L**	**L**

9.3.3.2 Management and Mitigation Measures

- Consult with the linefishing industry before finalising the position of the arrays to ensure there is no conflict between array location and historical linefishing target areas, specifically areas of historical groundfishing.
- Refer to the EMP in section 10.

9.3.4 ISSUE: Interaction with Existing and Future Mariculture Operations

9.3.4.1 Assessment of Impact

Nature and intensity, duration of impact & geographical extent

Mariculture is well established in Lüderitz Bay and is of significant socio-economic importance to Namibia, and Lüderitz in particular. The mariculture industry itself has rigorous monitoring requirements for disease controls, introduction of alien species and many other potential impacts on the ecosystem. Water space is at a premium and spacing between farms and the outgrowing of different species carefully managed in order to optimise production, particularly for filter feeders (mostly mussel and oyster farming). The introduction of a Kelp Grow-Out facility in Lüderitz Bay in similar areas to the established mariculture operations can have several different impacts, including physical displacement of current mariculture operations, introduction of alien species, increased anthropogenic nutrient loads etc. The introduction of kelp cultivation can, however, also have positive socio-economic and ecosystem effects.

As the mariculture industry in Lüderitz is well established, the location of any grow-out areas within allocated mariculture areas would result in an impact of high intensity. However, as the preferred alternative in Shearwater Bay is far removed from current mariculture plots (refer to section 7.1) the intensity would be low, remain highly localised to the grow-out site and persist for the duration of the project (medium-term).

Consequence

The consequence can thus be considered LOW.

Probability

In the preferred location in Shearwater Bay, interaction with the mariculture industry is UNLIKELY.

SIGNIFICANCE

The overall significance of the impact is considered **LOW**.

Increased anthropogenic loads will have a cumulative impact on natural productivity.

Tabulated summary of the assessed impact – Interaction with Existing and Future Mariculture Operations

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**M**	**L**	**L**	**L**	**L**
Mitigated	**L**	**M**	**L**	**L**	**L**	**L**

9.3.4.2 Management and Mitigation Measures

- Implement the preferred location for the grow-out area in Shearwater Bay.
- Consult with the mariculture industry before finalising the position of the grow-out area to ensure there it does not displace existing mariculture operations;
- Ensure that the design of the grow-out area allows for integration into the current designated water areas without negatively impacting existing mariculture production.
- Refer to the EMP in section 10.

9.3.5 ISSUE: Interaction with Diamond Mining

9.3.5.1 Assessment of Impact

Nature and intensity, duration of impact & geographical extent

With the exception of Area C, the proposed pilot plots and grow-out areas are all located within mining licence areas for precious stones currently held by three separate diamond-mining companies. Although not currently active, future operations could involve diver-assisted, vessel-based (ML-32 and ML-45) and remote seabed crawler (ML-111 and ML-128A) mining approaches. Further geophysical surveys prior to mining may also be undertaken by these companies. Once installed, the anchored arrays would in effect limit access by these companies to potential diamond resources located under the arrays.

Restricted access by mining licence holders to their potential mineral resource would be considered of moderate to high intensity and would persist for as long as the arrays remain in place (medium-term). Limited access would be highly localised, however, covering only the area of the array and its surrounding safety exclusion zone.

Consequence

The determining consequence MODERATE in the unmitigated scenario and LOW with mitigation.

Probability

Although there is currently no mining activity in the vicinity of the proposed locations of the arrays, future activities are POSSIBLE.

SIGNIFICANCE

The overall significance of the impact is considered **MODERATE** in the unmitigated scenario and **LOW** with mitigation.

Any effects on limited access would be fully reversible.

Tabulated summary of the assessed impact – Interaction with Diamond Mining

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M-H**	**M**	**L**	**M**	**M**	**M**
Mitigated	**L**	**M**	**L**	**L**	**L**	**L**

9.3.5.2 MANAGEMENT AND MITIGATION MEASURES

- Consult with the diamond mining licence holders before finalising the position of the arrays to ensure there is no conflict between array location and potential diamond resources.
- Refer to the EMP in section 10.

9.4 Unplanned events

With reference to Table 10, unplanned events relates to storm damage and/or loss of arrays; and pollution and accidental spills. The potential impacts associated with these unplanned events are assessed in the sections below.

The information in this section was sourced from the Marine Specialist Study (Pisces, et al, 2020) included in Appendix F.

9.4.1 ISSUE: Damage to and Loss of Arrays

9.4.1.1 Assessment of impact

Nature and intensity, duration of impact & geographical extent

The arrays will be constructed from either air-filled HDPE piping or air-filled steel pipe. This will be overlaid with a 4 m x 4 m grid of polyamide rope acting as a carrier for the kelp plants, which will be tie-wrapped to the frames. Kelp plants will be attached to the carrier ropes spaced in 1.5 m intervals. The array will be neutrally buoyant and suspended at 20 m depth below the sea surface above an anchor spread comprising 45 anchors. The array will be attached to the anchors by chains or hawsers spaced 80 m apart. Being neutrally buoyant, the anchor chains will be under constant tension.

