APPENDIX 1A

FISHERIES, MAMMALS AND SEABIRDS

NAMIBIAN MARINE PHOSPHATE (PTY) LTD

Sandpiper Project

Proposed recovery of phosphate enriched sediments from the Marine Mining Licence Area No.170 off Walvis Bay Namibia.

Environmental Impact Assessment Report for the Marine Component

Prepared by:
Mr. Jeremy Midgley (Pr.Sci.Nat)
J Midgley & Associates
In association with:
Enviro Dynamics
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ENVIRO DYNAMICS

March 2012

Mr. D Japp: Fisheries, Mammals and Seabirds

Capricorn Fisheries Monitoring cc
PO Box 50035
Waterfront 8002
South Africa

SPECIALIST STUDY NO. 1A:

Marine Specialist Study for a Proposed Development of Phosphate Deposits in the Sandpiper Phosphate Licence Area off the Coast of Central Namibia

Capricorn Fisheries Monitoring

Project:

The Dredging of marine phosphate enriched sediments from Mining Licence Area No. 170

Date:

March 2012

Prepared for:

Namibian Marine Phosphate (Pty) Ltd.

Prepared by:

M. J. Smith (CapFish)
D.W. Japp (CapFish)
Dr T. Robinson (Stellenbosch University)

Declaration:

I, *D.W. Japp* of Capricorn Fisheries Monitoring, do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the South African Environmental Impact Assessment Regulations, 2010

summary

A broad overview of Namibia's marine resources and commercial fisheries is presented. Five primary impacts of the proposed Sandpiper phosphate mining are suggested. These are: 1) the likely impact of mining on commercial fisheries; 2) the likely impact of mining on the main commercial fish species; 3) the likely impact of mining on the recruitment of commercially important species; 4) the likely impact of mining on fish biodiversity and 5) the likely impact of mining on seabirds and marine mammals.

We conclude that the impact on Namibian fisheries will vary depending on the sector. Overall the significance of impact on the fishery sector is considered to be negative and of medium to low significance. Of the main commercial fisheries, the monk-directed trawl fishery will be most impacted. The dredging will potentially cover a significant portion of the historical monk trawling grounds. It is estimated that based on the historical catch in the actual Mining Licence Area, 0.86% of the hake trawl, 0.32% of the midwater horse mackerel and 6.34 % of the monk trawl fisheries will be impacted (with a displacement and mortality of the resource in the actual area mined i.e. SP-1, SP-2, SP-3). Impact on the commercial fisheries catch in the actual mined areas (SP1, SP2 and SP3) will be low (< 0.05%), except for the monk trawl fishery where it is expected that about 1% of the historical catch will be directly impacted in SP-2 and 0.08% in SP-3 (zero % in SP-1). Commercial fishing operations are not expected to be directly impacted in a broader area extending outside the MLA to within a 25 km zone from the MLA margins (defined as the "Mine Site"). The impact in this zone is not expected to have a major effect on commercial fishery catch. There will however be an indirect impact relating to vessel movements and fishing vessel operations due to the proximity of the mining operations to these fishing grounds. This indirect impact relates primarily to vessel movements and normal trawling patterns with vessels expected to maintain a safe working distance from the MLA as well as having to trawl along tracks that may vary from historical effort in the zone. In this regard it is expected that based on recent historical catch and effort data in the MLA and Zone 1, 5.03% of hake trawl catch, 1.08% of horse mackerel midwater trawl catch and 19.75% of monk historical catch will be indirectly affected. Note this does not imply that this proportion of catch will be lost but that the fishery in this area will in some way have to adjust normal fishing operations. The hake trawl and longline fisheries will also lose fishing grounds although this is unlikely to happen in the first phase of dredging in the SP-1 mining area.

Of the other main fisheries, which include horse mackerel and other small pelagic species, the mining area does not overlap significantly with the grounds fished. Further, the nature of the gear deployed (mid-water and purse seine) is such that less interaction with the dredging is expected.

The impact of the proposed mining on the broader ecosystem, in particular the fish fauna will on average be moderate. The mining will displace fish resources and essential habitat occupied by these resources (such as monk, gobies, hake and others). In particular, gobies have been identified as a key forage feeder in the mining area and are also a key trophic species. Significant alteration of the ecosystem characteristics only in the immediate target mining sites is expected. Any expansion of the proposed dredging will significantly alter the potential to impact on the broader ecosystem.

There is an obvious impact in the immediate area of the mining which is serious and likely to be permanent (or at least > 20 years) – that is the physical removal and destruction of substrate. In particular monk recruitment is likely to be impacted although the significance and extent is difficult to state conclusively. Otherwise we could find no major impacts on fish recruitment. Factors such as sediment plumes are not expected to significantly affect recruitment as the mining operation is small and the plumes will disperse quickly over a short distance. Analysis of the available data also suggests that spawning and egg and larval abundance is not concentrated in or near the MLA. Hake juveniles are abundant in the depth range of the MLA, however their mobility will mitigate impacts (unlike for monk that are less mobile). These conclusions are however dependent upon the quality of the data available which in most instances do not coincide directly with the MLA but have had to be extrapolated to include the MLA.

With regard to biodiversity, the impact in the immediate mining area will be severe and will result in loss of fauna. There is no evidence to suggest that the mining will result in a permanent loss of biodiversity, assuming there are no species unique to the area to be mined. In this regard a precautionary approach is recommended since little is known of the biodiversity in the Mining Licence Area and as with fish recruitment, is data poor and requires extrapolation and assumptions on the status of the resources in the MLA

With regard to the third impact identified, that is the impact of fish recruitment, we consider the impact to be low relative to the total recruitment area in Namibian waters. There is an obvious impact in the immediate area of the mining which is serious and likely to be permanent (or at least > 15 years) – that is the physical removal and destruction of substrate. In particular monk recruitment is likely to be impacted although the significance and extent is difficult to state conclusively. Other factors such as sediment plumes are not expected to significantly affect recruitment as again, the mining operation is small and it is assumed the plumes will disperse quickly over a short distance. Most data suggest that spawning and egg and larval abundance is not concentrated in or near the Mining Licence Area. Hake juveniles are abundant in the depth range of the MLA, however their mobility will mitigate impacts (unlike for monk that are less mobile). We stress that our data are based on the best available information (mostly surveys) that do not necessarily represent the biological situation throughout a full year.

The final impact relates to seabirds and marine mammals. Mining, although localised, will result in modification of behaviour of mammals and seabirds. Small marine mammals e.g. dolphins and seals, may be attracted to the mining area, although this behaviour is unlikely to persist and to be negative. Large mammals, e.g. whales most of which are transient, will occur in the area but are also likely to avoid the mining area due to the activity. Noise levels from the dredging may also affect behaviour, but we have no firm conclusion on this impact which requires a specialist response.

Seabirds will also interact with the mining. The exact nature and extent of this interaction cannot be determined conclusively due to data paucity. For this reason we rate the impact on birds and mammals as negative but cannot judge the likely intensity or significance. Bird mortality associated with bird strikes will require mitigation.

With regard to likely vessel activity in the MLA, the monk fishery is expected to be the most active. To a lesser extent the hake trawl, horse mackerel, small pelagic and hake longline fisheries will be active in the MLA and surrounding area.

There are no realistic options to mitigate these impacts (apart from no directed mining). The accommodation of the needs of the monk fishery through a mutually agreed access operational plan should be given consideration.

Due to the small scale of the proposed dredging operations in the context of the larger ecosystem and extent of the marine resources it is unlikely that it will be possible to discriminate a clear signal relating to ecosystem change as a result of dredging (primarily due to the natural variability within the ecosystem).

In the short term both MFMR and the mining lease operator should establish appropriate monitoring line(s) through the Mining Licence Area to monitor the effects of dredging on a real-time basis (possibly coinciding with established surveys).

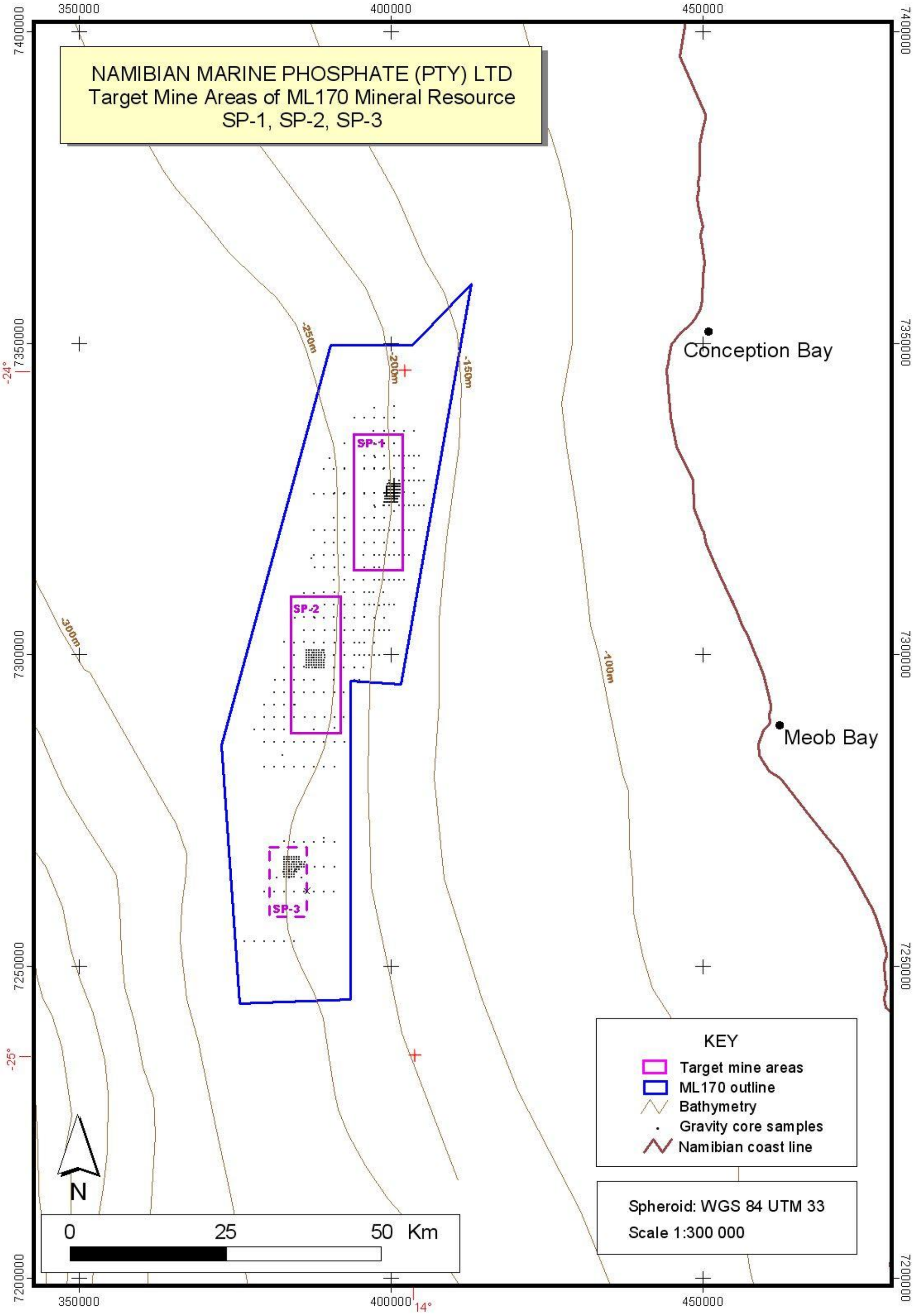
Given the number of industrial mineral EPLs that have been granted in the area between Walvis Bay and Lüderitz consideration should be given to requesting that the Benguela Current Commission incorporate into their Strategic Environmental Assessment of the mineral sector of the Benguela an ecosystem study of the potential impacts of dredging.

glossary of terms and abbreviations

Benthic	Occurring on the seafloor
Benguela Ecosystem	The region along the South African, Namibian and Angolan coasts influenced by the cold Benguela Current. The system is typified by coastal upwelling and high productivity.
CPUE	Catch Per Unit Effort
Demersal	Occurring near the seafloor.
Ichthyofauna	The assemblage of fish species occurring in a certain area
Ichthyoplankton	Eggs and larvae of fish, floating new born fish before they can adequately swim by themselves
JNCC	Joint Nature Conservation Committee
MFMR	Ministry of Fisheries and Marine Resources (Namibia)
MLA	Mining Licence Area
NatMIRC	National Marine Research Center
Pelagic	Occurring in the middle or surface layers of the ocean
Upwelling	The process where by wind-driven surface waters are replaced by cool nutrient rich waters
SP-1	Sandpiper Mining area No. 1 (as well as SP-2 and SP-3)
TAC	Total allowable catch

ACKNOWLEDGEMENTS

CapFish would like to acknowledge the support of the Ministry of Fisheries in Namibia, especially the scientists and staff who provided the necessary data. The Namibian fishing industry have also been extremely proactive while undertaking this assessment and are thanked for supporting Dr Kirchner to facilitate the acquisition of data for this assessment. Lastly, the persistence and support of Jeremy Midgley who coordinated this work was much appreciated.



Frontispiece: Location of the Mining Licence Area MLA 170, indicating the initial target mining areas of the Sandpiper deposit (SP-1, SP-2 and SP-3) of the mineral resource area.

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Tables and Figures

1 INTRODUCTION

Namibian Marine Phosphate (PTY) Ltd has identified the existence of a high grade phosphate deposit on the Namibian continental shelf. This deposit lies approximately 40-60 km offshore from Conception Bay in water depths of 190 to 300m. Within the context of increasing international demand for phosphates, the company has been granted a mining licence, subject to the completion of an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) to develop this resource. It is currently estimated that a total resource of 2443 Mt at 15 % P_2O_5 exists. This places Namibia as the country holding the seventh largest phosphate resource.

This specialist study was undertaken to assess the possible impacts of the proposed mining of the phosphate resource on fish, fisheries, seabirds and marine mammals. Impacts are expected to occur during the development, actual operation and decommissioning stages.

The information in this report includes the available scientific and other literature available in the region as well as direct information gained from scientists specialising in particular areas of marine and fisheries interest. To evaluate the potential environmental impacts, fish survey data and commercial fishing data, from the Namibian Ministry of Fisheries and Marine Resources (MFMR) were used to show the distributions of fish and fishing effort in relation to the Mining Licence Area (MLA) or ML-170. The distribution maps were created in ArcGIS 9 and show the position of the MLA with target mining areas (SP-1, SP-2 and SP-3) overlaid.

The mining licence (granted for 20 years) covers an area of 2233 km^2. The company proposes to recover 5.5 Mt of phosphate enriched sediments from an area of approximately 3 km^2 annually, this is an area of 60 km^2 over the granted period of the mining licence. These sediments are to be recovered from the target mine areas of the mineral resource which are described by SP-1 (Sandpiper-1), SP-2 (Sandpiper-2) and SP-3 (Sandpiper-3), (Frontispiece). SP-1 and SP-2 are each of 22 x 8 km (176 km^2) and SP-3 11 x 6 km (66 km^2) are the focus areas for sediment recovery using Trailing Suction Dredge Technology.

To quantify the extent of the impacts resulting from phosphate mining on fish, fisheries, marine mammals and seabirds we used six impact zones *viz.*

- Within the MLA (including target mining areas SP-1, SP-2 and SP-3),
- The MLA (whole area inclusive of SP-1, SP-2 and SP-3)
- Zone 1 : From MLA margin to 25 km boundary,
- Zone 2 : Local (25 -50 km),
- Zone 3 : Regional (50 -100km) and
- Zone 4 : National (>100 km)

For each impact zone the percentage of catch and fishing effort was calculated and used to help assess the significance of the impacts (Table 1a - c refers). This report follows a pre-defined format that first provides an overview of the species and fisheries in the affected marine system followed by a technical analysis of the zones, results and conclusions. The analysis and report preparation was undertaken by CapFish consultants (M. Smith, S. Wilkinson and D. Japp). In addition to the expertise within CapFish, specialists in different fields were also consulted. These included:

- Dr S. Elwen, Namibian Dolphin Project, Mammal Research Institute, University of Pretoria (Marine Mammals)
- Professor M.J. Gibbons (University of the Western Cape),
- Dr T. Robertson, Marine Biologist (University of Stellenbosch)
- Dr Carola Kirchner - Fisheries Consultant, Namibia

1.1 ASSUMPTIONS AND LIMITATIONS

This analysis and environmental risk assessment is based on the available literature and the data supplied mostly by the Namibian Ministry of Fisheries and Marine Resources (MFMR), in particular scientific staff of the research branch of MFMR the National Marine Research Centre (NatMIRC), based in Swakopmund.

Because of the extent of the environment under consideration assumptions may need to be made based on a broad understanding of the Benguela Ecosystem. Data provided are often limited in extent and may have spatial and temporal bias due to the sampling methods used.
The information provided by the fishing industry as well as Interested and Affected Parties is also acknowledged.

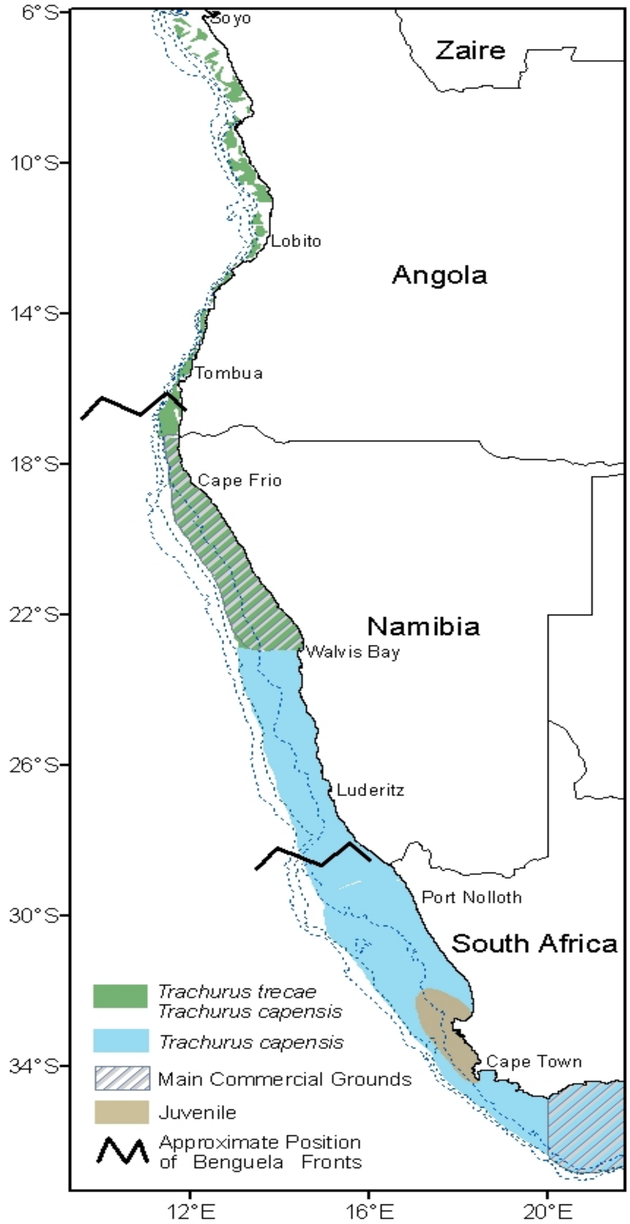

Figure 1. Distribution of horse mackerel in the Benguela region

2 OVERVIEW OF ICHTHYOFAUNA OF NAMIBIA

Supported by the high productivity of the Benguela upwelling ecosystem, abundant fish stocks typify Namibian waters. Fish resources in upwelling systems are typically high in biomass and relatively low in diversity (relative to non-upwelling environments). These stocks have traditionally supported intensive fishing activities. Although varying in importance at different times in history, fisheries have focused on demersal species, small pelagic species, large migratory pelagic fish, linefish (caught both commercially and recreationally) and crustacean resources (e.g. lobster and crabs). The following chapter is a review of the ecologically important species that may be affected by mining of marine phosphate in Namibia. For each species the spatial distribution, recruitment to the commercial fisheries and spawning behaviour are considered.

2.1 PELAGIC FISH SPECIES

2.1.1 Horse mackerel

Off Namibia horse mackerel *Trachurus trachurus capensis* generally occur in waters between 200 – 1000 m depth (Crawford *et al.* 1987) (Figure 1). Adults are found mostly north of 21°S. Here spawning is highest between October and March in the mixing zone between warm oceanic water and cool coastal waters (O'Toole 1977). Nursery grounds exist adjacent to these spawning grounds but closer to shore. Juveniles migrate south to Walvis Bay especially in winter. Maturing fish then move offshore and migrate north to spawn (Boyer and Hampton 2001a). Horse mackerel of up to two years of age feed predominantly on zooplankton that they consume near the sea surface. Research in the 1980s found that off Namibia 95% of the diet of adult horse mackerel comprised euphausiid shrimps (Konchina 1986 cited in Boyer and Hampton 2001a). This is in contrast to horse mackerel occurring off South Africa which feed opportunistically on euphausiids, polychaete worms, squid, crustaceans and fish such as bearded goby *Sufflogobius bibartus* (Konchina 1986 cited in Boyer and Hampton 2001a). Since the trophic structure of the northern Benguela system off Namibia has altered substantially in the last two decades (Kirkman 2007,

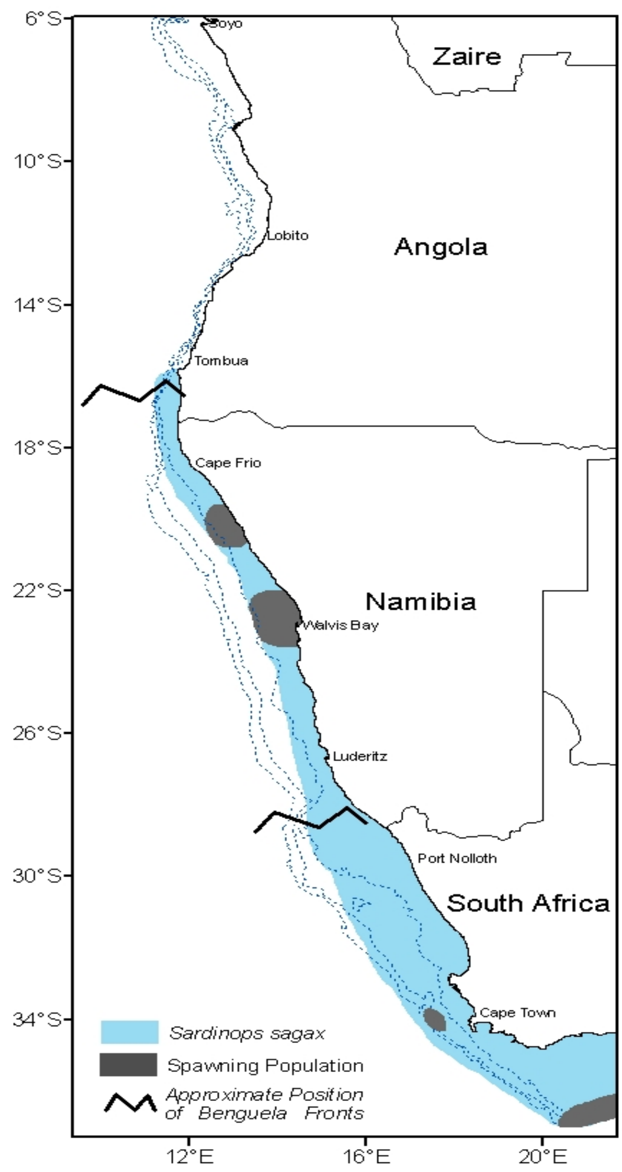

Figure 2. Distribution of sardine stocks in the Benguela region

Utne-Palm *et al*. 2010) and the bearded goby has become an increasingly important food source for predators (Crawford *et al*. 1987, Boyer and Hampton 2001a), there may have been a shift in diet of some species (including horse mackerel) to focus on *S. bibartus*.

2.1.2 Sardine

Historically spawning of sardine *Sardinops sagax* took place at two locations roughly 60 km off the Namibian coast: off Walvis Bay and further north at the meeting of the Benguela and Angola Current systems (O'Toole 1977) (Figure 2). Spawning in the north was predominantly by young adults and peaked in late summer / autumn around the 200 m isobath (Crawford *et al*. 1987). In contrast, older fish spawned further south in summer, in cooler waters close to upwelling zones. Following spawning, larvae drifted southward along the coast. Sardine would then migrate northwards where juveniles and young adults would spawn for the first time. Adult fish would subsequently return to south to spawn off Walvis Bay (Boyer and Hampton 2001a). Following the collapse of the sardine stock in the 1970s, spawning in the south is thought to have weakened (Crawford *et al*. 1987) as the migration of adult sardine has contracted (Boyer and Hampton 2001a). While the diet of juvenile sardine is focused primarily on zooplankton, phytoplankton is also utilised by adults in areas where it is consistently available in high abundance (James 1988).

2.1.3 Anchovy

The distribution and movement patterns of anchovy *Engraulis encrasicolus* in Namibian waters are similar to those described for sardine (Figure 3). The only exceptions are that significant spawning by anchovy takes place only north of Walvis Bay (Shannon and Pillar 1986) and larvae occurred in high density further than 100 km offshore (O'Toole 1977). Due to the very small size of current stocks, the present distribution and movement of anchovy off Namibia is unclear, but the life history of this species is likely to have changed from that previously recorded (Boyer and Hampton 2001a).