In the event of material failure under severe storm conditions, portions of the array may break off and (depending on the attached kelp and biofouling biomass) either drift to the surface or sink to the seabed. Complete array failure is considered highly unlikely.

If portions of the array sink to the seabed, it would crush benthic fauna in its footprint and potentially disturb or damage seabed habitats, but ultimately provide a hard surface for colonisation. If portions of the array float to the surface, they would pose a shipping hazard, and attached cables and chains could pose an entanglement hazard to turtles and marine mammals, potentially leading to physiological injury or death.

With the increased availability of particulate organic matter within and around the array, heavy biofouling by filter-feeding bivalves, barnacles, ascidians and hydroids on the array structures and kelp holdfasts can be expected. While these will be effective in reducing the amount of biodeposition reaching the seabed, they can add substantially to the weight of the array. Biofouling discards from mussel culture operations in Saldanha Bay, South Africa, have been estimated as amounting to ~12.5 tons per ha of culture rafts. Fouling of shellfish farms (in particular) has become recognised as a significant threat to the aquaculture industry, as population explosions of biofouling species can result in substantial crop losses. This needs to also be considered in the case of kelp farms, as the weight of the biofouling communities may exceed the buoyancy of the arrays leading to sinking and loss of the entire array and its associated crop[10].

If not retrieved, the loss of equipment would be considered of moderate to high intensity despite it resulting in only highly localised damage to or loss of biota. Depending on the materials used in the construction of the arrays, the impact of the lost gear on the seabed would persist over the long-term, or be permanent, even though the structure would be rapidly colonised by benthic organisms.

Consequence

The determining consequence is considered MODERATE to HIGH in the unmitigated scenario.

Probability

Depending on the engineering designs, the loss of equipment under severe storm conditions is POSSIBLE.

SIGNIFICANCE

The overall significance of the impact is considered is rated as **MODERATE** to **HIGH** in the unmitigated scenario and **LOW** in the mitigated scenario.

Cumulative impacts to marine fauna and habitats of lost equipment can be expected if gear is not retrieved.

Tabulated summary of the assessed impact – Damage to and Loss of Arrays

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**M-H**	**H-VH**	**M**	**M-H**	**M**	**M-H**
Mitigated	**M**	**L**	**L**	**L**	**L**	**L**

9.4.1.2 MANAGEMENT AND MITIGATION MEASURES

- Factor redundancy and material stress into engineering designs to ensure that lost equipment will still be recoverable at or near the surface.

[10] This has however been designed for by Kelp Blue and it can be mitigated over time by adding buoyancy.

- Develop plans to ensure that the retrieval of equipment lost to the seabed is achievable and factor the costs of such retrieval into project budgets.
- Establishing a hazards database listing the type of gear lost to the seabed and/or in the pilot area with the dates of abandonment/loss and locations, and where applicable, the dates of retrieval.
- Refer to the EMP in section 10.

9.4.2 ISSUE: Operational Spills and Vessel Accidents

9.4.2.1 Assessment of impact

Nature and intensity, duration of impact & geographical extent

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.

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. 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 a 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. 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. 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, 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. 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 with no apparent effects.

In the unlikely event of an operational spill or vessel collision, the intensity of the impact would depend on (a) the amount of fuel spilled; (b) the location of a spill, i.e. whether the spill occurred in offshore waters where encounters with pelagic seabirds and marine mammals would probably be comparatively low due to their extensive distribution ranges, or whether the spill occurred closer to the shore or to an island where encounters with sensitive coastal receptors will be higher; 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. Oil spill modelling studies undertaken in the area offshore of Lüderitz identified that an operational spill of 87 tons of marine diesel remained on the water surface for a maximum of 4.6 days during which it would travel in a north-easterly direction up to 100 km from the source. The three pilot plots and the grow-out area are all situated within the NIMPA, which was designed to protect not only the breeding sites of threatened seabirds but also some of their key foraging areas, makes this area particularly sensitive to diesel / oil pollution. The greatest risk of shoreline oiling would be from a spill that occurred in the vicinity of pilot plot B2, as the diesel would travel as a narrow plume in a north-westward direction, potentially coming ashore along the coast between Staple Rocks and Ichaboe Island. Diesel spills at the other pilot plot sites are unlikely to reach the shore in the prevailing south-southeasterly winds.

Consequence

The consequence would thus be LOW in the case of diesel spills, but MODERATE in the case of heavy fuel oils, especially given that the grow-out area and one of the pilot plots are situated relatively close to islands, in areas where seabird density / traffic is therefore relatively high.