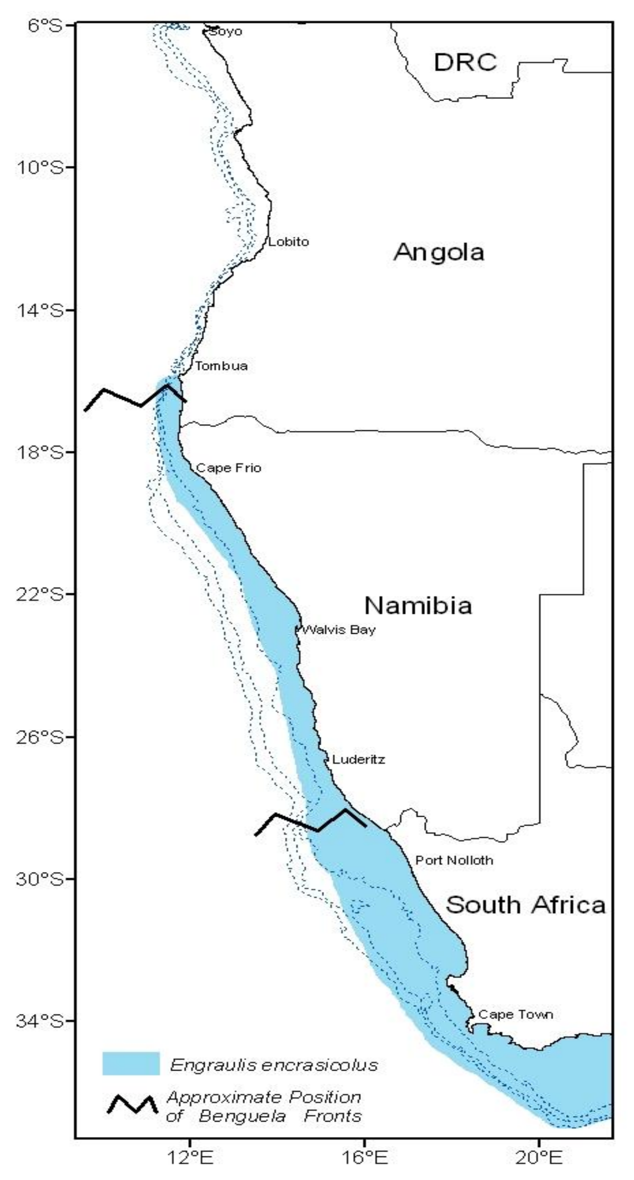

Figure 3. Distribution of anchovy in the Benguela Region

Anchovy feed predominantly on zooplankton (James 1988). Differing size selectivity between sardine and anchovy is thought to minimise competition for food between these two co-existing species (Louw *et al*. 1998).

2.1.4 Red-eye round herring

Similar to other small pelagic species the round herring *Etrumeus whiteheadi* is widely distributed along the Namibian coast (Boyer and Hampton 2001a). Spawning has not been explicitly studied in Namibian waters but is thought to occur throughout the year reaching a peak in late winter and early summer (Boyer and Hampton 2001a). This species feeds almost entirely on zooplankton (James 1988).

2.1.5 Snoek

An important predatory fish, snoek *Thyrsites atun* occur along the entire length of the Namibian coast (Boyer and Hampton 2001a). The Lüderitz upwelling cell is thought to separate the species into two separate stocks, although a certain amount of mixing does occur between the two (Griffiths 2003). This species occurs mainly in cool upwelled waters where it is an important predator of small pelagic species (Crawford and de Villiers 1985). Spawning patterns have not been established for the Namibian stock, but it is likely that these fish move offshore to spawn along the shelf break during winter and spring, as has been recorded for snoek off the South African west coast (Griffiths 2002). The diet of snoek consists mainly of fish. Inshore (<150 m) there is a focus on small pelagic species (e.g. sardines and anchovy) while offshore snoek also feed on demersal fish (e.g. hake) (Griffiths 2002).

2.2 DEMERSAL FISH SPECIES

2.2.1 Hake

Two species of hake commonly occur in Namibian waters. These are deep-water hake *Merluccius paradoxus* and the shallower water species *M. capensis*. Both species occur along the entire length of the Namibian coast, although *M. paradoxus* occurs mainly off southern Namibia while *M. capensis* occurs predominantly north of 27°S (Burmeister 2001) (Figure 4). There is some overlap of the Namibian and South African populations of both these species (Van der Westhuizen 2001). The two species show some spatial separation with *M. capensis* occurring from the near-shore to depths of 400 m – 500 m and *M. paradoxus* focused at depths greater than 400m (Gordoa *et al*. 1995 cited in Sundby *et al*. 2001). A zone of overlap does, however, exist at intermediate depths where both species co-occur.

Hake are opportunistic feeders and as a result their diets vary both seasonally and spatially (Roel and Macpherson 1988). Prior to reaching sexual maturity, juveniles of both species feed largely on planktonic crustaceans, pelagic gobies and lanternfish, with their diet becoming increasingly focussed on fish as they age (Punt *et al*. 1992). Squid and pelagic fish (e.g. lanternfish and lightfish) constitute a significant proportion of the diet of adult hake. However, the principal food items of larger fish are juvenile hake and other demersal fish (Punt *et al*. 1992)

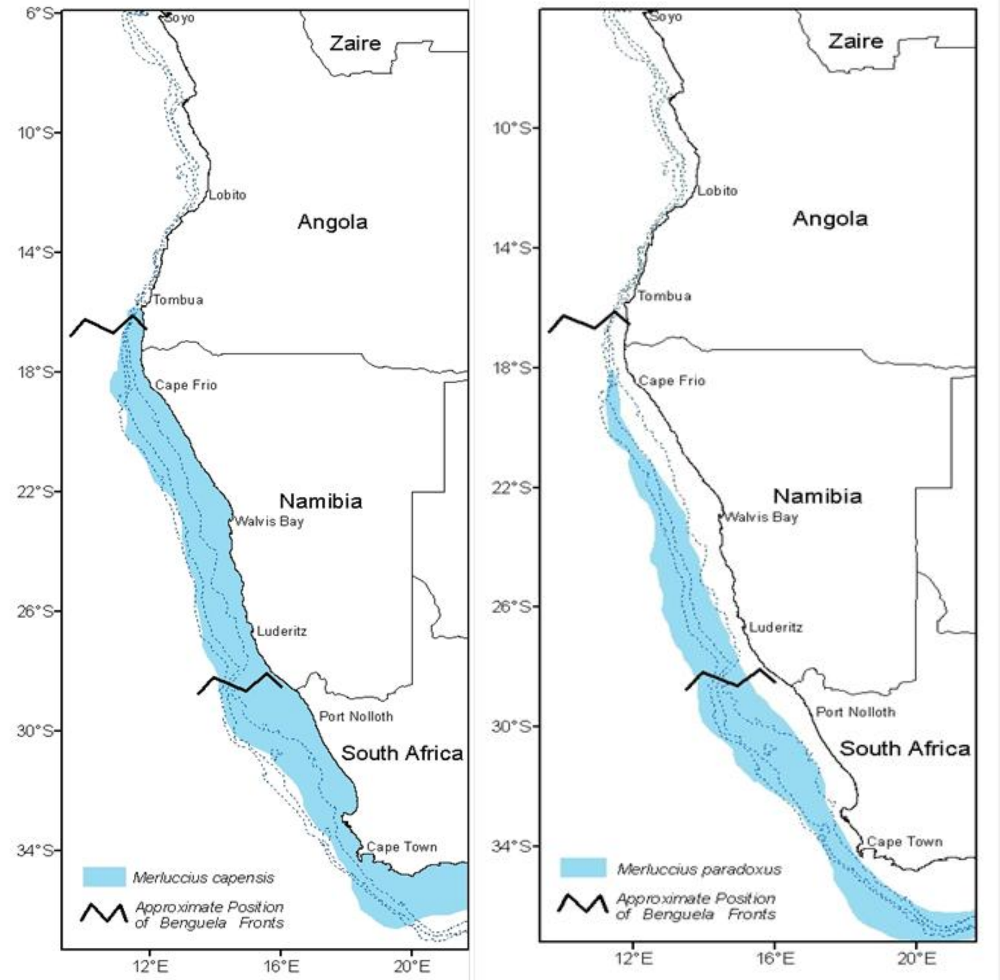

Figure 4. Distribution of the two main hake species in the Benguela ecosystem

While temporal and spatial patterns in hake spawning are yet to be fully resolved (Smith and Japp 2009), spawning by *M. capensis* has been recorded along most of the Namibian coast from about 27°S to 18°S (Olivar and Shelton, 1993). While spawning occurs across a wide range, areas of localised spawning appear to be focused off central Namibia (25°S to 20°S), although the exact location varies between years (Assorov and Berenbeim 1983 cited in Sundby *et al*. 2001, Olivar *et al*. 1988, Sundby *et al*. 2001) but these areas appear not to be permanent. It is, however, not clear if *M. paradoxus* spawns along the Namibian coast at all (Kainge *et al*. 2007). It has been suggested that both hake species are serial spawners with females spawning numerous times a year (Osborne *et al.* 1999). Spawning appears to occur year round with peak spawning periods in Namibian waters occurring from mid-July to mid-September (Roux pers comm.). During this time *M. capensis* appear to move to waters <200m to spawn (Gordoa *et al*. 2006). For their first year hake remain in a pelagic phase and aggregate inshore in nursery grounds. In their second year juveniles become demersal and systematically move offshore into deeper waters as they age. There is a general northward movement of hake along the Benguela coast as they age (Smith and Japp 2009). This is reflected in recent work which has recorded evidence of older hake off Cape Frio compared to Lüderitz in the south (J-P Roux, MFMR Lüderitz, *pers comm*.).

Diurnal vertical migration is known from both hake species, with individuals moving from the mid-water column at night to the sea floor during the day. This vertical migration pattern has been linked to nightly feeding in the water column (Punt *et al*. 1992). During the day as light intensity increases, the risk of predation is thought to increase, causing hake to remain close to the bottom.

2.2.2 Monkfish

Two species of monkfish are common in Namibian waters. *Lophius vomerinus* (Figure 5) occurs from northern Namibia to the east coast of South Africa (Boyer and Hampton 2001a) and *L. vaillanti* occurs north of Walvis Bay (Maartens and Booth 2001). While *L. vomerinus* inhabits the sea bottom from the tidal zone to depths of more than 600 m (Maartens *et al*. 1999), highest densities occur between 300 and 400 m off central Namibia (Maartens 1999). This species spawns throughout the year with a peak in spawning taking place in late winter and summer (Maartens and Booth 2005). Monkfish are known to recruit off Walvis Bay at depths of 150m and 300m, and near the Orange River at depths of 100 m to 300 m (Maartens and Booth 2005). Monkfish are non-selective predators which lure their prey by moving their illicium (Gordoa and Macpherson 1990). These fish feed during the day (Macpherson 1985) with their most important prey being shallow water hake (*M. capensis*) (Maartens *et al.* 1999).

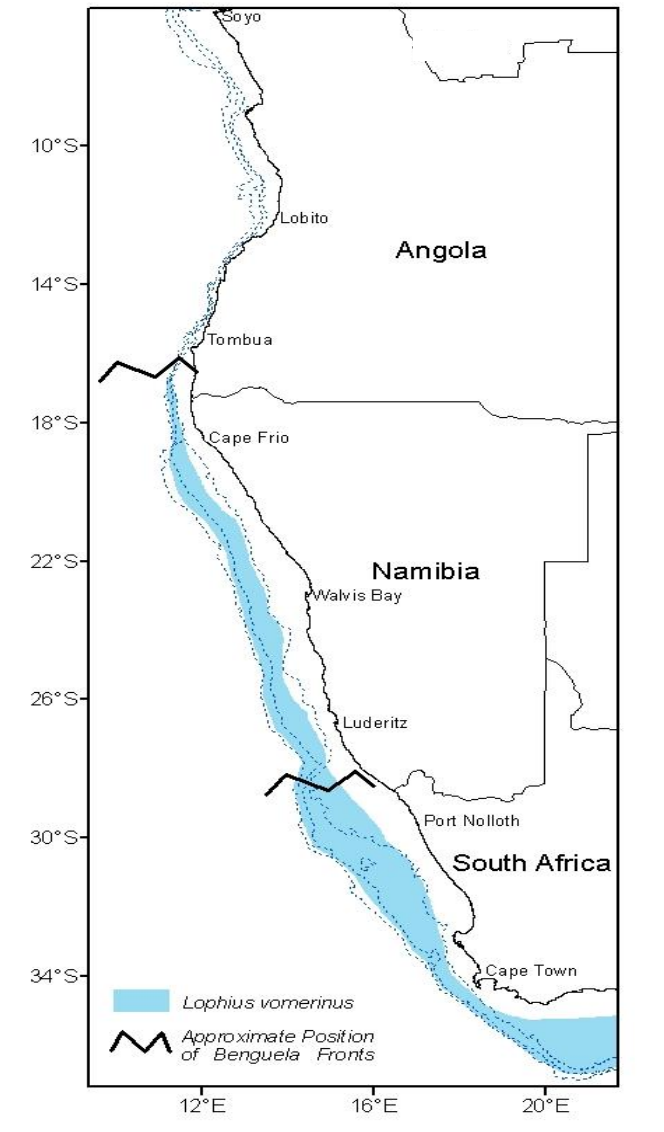

Figure 5. Distribution of monkfish in the Benguela region

2.2.3 Sole

The west coast sole *Austroglossus microlepis* occurs from northern Namibia to False Bay in South Africa (Diaz de Atarloa 2002). *A. microlepis* inhabits muddy substrata at depths of 100-300m (Heemstra and Gon 1995), where adults prey on polychaete worms, crustaceans, molluscs, and fish (e.g. gobies) (Bianchi *et al*.

1999). No information exists in the published literature regarding spawning and recruitment of west coast sole along the Namibian coast.

2.2.4 Orange roughy

Orange roughy *Hoplostethus atlanticus* is a deep sea species occurring at depths of 400 – 1400 m (Branch 2001). These fish are unusual in that they are very long-lived (> 100 years) and slow growing (reaching sexual maturity at around 25 years), have low fecundity and show low natural mortality (Boyer and Hampton 2001a, Boyer *et al*. 2001b, Branch 2001). Off Namibia this species has a restricted spawning period of less than a month in late July, when spawning takes place in dense aggregations close to the bottom in small areas typically between 10 and 100 km^2 in extent (Boyer and Hampton 2001b).

2.3 OTHER FISH SPECIES

2.3.1 West coast steenbras

Two stocks of west coast steenbras *Lithognathus aureti* occur in Namibian waters, a southern population around Meob Bay and a northern population in central and northern Namibia (Holtzhausen and Kirchner 2001a). The southern population falls within the restricted area of the Namib-Naukluft Park. No spawning migration is known for this species, although males of the northern population appear to disperse south in search of gravid females (Holtzhausen *et al*. 2001). The diet of this species is focused on the mussels *Choromytilus meridionalus* and *Perna perna* (Holtzhausen and Kirchner 2001b).

2.3.2 Silver kob

Silver kob *Argyrosomus inodorus* occurs along the entire length of the Namibian coast but are most abundant from Meob Bay to Cape Frio (Kirchner and Voges 1999). Namibian stocks are distinct from those occurring off South Africa (Van der Bank and Kirchner 1997). Spawning adults move southwards from the northern end of their distributional range in early summer. Spawning occurs at Meob Bay and Sandwich Harbour (Holtzhausen *et al*. 2001). From here larvae drift northward to the nursery area between Sandwich Harbour and the Ugab River mouth. Two years after spawning juveniles reach the area north of the Ugab River. It is to this same area that adults return after spawning (Kirchner and Holtzhausen 2001). Note that there is a concern that the discharge pipeline from the dredging operations (which is 2 m in diameter and will be laid on the sea floor i.e. not buried, for the first two years of operation) will obstruct kob on their way to and from the spawning ground at Sandwich Harbour however this has been considered and referred to in Pulfrich and Steve Lamberth terrestrial EIA report. In northern Namibia silver kob feed mainly on pelagic fish, shrimps and squid, whereas in the central and southern Namibia shrimps dominate the diet of these fish (Kirchner 1999).

2.3.3 Bearded goby

The bearded goby *Sufflogobius bibarbatus* occurs from the Kunene River to the east coast of South Africa (Cruickshank *et al*. 1980). Juveniles of this species usually inhabit inshore waters shallower than 200m, with the greatest concentrations occurring within 10 km to 30 km of the coast (Cruickshank *et al*. 1980, Cruickshank 1982 in Melo and Le Clus 2005). In contrast adults occur across the shelf (Melo and Le Clus 2005, Utne-Palm *et al*. 2010).

Following the collapse of the Namibian sardine stocks, bearded gobies became an important food source for commercial fish such as hake and horse mackerel as well as seabirds and seals (Crawford *et al*. 1985, Crawford *et al*. 1987, Boyer and Hampton, 2001b). Recent research has shown that gobies have been able to sustain these levels of predation due to unique physiological and behavioural adaptions which enables them to inhabit environments which are inhospitable to their predators (Utne-Palm *et al*. 2010). During the day bearded gobies rest on or hide in muddy sediments on the seafloor and feed on polychaete worms and diatoms which constitute an estimated 15% of their diet (Utne-Palm *et al*. 2010). While at the sea bottom these fish are exposed to extremely low levels of oxygen and high levels sulphide, conditions which are fatal to most other organisms (including their predators). At night the gobies ascend into the water column where they reoxygenate and digest the food they consumed earlier (Utne-Palm *et al*. 2010). While in the water column bearded gobies tend to associate with jellyfish (which are avoided by their predators). Presently, jellyfish account for up to 70% of the diet of bearded gobies (Utne-Palm *et al*. 2010) although it is unclear if this constitutes live jellyfish taken at night, or dead jellyfish which are consumed in the benthic environment during the day. This consumption of jellyfish is of significant ecological importance, as gobies make nutrients and energy available to their predators that would otherwise essentially be lost to the food chain (Utne-Palm *et al*. 2010).). The migratory behaviour makes the goby available to a wide variety of predators, including pelagic seabirds, seals and a variety of fish. Indeed, since the collapse of the pelagic fishery off Namibia during the 1970s, the bearded goby has replaced sardine *Sardinops sagax* in the diets of many of the higher trophic levels within the system and it is now playing a key role within the regional food webs (Cury and Shannon 2004). Despite the high level of predation pressure, the regional biomass of the bearded goby is increasing (Staby and Krakstad 2006). Its success within the altered ecosystem off Namibia is likely to be a result of its physiological adaptions to hypoxic conditions as well as its ability to utilise the increasing jellyfish biomass and the bacteria-rich sediments for nourishment (van der Bank *et al.* 2011).

2.4 WEST COAST ROCK LOBSTER IN NAMIBIA

While the west coast rock lobster *Jasus lalandii* occurs from Cape Cross to the east coast of South Africa, significant densities only occur south of Meob Bay (Cockcroft 2001). The spawning cycle of this species is strongly related to the annual moulting cycle. Males moult in spring and mating takes place after the females have moulted in late autumn and early winter (Boyer and Hampton 2001a). Females carry their eggs until they hatch in October and November, releasing planktonic larvae (Pollock 1986). These larvae remain in the plankton for a period of months before becoming free-swimming (Crawford *et al*. 1987) and settling in near-shore rocky areas. Adults generally occur further offshore than juveniles, except in central Namibia where the whole population is forced close to the shore by low-oxygen conditions (Pollock and Beyers 1981). Seasonal variability in dissolved oxygen near the seabed also drives seasonal changes in the depth distribution of adult lobsters (especially males) (Grobler and Noli-peard 1997). The diet of west coast rock lobster is dominated by mussels (especially *Aulacomya ater*), except in areas where mussel abundance is low and lobsters feed on a variety of invertebrates such as sea urchins, starfish, gastropods and seaweeds (Pollock and Beyers 1981). Cannibalism is known to occur in crowded conditions (Boyer and Hampton, 2001a).

3 COMMERCIAL FISHERIES IN NAMIBIA

A review of the Namibian fisheries is provided in the following section. Note although all the fishing sectors were examined only the sectors that could potentially be impacted by the phosphate mining project are included in this report. For each fishing sector the geographic extent of the fishery, fishing methods, gear, catches and environmental impacts of the fishing are considered.

3.1 DEMERSAL TRAWL FISHERY

A fleet of about 100 Namibian-registered trawlers operates within Namibian waters primarily targeting hake (*Merluccius paradoxus* and *M. capensis*). Main by-catch species include monkfish (*Lophius* spp.), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*). The directed hake trawl fishery is Namibia's most valuable fishery with a current annual hake TAC of 131,780 tonnes (2011). Recent TACs for hake and monkfish are shown in Figure 6.

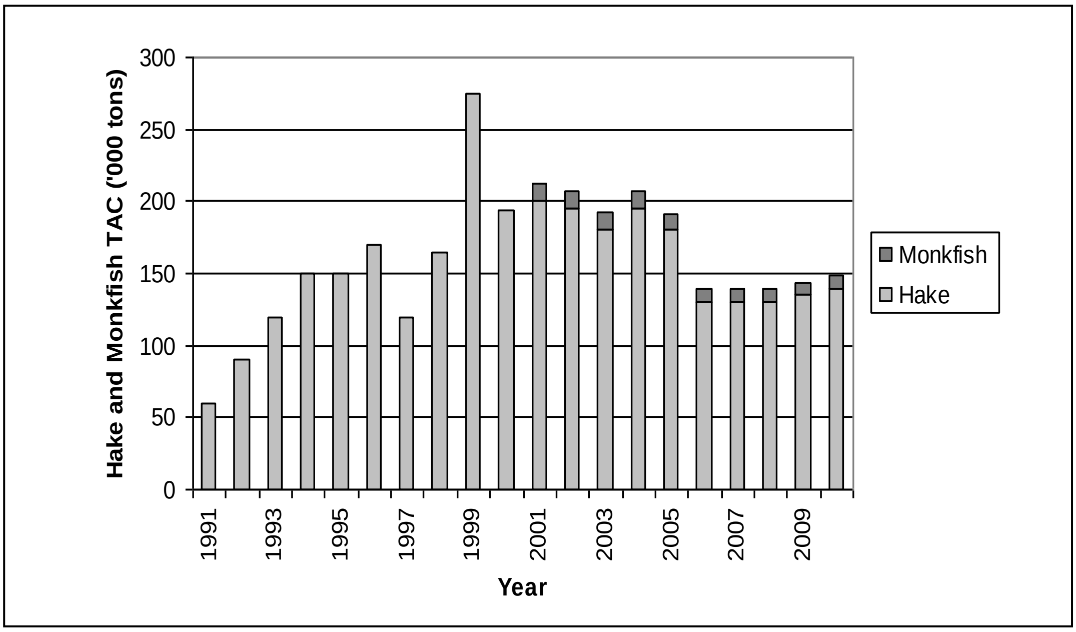

Figure 6. Total Allowable Catches set for hake and monkfish from 1991 to 2010

The fishery is active year-round except for a closed period during October each year. Trawlers are based predominantly in Walvis Bay, but also operate from Lüderitz and fishing grounds extend along the entire coastline between a depth of 200 m and 850 m. Trawlers are prohibited from operating inshore of the 200 m isobath. The past five years (2005 – 2009) have shown an average annual effort of ~170,000 hake-directed trawling hours per year (Figure 7).

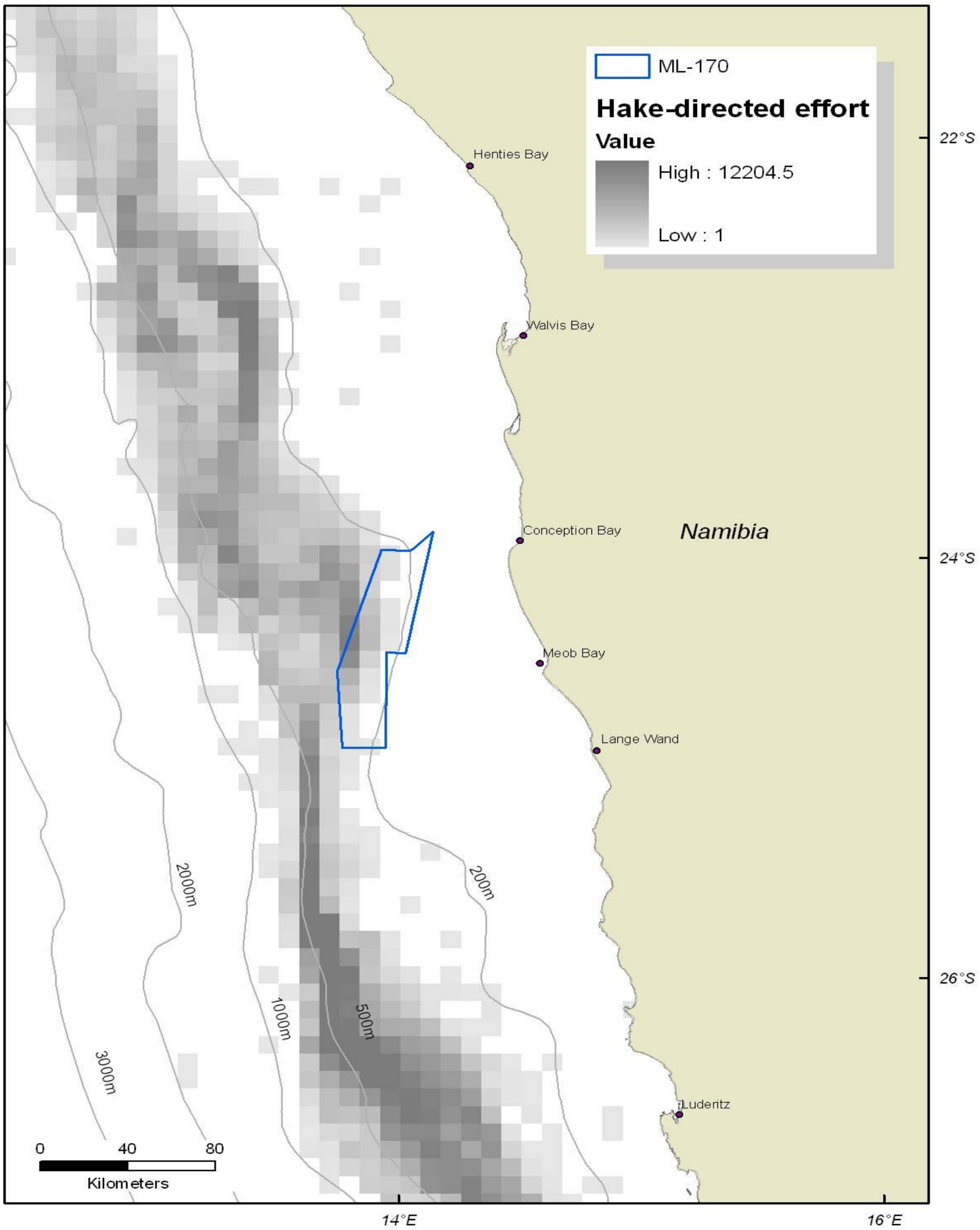

Figure 7. Distribution of fishing effort by the hake-directed demersal trawl fishery with respect to the phosphate Mining Licence Area (ML 170) for the years 2005 to 2009

The deep-sea fleet is segregated into wet fish and freezer vessels which differ in terms of the capacity for the processing of fish offshore (at sea) and in terms of vessel size and capacity (shaft power of 750 – 3000 kW). There are currently 13 licensed freezer trawlers and 59 licensed wetfish trawlers. Wet fish vessels (which hold fish on ice – mostly whole or headed and gutted) have an average length of 45 m, are generally smaller than freezer vessels (which freeze the fish at sea, usually after processing) which may be up to 90 m in length. While freezer vessels may work in an area for up to a month at a time, wet fish vessels may only remain in an area for about a week before returning to port. Trawl gear configurations are similar for both freezer and wet fish vessels, the main elements of which are trawl warps, bridles and doors, a footrope, headrope, net and codend (see Figure 7). Generally, trawlers tow their gear at 3.5 knots for up to four hours per drag. When towing gear, the distance of the trawl net from the vessel is usually between two and three times the depth of the water. The horizontal net opening may be up to 50 m in width and 10 m in height. The swept area on the seabed between the doors may be up to 150 m. All bottom trawls must have a cod-end with a mesh size of at least 110 mm however the smaller, older trawlers are still permitted a mesh of size of 75mm in the cod-end. Traditionally trawling was restricted to soft sediments but the development of trawl gear that is able access rocky grounds has meant that trawling now takes place on a variety of substrata.

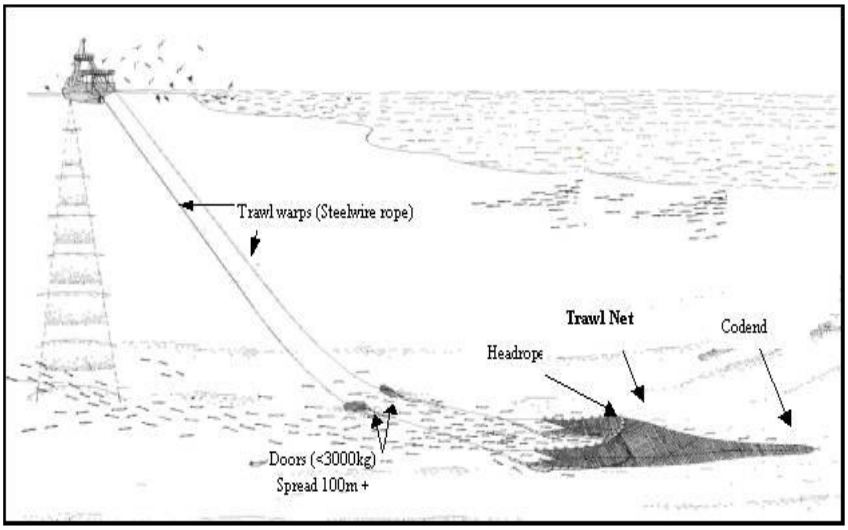

Figure 8. Schematic diagram of trawl gear typically used by deep-sea demersal trawl vessels

Typical demersal trawl gear configuration (Figure 8) consists of :

- Steel warps up to 32 mm diameter - in pairs up to 2 km long when towed
- A pair of trawl doors (500 kg to 3 tonnes each);
- Net footropes which may have heavy steel bobbins attached (up to 24" diameter) as well as large rubber rollers (“rock-hoppers”); and
- Net mesh (diamond or square shape) is normally wide at the net opening whereas the bottom end of the net (or cod-end) has a 130 mm stretched mesh.

The environmental impacts associated with bottom trawling have been widely considered in the scientific literature, and it is accepted that trawling significantly alters benthic communities (Collie *et al*. 2000, Kaiser *et al*. 2006). A recent study conducted in the southern Benguela (including a site to the south of Lüderitz) found that epifaunal abundances and species diversity decrease with increasing trawling intensity (Atkinson *et al*. 2011). Besides the impacts on benthic fauna, bottom trawls also pose a threat to seabirds that collide with the warp cables or become tangled in trawl nets (Watkins *et al*. 2008).

3.2 DEEP-WATER TRAWL FISHERY

These species, e.g. the orange roughy, are extremely long-lived and aggregate densely, leading to high catch rates. Fishable aggregations are usually found on hard grounds on features such as seamounts, drop-off features or canyons (Branch, 2001).

In Namibia the orange roughy fishery is split into four Quota Management Areas (QMA's) referred to as "Hotspot", "Rix", "Frankies" and "Johnies" (Figure 9) and TACs are set for each specific QMA. Almost no fishing for this species takes place outside of the designated QMAs. Fishing grounds were discovered in 1995/1996 and total catches reached 15,500 tonnes in 1997. At this point catch limits were set and effort was limited to five vessels. Following a drop in the biomass levels, TACs were decreased from 12,000 tonnes in 1998 to 1,875 tonnes in 2000. General aggregations of the stock occur between June and August. The fishery uses a similar gear configuration to that used by the demersal hake-directed trawl fishery (Figure 7).

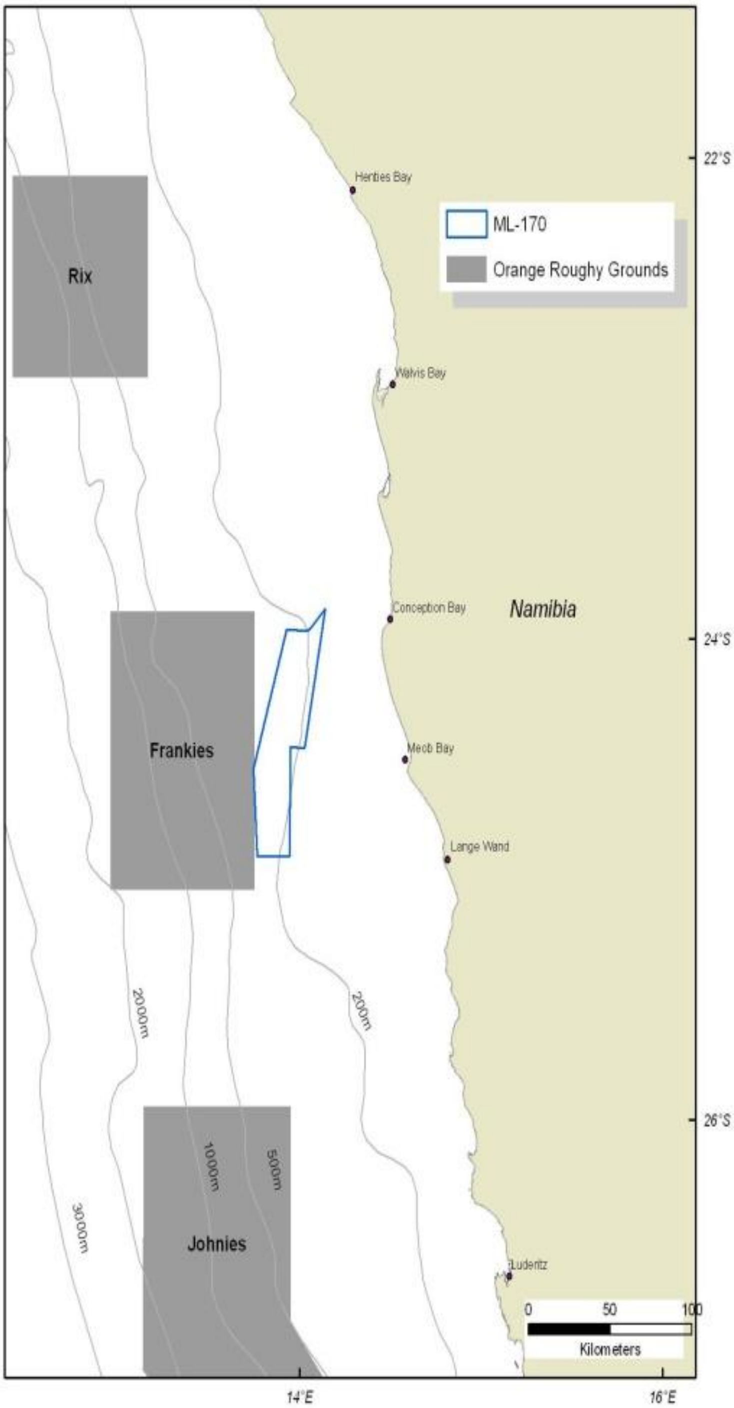

Figure 9. ***Commercial fishing grounds for Namibian Orange Roughy in relation to the phosphate Mining Licence Area (ML 170).***

While certain groups of biota inhabiting soft sediments show resilience to the impacts of trawling (Kenchington *et al.*

2001), the biota of hard grounds are known to be particularly vulnerable to the physical disturbance associated with trawling (Turner *et al*. 1999). Typically trawling on and around hard grounds and seamounts (such as that associated with the orange roughy fishery) causes damage to the structure-forming biota associated with these habitats (Ragnarsson and Steingrimsson 2003). This in turn causes reduced habitat complexity, affecting community structure and diversity (Kaiser *et al*. 2000). No studies specific to the impacts of trawling on Namibian hard grounds have been conducted.

3.3 MID-WATER TRAWL FISHERY

The Cape horse mackerel has the highest volume and catch of all Namibian fish stocks; however by economic value it is the second highest contributor to the fishing industry behind the fishery for hake. Horse mackerel are either converted to fishmeal or sold as frozen, whole product. Landings for the year 2006 were valued at N$800 million (MFMR unpublished data in Kirchner *et al*. 2010). The stock is caught by the mid-water trawl fishery (targeting adult horse mackerel) and pelagic purse-seine fishery (smaller quantities of juvenile horse mackerel). Maximum historical catches were reported during the 1980s but catch rates have since declined with an average of 252,680 tonnes between 1990- 2008 (see Figure 10 for annual set TACs and catches). TACs have decreased from 360,000 to 230,000 tonnes following a decline in estimated stock biomass in recent years.

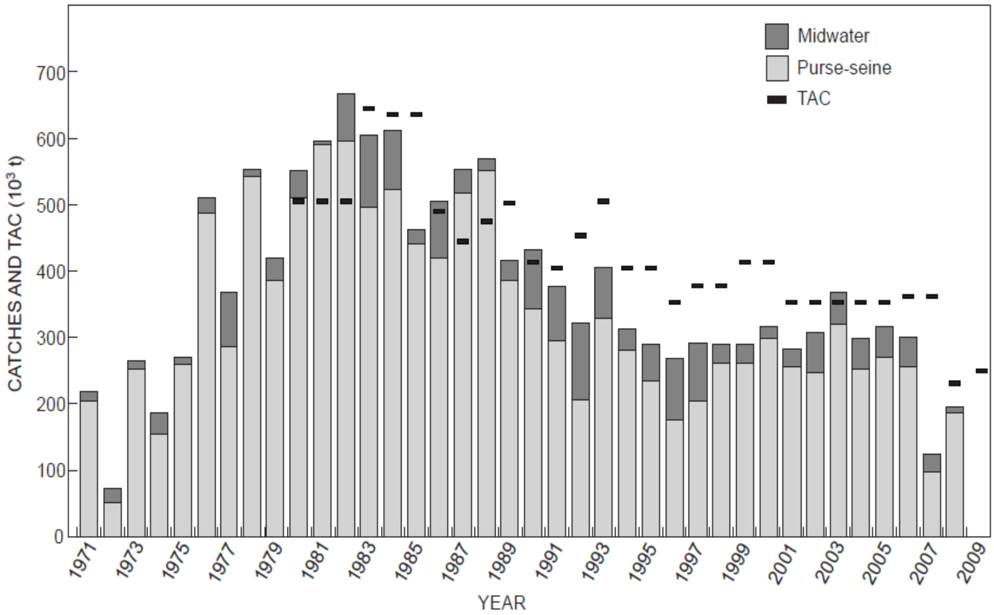

Figure 10. ***Catches (mid water and purse seine) and TACs set for the Namibian stock of Cape horse mackerel from 1961 to 2009 (Kirchner et al. 2010)***

The target catch species is meso-pelagic (i.e. found at depths between 200 – 1000 m above the sea floor) and shoals migrate vertically upwards through the water column between dusk and dawn. Mid-water trawlers exploit this behaviour (diurnal vertical migration) by adjusting the depth at which the net is towed (this typically varies from 400 m to just below the water surface). The net itself does not come into contact with the seafloor (unlike demersal trawl gear) and towing speed is greater than that of demersal trawlers (between 4.8 and 6.8 knots) – Figure 11 refers.

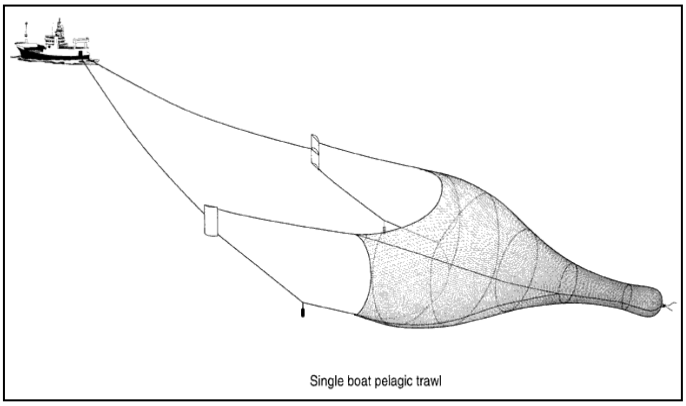

Figure 11. Typical gear configuration used during mid-water trawling operations

Once the gear is deployed the vessel is hampered in its ability to manoeuvre as the gear may extend up to 1 km astern of the vessel (depending on the depth being fished).

Trawl warps are heavy, ranging from 32 mm to 38 mm in diameter. Net openings range from 40 m to 80 m in height and up to 120 m in width (Figure 11). Weights in front of, and along the ground-rope assist in maintaining the vertical opening of the trawl. To reduce the resistance of the gear and achieve a large opening, the front part of the trawl net is usually made from very large rhombic or hexagonal meshes. The use of nearly parallel ropes instead of meshes in the front part is also a common design. On modern, large mid-water trawls, approximately three quarters of the length of the trawl is made with mesh sizes above 400 mm.

In 2006, 12 rights-holders and 12 vessels were registered within the mid-water trawl fishery. The fleet operates exclusively out of the port of Walvis Bay and fishing grounds extend north of 25ºS to the border with Angola and effort is highest in the north (Figure 12). Juvenile Cape horse mackerel move into deeper water when mature and are fished mostly between the 200 m and 500 m isobaths towards the shelf break.

Mid-water trawl fisheries are not usually considered to have significant impacts on benthic biodiversity (Atkinson and Sink 2008). Nonetheless, as they tow their nets at a relatively high speed they regularly entangle sea birds, sharks, dolphin and seals (Nel 2004).

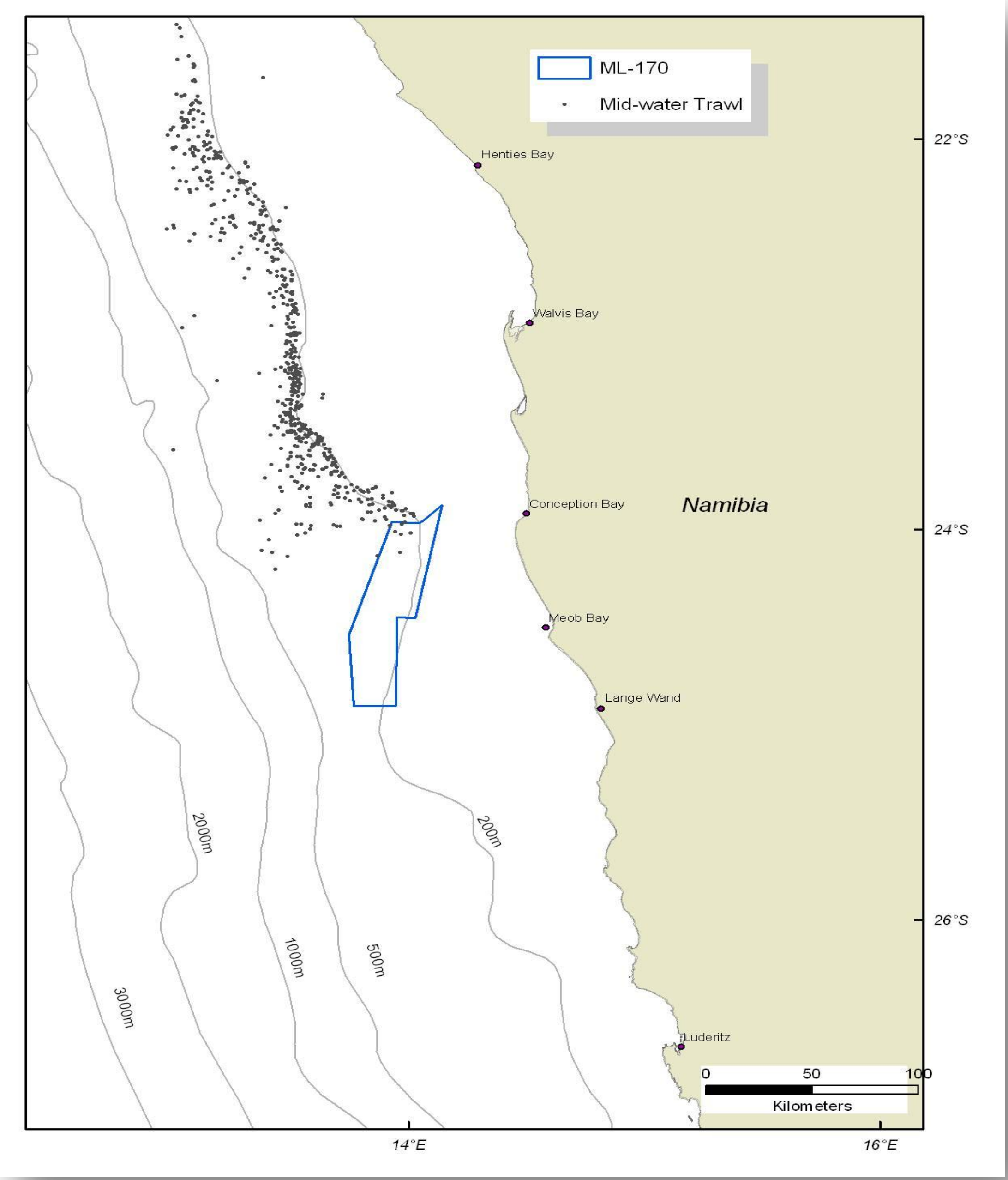

***Figure 12.** Distribution of fishing effort by the mid-water trawl fishery targeting horse mackerel in relation phosphate the Mining Licence Area (ML 170) for the years 2008 to 2009*

3.4 SMALL PELAGIC PURSE-SEINE FISHERY

The small pelagic purse-seine fishery is based on the Namibian stock of sardine (*Sardinops sagax*) and small quantities of juvenile horse mackerel. Commencing in 1947, the fishery is the largest by volume of landings and is operated predominantly from the port of Walvis Bay. The fishery grew rapidly until 1968 at which time the stocks collapsed. Fishing continued thereafter at a low level of effort, but the resource has not fully recovered

It has since been reopened with 25,000 tonnes of sardine allocated in 2010 (the TACs allocated for sardine in recent years are shown in Figure 13). Recent biomass surveys have shown small aggregations of the stock located inshore of the 100 m isobath.

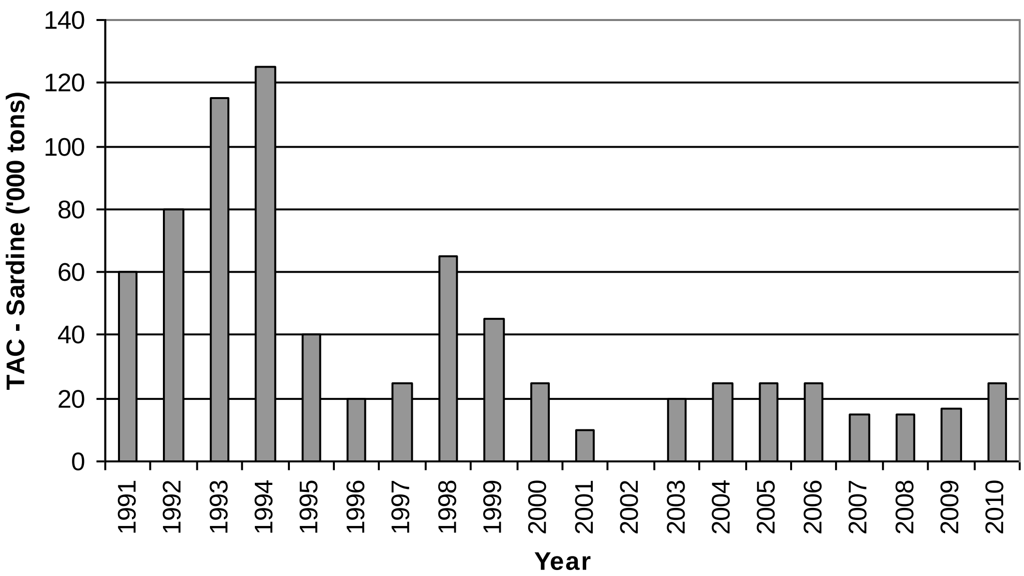

Figure 13. Total allowable catches of sardine for the years 1991 to 2010

The fleet consists of approximately 30 wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 21 m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel will steam around it and encircle it with a large net, extending to a depth of 60 to 90 m (Figure 14). Netting walls surround the aggregated fish, preventing them from escaping by diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped on board into the hold of the vessel. It is important to note that after the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered on board and this may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

The environmental concerns associated with these fisheries are centred on the impacts of reduced abundance of the target species. Purse-seine fishing operations are very selective and this sector tends to have low discard rates (Atkinson and Sink 2008).

As such direct impacts on non-target species are unlikely to occur. Rather it is the potential for the fishery to increase mortality on an already depleted target resource that is the main concern. Small pelagic species (sardine, horse mackerel, bearded gobies are an important link in marine food webs (Cury *et al*. 2000) and reductions in their abundance can have negative impacts on ecosystem structure and functioning (Crawford *et al*. 1985, Crawford *et al*. 1987, Boyer and Hampton 2001b).

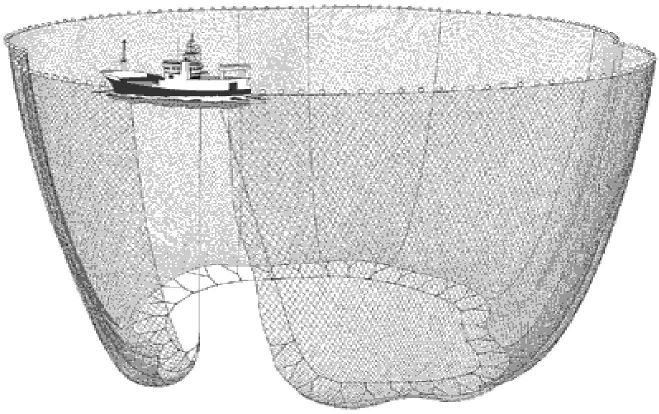

Figure 14. Typical gear configuration of a pelagic purse seine vessel targeting small pelagic species

3.5 DEMERSAL LONG-LINE FISHERY

Like the demersal trawl fishery the target species of this fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. The catch landed is predominantly prime quality (PQ) hake for export to Europe.

The catch is packed unfrozen on ice – the fresh product is approximately 50% higher than that of trawled hake. Longline vessels fish in similar areas targeted by the hake-directed trawling fleet, in a broad area extending from the 300 m to 600 m contour along the full length of the Namibian coastline. Approximately 18 boats are currently (2011) operating primarily in three broad areas. Vessels based in Lüderitz work south of 26°S towards the South Africa border while those based in Walvis Bay operate between 23°S and 26°S and north of 23°S. Operations are *ad hoc* and intermittent, subject to market demand. A total hake TAC of 131,780 tonnes was set for 2011 but less than 10,000 tonnes of this is caught by long-line vessels.

A demersal long-line vessel may deploy either a double or single line which is weighted along its length to keep it close to the seafloor (Figure 15). Steel anchors, of 40 to 60 kg are placed at the ends of each line. These anchor positions are marked with an array of floats. Lines are typically 20 – 30 nautical miles in length. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of 5 – 9 knots. Once deployed the line is left to soak for up to eight hours before it is retrieved. A line hauler is used to retrieve gear (at a speed of approximately 1 knot) and can take six to ten hours to complete. During hauling operations the vessel's manoeuvrability is severely restricted.