Probability

Although operational spills are POSSIBLE, vessel accidents and collisions are UNLIKELY.

SIGNIFICANCE

The significance of the impact is therefore considered **LOW** to **MODERATE** if not mitigated.

Tabulated summary of the assessed impact – Operational Spills and Vessel Accidents

Mitigation	Intensity	Duration	Extent	Consequence	Probability of Occurrence	Significance
Unmitigated	**L-M**	**L-M**	**M***	**L-M**	**L-M**	**L-M**
Mitigated	**L-M**	**L**	**L**	**L**	**L**	**L**

* Local (operational spill) to Regional (vessel accident): limited to within ~100 km of the spill site

9.4.2.2 Management and Mitigation Measures

- Ensure that vessels operate in accordance with Namibian safety regulations to minimise risks of accidents.
- 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 MET/MFMR.
- Refer to the EMP in section 10.

10 ENVIRONMENTAL MANAGEMENT PLAN

10.1 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 proposed Kelp cultivation Pilot Project.

The EMP gives the environmental commitments, which will be implemented by Kelp Blue.

10.2 KEEPING THE EMP CURRENT

Kelp Blue will conduct periodic reviews of the EMP should circumstances change.

Should a listed activity(s) as defined in the Environmental Impact Assessment Regulations: Environmental Management Act (EMA), 2007 (Government Gazette No. 4878) be triggered (as a result of future modifications/changes, i.e. the commercial scale project), this EMP will be required to be updated through another EIA process as stipulate in the EMA and its Regulations.

10.3 MANAGEMENT AND MITIGATION MEASURES (ACTION PLANS) TO ACHIEVE OBJECTIVES

The management and mitigation measures (or actions) to achieve the above-mentioned objectives, relating to the various environmental issues are listed in the Sections below.

Kelp Blue will have overall accountability for ensuring the EMP gets implemented, through contracts with local contractor(s). However, all contractors are expected to understand the EMP requirements and implement them.

Relevant monitoring requirement are stipulated in section 10.12.

10.3.1 MARINE ENVIRONMENT

10.3.1.1 INTRODUCTION OF NON-NATIVE KELP – MANAGEMENT AND MITIGATION MEASURES

- No mitigation is possible other than the no-project alternative.
- It is recommended that the potential long distance dispersal of Macrocystis by rafting be modelled with satellite-tracked drifters or using oil spill dispersal modelling software (e.g. MIKE 21/3). Such a dispersal study should be undertaken prior to start-up of the pilot phase and once the pilot plot locations have been finalized to gain a better understanding of where along the coast the kelp could potentially establish following dislodgement during storms given the correct environmental conditions. The outcome

of such a study would also provide an indication of the most appropriate stretches of coast to monitor.

- Monitoring requirements are however included in section 10.7.

10.3.1.2 Introduction of Associated Diseases, Parasites and Pests – Management and Mitigation Measures

- Ensure strict biosecurity controls are in place in all laboratory and culture facilities.
- Refer to section 10.12 for monitoring requirements.

10.3.1.3 Seawater Abstraction and Discharge at Hatchery – Management and Mitigation Measures

- Ensure installation of screens on the end of the intake pipe, or the use of a screen box or shroud.
- Adjust peak intake velocities at the hatchery seawater intakes to <0.15 m/s.
- Abstracted seawater must be treated as outlined in Annexure H of the Regulations relating to the Import and Export of Aquatic Organisms and Aquaculture Products (2010).
- Effluents released from the hatchery facility must comply with the requirements outlined in Annexure H of the Regulations relating to the Import and Export of Aquatic Organisms and Aquaculture Products (2010).
- As an alternative, the seawater and municipal water effluents could be blended to reduce salinity and discharged into the town sewage system.

10.3.1.4 Disturbance and/or Loss of Benthic Macrofauna – Management and Mitigation Measures

- Undertake a survey of the seabed at the pilot sites using geophysical (e.g. side-scan sonar, multibeam echo sounder) or remote visual (Remotely Operated Vehicle-mounted video) techniques to determine the distribution of seabed sediments and to identify any significant topographic features (e.g. rocky outcrops) or vulnerable habitats (e.g. hard grounds). The seabed survey should cover an area well in excess of the array spread thereby enabling flexibility in final positioning.
- If significant topographic features or vulnerable habitats are detected within the anchor spread area, the final position of the array should be adjusted to avoid such sensitive seabed features or habitats.

Further Recommendations:

- Use a Remotely Operated Vehicle (ROV) to survey the seafloor prior to anchoring the arrays, to identify any significant topographic features (e.g. rocky outcrops) or vulnerable habitats (e.g. hard grounds) and species (e.g. cold-water corals, sponges). The ROV survey should comprise a grid of equally spaced transects over the full extent of the required anchor spread. If significant topographic features or vulnerable habitats are detected within the anchor spread area, the position of the array should be adjusted accordingly.