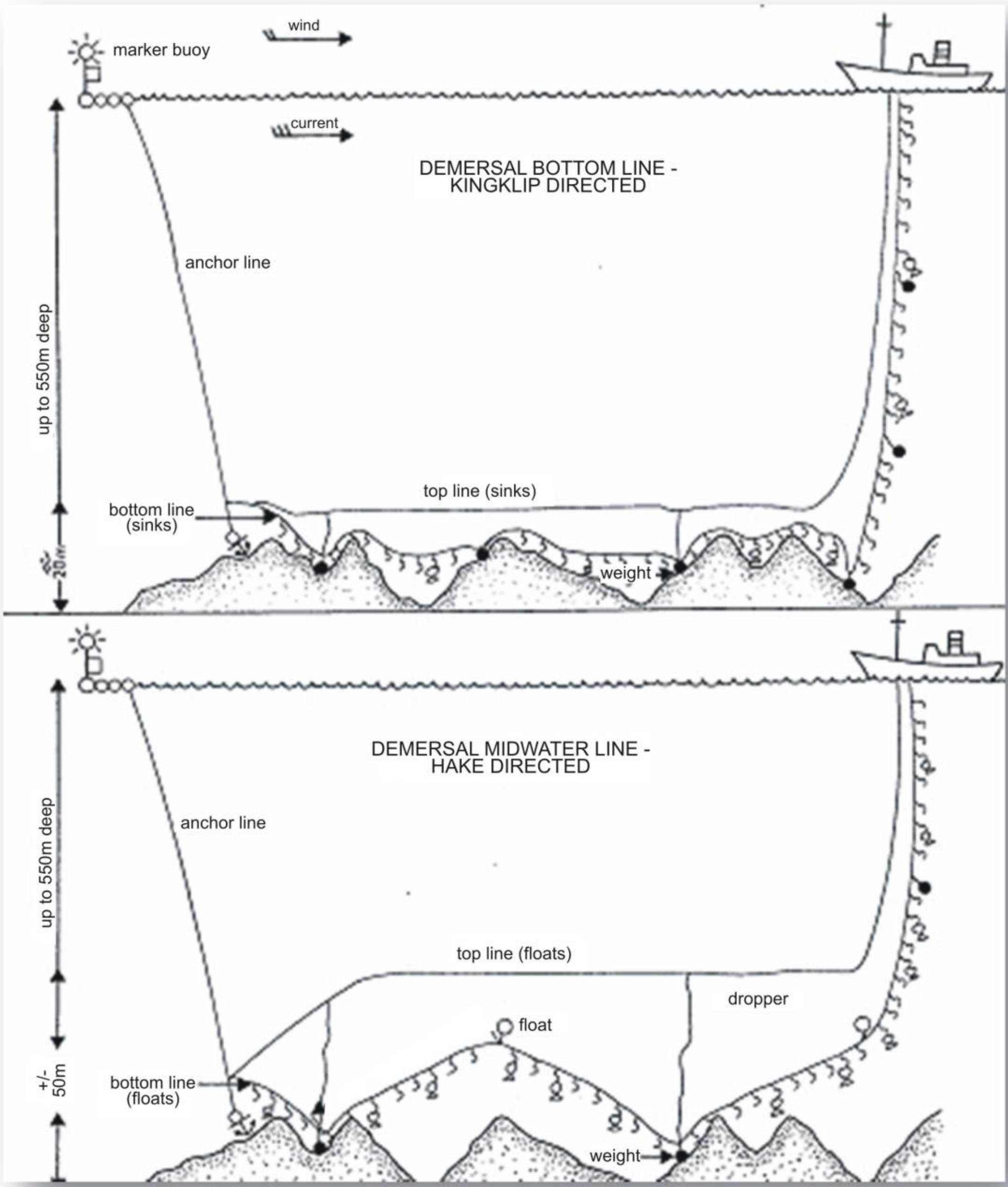

Figure 15. Typical configuration of demersal (bottom-set) hake longline gear used in Namibian waters

3.6 WEST COAST ROCK LOBSTER FISHERY

The small but valuable fishery of rock lobster (*Jasus lalandii*) is based exclusively in the port of Lüderitz. The lobster stock is commercially exploited in Namibian waters between 28º30'S and 25ºS from the Orange River border in the south to Easter Cliffs/Sylvia Hill north of Mercury Island (see Figure 16 for the location of commercial fishing grounds). Catch is landed whole and is managed using a TAC. The current TAC approximates 350 tonnes although historically the fishery sustained relatively constant catches of up to 9,000 tonnes per year until the fishery collapsed in the late 1960s. Activity is greatest over January and February with up to 25 vessels active per day over this period with the number of vessels declining towards the end of the season in May.

The sector operates in water depths of up to 80 m. Baited traps consisting of rectangular metal frames covered by netting, are deployed from small dinghys and delivered to larger catcher reefers (refrigerated vessels) to take to shore for processing. The rock lobster fishing fleet consists of vessels that range in length from 7 m to 21 m. Traps are set at dusk and retrieved during the early morning using a powerful winch for hauling.

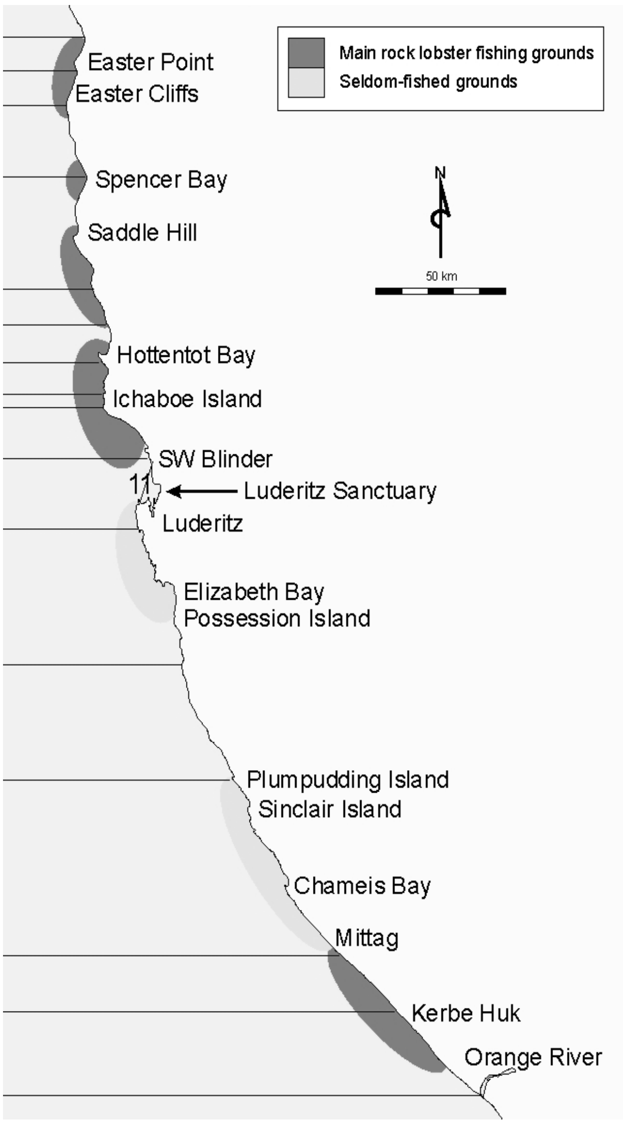

Figure 16. Location of commercial fishing grounds within the Namibian rock lobster fishery

As fishing for west coast rock lobster takes place mainly on or adjacent to rocky reefs. The use of traps has the potential to disrupt these habitats by damaging the associated fauna and flora (Atkinson and Sink 2008). In addition, the consistent removal of large rock lobsters from an area may impact on the structure of the benthic community (Atkinson and Sink 2008).

4 COMMONLY OCCURRING MARINE MAMMALS AND SEABIRDS IN NAMIBIAN WATERS

4.1 SEABIRDS

Introduction

A total of 51 species of seabird has been recorded in the waters of southern Namibia (Appendix 1a - 1). Of these, 13 (25%) are southern African breeding species, 14 (27%) are non-breeding migrants from the northern hemisphere, and 24 (47%) are non-breeding migrants from islands in the Southern Ocean (Ryan and Rose 1989; Sinclair *et al*. 2011).

Conservation concern has been expressed for more than one third of the seabird species occurring in southern Namibian waters. Threatened species include both migrants (albatrosses and petrels) and southern African breeding species. No species is considered to be Critically Endangered and five are considered Endangered (Appendix 1). Of the 51 species, 18 (35%) have been given a IUCN (World Conservation Union) category of threat. Five seabird species are Endangered, five are Vulnerable, six are Near Threatened and two are of Least Concern (Sinclair *et al*. 2011; http://www.iucnredlist.org/ .).

Namibia's first Marine Protected Area (MPA), the Namibian Islands Marine Protected Area (NIMPA) was proclaimed in 2009 (Ludynia *et al*. 2011). The NIMPA runs for 400 km southwards from Hollamsbird Island along the southern coast of Namibia. It covers approximately 10 000 sq km and averages 25 km in width (Figure 17). A major objective of the NIMPA is to protect the breeding sites as well as the main foraging areas of the Threatened African Penguin, Cape Gannet, and Bank Cormorant.

4.1.1 Coastal Seabirds

There are four species of coastal seabird that have the potential to interact with the dredger and the dredging operations: African Penguin, Cape Gannet, Bank and Cape cormorants.

African Penguin

The African Penguin *Spheniscus demersus* population has declined significantly throughout its range and this is reflected in the change in conservation status from Vulnerable in 2000/2003 to Endangered in 2010. The population in Namibia has declined at a rate of 5.1% per year since 1956/57 when it stood at 42 000 pairs to just 3 000 pairs in 2006/07 (Kemper *et al*. 2007).

The diet of breeding birds primarily consists of the bearded goby *Sufflogobius bibarbatus*, which is of a poorer food quality than sardines and anchovies. In Namibia the stocks of these two fishes are too distant from the breeding islands for the African Penguin to exploit (Crawford *et al.* 2005).

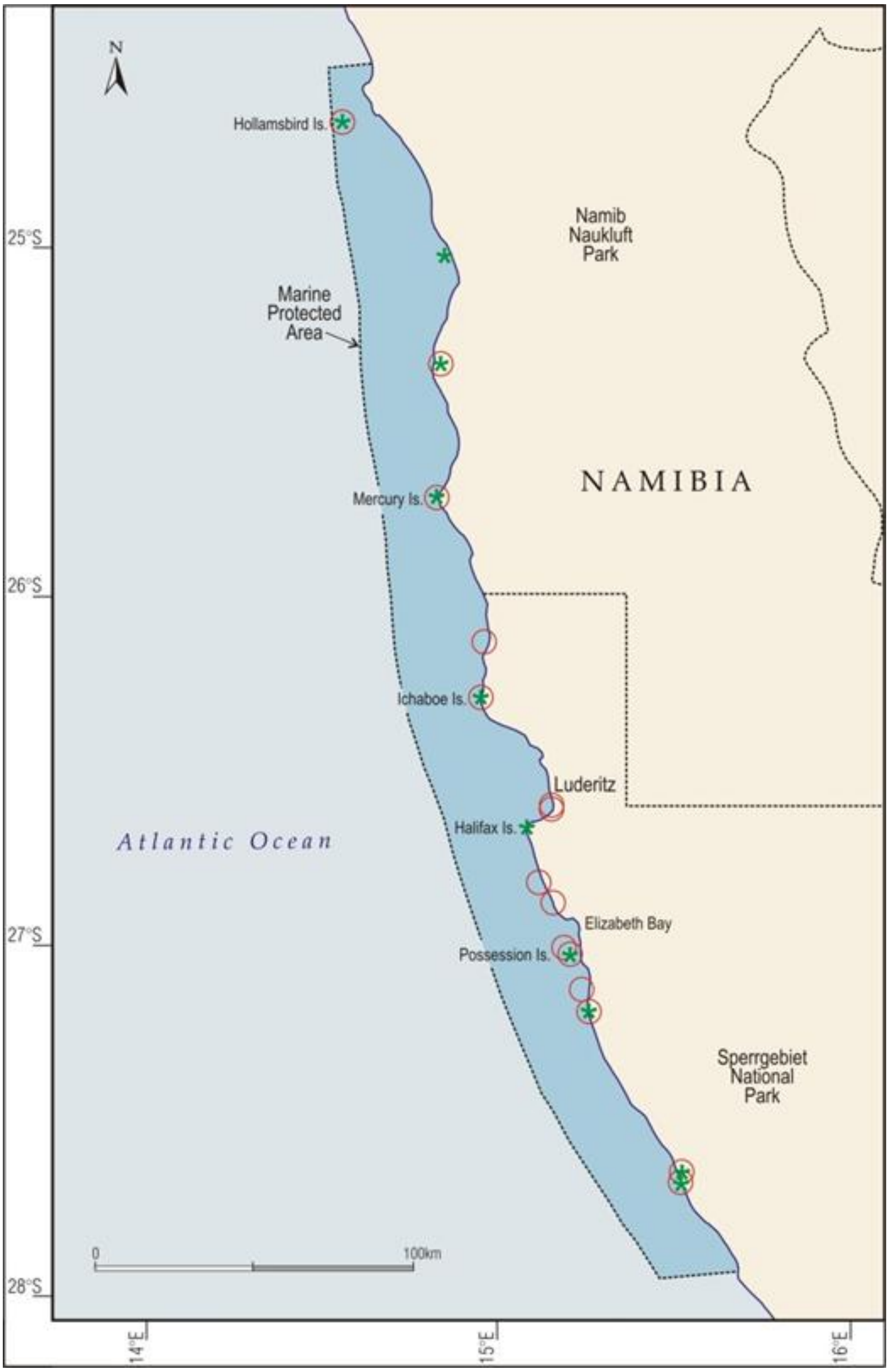

Figure 17. Namibian islands and MPAs

Whereas breeding penguins usually forage within approximately 30 km of their colonies (Ludynia *et al*. 2011), non-breeding birds may range along the entire Namibian coastline and as far as 100 km offshore (Crawford and Whittington 2005). This has the potential for encounters between the dredger and penguins in ML 170. The African Penguin has been recorded diving to a depth of 130 m (Wilson 1985), however the phosphate deposit in ML 170 lies in depths between 200 m and 300 m thus dredging operations should pose no threat to these birds. In addition the pumps only operate when the dredge draghead is in contact with the sea floor some 70+m below the diving limit of the African Penguin.

Cape Gannet

The Cape Gannet *Morus capensis* population in Namibia has declined significantly and is now regarded as Vulnerable (BirdLife International, 2004). Crawford *et al*. 2007(a) reported that the Cape Gannet population in Namibia fell by 85 - 98% over the years 1956/57 and 2005/06. This decline in the Namibian Cape Gannet population has been attributed to a combination of over-fishing of its preferred prey (sardines and anchovies), environmental change, displacement by seals and the necessity to forage further for poorer quality food including whitefish discards from trawlers (Pichegru *et al*. 2007; Crawford *et al*. 2007a).

Cape Gannets breed at three islands in Namibia: Mercury, Ichaboe, and Possession, and at a further three in South Africa: Bird (Lambert's Bay), Malgas on the west coast, and Bird in Algoa Bay on the east coast.

GPS tracking studies show that Cape Gannets from Mercury Island, the nearest breeding colony to ML 170, travel as far north as 24°15'S and to 13°50'E when foraging (Ludynia *et al*. 2011). These birds, therefore, may approach the southeastern corner of ML 170 but, based on the limited number of birds tracked, the foraging range of breeding birds does not actually overlap with the Mining Licence Area.

Non-breeding birds disperse widely from the breeding colonies (Crawford *et al*. 2005) but the distance travelled seawards by non-breeding birds has not been recorded. It is possible that adult (non-breeding) Cape Gannets may be encountered in ML 170. However, since these birds are shallow plunge-divers, there should be no adverse interaction with the dredger. Juveniles move northwards probably as far north as the Gulf of Guinea but there is a possibility some birds, reported as juvenile Cape Gannets, are juveniles of *Sula bassana* from Europe with which they can easily be confused.

Bank Cormorant

The Bank Cormorant *Phalacrocorax neglectus* is listed as Endangered (Kemper *et al*. 2007; IUCN 2008). Mercury and Ichaboe islands, near the northern extremity of the species' range, support approximately 70 - 80% of the entire global population of the species. The Bank Cormorant population in Namibia declined by 68% between 1993 and 1998 (Roux and Kemper, 2009) and continues to decline. The primary reason for this population decline is ascribed to a shortage of food but displacement and predation by seals (Crawford *et al*. 1989: du Toit *et al*. 2003) probably have contributed to the population decline in Namibia.

Bank Cormorants from Mercury, fitted with GPS trackers, targeted bearded goby *Sufflogobius bibarbatus* within 5 km of the coast in water depths of 30 - 40 m (Ludynia *et al*. 2010). The Bank Cormorant is highly unlikely to occur in ML 170 and therefore, will not be affected by the dredging operations.

Cape Cormorant

The Cape Cormorant *Phalacrocorax capensis* is considered to be Near Threatened having declined from 143 000 pairs in 1978/79 to 92 000 pairs in 1995/96 (Crawford *et al*. 2007b). The construction of guano platforms, providing greater secure breeding areas, is believed to have led to the increase of the population of Cape Cormorants in Namibia in the late 1970s. The subsequent decline has been attributed to a lack of sardines and anchovies, greater foraging effort and poorer food quality. Unlike the populations of the Cape Gannet, Namibia remains the stronghold of the Cape Cormorant population. In 2005/05 it supported 60.6% of the global breeding population of 94 539 pairs (Crawford *et al*. 2007b). Of the 57 323 pairs in Namibia in 2005/06 43% were south of Walvis Bay and 57% to the north where they breed on artificial platforms designed to collect their guano.

Similar to the Bank Cormorant, the Cape Cormorant is an inshore species, which is highly unlikely to occur in ML 170, and therefore, will not be affected by the dredging operations.

4.1.2 Pelagic seabirds

Crawford *et al*. (1991) reviewed the role of seabirds as consumers in the Benguela Current and western Agulhas ecosystems. Four regions were recognised: northern Namibia, southern Namibia, western South Africa and southern South Africa. The southern Namibia region corresponds to the location of ML 170 and its environs. Populations of pelagic seabirds are highest during the austral winter when Southern Ocean species, such as albatrosses, petrels, shearwaters and storm petrels, move north to temperate and subtropical regions. Some shearwaters, storm petrels and jaegers from the Northern Hemisphere are present in the austral summer but in much smaller numbers than the austral pelagic species (Appendix 1a-1). Petersen *et al*. 2007 and Nel (2004) have also highlighted the impact of bird mortality (albatrosses and petrels predominantly) in mostly large pelagic fishing operations (occurring mostly well offshore and beyond the MLA.

None of these species is deep-diving thus the dredging operation should have no effect on them. These birds may however be attracted to the dredger's lights, particularly in foggy conditions. The potential impact of lights on seabirds was stressed by Ryan (1991). “Night strikes” due to birds being dazzled by bright lights can be a significant source of mortality of seabirds in the Tristan da Cunha rock lobster fishery. This effect was however minimised through mitigation[1].

[1] Note. The lack of facilities for handling oiled seabirds at MFMR Walvis Bay / Swakopmund is noted.
This applies to all marine activities in which oil spills may occur and should be the responsibility of the competent authority. This does not negate the responsibility of the mining operator to minimize the potential for oil pollution and impacts on sea birds.

4.2 TURTLES

Five of the eight species of turtle worldwide occur off Namibia (Bianchi *et al*. 1999 quoted in Pulfrich 2011). Turtles that are occasionally sighted off central Namibia, include the Leatherback Turtle (*Dermochelys coriacea*), which are known to frequent the cold southern ocean and are often recorded off the southern African West Coast. They inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey (primarily jellyfish). While hunting they may dive to over 100 m and remain submerged for up to 35 minutes. Although they tend to avoid nearshore areas, they may be encountered in Walvis Bay and off Swakopmund between October and April when prevailing north wind conditions result in elevated seawater temperatures. Leatherbacks feed on jellyfish and are known to have mistaken plastic bags, raw plastic pellets, plastic and styrofoam, tar balls and balloons for their natural food. Leatherback Turtles are listed as Critically Endangered worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species). Although Namibia is not a signatory of CMS, Namibia has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles. Namibia is thus committed to conserve these species at an international level. Their abundance in the MLA area is however expected to be low.

Other turtles species found in the Benguela Ecosystem include Green turtles (*Chelonia mydas*), Loggerhead (*Caretta caretta*), Hawksbill (*Eretmochelys imbricata*) and Olive Ridley (*Lepidochelys olivacea*) turtle. All are relatively rare even though they are reported to be caught in the offshore pelagic longline fisheries in Namibian waters (Petersen *et al*. 2008*)*. Although these turtle species may be found in the MLA and may be impacted, the likelihood of interacting with the dredging operation is considered very low.

4.3 MARINE MAMMALS IN NAMIBIA

4.3.1 Introduction

Information on cetaceans for the Namibian coastal area was obtained from a number of sources, including scientific and incidental sighting records, historical whaling catches and sightings and stranding records. The available published literature was reviewed for records of sightings or strandings from the southern Namibian region or the greater southern African region (in the case of further species, which are expected to be found in the southern Namibian region). Ross (1984) reviewed cetacean distribution patterns and biology from the south eastern coast of southern Africa. Findlay (1989 unpublished) reviewed the distribution patterns of all 37 species of cetaceans then found in southern Africa, from which Findlay *et al*. (1992) published the distribution patterns of smaller odontocete cetaceans from the region. Peddemors (1999) reviewed the distribution of the 18 delphinid species from southern African waters. Best (2007) provides the most recent comprehensive overview of cetaceans in southern African waters.

The cetacean fauna of the Namibian coast comprises between 22 and 31 species (Cetus Projects 2008; Currie *et al*. 2009 (cited in Pulfrich, 2007), the diversity reflecting both species recorded from the waters of Namibia and species expected to be found in the region based on their distributions elsewhere along the southern African West coast. The range in species number is due to taxonomic uncertainty at species and sub-species level, rather than uncertainty of occurrence or distribution patterns. Nonetheless, the diversity is comparatively high, reflecting the cool inshore waters of the Benguela upwelling system and the occurrence of warmer oceanic water offshore of this. Cetaceans can be divided into two major groups, the mysticetes or baleen whales which are largely migratory, and the toothed whales or odontocetes which may be resident or migratory. The range in the number of species reflects taxonomic uncertainty rather than a lack of information on distribution patterns.

Pulfrich (2007)[2] states that of the species recorded, the endemic Benguela (Heaviside's) Dolphin *Cephalorhynchus heavisidii* and the dusky dolphin (*Lagenorhynchus obscurus*), are found in the extreme nearshore region between the northern Namibian border and Cape Point. The bottlenose dolphin (*Tursiops truncatus*) is found in the extreme nearshore region between Walvis Bay and Cape Cross, as well as offshore of the 200 m isobath along the Namibian coastline. Southern right-whale dolphins (*Lissodelphis peronii*) have an extremely localised year-round distribution associated with the continental shelf and the shelf-edge in the region between 24° and 28° S. A further 11 species are resident within the offshore area of the Namibian coastline in water depths of over 500 m. These include the long-finned pilot whale (*Globicephala melaena*), Grays beaked whale (*Mesoplodon grayii*), Layard's beaked whale (*Mesoplodon layardii*), the pelagic form of common dolphin (*Delphinus delphis*), false killer whale (*Pseudorca crassidens*), Risso's dolphin (*Grampus griseus*), sperm whale (*Physeter macrocephalus*), Cuvier's beaked whale (*Ziphius cavirostris*), Pygmy killer whale (*Feresa attenuata*) and pygmy sperm whale (*Kogia breviceps*). Killer whales (*Orcinus orca*) are found throughout Namibian waters.

Of the southern hemisphere migratory whale species, blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), sei whales (*B borealis*), minke whales (*B. acutorostrata*), Bryde's whale (*B. edeni*) and humpback whales (*Megaptera novaeangliae*), and two species of balaenid whale, the southern right whale (*Eubalaena australis*) and the pygmy right whale (*Caperea marginata*) have been recorded in Namibian waters, primarily off the continental shelf during winter months. Although humpback whales commonly have a summer distribution in polar waters (feeding grounds) and a winter distribution lower latitudes (breeding/calving grounds), these whales have been found off the Namibian coast in summer. Migrations of baleen whales occur primarily off the continental shelf, although in recent years a number of the sheltered bays between Chameis Bay (27°56'S) and Conception Bay (23°55'S) have become popular calving sites for Southern Right whales. Of the migratory cetaceans, the blue, sei and humpback whales are listed as "Endangered" and the Southern Right and fin whale as "Vulnerable" in the International Union for Conservation of Nature (IUCN) Red Data book (Appendix 1a – 2). All whales and dolphins are given absolute protection under the Namibian Law.

A number of other species may occur in the warmer offshore waters off Namibia beyond the Benguela Upwelling System, including dwarf sperm whale (*Kogia sima*), southern bottlenose whales (*Hyperoodon planifrons*), Gervais' beaked whale (*Mesoplodon europaeus*), Blaineville's beaked whale (*Mesoplodon densirostris*), short-finned pilot whale (*Globicephala macrorhynchus*), pantropical spotted dolphin (*Stenella attenuata*), striped dolphin (*Stenella coeruleoalba*), melon-headed whales (*Peponocephala electra*), and rough-toothed dolphin (*Steno bredanensis*). With the exception of the southern bottlenose whale, all of these species have more warm temperate

[2] Note text relating to mammals extracted from Pulfrich, (2007)

/ subtropical offshore habitats (elsewhere in the world) and would therefore be more likely to occur (if at all) both further offshore and in the more northerly extent of Namibian waters, than the cold temperate conditions characterising the Namibian coast. Stranding or skeletal records of southern bottlenose whales, rough toothed dolphin and Gervais' beaked whale have been recorded from the Namibian coast, although the level to which these may be extra-limital records is unknown. There are no data on the population status of these species off the southern African coast.

The main species characteristics and relevance to the MLA are outlined herewith and also listed in Appendices 1a – 2 and 3.

4.3.2 Mysticete (baleen) whales (Appendix 1a - 2)

Blue whales : Two forms of blue whales are recorded from the Southern Hemisphere. Antarctic or true blue whales (*Balaenoptera musculus intermedia*) migrate from summer feeding grounds within the southern ocean (near the Antarctic ice edge) to winter calving grounds in temperate waters, although little is known of their definite destination in winter (Mackintosh 1966). Pygmy blue whales (*B. m. brevicauda*) are recorded from the southern Indian Ocean. Harmer (1931) noted on the basis of the peak of the catches being sharper off Moçamedes (now Namibe), Angola, than Walvis Bay, Namibia, that Angola was closer to the northern point of the blue whale migration than Walvis Bay. The seasonality of catches of blue whales from the southern African west coast suggests that the majority of blue whales migrate northwards through southern Namibian waters between May and July to Angolan waters (July and August) and return southwards after August.

Although no offshore distribution patterns were recorded off Namibia, catches of blue whales in waters 65 to 95 kilometres offshore of the South western Cape coast of South Africa suggest that the migration occurs off the continental shelf slope (in waters of depths of between 2000 and 3500 metres). Furthermore, catches of blue whales off the southern Africa west coast generally occurred after catches of humpback whales which suggest that blue whales occurred in offshore, deeper waters than humpback whales. Olsen (1915) however noted that off the Western Cape, large schools moved inshore from the north between June and August.

- Blue whales are unlikely to pass in or near the MLA

Fin whales (*B. physalus*) : Like blue whales, little is known of the winter migration destinations of fin whales. Gambell (1985) noted that fin whale migrations occur after blue whale migrations, but precede those of sei whales. Harmer (1931) reported that catches off the Western Cape had a bimodal distribution (with maxima in May – July and October – November). Fin whales have been recorded in catches from Walvis Bay and Angola (Harmer 1929), and off Gabon in 1934 (Budker and Collignon 1952), and although no seasonal maxima are provided, these records show migrations to the north of the Western Cape.

If the shelf edge is taken as 200 m, most of the fin whales should pass inshore of the mining area. Although the offshore distribution of fin whales in southern Namibia is unknown, there is some suggestion that the species migrates along the continental shelf edge (Macintosh 1966).

- There is a low likelihood that Fin whales will pass in or near the MLA

Sei whales (*B. borealis*) : Harmer (1929) found sei whales particularly numerous off the Cape Colony, although he suggests that some confusion between sei and Bryde's whales may have occurred. Best and Lockyer (unpublished, in Horwood 1987) note that such confusion may have continued up until 1962. Best (1967) found catches of sei whales in the Saldanha Bay whaling grounds to show an annual peak over the period of August and October, and although a second peak was reported from sightings between March and April, Best (*op cit*.) suggests that these may have been Bryde's whales. Best (1967) suggested that sei whales off the southern African west coast are mainly found in waters of 16º-18º C, 60 to 100 nautical miles offshore.

- Sei whales could be encountered in the MLA.

Minke whales : There is little information on the distribution or seasonal abundance of minke whales off the west coast of southern Africa, although Stewart and Leatherwood (1985) note their presence in these waters. Possibly two forms of minke whales, the dwarf minke whale (*Balaenoptera acutorostrata*) and the larger Southern Hemisphere minke whale (possibly (*Balaenoptera bonaerensis)* may be found off the coast of southern Namibia. Findlay (unpublished 1989) reports incidental sightings of minke whales inshore off Lüderitz, which may well correspond to the dwarf form.

- There is a low likelihood that Minke whales will occur in or near the MLA

Bryde's whales : There is little information on the distribution and seasonal occurrence of Bryde's whales in southern Namibia. Two forms of Bryde's whales are recorded from southern African waters (Best 1977, Best 2007, Rice 1999). The smaller resident form (of which the taxonomic status is uncertain) is found year-round along the southern Cape coast between Algoa Bay and Lamberts Bay. A larger offshore form (*B. edeni*) appears to migrate along the African west coast, being most abundant in the Saldanha Bay whaling grounds between March and May and in October, and possibly migrating northwards along the African west coast in winter.

No information on the distribution of Bryde's whales in southern Namibia could be located. As it is the larger migratory form that is found in these waters it is assumed that the distribution would be off the continental shelf.

- There is a likelihood that Bryde's whales will pass in or near the MLA

Humpback whales (*Megaptera novaeangliae*) : Humpback whales utilise coastal waters of southern hemisphere continents as migratory corridors during annual migrations between summer Antarctic feeding grounds and breeding grounds in coastal tropical and subtropical waters. It appears that some humpback whales remain off the southern African west coast throughout summer (Findlay and Best, 1995), possibly taking advantage of upwelling productivity to feed within the Benguela System (as suggested for other upwelling areas by Papastavrou and van Waerebeeck 1997).

- There is a likelihood that humpback whales will pass in or near the MLA

Southern Right whales (*Eubalaena australis*): Southern right whales were heavily exploited by open-boat whalers between Walvis Bay in Namibia and Delagoa Bay in Mozambique prior to 1835 (Richards and du Pasqier 1989, Best and Ross 1986). Right whales were protected from 1935 onwards (although such protection was only promulgated in South Africa in 1940). Annual surveys have shown the population utilising the coast between Muizenberg and Algoa Bay to now be recovering at approximately 7% per annum. IWC (in press) stated that few sightings are recorded off the coast of Namibia each year, although it noted that no surveys for right whales are being undertaken.

- Based on distributions elsewhere in southern African waters (Best 2000), southern right whales in southern Namibia would be expected in extreme coastal waters (within the 50 m isobath) i.e. inshore of the Mining Licence Area between the months of July and November.

Pygmy right whales (*Caperea marginanta*) : The pygmy right whale is a little known species, which has been recorded incidentally in the inshore waters around the South African coast between Algoa Bay and Walvis Bay and if it occurs at all, it will be inshore of the Mining Licence Area. The incidence within southern Namibia is expected to be extremely low. A summary of the distribution and seasonal abundance of baleen whales in southern Namibian waters is presented in Appendix 1a - 2.

- It is unlikely that pigmy right whales will pass or be found in the MLA

4.3.3 Odontocetes (toothed whales and dolphins)(Appendix1a - 3)

The majority of toothed whales and dolphins have more resident than migratory distribution patterns. Findlay *et al.* (1992) investigated the distribution patterns of small odontocete cetaceans off the coast of Namibia and South Africa. The distribution and seasonal abundance of odontocetes (toothed whales and dolphins) in southern Namibian waters are summarized in Appendix 1a - 3.

Sperm whales (*Physeter macrocephalus*) : The major part of global sperm whale distributions lie within tropical oceanic waters, although females and small males occur as far south as 40° – 50°S, while mature males are found as far south as the Antarctic ice edge. Sperm whales are recorded throughout southern African pelagic waters. Their distribution would be expected to the west of the proposed mining area in deeper pelagic waters. Some migratory habits are suggested from historical catch records off Saldanha Bay, with Best (1969) suggesting northward movement in autumn and southward movement in spring.

- There is a very low likelihood that sperm whales will pass or be found in the MLA

Pygmy Sperm whales (*Kogia breviceps*) : The pygmy sperm whale appears to be confined to warm oceanic waters. A number of strandings have been recorded on the Namibian coast, which probably originate from warm offshore waters. It is, therefore, unlikely to occur in the mining area.

- The likelihood of pygmy sperm whales being impacted by the dredging operation is extremely low

Cuvier's beaked whale (*Ziphius cavirostris*) : Cuvier's beaked whale appears to have a pelagic cosmopolitan distribution in southern African waters. Although strandings have been recorded from the Namibian coast, it is expected that these originated from further offshore than the mining area.

- There is a very low likelihood that Civiers beaked whales will pass or be found in the MLA

Layard's beaked whale (*Mesoplodon layardii*) : Layard's beaked whale is distributed in cold temperate waters in the Southern Hemisphere with strandings from Namibian waters resulting from the whales moving inshore into cold Benguela system on the southern African west coast. However this species has an offshore distribution elsewhere in the world and is expected to occur offshore of the mining area.

- There is a very low likelihood that Layards beaked whales will pass or be found in the MLA

Gray's beaked whale (*M. grayii*) : As with Layard's beaked whale Gray's beaked whale appears to be restricted to cold temperate oceanic waters south of 30^{o} S, although there are a few records from within the Benguela system. It too has an expected offshore distribution outside of the mining area.

- The likelihood of Gray's beaked whales being found in or near the MLA is very low.

Killer whale (Orcinus orca) : Killer whales (*Orcinus orca*) have a cosmopolitan distribution in all major oceans of the world (Leatherwood and Reeves, 1983) and is found throughout southern African waters regardless of season or water depth (Findlay *et al*. 1992, Peddemors 1999).

- Killer Whales are likely to occur within the mining area.

False killer whale (*Pseudorca crassidens*) : The false killer whale (*Pseudorca crassidens*) is an offshore species found in tropical and temperate waters of all oceans (Ross 1984). This species occurs offshore of the 1000 m isobath all along the southern African coast (Findlay *et al.* 1992, Peddemors 1999).

- False Killer Whales are unlikely to occur within the MLA

Pygmy killer whale (*Feresa attenuata*) : Pygmy killer whales appear to be confined to the tropical, subtropical and warm temperate oceanic waters of the world. Strandings within southern African waters are limited to the north of Cape Point and to the east of Algoa Bay, possibly as a result of the wider continental shelf over the Agulhas Bank. Stranding records within Namibian waters are surprising given the species preference for warm waters, and it is assumed that such animals originated from warmer offshore waters (Findlay *et al.* 1992).

- There is a low likelihood that Pygmy killer whales will be found in the MLA

Long finned pilot whale (*Globicephala melas*) : Long-finned pilot whales have been recorded from within southern Namibian waters, albeit in slightly deeper waters than the mining area (Findlay *et al.* 1992).

- There is a small likelihood that Long finned pilot whales will pass near to or may occur in the MLA

Risso's dolphin (*Grampus griseus*) :Risso's dolphins are found year round throughout southern African oceanic waters (Findlay *et al.* 1992).

- There is a small likelihood that Risso's dolphins will be found in the MLA

Common dolphin : Although common dolphins are recorded from Namibian waters, an absence of sightings within coastal neritic waters, suggest that common dolphins avoid the cooler inshore waters of the Benguela Current region (Findlay *et al.* 1992). Consequently the species would not be expected to occur in the mining area, but may occur in warmer offshore waters.

- There is a small likelihood that common dolphins will be found in the MLA

Dusky dolphin (*Lagenorhynchus obscurus*): Dusky dolphins are a year round resident species within coastal waters of the southern African west coast between southern Angola (12°S) and Danger Point (19°20'E). Although generally occurring within the 50 m isobath, they may be found out to the 500 m isobath (Findlay *et al.* 1992, Peddemors 1999).

- There is a small likelihood that dusky dolphins will be found in the MLA

Heaviside's (Benguela) dolphin *(Cephalorhynchus heavisidii*) : Heaviside's dolphin is a resident species endemic to the nearshore waters of the west coast of southern Africa between Cape Point (34°20'S) and northern Namibia (17°30'S). Although the species does occur out to the 200m isobath, the highest densities have been recorded inshore of the 100 m isobath (Findlay *et al*. 1992).

- There is small likelihood that Heaviside's dolphins will be found in the MLA

Southern right-whale dolphin (*Lissodelphis peronii*) : Southern right-whale dolphins are generally limited to the cooler waters of the Southern Hemisphere, between the Subtropical Convergence and the Antarctic Convergence, or within the "West Wind Drift", although they have been recorded as far north as 19ºS in the Humboldt Current. However, an apparent isolated distribution of southern right-wale dolphins occurs off the coast of southern Namibia between 24ºS and 30º30'S (Rose and Payne 1991, Findlay *et al.* 1992, Peddemors 1999). These animals have been recorded year round in water depths between the 100 - 200 and 1000 - 2000 m isobaths. This distribution is possibly associated with the Lüderitz upwelling cell.

- There is a small likelihood that Southern right-whale dolphins will be found in the MLA

Bottlenose dolphin (*Tursiops truncatus*) :Two forms of bottlenose dolphin occur in inshore waters around the southern African coast (a smaller form on the east coast and a larger form in the extreme inshore region of northern Namibia), while a larger form appears to occur throughout southern African offshore waters (Findlay *et al*. 1992, Peddemors 1999). The species is not expected to occur in the mining area, but may occur offshore to the west in warmer offshore waters.

- There is small likelihood that Bottlenose dolphins will be found in the MLA

4.3.4 Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) is common along the Namibian coastline, occurring at numerous breeding sites on the mainland and on nearshore islands and reefs . All have important conservation value since they are largely undisturbed at present, as public access to the southern Namibian coast is restricted. Atlas Bay, Wolf Bay and Long Islands (near Lüderitz) together represent the largest breeding concentration (about 68,000 pups) of seals in Namibia. Currently the largest breeding site in Namibia is at Cape Cross north of Walvis Bay where about 51,000 pups are born annually (MFMR unpubl. data). The colony supports an estimated 157,000 adults (Hampton 2003), with unpublished data from the Department of Agriculture, Forestry and Fisheries (DAFF, South Africa) suggesting a number of 187,000 (Mecenero *et al*. 2006). A further colony of ~ 9,600 individuals exists on Hollamsbird Island south of Sandwich Harbour. The colony at Pelican Point is primarily a haul-out site. The mainland seal colonies present a focal point of carnivore and scavenger activity in the area, as jackals and hyena are drawn to this important food source.

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991). Namibian populations declined precipitously during the warm events of 1993/94 (Wickens 1995), as a consequence of the impacts of these events on pelagic fish populations. Currently, half the Namibian seal population occurs in southern Namibia, south of Lüderitz. It consists of about 300,000 seals, producing roughly 100,000 pups per year. Population estimates fluctuate widely between years in terms of pup production, particularly since the mid-1990s (MFMR unpubl. data; Kirkman *et al*. 2007).

There is a controlled annual quota, determined by government policy, for the harvesting of Cape fur seals on the Namibian coastline. The Total Allowable Catch (TAC) currently stands at 60,000 pups and 5,000 bulls, distributed among four licence holders. The seals are exploited mainly for their pelts (pups), blubber and genitalia (bulls). The pups are clubbed and the adults shot. These harvesting practices have raised concern among environmental and animal welfare organisations (Molloy and Reinikainen 2003).

- There is a high likelihood that Cape Fur Seals will be found in the MLA

5 LEGISLATION

5.1 THE MARINE RESOURCES ACT 27 OF 2000

Namibia regulates every facet of its fishing sector. The principal legislation under which all marine living resources are managed in Namibia is the Marine Resources Act 27 of 2000. (with the associated regulations). The act is administered by the Ministry of Fisheries and Marine Resources (MFMR). MFMR's primary mandate is couched as the sustainable utilization and long term protection of marine resources, and the conservation of the marine ecosystem. No fishing may take place without authorization in the form of a fishing licence or permit. Rights allocation processes have taken place within stated policy frameworks. Importantly, as in South Africa, this has included and incorporated the Ecosystems Approach to Fisheries Management (EAF).

This Act provides for the conservation of the marine ecosystem; for the responsible utilization, conservation, protection and promotion of marine resources on a sustainable basis. Section 52 states: *"Any person who discharges in or allows to enter or permits to be discharged in Namibian waters anything which is or may be injurious to marine resources or which may disturb or change the ecological balance in – any area of the sea, or which may detrimentally affect the marketability of marine resources, or may hinder their harvesting, shall be guilty of an offence and liable on conviction to a fine not exceeding N$500 000."*

Section 52 (3) (f) states: "*Any person who kills or disables any marine animal by means of any explosive, poison or noxious substance, or by means of a firearm except as may be prescribed, shall be guilty of an offence and liable on conviction to a fine not exceeding N$ 500 000."*

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. The Act also provides for the declaration of Marine Protected Areas and fishing areas.

From an International perspective, Namibia's regional and International legal and policy documents, instruments and declarations require the protection of 20 – 30 per cent of all marine habitats (under the jurisdiction of individual Governments) by 2012. In this regard Namibia's first Marine Protected Area (MPA), the Namibian Islands Marine Protected Area (NIMPA) was proclaimed in 2009 (Ludynia *et al*. 2011). The NIMPA runs for 400 km southwards from Hollamsbird Island along the southern coast of Namibia. It covers approximately 10 000 sq km and averages 25 km in width (Figure 17). A major objective of the NIMPA is to protect the breeding sites as well as the main foraging areas of the Threatened African Penguin, Cape Gannet, and Bank Cormorant.

Other legal instruments include the Convention on Biodiversity (CBD), the 2003 World Parks Congress (WPC) recommendations V.22, policy declarations, targets and goals issued and proclaimed at the World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002, the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem, the SADC Fisheries Protocol (encapsulating the Ecosystem Approach to fisheries management – EAF), the Ramsar Convention and the Algiers Convention. Namibia also signed the revised African Convention on Nature and Natural Resources on 9 December 2003. This revolutionary regional treaty was adopted by the African Union in the same year, as a replacement treaty of the former Algiers Convention. One of the objectives was to '…take into account recent developments in the African environment and natural resources scenes, while bringing the Convention to the level and standard of current multilateral environmental agreements (MEAs).'

The broad objectives of this African Convention apply to all environmental media excepting the atmosphere. They include the declaration of marine protected areas, the fostering and sustainable use and conservation of natural resources, the protection and utilization of fauna and flora, and the harmonization and co-ordination of policies in these fields.

6 IDENTIFICATION OF IMPACTS AND RISK ASSESSMENT

Namibia Marine Phosphate (NMP) has been granted a 20-year Mining Licence (ML 170) by the Ministry of Mines and Energy, to recover phosphate-rich sediment from the Namibian seabed (subject to this Environmental Impact Assessment).

A Trailing Suction Hopper Dredge (TSHD) will be used to remove 3 m of phosphate deposits from the seabed. A volume of 5.5 million tonnes will be removed annually from an area of up to 3 km^2. Dredging will occur in water depths of up to 275 m and the slurry will be transported to shore and transferred (pumped) from the vessel to the shore by a pipeline.

The Mining Licence Area (MLA) is located on the Namibian continental shelf approximately 40-60 km off the coast of Conception Bay (see Figures 18 to 47). The area of the mining lease area covers 2233 km^2. There are three areas of phosphate enrichment identified for exploitation. These areas are referred to as; Sandpiper-1 (SP-1), Sandpiper-2 (SP-2) and Sandpiper-3 (SP-3) and these serve as the primary mining targets of the deposit within the MLA. It is proposed to exploit each area systematically over time staring in SP-1.

6.1 DATA AND METHODOLOGY OF IMPACT ASSESSMENT

The data used in this specialist study to assess the impact of mining on fish, fisheries, mammals and seabirds are listed in Appendix 1a - 4. These include commercial catch and effort data of the main commercial fisheries sectors, fisheries survey data and numerous historical data sets provided by the Namibian Ministry of Fisheries and Marine Resources (MFMR). These data were used primarily in a spatial context to identify areas of overlap between fisheries and the Mining Licence Area (ML-170).

The distribution maps were created in ArcGIS 9 (refer to Figure 18 and onwards) to show the position of the MLA and the target mining areas (SP-1, SP-2 and SP-3) relative to the different fishing sectors as well as numerous other data to help identify the impact of the proposed mining. To quantify the extent of the impacts due to phosphate mining, six impact zones were considered:

1. Within the MLA (including target mining areas SP-1, SP-2 and SP-3),
2. The MLA (whole area inclusive of SP-1, SP-2 and SP-3)
3. Zone 1 : From MLA margin to 25 km boundary),
4. Zone 2 : Local (25 -50 km),
5. Zone 3 : Regional (50 -100km) and
6. Zone 4 : National (>100 km)

The following methods have been used to determine the significance rating of impacts identified in this benthic specialist study:

1. Description of impact - reviews the type of effect that a proposed activity will have on the environment;
2. What will be affected; and
3. How will it be affected.

Points 1 to 3 above are to be considered / evaluated in the context of the following impact criteria:

- *Extent*;
- *Duration*;
- *Probability*; and
- *Intensity*.

These impact criteria are to be applied as prescribed in the table below:

Impact Criteria:

Extent	**Dredge Area** Per vessel cycle i.e. ~66,000m^2 or 6.6 ha	**Annual Mining Area** Up to 3 km^2	**Specific Mine Site** (SP1 or SP2) each is 22x8 km or 176km^2	**Local** 25-50 km or 2,000km^2- 8,000km^2	**Regional** 50-100 km or 8,000km^2 – 30,000km^2	**National** 100 km to EEZ (200 nautical miles)[3] 100 to 370 km, or >30,000km^2

Duration	**Very Short Term** 3 days	**Short term** 3 days – 1 year	**Medium term** 1 - 5 years	**Long term** 5 – 20 years	**Permanent** > 20 years (life of mine)

Intensity/ Magnitude	**No lasting effect** No environmental functions and processes are affected	**Minor effects** The environment functions, but in a modified manner	**Moderate effects** Environmental functions and processes are altered to such extent that they <u>temporarily</u> cease	**Serious effects** Environmental functions and processes are altered to such extent that they <u>permanently</u> cease

Probability	**Improbable**	**Possible**	**Probable**	**Highly Probable/ Definite**

[3] 1 nautical mile = 1,85 kilometres

The <u>status of the impacts and degree of confidence</u> with respect to the assessment of the significance are stated as follows:

Status of the impact: A description as to whether the impact is positive (a benefit), negative (a cost), or neutral.

Degree of confidence in predictions[4]: The degree of confidence in the predictions, based on the availability of information and specialist knowledge. This had been assessed as **high**, **medium** or **low**.

Based on the above considerations, the specialist provides an overall evaluation of the **significance** of the potential impact, which is described as follows:

	None	Low	Medium	High
Impact Significance	A concern or potential impact that, upon evaluation, is found to have no significant impact at all.	Any magnitude, impacts will be localised and temporary Accordingly the impact is not expected to require amendment to the project design	Impacts of moderate magnitude locally to regionally in the short term Accordingly the impact is expected to require modification of the project design or alternative mitigation	Impacts of high magnitude locally and in the long term and/or regionally and beyond Accordingly the impact could have a 'no go' implication for the project unless mitigation or re-design is practically achievable

Furthermore, the following are being considered:

1. Impacts are described both **before** and **after** the proposed **mitigation** and management measures have been implemented;
2. Where possible the impact evaluation takes into consideration the **cumulative effects** associated with this project. Cumulative impacts can result from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts;
3. **Mitigation / management actions:** Where negative impacts were identified, the specialists specified practical mitigation measures (i.e. ways of avoiding or reducing negative impacts); and
4. **Monitoring (forms part of mitigation):** Specialists recommend monitoring requirements to assess the effectiveness of mitigation actions, indicating what actions are required, the timing and frequency thereof. From a fisheries and broad ecosystem perspective there are clearly data deficiencies suggesting that monitoring of the mining operation is required and that a baseline study could be established prior to mining. It should be noted however that Namibia already has many years of monitoring data in the proximity of the MLA (although the sampling

[4] The Precautionary Approach
The concept of sustainability and Precautionary Approaches underpin much of the current fisheries and environmental legislation globally. This impact assessment undertaken for the fisheries sector addresses the specific impact on the fishing industry, fish, biodiversity etc. of the mining and does not explicitly address the Precautionary Approach. The relevant government authority is the mandated institution responsible for evaluating the EIA and applying other considerations (such as political and social aspects and the precautionary approach).

stations may not coincide with the exact location of the area to be mined). Adaptation of current monitoring as well as extrapolation of current knowledge to the MLA is a prerequisite to use the best available information to understand the potential impacts prior to mining

6.2 ZONES USED IN THE ASSESSMENT OF FISHERIES IMPACTS

Due to the nature of the fisheries and fisheries data this assessment used distinct Zones to assess impacts. It should be pointed out that this assessment determined that the impact of dredging can be either

A) Direct – that is the physical impact of the dredging operation, or

B) Indirect – that is the mining will have an indirect effect on the areas adjacent to the actual area being mined. In this regard we assume that a fishery will be affected differently and to a lesser degree the further away fishing takes place from the actual mined area (i.e. SP-1, SP-2 and SP-3)

We stress also that the areas or zones selected are only a mechanism by which we could gauge possible effects. For example although substrate is removed in the mined area (SP-1 to 3) the fisheries in the adjacent areas to SP-1 to 3 are also likely to be affected – we use the term “Mining Licence Area”, or MLA. Thereafter we zoned areas (Zone 1-4) at different intervals as follows:

Zone 1. The area extending from the margins of the MLA to approximately 25 km seawards in all directions;

Zone 2. The area extending from Zone 1 seawards in all directions to 50km;

Zone 3. The area extending from Zone 2 seawards in all directions to 100 km;

Zone 4. The area extending from Zone 3 seawards in all directions to the Namibian EEZ.

These areas and zones are illustrated in Figure 18.