10.3.1.5 Disturbance of Seabirds – Management and Mitigation Measures

- Limit any activities that could create a disturbance in the vicinity of the seabird islands, including loud, sudden noises.
- No islands may be accessed, except to retrieve lost gear that may have washed up on an island. In this case permission must be sought from the MFMR Lüderitz office.

Further Recommendations:

- Limit operations to daylight hours thereby avoiding disturbance of seabirds by vessel lights.

10.3.1.6 Entanglement Risks – Management and Mitigation Measures

Seabirds

- Materials used for the arrays in the grow-out area and the three pilot plots should be “seabird-friendly”. Nylon twine used for seeding kelp in the grow-out area should not be too thin to minimize the risk of it (a) breaking off the array and drifting off, and/or (b) forming dense balls that could increase an entanglement risk. Seeding twine should be wrapped tightly around ropes, remain under tension and not become loose and form loops that could trap seabirds diving through the array.
- Choose twine and rope material carefully. Materials to be used should (a) be thick enough to limit tangling into shapes in which seabirds could become entangled and (b) not be prone to produce loose strands that break off easily.
- Ensure regular inspection of arrays / seeding ropes and prompt replacement of damaged ropes / twine before they become an entanglement hazard.

Marine Turtles and Marine Mammals

- All mooring hawsers, rope arrays and ropes to floats should be rigid or under constant tension.

- Install navigational warning devices (e.g. buoyed radar reflectors) marking the outer boundaries of the arrays. These should be of a design which ensures constant tension or preferably rigid links to the raft ("pencil buoys").
- Space mooring lines / blocks to be placed more than 25 m apart.

10.3.1.7 Biological Impact on stocks and stock recruitment – Management and Mitigation Measures

- Apply the precautionary principle to the development of the offshore kelp farms by managing the scale of future operations conservatively thereby avoiding potential irreversible impacts over large areas of the NIMPA.
- Implement systematic monitoring of the ecosystem using reliable ecosystem indicators (see section 10.7).

10.3.1.8 Noise and Pollution Effects – Management and Mitigation Measures

- Ensure that operational discharges are undertaken in a manner consistent with good international industry practice and in compliance with the applicable requirements in MARPOL 73/78, regardless of the size of the vessel, and in compliance to the local legislation.
- Ensure that all wastes generated on board are stored in dedicated, clearly labelled, containers (bins, skips, etc.) and frequency removed to a licenced land-fill site.

10.3.2 Heritage

10.3.2.1 Damage to archaeological resources (shipwrecks, etc.) - Management and Mitigation Measures

- Undertake a survey of the pilot sites to determine if there are any shipwrecks and other archaeological and historical remains on the seabed.
- Consult a qualified Archaeologist to confirm most appropriate survey and to advice on the survey results.
- If significant archaeological shipwrecks / remains are found within the anchor spread area, the final position of the array should be adjusted to avoid such sensitive remains features or habitats.
- In the event that archaeological resources are discovered during the installation of the arrays or during the harvesting activities, 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; and

- An appropriate heritage specialist will be appointed to assess the find and related impacts.

- 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 Pilot Project development should be reported to the National Heritage Council.

10.3.3 SOCIO-ECONOMIC

10.3.3.1 EMPLOYMENT – MANAGEMENT AND MITIGATION (ENHANCEMENT) MEASURES

- Use local Namibian / /!Nami‡Nûs constituency/ ǁKaras Region / Lüderitz suppliers of goods and services where possible.
  - Include local service providers in the tendering process for supplies and services
  - Ensure that strategies and programmes are in place prior to construction which maximise use of the local labour force during construction and operations.
  - Give hiring priority to suitably qualified or experienced Namibian citizens (locals), as positions become available
- Pay fair salaries and wages.
- Be gender sensitive and select women for interview, training and recruitment, where possible.
- Promote continuous learning programmes to diversify and upgrade skills of employees.
- Ensure a comprehensive HIV, AIDS, TB and COVID-19 workplace policy and wellness programme which will detail relevant prevention measures in the workplace and enable easy access to AIDS treatment, care and support for employees is developed and implemented.
- Promote public health and safety by supporting the Ministry of Health and other stakeholders' initiatives to reduce the spread of communicable diseases such as sexually transmitted diseases, including HIV, TB and malaria and COVID-19 by organising awareness programmes, ensuring that codes of conduct for workers are implemented and adhered to, and by promoting healthy lifestyles and in their health campaigns.
- All Kelp Blue work areas will be operated as alcohol-free and drug-free areas. Random alcohol and drug testing of employees and contractors may be conducted upon entry to site(s.

Further Recommendations:

- Liaise with the "Luderitzbucht Foundation" (voluntary Association) who's aims and objectives "are to promote, encourage, support and contribute towards the continued existence and development of Lüderitz and its surrounding region, and aim to revitalize communication between governmental departments, commerce and industry and the local population on matters of existing and future planning", amongst others (Luderitzbucht Foundation, 1980).

10.3.3.2 Interaction with Marine Traffic – Management and Mitigation Measures

- Ensure that normal maritime traffic rules are followed at all times and that Port Authority conditions are applied.
- Negotiations around usage of water area and the exact location of grow-out and pilot areas is the mandate of the Port and Namibian transport authorities.
- Ensure that suitable navigational warning devices (e.g. buoyed radar reflectors) are installed to mark the outer boundaries of the arrays.
- Prior to array installation inform the Namibian Ports Authorities and the SAN Hydrographic Office at Silvermine to put out Radio Navigation Warnings throughout the operational period, and to publish particulars of the array locations in the Notices to Mariners.
- Consider moving Pilot Plot A further west to avoid interaction with the traffic route heading south.

10.3.3.3 Interaction with the Rock Lobster Fishery – Management and Mitigation Measures

- Consult with the rock-lobster fishing industry before finalising the position of the arrays to ensure there is no conflict between array location and potential fishing target areas.

10.3.3.4 Interaction with the Line-Fishery – Management and Mitigation Measures

- Consult with the linefishing industry before finalising the position of the arrays to ensure there is no conflict between array location and historical linefishing target areas, specifically areas of historical groundfishing.

10.3.3.5 Interaction with Existing and Future Mariculture Operations – Management and Mitigation Measures

- Implement the preferred location for the grow-out area in Shearwater Bay.
- Consult with the mariculture industry before finalising the position of the grow-out area to ensure there it does not displace existing mariculture operations;

- Ensure that the design of the grow-out area allows for integration into the current designated water areas without negatively impacting existing mariculture production.

10.3.3.6 Interaction with Diamond Mining – Management and Mitigation Measures

- Consult with the diamond mining licence holders before finalising the position of the arrays to ensure there is no conflict between array location and potential diamond resources.
- The mining companies are also likely to be in possession of detailed bathymetry and sediment texture maps, which would assist Kelp Blue in the most appropriate positioning of the arrays in the selected pilot areas.

10.3.4 Land-based activities

10.3.4.1 Waste and sewage management

- Ensure proper removal of waste from site and disposal at licensed disposal site. Obtain records of safe disposal.
- All general waste will be separated according to type and disposed of according.
- Recycling will be promoted on site.
- Bins with labels according to waste type, and with lids in order to prevent wind-blown litter, will be provided at strategic locations through the site and will be emptied regularly in order to ensure no overflows.
- No littering will be permitted.
- Ensure all onshore working areas have proper toiler facilities. Provide proper mobile toilet facilities, which are regularly marinated at the pilot arrays assembly area.

10.3.4.2 HYDROCARBONS SPILLS

- Ad hoc spills will be cleaned up/remediated immediately
- Safely dispose of hydrocarbon contaminated material
- Ensure that checking for hydrocarbon spills is included in the daily inspections.

10.3.4.3 Noise, Dust & Odour

- Develop a grievance procedure which it will publicise to neighbours and relevant stakeholders, so that issues and concerns can be addressed adequately and promptly.
- To reduce the noise impact of mobile equipment the following recommendations apply:
    - All diesel-powered equipment and plant vehicles should be kept at a high level of maintenance.

  - Avoid unnecessary revving of engines and switch off equipment when not required.
  - Audible reversing warning systems on mobile plant and vehicles should be of a type which, whilst ensuring that they give proper warning, have a minimum noise impact on nearby sensitive receptors.

10.3.5 Unplanned Events

10.3.5.1 Damage to and Loss of Arrays – Management and Mitigation Measures

- Factor redundancy and material stress into engineering designs to ensure that lost equipment will still be recoverable at or near the surface.
- Develop plans to ensure that the retrieval of equipment lost to the seabed is achievable and factor the costs of such retrieval into project budgets.
- Establishing a hazards database listing the type of gear lost to the seabed and/or in the pilot area with the dates of abandonment/loss and locations, and where applicable, the dates of retrieval.

10.3.5.2 Operational Spills and Vessel Accidents – Management and Mitigation Measures

- Ensure that vessels operate in accordance with Namibian safety regulations to minimise risks of accidents.
- 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. The plan should also include:
  - Details on the required incident reporting structure;
  - Basic wildlife response protocols;
  - Emergency contact list (regularly updated);
  - List of available equipment (including dispersants) and its location.
- 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 MET/MFMR.