NOTE also that the areas beyond Zone 1 are probably of little overall significance. The area of greatest potential impact and risk to both the fisheries and the resources are most likely to occur within the MLA and outwards to the 25 km (Zone 1 outer margin) i.e. a consolidation of the MLA and Zone 1. We classify this as the “Mine Site” The rationale for this is as follows:

Data supplied by MFMR (NatMIRC) had limitations – only single daily locations were provided for most fishing sectors. In lieu of having vessel track data or start and end points of actual fishing events we must assume that on average a tow distance or line set (longline) will approximate 25 km (for trawling 3 hour trawl at 3.5 knots approximating no more than 25 km) from the border of the MLA. A more concise spatial assessment was not possible (data requested).

In a further analysis we used a modified methodology to estimate the levels of historical activity in and around each SP-1, SP-2 and SP-3 area in order to consolidate the expected levels of marine traffic in these areas.

6.3 COMMERCIAL FISHERIES DATA

The percentage catch in the main fisheries within the MLA (including SP1-3) and zones around the MLA was calculated and used to inform the assessment of the significance of the impacts.

In fisheries for which data for the whole Namibian EEZ was provided (hake, monk and horse mackerel) the percentage catch taken within each area / Zone as a proportion of the EEZ catch was calculated (Equation 1).

$$\frac{\text{Mine site;Local;Regional catches (t)}}{\text{Cumulative catches t to 100 km}}\ x\ 100 \text{............} \textit{Equation 1}$$

In cases where spatial data on catch and effort was not provided for the whole Namibian coast for all fisheries, the percentage (per zone) of the cumulative catch to the 100 km boundary (from the MLA) was calculated (Equation 2). This applied to the hake longline and small pelagics sectors as the data provided only incorporated catches from the area between 23°S and 26°S. For these sectors the percentage catch within the MLA in relation to the EEZ could not be calculated :

$$\frac{\text{Mine site catches (t)}}{\text{Total EEZ catches (t)}}\ x\ 100 \text{ ....} \textit{Equation 2}$$

6.4 SURVEY DATA

In addition to using commercial catch and effort data for spatial assessments, data from numerous fisheries surveys were provided by MFMR. This included data from the main annual biomass surveys for hake, monk, horse mackerel and small pelagic species (Appendix 1a - 4). In many instances samples are taken from the same stations on successive annual surveys – interpretation using these data for the respective impact zones had, therefore, to consider any bias this may have given. For example, the distribution of biological data used to help interpret impacts on recruitment to the commercial fisheries (e.g. spawning, juveniles fish, eggs and larvae) were visually assessed by declaring "Yes or No" to whether the catches overlapped with the MLA or not (Tables 1c, 3 and 5). Note, an analysis is only declared "Yes" if there is an overlap of catches in one of the three target areas (SP-1, SP-2 and SP-3).

7 IDENTIFICATION OF IMPACTS FOR ASSESSMENT

7.1 RATIONALE FOR IMPACT CATEGORISATION

The displacement of the commercial fishing activities and the redistribution, survival and recruitment of ecological important fish species, seabirds and mammals could be influenced by the mining of phosphate in several **direct** ways. For example:

- **Exclusion of fishing to avoid mining, and the loss of potential fishing grounds**

We assume that if phosphate dredging proceeds fishing activities will be limited to certain areas in the MLA during the mining operations because of the physical nature of phosphate mining (habitat removal) and increased levels of maritime traffic. This means that the whole MLA will not be restricted to fisheries and only the areas around SP-1 in the first phase will be closed (and areas within any imposed maritime safety limitations). Fishing effort will certainly be displaced for the full term of the mining inside the MLA and around SP-1 in the first phase. In the whole of the "Mine Site" area (which is the area that includes the mining location – SP1-3 and extending into the MLA and Zone 1 as we identify in Figure 18), fishing is unlikely to be completely excluded. Fishing vessel operations and maritime traffic are however expected to have to alter normal operations and or transits. In particular, fishing operations which may historically have followed specific trawl tracks will be affected. In this regard we have assumed that an average trawl is three hours long at 3.5 knots – or approximating 25 km. Based on this assumption it is reasonable to assume that fishing operations in general will have to be altered from the historical norm in the Mine Site area (that is up to and including the MLA and an area around the MLA with a radius of 25 km).

- **The removal of habitats (or disturbance of bacterial mats, if present) utilised by marine fauna.**

Demersal fish species live on the sea bottom and will be displaced by loss of habitat through the direct removal of substrate. The removal of the "giant" bacteria *Thiomargarita* and *Beggiatoa* is also a consideration (but not considered directly in this assessment).

- **The creation of sediment plumes (turbidity) that might affect species abundance (area avoidance, mortality, loss of feeding and spawning grounds etc).**

Mining for marine phosphate deposits by dredging the seafloor may increase the amount of suspended nutrients in the surrounding sea water if soluble phosphate is present in the sediment pore water (Note: the phosphate ore to be mined is insoluble in sea water). When nutrients increase in the water column, the amount of phyto- and zooplankton possibly may change.

- **Loss of biodiversity through direct physical removal of fauna;**

This is a difficult impact to assess however it is an important consideration if unique species occur in the MLA that may result in the permanent loss of biodiversity (refer to Appendix 1a-5). Note that this specialist assessment only considers biodiversity in the context of ichthyofauna and is based only on the survey data provided by MFMR. This has obvious limitations in terms of biodiversity estimates as these surveys mostly focus on biomass assessments of commercial fisheries.

Indirect effects may also occur such as:

- **Displacing the normal behaviour of seabirds and mammals due to the physical disturbance of the mining activity (including noise from the dredging operation);**

Underwater sound can have a variety of effects on marine life, ranging from subtle to strong behavioural reactions such as startle response to complete avoidance of an area. In extreme instances it may create conditions that contribute to reduced productivity and effects on survival. Dredging sounds generally fall within the lower end of the frequency ranges although insufficient knowledge exists to confidently predict at what levels sound can cause injury, such as hearing damage or communication interference. The impact of the dredging operations physical presence is also a consideration, in particular the use of deck lights which can result in seabird interactions and potential mortality (Ryan 1991).

- **Disturbance of normal trophic interactions and the general ecosystem functioning;**

This is a general consideration relating to the effect of mining on the broader ecosystem, in particular the potential for the removal or disturbance of parts of the ecosystem and the related cascade effects in the system. In this regard we can only generalize on impacts and risks focusing on possible trophic effects such as the removal of top predators, commercial fish species, and key species on which data are available. Note also that trophic effects on the ecosystem also apply to the broader ecosystem relating to other climatic and anthropogenic influences such as pollution, fishing and climate change. Due consideration must be given to the scale of the proposed mining related to these other effects and the broader marine environment of the Benguela Current ecosystem.

7.2 IMPACT CATEGORIES

We have categorised our assessment into the different types of impacts for ease of interpretation. These include the likely impact of the proposed phosphate mining on fishing, the ecosystem in general, on recruitment risk to fisheries, biodiversity (predominantly fish) and the likely impact of the mining operations on seabirds and marine mammals.

Our five primary impacts that have been assessed independently according to the significance rating and impact criteria provided are:

1. **Impact 1** : The likely impact of mining **ON** commercial fisheries (hake and monk demersal trawl fishery, the hake longline fishery, the mid-water trawl fishery and the small pelagic purse seine fishery). The fishing sectors may not be able to operate effectively in the MLA and to a lesser extent in Zone 1 due to a) the disturbance caused from actual mining operations; b) associated sediment plumes; c) exclusion zones around the mining site; and d) increase levels of maritime traffic associated with the mining operation;

2. **Impact 2** : The likely impact of mining **ON** the main commercial fish species (hake, monk, horse mackerel, small pelagics, sole, orange roughy, snoek and bearded goby). The fish fauna is a critical component of the broader marine ecosystem and may be displaced and/or redistributed by the mining operation primarily because of the a) actual mining activities; b) habitat disturbance; and 3) sediment plumes (turbidity);

3. **Impact 3 :**The likely impact of mining **ON** the recruitment of commercially important species (hake, monk, horse mackerel and small pelagics). The dispersal and survival of juveniles, eggs and larvae will be affected by a) physical disturbance of the fishing grounds and b) sediment plumes (turbidity);

4. **Impact 4** : The likely impact of mining **ON** the fish biodiversity. Mining operations will result in a reduction or loss in biodiversity because of the a) actual mining operations, b) the habitat destruction and c) sediment plumes; and

5. **Impact 5 :** The likely impact of mining **ON** seabirds and marine mammals. Mining operations will cause the displacement and/or redistribution of seabirds and mammals due to a) noise pollution b) artificial light intensity and c) disturbance of normal ecosystem processes.

NOTE that this assessment in no way assumes that phosphate dredging in the MLA will proceed. The impacts identified in this assessment must however assume the likelihood that the operations will proceed so that the environmental impacts and impacts on the commercial fisheries can be estimated.

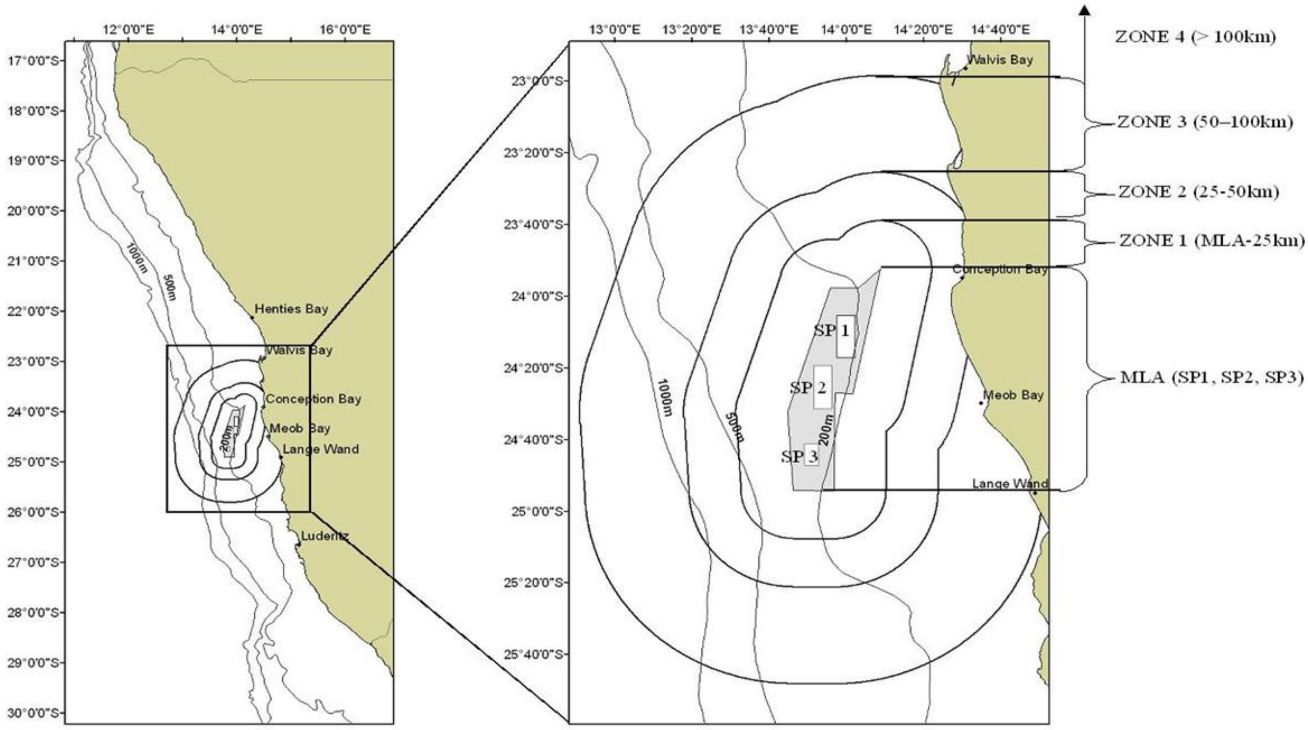

Figure 18. Illustration of zones and areas defined in the fisheries assessment

8 RESULTS

Refer to Figure 18 illustrating the different areas and Zones used in this assessment. Refer also to Tables 1a, b and c summarising fisheries data used to assess impacts and spatial distributions of impacts.

8.1 IMPACT 1: THE IMPACT OF THE MINING OPERATIONS ON COMMERCIAL FISHERIES.

We used spatial analysis to estimate the proportion of fished areas (catch and effort) likely to fall within each proposed mining location (SP-1, SP-2 and SP-3), the whole MLA and in Zones adjacent to the MLA (as defined in Para. 6.2). Refer also to Figures 19 - 26 for the specific fisheries. Refer also to Tables 1a-c for our estimates of the likely proportion of catch and effort that will be affected by each zone adjacent to the mining operations. The significance of the impacts is summarised in Table 2**.**

Table 1a. Commercial fisheries data showing percentage catches per impact zone for fisheries in which data were supplied for the whole Namibian EEZ

	SP-1		SP-2		SP-3		MLA (incl. SP-1, SP-2, SP-3)		Zone 1 (Area between MLA – 25 km)		Cumulative to 25 km		Zone 2 (Area between 25 – 50km)		Cumulative to 50 km		Zone 3 (Area between 50 – 100 km)		Cumulative to 100 km		Zone 4 (Area greater than 100 km)		Total catch (t)
	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)	%	Catch (t)
Hake 2004-2009	6	0.00	297	0.06	0	0.00	4606	0.86	22382	4.17	26988	5.03	19004	3.54	45992	8.57	48059	8.96	94051	17.53	442601	82.47	536651
Horse mackerel 1997-2011	1694	0.05	191	0.01	222	0.01	10393	0.32	24622	0.76	35015	1.08	47267	1.45	82281	2.53	110672	3.40	192954	5.93	3063404	94.07	3256357
Monk 2005-2010	2	0.00	802	0.98	64	0.08	5163	6.34	10924	13.41	16087	19.75	6749	8.29	22836	28.04	11945	14.67	34781	42.70	46664	57.30	81445

Table 1b. Commercial fisheries data showing percentage effort per impact zone for fisheries in which data were supplied for the whole Namibian EEZ

	SP-1		SP-2		SP-3		MLA (incl. SP-1, SP-2, SP-3)		Zone 1 (Area between MLA – 25 km)		Cumulative to 25 km		Zone 2 (Area between 25 – 50km)		Cumulative to 50 km		Zone 3 (Area between 50 – 100 km)		Cumulative to 100 km		Zone 4 (Area greater than 100 km)		Total effort (hrs)
	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)	%	Effort (hrs)
Hake 2004-2009	7	0.00	857	0.00	0	0.00	9417	1.04	39470	4.37	48887	0.05	32782	0.04	81669	9.04	86550	0.10	168219	18.61	735601	0.81	903820
Horse mackerel 1997-2011	224	0.05	33	0.01	78	0.02	1864	0.38	4233	0.87	6096	1.25	8325	1.71	14421	2.96	18058	3.71	32479	6.66	454864	93.34	487343
Monk 2005-2010	14	0.00	2413	0.62	237	0.06	19327	4.93	48585	12.40	67912	17.33	31704	8.09	99617	25.42	59510	15.19	159127	40.61	232681	59.39	391808

Table 1c. Commercial fisheries data showing percentage catches per impact zone for fisheries in which data were not supplied for the whole Namibian EEZ (Note that % calculations ONLY include the area up to 100km from the MLA for these fisheries data for the whole EEZ were not used)

<table>
<tr><th>Dataset</th><th>Dates</th><th>Species</th><th>MLA + Zone 1 (SP-1, SP-2 and SP-3)</th><th>Zone 1 < 25 km</th><th>Zone 2 (Local) 25 - 50 km</th><th>Zone 3 (Regional) 50 - 100 km</th><th>National >100 km</th></tr>
<tr><td>Hake commercial longline data</td><td>2006-2010</td><td>Hake (Merluccius paradoxus and M. capensis)</td><td rowspan="4">Very low or negligible evidence of recent fishing activity</td><td>31.49</td><td>21.11</td><td>47.4</td><td>No data</td></tr>
<tr><td rowspan="3">Small pelagics commercial data</td><td rowspan="3">2000-2011</td><td>Anchovy (Engraulis encrasicolus)</td><td>1.67</td><td>42.28</td><td>56.06</td><td>No data</td></tr>
<tr><td>Sardine (Sardinops sagax)</td><td>17.44</td><td>29.17</td><td>53.39</td><td>No data</td></tr>
<tr><td>Round herring (Etrumeus whiteheadi)</td><td>1.82</td><td>23.67</td><td>74.52</td><td>No data</td></tr>
</table>

Explanation of Tables 1a, b and c: The percentages in Zones reflect the following:

SP-1, 2 and 3 : % of catch and effort in actual areas to be mined of total Namibian historical catch and effort for years specified (direct impact)

MLA : Historical catch and effort in the whole Mine Lease Area as a % of the total Namibian catch and effort for the years specified (likely impact)

Zone 1 : Historical catch and effort in Zone (1) only [MLA margin to 25 km] as a proportion of the total Namibian catch and effort (equation 1 – see section 6.3) (likely impact).

Zone 2 : Historical catch and effort in Zone (2) only [>25 to 50 km margin] as a proportion of the total Namibian catch and effort (equation 1 – see section 6.3)(indirect impact)

Zone 3 : Historical catch and effort in Zone (3) only [>50 to 100 km margin] as a proportion of the total Namibian catch and effort (equation 1 – see section 6.3)(indirect impact)

Zone 4 : Historical catch and effort in Zone (4) [>100 km to EEZ) as a proportion of the total Namibian catch and effort (equation 1 – see section 6.3)(indirect impact)

Table 1c : Column MLA: Mining will or will not result in fishing being affected based on recent catch and effort reported in the MLA – yes / no

Specifically for each fishing sector we summarise as follows:

The hake trawl fishery (Figures 19 and Tables 1a and c)
Figure 19 (and Tables 1a and b) shows the position of hake trawls carried out during the period 2004 – 2009. Trawling intensity is expected to be moderate as the preferred trawl depth for the fishery is greater than 300 m. Catches taken from the MLA and Zone 1 (i.e. Mine Site) is a small proportion of the entire Namibian EEZ and constitutes 5.03% of the total catches (Table 1a) and 4.37% of effort. Within the MLA the historical catch is 0.86% or about 1% of total hake trawl effort. There are minimal records of fishing in SP-1 and SP-3 but fishing has been reported in SP-2. Hake trawling however is likely to be impacted within the whole MLA, in particular on the seaward (deeper) areas (western fringes of the MLA). Trawling for hake, although it occurs significantly beyond the MLA, is highly unlikely to be affected. The only caveat in this regard is the extent of any exclusion zone around the mining operation (which is not likely to be beyond the MLA).

The hake longline fishery (Figure 20 and Table 1c)
Hake is also targeted by the demersal longline fishery and the position of the throws relative to the MLA is represented in Figure 20. The catch distribution of longline is similar to the trawl in that in the MLA the fishery overlaps on the fringes of their catch distribution profile. The demersal longline fishery should only be impacted in the south western portion of the MLA. Note % shown in Table 1c is not for the whole EEZ catch, it is only up to the 100km boundary – Zone 3.

The monk trawl fishery (Figure 21 and Table 1a and b)
This fishery deploys similar bottom-trawl gear to hake but target monk using gear with some modifications (such as tickler chains). The mining operation is expected to significantly impact monk-directed trawling as the data show that historically an estimated 6.34% (Table 1a) of monk are taken in the MLA (Figure 21) and 19.75% if Zone 1 is included. Catches are taken from more than 50% of the MLA and in particular monk trawling will be excluded from the SP-2 and SP-3 areas. The proximity of SP-1 to monk grounds is also likely to exclude monk trawling. We conclude therefore that monk trawling will be largely excluded from parts of the MLA especially in SP-2 during the second phase of mining.

Horse mackerel (Figure 22 and Table 1a and b)
The bulk of the mid-water fleet catches of horse mackerel are usually made north of 20°00'S. Only a small percentage (0.32% Table 1a) of the fishing activity occurs in the MLA (Figure 22) and 1.08% if Zone 1 is included. The frequency (intensity) of midwater trawling in the MLA is therefore expected to be low as the cumulative effort (hours trawled) approximates 1.25% (Table 1b) .Note however that the data suggest that fishing has occurred in the whole of the MLA but that fishing intensity is low. This implies that the mid-water trawl fishery will lose the option of fishing in the MLA but that due to the low frequency of fishing in the area, the overall impact on the fishery will be moderate to low.

Small pelagic (Figures 23-26 and Table 1c)
Though the MLA is not situated in the main small pelagic fishing grounds (sardine – Figure 25; round herring – Figure 26), the MLA is an area of occasional high abundance of adult fish (Figure 23). For sardine the estimated historical catch in the MLA and Zone 1 approximates 17% (of the 100km around the MLA) with most taken in Zone 1 and zero catch in each of SP-1, 2 and 3. The northern extent of the MLA overlaps marginally with purse seine grounds and to a greater extent

northwards of the MLA into the zones more distant from the mining area. This has significance depending on the extent of the plume generated by the actual mining operation and the discharge of water once settled in the dredger. As the extent of the plume is understood to be localised (and not extend much further than 500 to 1500 m) (CSIR 2006b) it is considered highly unlikely that mining will impact the small pelagic fishery.

In general for all fisheries the likely impacts on are summarized in Table 2[5] .
Note :

- Hake trawl, horse mackerel, midwater trawl and monk trawl will be directly impacted on by mining within the actual mining locations (SP1-3) and within the MLA.
- In all other zones the proportion of fishing that may be indirectly impacted will vary with distance from the actual Mining Lease Area.
- With respect to demersal and pelagic fish, the dredge overspill plume impacts will likely be low or minimal and localised, provided that plumes are contained within the mining or immediate operational area.
- Due to the northward-flowing current along the Namibian shelf it is possible, but unlikely, that the impact of the operations might be transported into the main distribution areas for hake, horse mackerel, sardine and monk.
- Depending on the concentration of the dredge overspill particles in the water column, the effects can vary. Small pelagic fish as filter feeders are expected to be disturbed by dredging activity, either directly by gill clogging or indirectly through the food web.
- There is a remote possibility that dredging would alter the plankton abundance and community and disturb normal feeding behaviour of small pelagic species.
- As long as the effects of dredging are not transported inshore where most small pelagic spawning activity occurs, the effects of phosphate mining on small pelagic commercial fish are considered low.

[5] Our assessment does not consider the impact of the removal or disturbance of naturally occurring bacteria in the MLA (refer to Appendix 1c).

Table 2. Impact assessment table summarizing the impact of phosphate mining on the main Namibian fisheries

Nature of the impact	The impact on fishing operations of phosphate mining on the main Namibian fishing sectors; **a)** hake trawl and **b**) hake longline, **c)** monk trawl **d**) horse mackerel mid-water trawl, and **e)** small pelagic purse seine fisheries. The fishing sectors will not be able to operate in certain areas due to **1)** actual mining operations due to dredging operations and vessel activities, **2)** associated sediment plumes **3)** exclusion zones around the mining site and **4)** increase levels of maritime traffic associated with the mining operation.
Extent	MLA - fishing operations will be affected in the MLA and beyond to within a 25 km boundary of the actual target mining sites SP-1, SP-2 and SP-3.
Duration	Long term - the direct impact will cease once the mining activity ends after 20 years (the period for which the mining licence is issued). Thereafter the recovery of the fishing grounds and fish abundance to levels prior to the commencement of mining operations is expected to take up to 20 years (long term)
Intensity	Serious effects - significant impacts will occur for the duration of mining in the MLA, moderate effects are expected to occur in the long term once mining ceases (up to 20 years).
Probability	Definite- consequences will occur in all instances for the duration of mining. Once mining ceases consequences are expected to occur in some instances (moderate effects) within the MLA and persist at a reduced level in the long term within the 25 km boundary zone.
Status (+ or -)	Negative - the impact will result in a direct loss in fishing operations in MLA
Significance (no mitigation)	Medium - the project design might require modification to accommodate certain fishing operations
Mitigation	Consider options to minimise impact on fishing operations for example options with respect to spatial and temporal area closures.
Significance (with mitigation)	Medium to low
Confidence level	High - the evaluation is based on good qualitative and quantitative, historical and current fisheries related data.