10.4 INTERNAL REVIEW AND AUDITING

An internal review process and procedure shall be established Kelp Blue to monitor the progress and implementation of the EMP.

As Kelp Blue will ensure regular inspections and audits are carried out, throughout the stages of the Pilot Project development.

10.4.1 EMP Compliance

- Ensure that a copy of the EMP is provided the all contractors.
- Conduct and record monitoring of EMP compliance.
- Compile and submit Bi-annual environmental reports to MET.

10.5 ENVIRONMENTAL AWARENESS TRAINING

Before the commencement of relevant activities relating to the Pilot Project, Kelp Blue shall ensure environmental awareness-training (relating to the commitments of the EMP) are provided to all contractors and employees.

10.6 PERMITS AND OTHER REQUIREMENTS

- Application for Aquaculture Licence.
- Application for an abstraction and discharge permit for any effluents released from the laboratory (hatchery) to the marine environment from the Ministry of Agriculture Water and Land Reform's (MAWL) - Department of Water Affairs (DWA).
- Comply with relevant legal requirements (refer to the list of relevant legislation / regulations in section 4), e.g. the Regulations relating to the Import and Export of Aquatic Organisms and Aquaculture Products (2010) covers the permitting requirements and conditions for the import and export of aquatic organisms
- 'Clearance' from NamPort for the development in or around the port precinct (i.e. grow out area) and other port related activities (where relevant).

10.7 MONITORING

10.7.1 Laboratory activities

- Considering the potentially substandard quality of the seawater in Lüderitz, regularly monitor the quality of the intake water for the laboratory / hatchery activities and ensure that filtration systems are functioning effectively.

10.7.2 Introduction of Non-native Kelp

As the *Macrocystis* canopy floats, beds developing in shallow water would generally be visible, either from the shore or from the air, particularly at low spring tide. The potential establishment of *Macrocystis* along the coast of the pilot project area should be monitored in the following ways:

- At selected sheltered bays within and to the north and south of the pilot project area, regularly check the kelp canopy at low spring tide for the appearance of *Macrocystis*. Permission to access the diamond areas would be required.
- Check the coastline within and to the north and south of the pilot project area during a low spring tide from a microlight/helicopter or using a camera/video-mounted drone. Permission to fly over the diamond areas would be required.
- Should developing *Macrocystis* stands be identified, these should be physically removed. This would require removal of the entire sporophyte, especially the holdfast and haptera as these are able to regenerate new individuals.
- Distribute “wanted” posters and information pamphlets around Lüderitz town and accommodation facilities to alert visitors and/or recreational marine users in the area of the potential occurrence of *Macrocystis*. If Giant Kelp is found, the location must be recorded and a sample collected to be brought back to MFMR/Kelp Blue offices for identification and further investigation. Such citizen science initiatives, in possible combination with the incentive of a small promotional gift (e.g. Kelp Blue cap/pin), can yield valuable information.

10.7.3 Further monitoring requirements relating to Kelp Cultivation

- Monitor the developing crop regularly for any sign of disease or parasites.
- Consider incorporating a section on quantifying the production of marine litter that may entangle seabirds into general monitoring protocols.
- Monitor and report on the incidence of seabird entanglements during the pilot phase of the project.

- Line, cable, rope and twine tension to be monitored regularly.
- Regularly inspect the arrays for the establishment of biofouling organisms and quantify the abundance, biomass and species diversity of colonising benthos on the arrays and on the kelps themselves.
- Monitor the wear and tear of ropes and twine used on the arrays – specifically the incidence of twine and rope strand loss and potential of wrapped twine getting loose and making loops. Detailed monitoring protocols and schedules should be drawn up.
- Set up a regular (monthly and replicated) monitoring programme to establish nutrient availability and uptake by the arrays relative to a ‘control’ area. This should include:
    - Water samples from within, upcurrent and down current of the array(s) and from suitable control areas, to establish nitrogen and phosphorus flux;
    - Nitrogen, carbon and phosphorus content of different portions of the kelp plant;
    - Growth rates (increase in length) of marked kelp uprights (this would be necessary information if considering upscaling of the operation);
    - Tagging and regular measurement of many uprights to give estimates of monthly loss rates.
- Set up a regular (monthly and replicated) monitoring programme to establish plankton abundance, biomass and species richness within each plot and at selected sites at increasing distance from the array(s).
- Set up a regular (biannual and replicated) monitoring programme to establish changes in sediment structure and abundance, biomass and species richness of macrofaunal communities in/on the seabed beneath the array(s) and at selected sites at increasing distance from the array(s).
- Use satellite remote sensing data (before/after) to determine changes in chlorophyll concentrations in response to the presence of the arrays. There are also various proxies to get nutrient levels from satellite data, which could show whether a large system in place was affecting surface nutrients to a major extent.
- Consider monitoring rock lobster puerulus settlement and recruitment within the cultivation array to determine the potential for the forests to enhance local rock lobster populations. If positive enhancement could be demonstrated this would be a strong public relations opportunity for the company.

- Record all seabird, turtle and marine mammal entanglement incidents and ensure that suitable disentanglement protocols are in place and that any entanglement incidents are accurately recorded and the data submitted monthly to the MFMR.
- Implement systematic before-after/control-impact monitoring of the ecosystem using reliable ecosystem indicators. This could include the following:
    - 1) benthic habitat indicators (e.g. sediment structure, abundance, biomass and species richness) to measure changes in/on the seabed beneath the array(s) and at selected sites at increasing distance from the array(s),
    - 2) biochemical indicator of the water column (e.g. dissolved oxygen, nitrate levels, particulate organic carbon), and
    - 3) pelagic communities indicator (e.g. video monitoring of certain fish species, seabirds and marine mammals associated with the arrays relative to open-water areas).
- Consider partnering with UNAM/NUST to conduct Honours level projects related to monitoring some of the environmental aspects that might highlight unexpected ecological changes and would be of relevance should the project advance to a full-scale commercial phase. This could include monitoring projects on:
    - lobster recruitment in the new kelp beds;
    - fauna and flora settlement / ecological succession / community structure on arrays;
    - use of the kelp beds by seabirds, turtles and mammals;
    - use of kelp beds by fish;
    - incidence of entanglements;
    - settlement and biomass of fouling organisms.
- Empirical measurements undertaken during the pilot phase, will provide opportunity to model the major potential impacts of a full-sized farm on the nutrient conditions in the region. Similarly data of the nitrogen flux in the region where the rafts are situated would allow calculation of the proportion of that nitrogen likely to be taken up by the artificial kelp forests, thereby estimating the relative impact of the system in the nutrient dynamics of the regions where it is situated.

10.8 DECOMMISSIONING

Being located in the NIMPA, it is critical that the pilot arrays be completely removed at the end of the test phase or at the end of the life span of the structures (estimated at >12 years) should the project not prove feasible.

Whereas the anchor blocks could be left on the seabed to serve as artificial reefs, all chains, ropes, floats, array frames etc. would need to be effectively removed at the end of the project. Ease of removal during decommissioning should therefore be factored in during the engineering design phase of the project.

10.9 RESPONSIBILITIES

The Kelp Blue Management Team shall ensure compliance to this EMP. The EMP will be part of the contract with all contractors working on the Pilot Project. Management will ensure:

- To implement all provisions of the EMP. If the contractor(s) encounters difficulties with specifications, he / she must discuss this with Kelp Blue.
- To ensure that all staff are familiar with the EMP.
- To make personnel aware of environmental issues and to ensure they show adequate consideration of the environmental aspects of the project.

11 WAY FORWARD

The way forward is as follows:

- Submission of the final report (including I&APs' comments) to MFMR and MEFT for their review and decision.

12 ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSIONS

The direct ecological effects of a pilot farm for the offshore cultivation of *Macrocystis* are expected to be small, due to the limited size of the operation. Its restricted occurrence in the Southern Benguela suggests that *Macrocystis* is unlikely to become so well established in the natural environment off central Namibia that it may pose a competitive threat to local kelp species. Diseases and pathogens are typically species specific and only develop in the adult crop after many years of intense cultivation. Any negative effects on seabed communities of the placement of the anchor blocks will with time be offset as the blocks will provide an alternative hard substrate to other mobile and sessile benthic species. Being 'ecosystem engineers' the floating *Macrocystis* forests would create their own microecosystem, providing shelter, feeding and nursery areas for a highly diverse associated fauna. By extracting nutrients from the water column, there may however be localised changes in plankton abundance and diversity in the vicinity of the arrays, and changes in sediment properties and benthic communities below the arrays due to biodeposition.

On a limited scale the positioning of the pilot plots may result in conflicts with diamond mining licence holders, vessel traffic and fisheries. As fishing is a high risk industry with many economic constraints, any development that may impact on fishing will increase the risk to both the fishery operations as well as potentially having associated biological impacts to the commercial fish stocks (leading to reduced catch rates).

The design of the arrays and their positioning at ~ 20 m depth should ensure that entanglement by marine fauna would be minimal, with highest risks occurring during installation or in the unlikely event of array failure and loss. It is, however, crucial that materials used in the pilot plots are rigorously tested in order to gauge the wear and tear of the design (and with that the potential for creating entanglement opportunities for marine animals) and the likelihood of losing arrays in rough sea conditions.

A Precautionary Approach to the offshore cultivation of giant kelp is advised with regard to the scale of any development until such time as the technical, oceanographic and environmental impacts of the pilot project and any future expansion is understood.