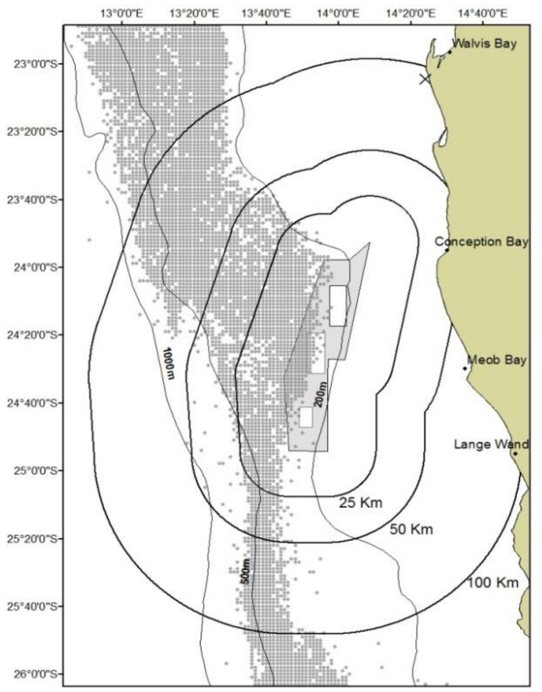

Figure 19. ***Hake commercial data (2004-2009). Each dot represents the position per trawl relative to the MLA. n=63351***

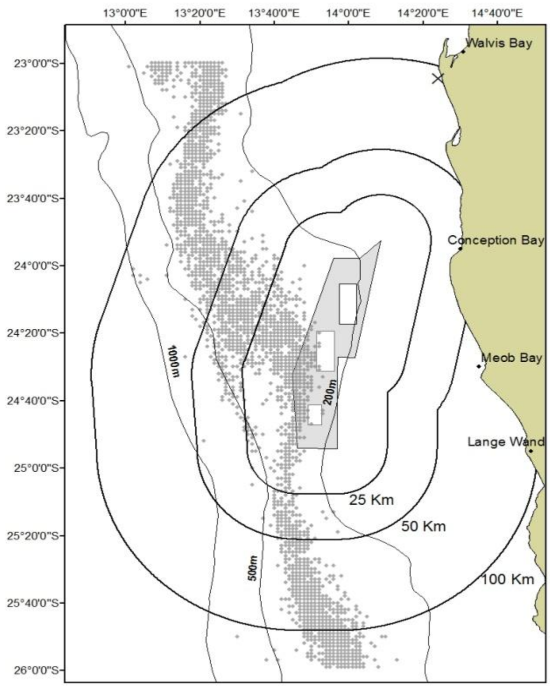

Figure 20. ***Hake commercial longline data. Each dot represents the position per throw relative to the MLA. n = 4553***

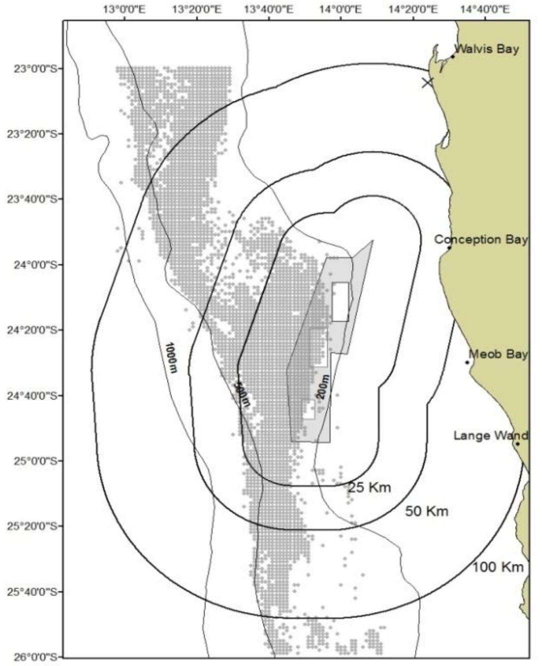

Figure 21. ***Monk commercial data (2005-2010). Each dot represents the position per trawl. n=36798***

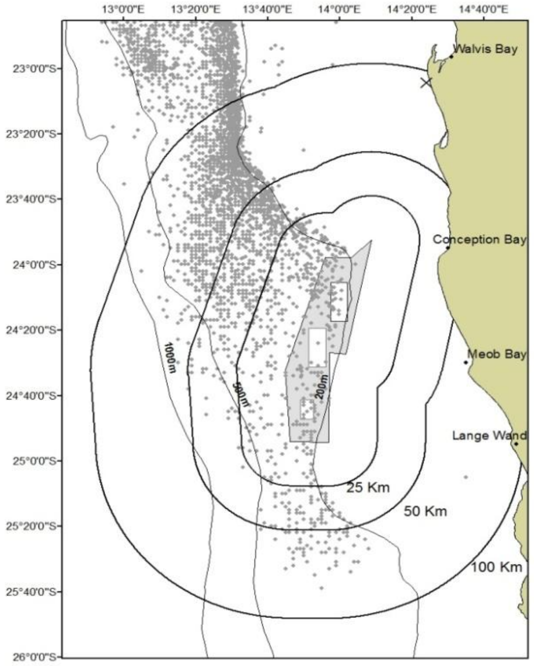

Figure 22. ***Horse mackerel commercial data (1997-2011). Dots are the position of the last trawl per day. n=39697***

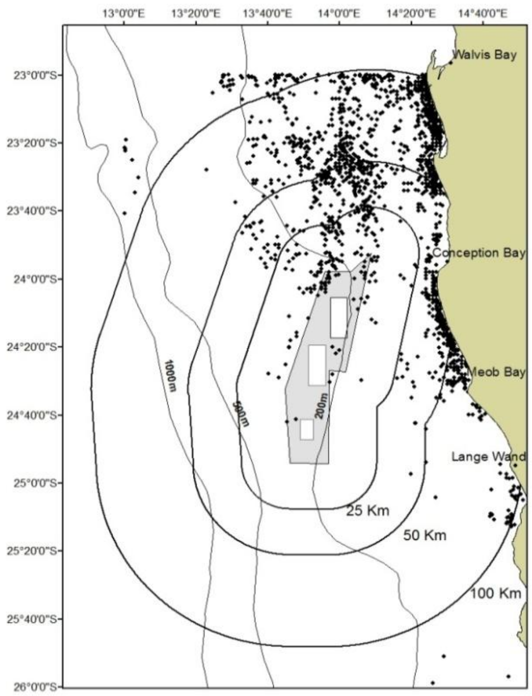

Figure 23. Small pelagic commercial data (anchovy, sardine and round herring) 2000 – 2011. n=2260

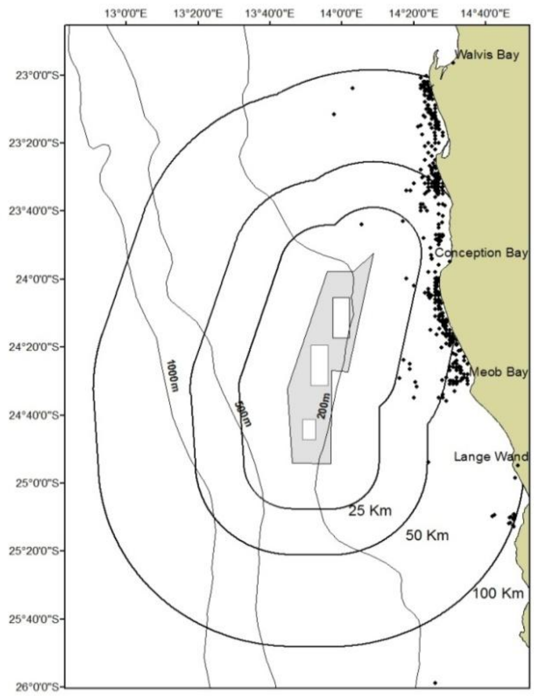

Figure 24. Location of anchovy catches from commercial data (2000 – 2011). n=552

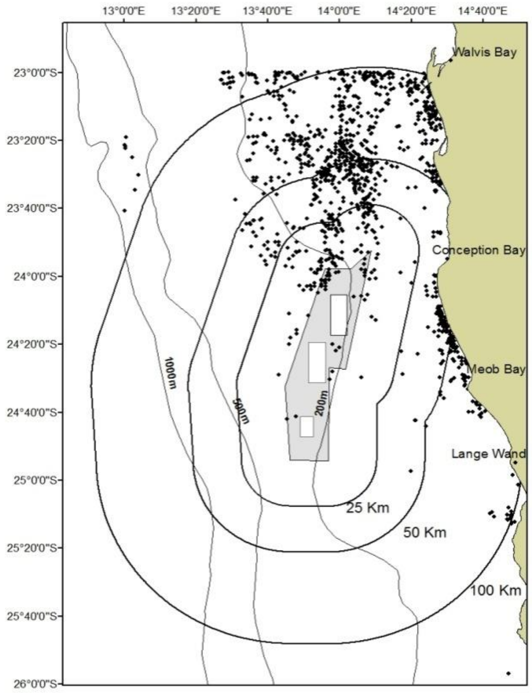

Figure 25. Location of sardine catches from commercial data (2000 – 2011). n=1099

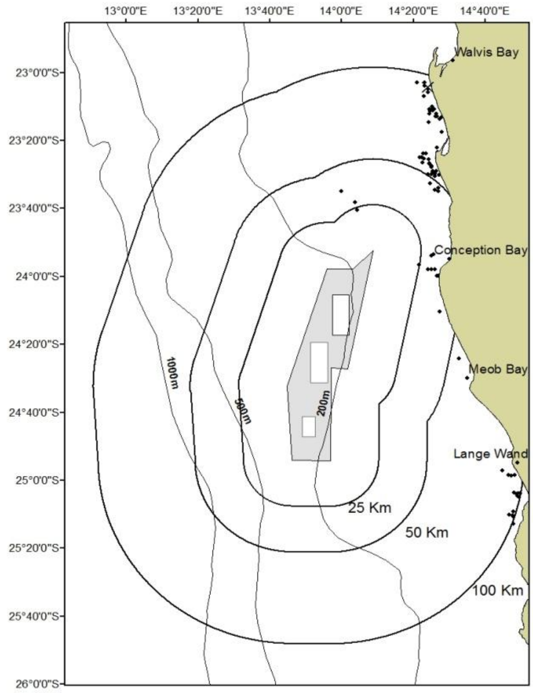

Figure 26. Location of round herring catches from commercial data (2000-2011). n=83

8.2 IMPACT 2: THE IMPACT OF THE MINING OPERATIONS ON THE ECOSYSTEM (TROPHIC INTERACTIONS)

As commercial data are not "independent", we used survey data as the basis for estimating the approximate spatial distribution of the main commercial fish species. These species are used as biological indicators of the main fish components of the ecosystem, in particular their distribution reflects the likely trophic structure of the ecosystem in the vicinity of the MLA. Note that trophic modelling of the Benguela ecosystem has been done although the specific application to Namibia and the MLA in particular can only be inferred from these broad studies (Shannon, 1986). Note also that trophic modelling is inclusive of top predators as well as species lower in the food chain including benthic organisms removed with the substrate in the dredging process. We have enquired regarding the status of trophic marine modelling in Namibia and the BCC but have as yet no conclusive models or data on which to give a more informed assessment of the impacts on the ecosystem. Equally this problem applies to all aspects of the Benguela ecosystem including fishing and other anthropogenic effects.

The survey data (see Table 3) were analysed by visually examining the maps (Figures 27 – 38). To determine the likely impact of mining we used it as an indicator for the distribution and abundance of each species relative to their proximity to the MLA. The unit or index applied is simply the cumulative catch of a particular species in the different surveys.

This rough assessment is summarized in Table 3 - i.e. the likelihood of the species listed being found (and impacted) in the actual mining locations within the MLA. The significance of the impact is summarised in Table 4. Note also that our data pertain only to the species recorded in the surveys we had access to. We are aware that many more species are found in the MLA, but that there is no data or records of these we are aware of (excluding the benthic sampling undertaken for the phosphate pre-studies). As such the data we have had access to can only be considered an "indicator" with no direct inference to all species potentially impacted by the proposed dredging.

Table 3. Visually assessment of the potential impacts of phosphate mining on ecologically important commercial fish species

Dataset	Dates	Species	MLA (SP-1, SP-2 and SP-3)
Hake survey data	1995-2010	Horse mackerel	No
		Snoek (*Thyrsites atun*)	No
		Bearded Goby (*Sufflogobius bibarbatus*)	Yes
		Monk	Yes
		Hake	Yes
		Sole (*Austroglossus microlepis*)	Yes
Monk survey data	2007-2010	Monk	No
		Goby	No
		Orange roughy (*Hoplostethus atlanticus*)	No
		Sole	No
Small pelagic survey data	2002-2011	Horse mackerel, anchovy, sardine and round herring	No
Hake, monk and small pelagics survey data combined	1995-2011	All species counted per sample station	Yes

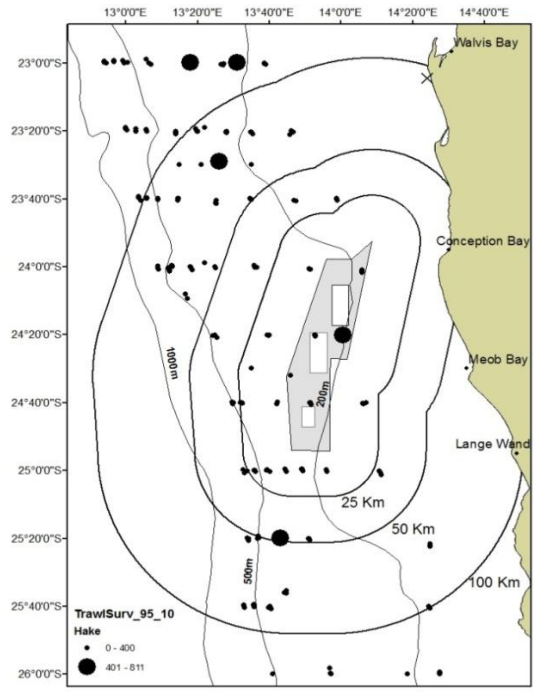

Figure 27. Distribution of hake from hake-survey data (1995-2010). Dots show the cumulative weights per station. n=678

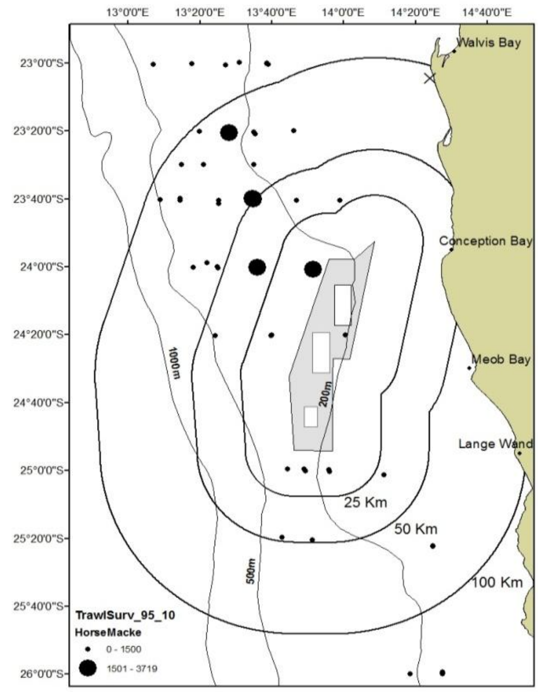

Figure 28. Horse mackerel from hake-survey data (1995-2010).). Dots show cumulative weight per station. n=78

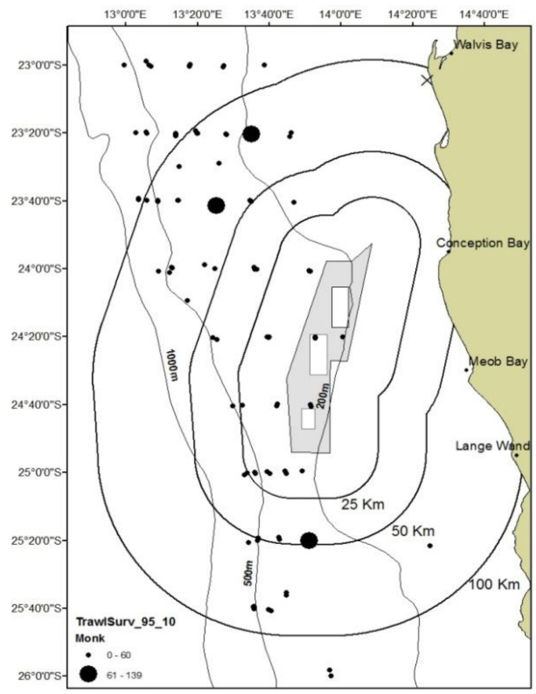

Figure 29. Monk from hake- survey data (1995 – 2010). Dots show cumulative weight station. n=134

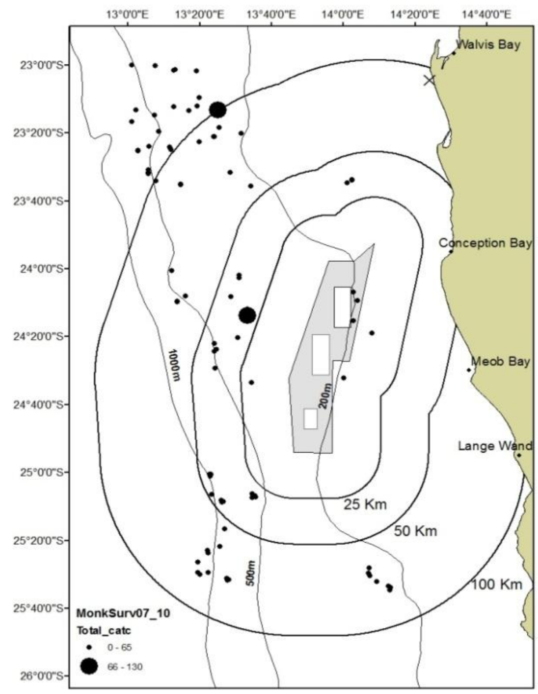

Figure 30. Monk from monk-survey data (2007-2010). Dots show cumulative weight per station. n=100

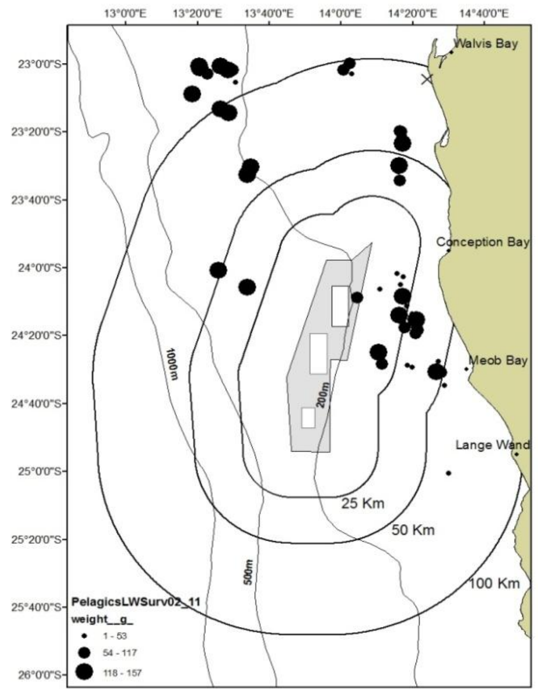

Figure 31. Pelagic (anchovy, sardine and round herring) weights from pelagic-survey data (2002 – 2011). n=2557

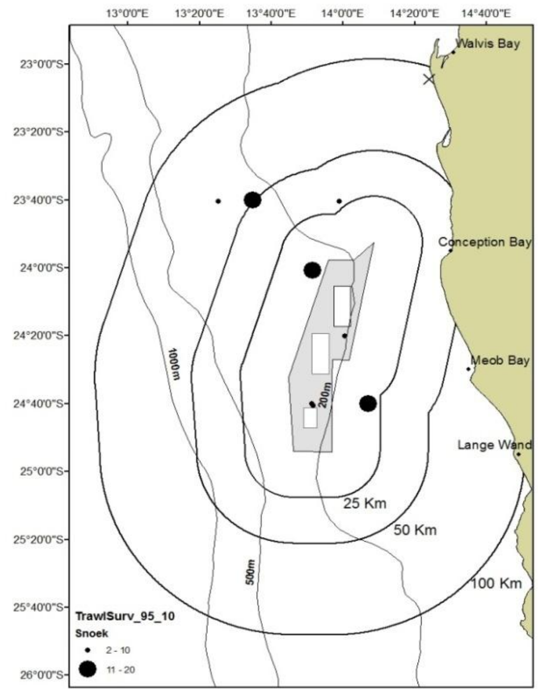

Figure 32. Total catch per station for snoek from hake-survey data (1997-2010). n=8

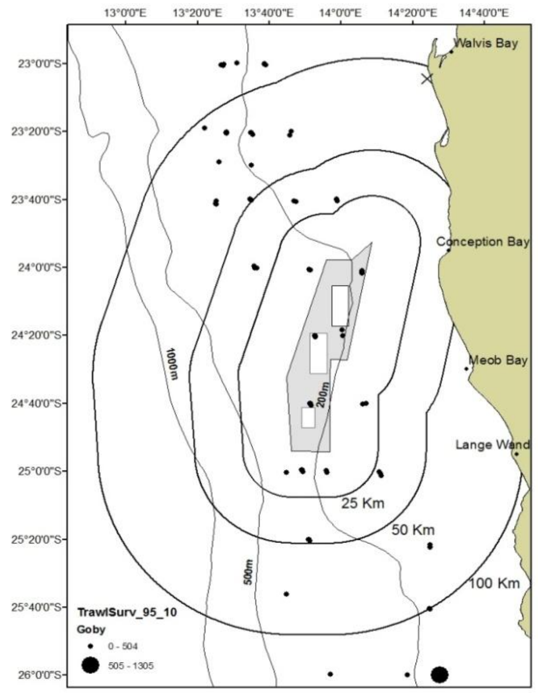

Figure 33. Distribution of goby from hake-survey data (1995 – 2010). n=93

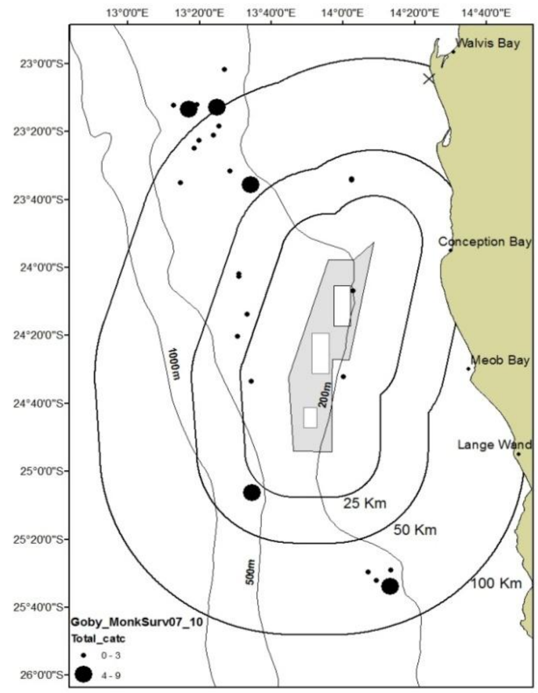

Figure 34. Distribution of goby from monk-survey data (2007 – 2010). n=24

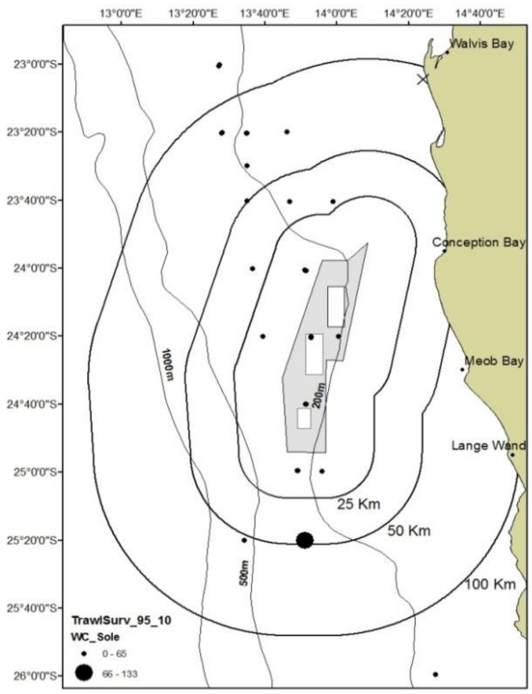

Figure 35. Total catch per station for west coast sole from hake-survey data (1997 – 2010). n=48

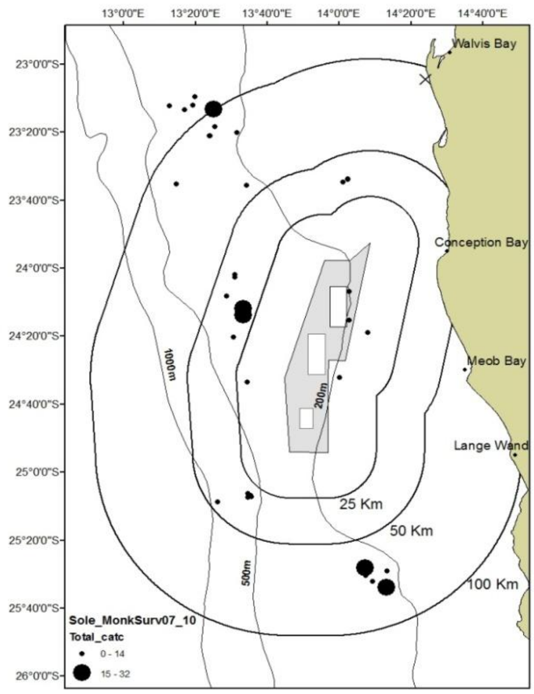

Figure 36. Total catch per station for west coast sole from monk- survey data (1997 – 2010). n=42

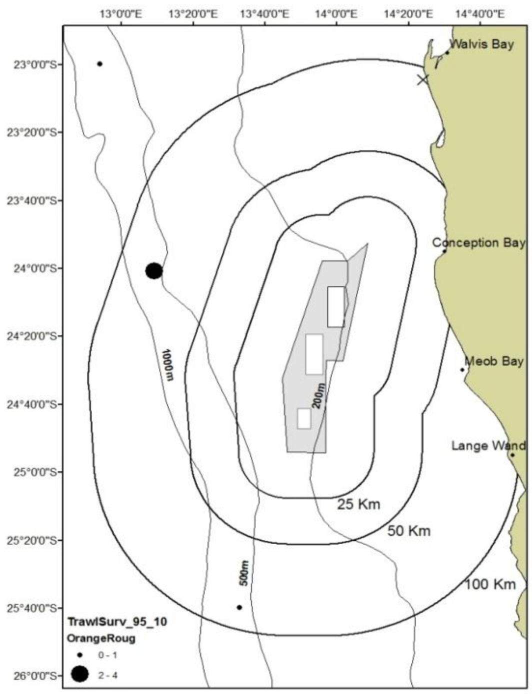

Figure 37. Distribution of orange roughy from hake-survey data (1995 – 2010). n=4

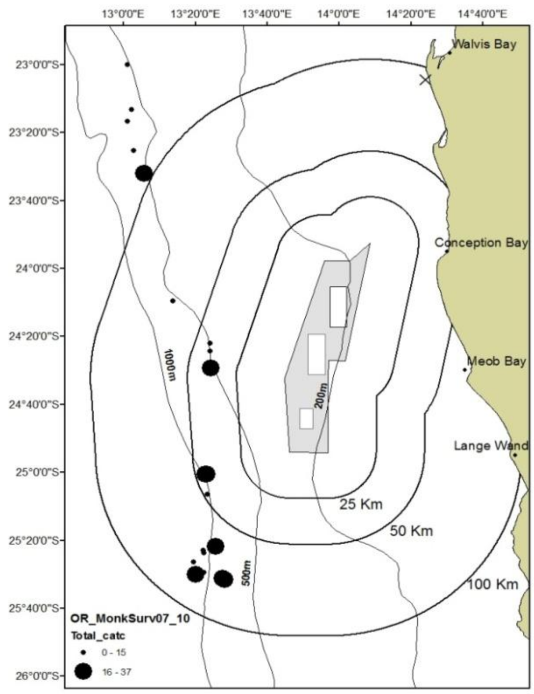

Figure 38. Distribution of orange roughy from monk-survey data (2007 – 2010). n=29

Based on the survey data we conclude the following with respect to the impact of the mining on the abundance and distribution of the main commercial fish species :

Hake : (Figure 27) - Hake (*M. capensis*) are found throughout the mining lease area. One station in the MLA and just south of SP-1 has a high frequency of occurrence of hake. Otherwise we assume the abundance of hake in the MLA and surrounding areas is fairly uniform with higher levels of hake abundance in deeper water. Mining at the specific sites is therefore expected to impact on hake but due to their mobility hake will most likely avoid the mined area. This will result in displacement of hake biomass into adjacent areas, mortality is unlikely. From an ecosystem perspective this will have implications only in a localised context (we assume hake will avoid the mined area). Disturbance of the substrate will not result in loss of food for hake since hake generally do not feed on substrate organisms and predate mostly on other fish species and squid.