In terms of fuel pollution, provision needs to be made to effectively manage even a small fuel spill – especially if it involves heavy fuel oils. Cognisance needs to be taken that the equipment required to contain a spill (booms, assisting vessels, dispersants) is more readily available closer to Lüderitz and that attending to a spill further offshore could prove more of a challenge.

It is Namisun's opinion that the environmental aspects and potential impacts relating to the proposed Kelp Blue Namibia Pilot Project has been successfully identified and assessed as part of this EIA process. Relevant management and mitigation measures have been provided to ensure significant environmental and social impacts are avoided / minimised and positive social impacts enhanced, where relevant. These measures are included in the EMP (section 10 of this report).

The following aspects and their potential impacts have been assessed:

- Potential impacts on the Marine Environment, relating to the following:
    - Biosecurity risks of introducing non-native kelp;
    - Biosecurity risks of introducing associated diseases, parasites and biofouling pests to the Benguela;
    - Seawater abstraction and discharges from the land-based hatchery;
    - Disturbance of benthic habitats and associated communities;
    - Disturbance of marine mammals and seabirds;
    - Noise and pollution effects from machinery;
    - Marine mammal and turtle entanglement risks in ropes and buoys;
    - Seabird entanglement in disintegrating rope strands / twine;
    - Habitat creation and/or exclusion and physical presence of floating structures in the pelagic realm;
    - Effects on seawater nutrient chemistry and clarity;
    - Alteration of plankton community structure around arrays;
    - Biodeposition of detritus below the arrays and associated changes to physico-chemical and biological properties of the sediments;
    - Disturbance of seabirds;
    - Biological impacts on fisheries and mariculture stocks and recruitment;
- Unplanned Events, i.e. storm damage and/or loss of arrays; and pollution and accidental spills.
- Heritage impacts (i.e. shipwrecks), and
- Socio-economic impacts (positive and negative), including the following:

- Fishery operational impacts including navigation (rock lobster and line fisheries); and
- Hazard to marine traffic and conflict with other users.

A summary of the assessment findings is presented in Table 14 below.

TABLE 14: SUMMARY OF POTENTIAL IMPACTS ASSOCIATED WITH THE PROPOSED PILOT PROJECT

Potential Impact	Significance	
	Before mitigation	**After mitigation**
Marine Environment		
Introduction of Non-native Kelp into the Lüderitz area	M	L-M
Introduction of Associated Diseases, Parasites and Pests	L	L
Seawater Abstraction and Discharge at Hatchery	L	L
Disturbance and/or Loss of Benthic Macrofauna	M-H	M
Disturbance of Seabirds during Installation, Operation and Decommissioning	L	L
Habitat Creation and Alteration of Plankton Community	H+	H+
Alteration of Plankton Community	L	L
Biodeposition and Changes to Sediment Properties	L	L
Namibian Islands' Marine Protected Area	L	L
Biological Impact on stocks and stock recruitment	L	L
Noise and Pollution Effects	L	L
Heritage		
Damage to archaeological resources (shipwrecks, etc.)	M-H	L
Socio-Economic		
Interaction with Marine Traffic	M	L
Interaction with the Rock Lobster Fishery	M	L
Interaction with the Line-Fishery	M	L
Interaction with Diamond Mining	M	L
Unplanned Events		
Damage to and Loss of Arrays	M-H	L
Operational Spills and Vessel Accidents	L-M	L

Namisun believes that a thorough assessment of the proposed Pilot Project has been achieved and that an environmental clearance certificate could be issued on condition that the management and mitigation measures in the EMP be adhered to.

Should Kelp Blue find all relevant aspects of the Pilot Project to be feasible and they plan to proceed with the Commercial Scale Project, a separate EIA (application) process will have to be conducted, taking cognisance of the risks identified by the Environmental Team during the execution of the EIA for the Pilot Project.

13 REFERENCES

Note:

Various references were made in the Marine Specialist Report (see below), which was not repeated in this report. For the detailed list of references refer to sections 5 and 8 of the Marine Specialist Report (Appendix F).

FROEHLICH, H.E., AFFLERBACH, J.C., FRAZIER, M. & B.S. HALPERN (2020, IN PRESS) BLUE GROWTH POTENTIAL TO MITIGATE CLIMATE CHANGE THROUGH SEAWEED OFFSETTING. CURRENT BIOLOGY HTTPS://DOI.ORG/10.1016/J.CUB.2019.07.041

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APPENDIX A: CURRICULUM VITAE

APPENDIX B: INFORMATION SHARING RECORD

APPENDIX C: MINUTES OF MEETINGS

APPENDIX D: I&AP DATABASE

APPENDIX E: ISSUES & RESPONSE REPORT

APPENDIX F: MARINE SPECIALIST REPORT