Horse mackerel : (Figure 28) - In the MLA horse mackerel abundance is low although high incidence of this species is expected north and westwards of the MLA. Horse mackerel are highly mobile and as with hake, are expected to be displaced outside of the mined locations. Mortality is not expected and the impact on the ecosystem is expected to be low.

Monk : (Figures 29 and 30) - Monk are found throughout the MLA and the adjacent areas. Distribution appears fairly uniform. Monk are aggressive ambush predators and are found mostly on flat muddy substrate. They are also not highly mobile fish and have mostly patchy localised distribution patterns. These characteristics are expected to make monk vulnerable to mortality from the physical nature of the dredging process. This will have a localised impact on the trophic ecology but due to the relatively small area of the mining sites (up to 3 km^2 mined annually and 60 km^2 in the 20 year life of mine), this impact is expected to be moderate. The removal of the preferred substrate type for monkfish will have a long-term (at least 15 years) impact on the availability of monk in and around the mining sites (starting with SP-1). Note it is not possible without long-term monitoring to determine the rate of substrate recovery (appendix 1c) or the potential for monk to repopulate the mined areas.

Pelagic species : (Figure 31) - Abundance of small pelagic species is assumed to be low (based on the distribution of catch and effort only) in the MLA. Availability of this species group increases into Zone 1 and northwards into Zones 2 and 3. Due to data limitations we are unable to estimate relative abundance beyond 23°S. One survey station indicates that small pelagic species are found in the MLA. We assume therefore that small pelagic species are highly likely to be found throughout the MLA but that the impact of mining and the resulting plumes cannot be stated with sufficient confidence.

Snoek : (Figure 32) - This species is found in and around the MLA. They are highly mobile and are only found seasonally and in aggregations with high abundance at these times. Snoek, when occurring in the area of the MLA and mining operation, are expected to avoid the area – i.e. will be displaced. This is not expected to have a significant impact on the ecology in the MLA and adjacent zones.

Bearded goby : (Figures 33 and 34) - Two surveys suggest that gobies are distributed throughout the MLA and will occur inside the mining sites (SP1-3). Gobies have been identified as having a key trophic role in the ecosystem. As gobies are a mobile species they will be displaced. Mortality is expected at the dredging location. Both the displacement and mortality of this species will have a moderate impact on the whole ecosystem in the MLA only.

Sole : (Figures 35 and 36) – Similar to monk, sole are a sedentary species preferring muddy substrate. They feed on polychaetes and other worms and fauna in the substrate. Their distribution is throughout the MLA and extending into the adjacent zone. Dredging operations will have a significant impact on sole abundance due to localise mortality. Some displacement of sole to adjacent areas away from the mining is expected. This localised impact will be long-term (at least 15 years) due to the removal of the preferred substrate of sole.

Orange roughy : (Figures 37 and 38) – Orange roughy are only found in deeper waters and well outside of the MLA. No impact on the ecosystem is expected.

Table 4. Impact assessment table of phosphate mining on the ecosystem

Nature of the impact	The impact of phosphate mining on the ecologically important demersal and pelagic fish species. The impact will result in the redistribution and/or displacement of hake, monk, horse mackerel, sole, orange roughy, bearded goby populations and small pelagics because of **1)** actual mining activities due to dredging operations and vessel activities **2)** habitat disturbances and the removal of substrate and **3)** sediment plumes (turbidity)
Extent	MLA - demersal and pelagic fish species will be displaced or redistributed from inside the MLA and possibly from the surrounding areas into Zone 1.
Duration	Permanent (>20 yrs) - the impact will cease once the mining activity ends after 20 years (the period for which the mining licence is issued) however fish recovery is expected to occur sooner
Intensity	Moderate effects - only a small fraction (compared to the regional extent) of fish inhabit the MLA and fish populations will recovery or settle in areas after mining operations ceases however habitat destruction may cause a longer period of recovery particularly for monk and sole.
Probability	Highly probable - fish (and in particular demersal fish) are expected to move away from the mining activity resulting in displacement of biomass
Status (+ or -)	Negative
Significance (no mitigation)	Medium - the duration of the impact is permanent but recovery of fish populations in the area may occur in the long term. The intensity is minor to moderate and the extent is confined to the MLA and Zone 1
Mitigation	In terms of the ecosystem as a whole there are no particular mitigation measure that can be implemented.
Significance (with mitigation)	Not applicable (no mitigation alternatives)
Confidence level	Low to medium - assumptions based on fish ecology is limited by the data available

8.3 IMPACT 3: THE IMPACT OF PHOSPHATE MINING ON FISH RECRUITMENT

We identify recruitment as the mechanism by which most fish species breed, spawn, migrate and ultimately become available for exploitation. The data used to this assessment are given in Table 5. The significance of the impact is summarised in Table 6.

Table 5. Data (surveys) used in the assessment of the potential impacts of phosphate mining on fish recruitment

Dataset	Dates	Species (percentage of 100km buffer zone)	MLA (SP-1, SP-2 and SP-3)
Hake length-frequency survey data	1995-2010	Horse mackerel juveniles (<21cm)	No
		Hake juveniles (<21cm)	Yes
		Monk juveniles (<21cm)	Yes
Pelagic length-frequency survey data	2002-2011	Horse mackerel, anchovy, sardine and round herring juveniles (<8cm)	No
Hake maturity survey data	1995-2010	Hake stage 4 (spawning stage)	Yes
Pelagic egg and Larvae from Spanish survey data		Anchovy eggs and larvae	No
		Sardine eggs and larvae	No
Pelagic egg and Larvae from Nansen survey data	1999 - 2005	Sardine eggs	No
		Horse mackerel eggs and larvae	No
Pelagic egg from SWAPELS survey data	1978-1985	Sardine	No
		Anchovy eggs	No
Mesopelgic fish eggs	August 2006	Lightfish	Yes
		Lanternfish	No
		Red eye	No

Hake : (Figures 39 and 40) – The distribution of juvenile hake (< 21 cm) occurs throughout and mostly shallower than the 200 m bathycontour. This is a typical distribution pattern for juvenile hake that recruit in shallow water and then migrate deeper as they age. Specifically juvenile hake are found in the MLA in the northern part near SP-1. Juvenile hake are expected to be displaced from the dredging area, but their mobility should limit the likelihood of mortality. The distribution of stage 4 adult hake is an indicator that these fish are spawning. The data provided suggest that spawning hake are not commonly found in the MLA and are generally found in the areas north of the MLA well away from the mining site. Hake recruitment is therefore **not** expected to be significantly impacted. We note however that maturity estimates and spawning activity estimates are constrained by the data limitations i.e. to survey periods.

Horse Mackerel : (Figures 41 and 46) – Horse mackerel juveniles are not in high abundance in the MLA and Zone 1. They occur mostly northwards of the MLA (Zone 2 and beyond). Similarly, horse mackerel eggs and larvae are found predominantly north of the MLA. The impact on the recruitment of horse mackerel is therefore expected to be **low**.

Monk : (Figure 42) – Juvenile monk (< 21 cm) are found throughout the MLA but are not in high abundance (note this is surmised from hake survey data only). The impact on juvenile monk as a direct result of the dredging operation will be high (mortality) – the data given however suggest that the extent of the mining area is small compared to the overall distribution of monk. Total recruitment effects on monk are therefore expected to be **low**.

Small pelagics : (Figures 43, 44, 45, 47 and 48a) – The known distribution patterns of small pelagic juveniles (species combined) suggests that they are predominantly found landwards (shallower) than the MLA. Further, egg and larval surveys suggest spawning occurs well north of the MLA. Historical data suggests also that spawning occurred north of Walvis Bay and far away from the MLA. There is however some evidence that historically sardine and anchovy eggs were found in small numbers south of Walvis Bay and across the MLA. In the context of the attempts to rebuild the much depleted small pelagic stocks however, any minor disturbance or disruption of potential spawning by small pelagic species raises the impact implications to **moderate**.

Fish Recruitment Summary

- In general the mining operations are unlikely to have a significant impact on the recruitment of most commercially and ecological important fish species. However Cape hake spawn in deep water (100 and 400 m) between Cape Cross and Conception Bay (22-24°30'S) (Sundby *et al*. 2001). Depending on environmental conditions (cross-shelf circulation, low oxygen layers, meso-scale gyres), the dredging activities could impact on the hake spawning throughout the water column
- The potential increased turbidity around the mining area is unlikely to impact on all species but it should be noted that turbidity plumes might extend into important areas for Cape hake (*M, capensis*) and monk juveniles. There is, therefore a concern that the mining operations might have an effect on recruitment of these species
- The distribution of sardine and anchovy ichthyoplankton (eggs and larvae) (Figures 44 – 48a) are found further north and do not overlap with the MLA. It should be noted that this could purely be a result of the lack of survey stations in the southern areas of Namibia.

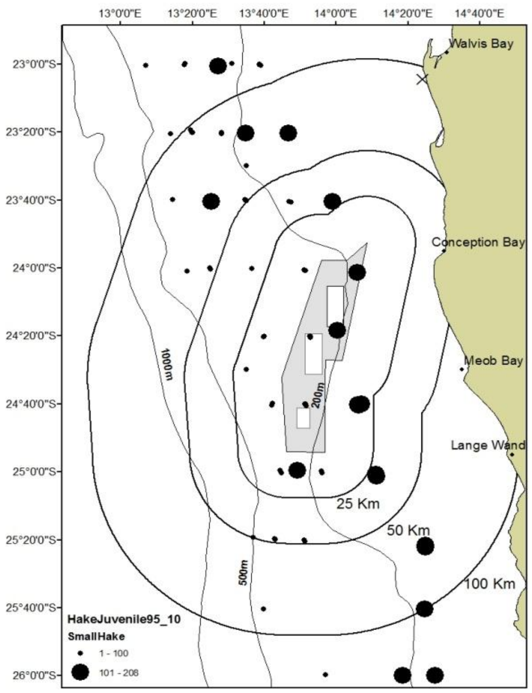

Figure 39. Hake juvenile numbers (<21cm) from length frequency hake- survey data (1995-2010). n=6649

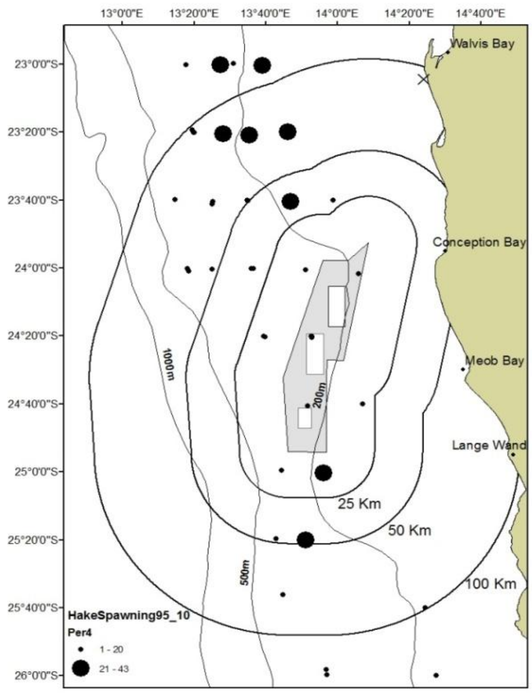

Figure 40. Hake stage 4 represented as a percentage of the total number of all stages per station form hake- survey data (1995-2010). n=8769

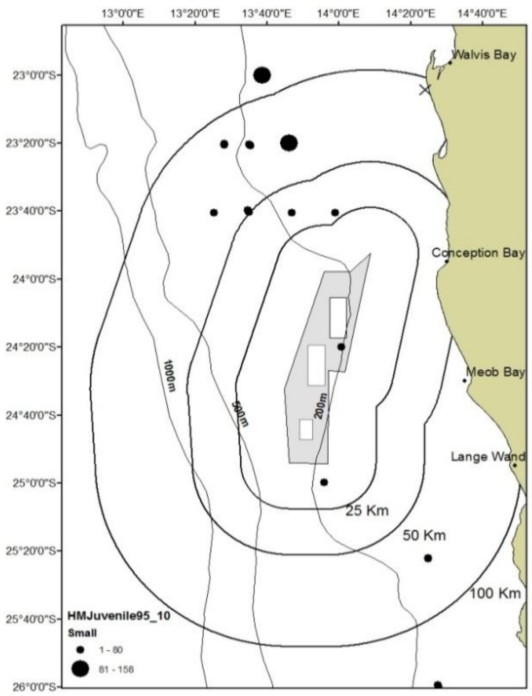

Figure 41. Horse mackerel juvenile numbers (<21cm) from hake- survey data (1995-2010). n = 1368

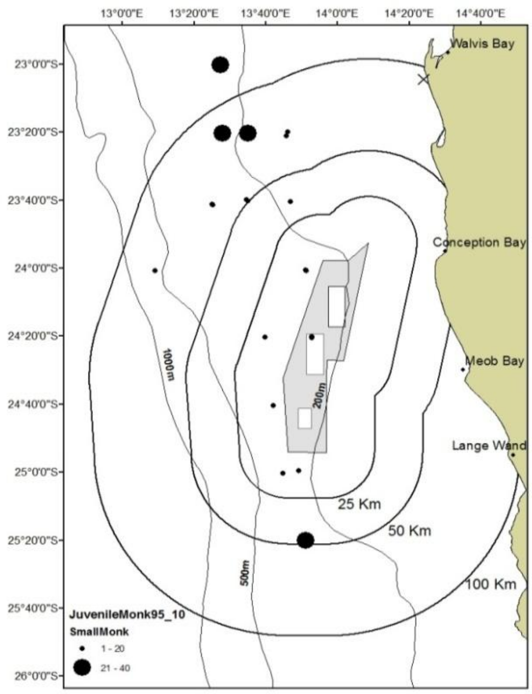

Figure 42. Juvenile monk (<21 cm) from hake- survey data (1995-2010) represented as numbers per station. n=263

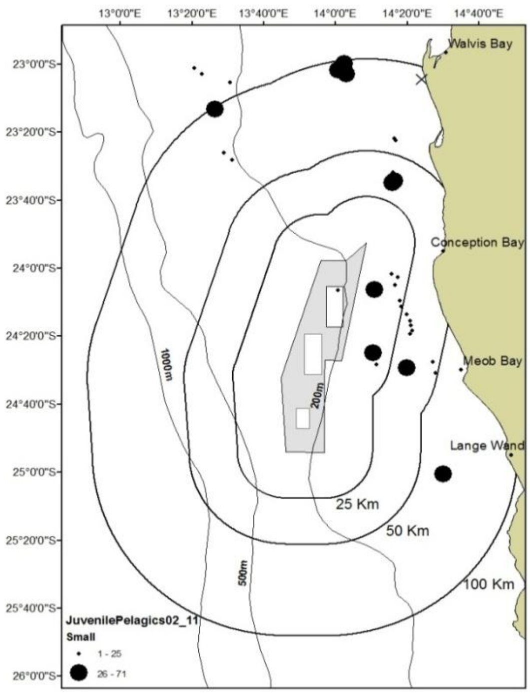

Figure 43. ***Pelagic (anchovy, sardine, and herring) juveniles numbers (< 8cm) from pelagic-surveys 2002-2011. n=10714***

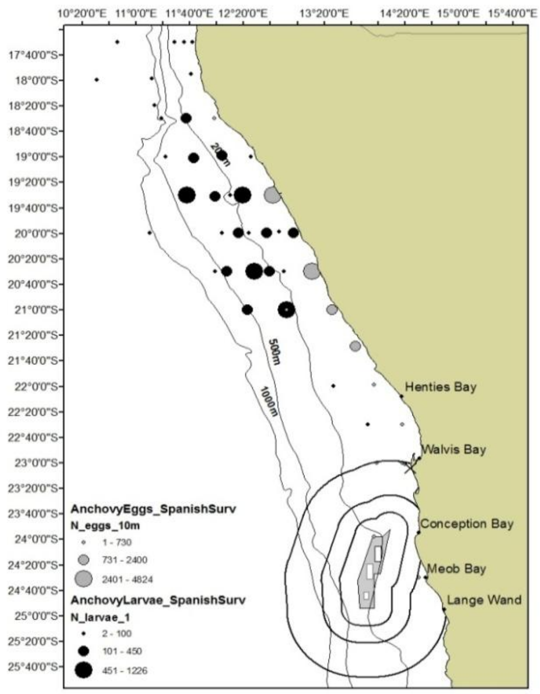

Figure 44. ***Distribution of anchovy eggs (grey) and Larvae (black) from Spanish survey data. n=333***

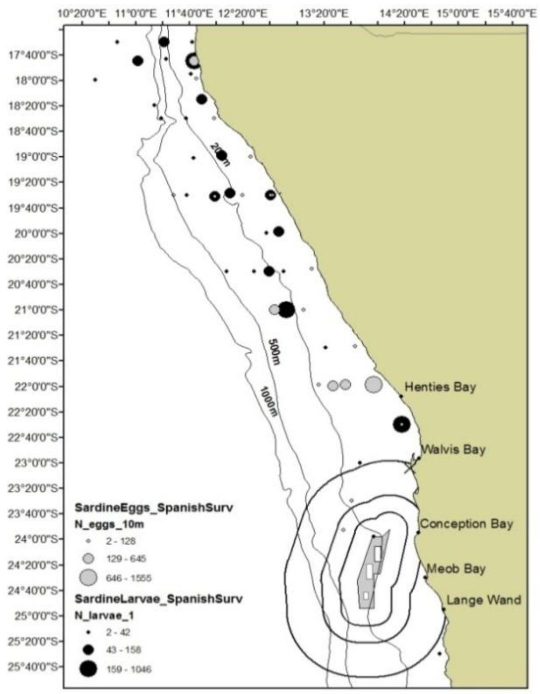

Figure 45. ***Distribution of sardine eggs (grey) and larvae (black) from Spanish survey data. n=333***

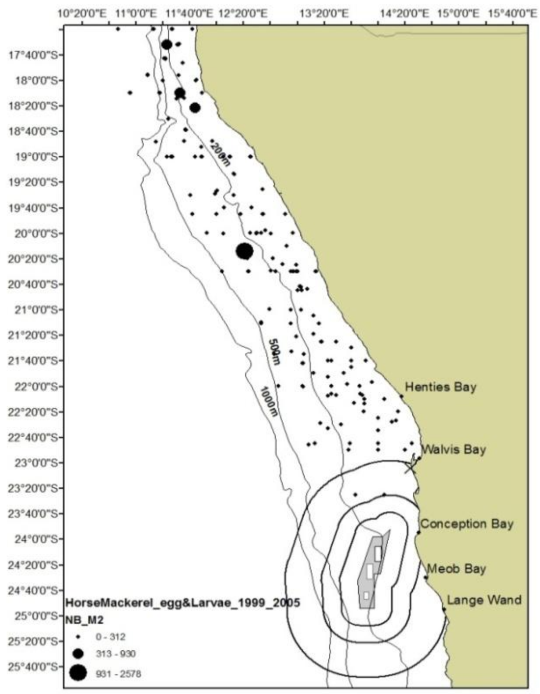

Figure 46. ***Horse mackerel eggs and larvae from Nansen survey data (1999-2005). n=2811***

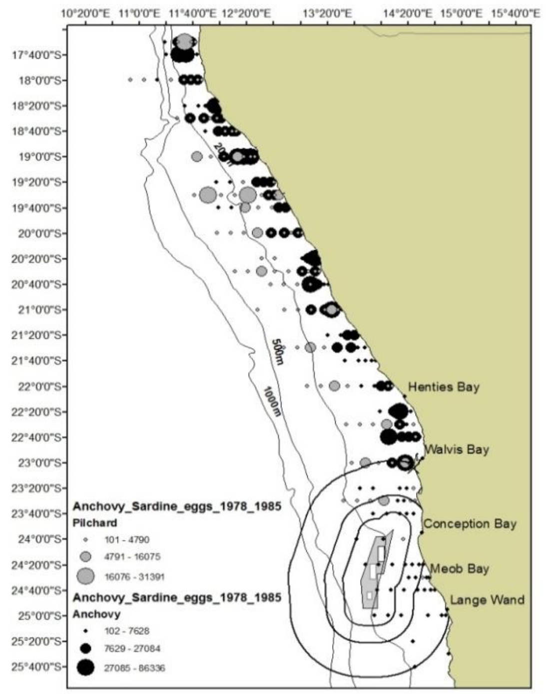

Figure 47. ***Distribution of sardine (grey) and anchovy (black) eggs from SWAPELS survey data (1978-1985). n=265***

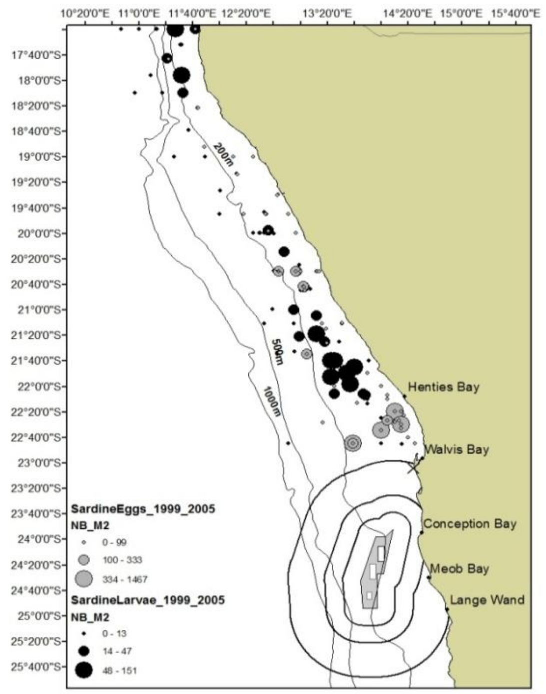

Figure 48a. ***Distribution of sardine eggs (grey) and larvae (black) from Nansen survey data (1999 – 2005). n=2811***

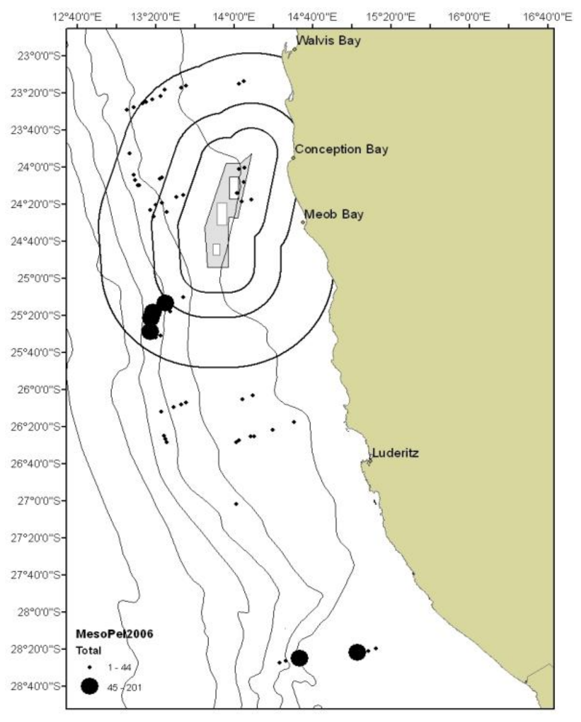

Figure 48b. Distribution of mesopelgaic eggs (lightfish, lanternfish and red eye)

Table 6. Impact Assessment of phosphate mining on fish recruitment

Nature of the impact	**The impact of phosphate mining on the recruitment of key commercial fish stocks a) hake b) horse mackerel c) monk and d) small pelagic species. The dispersal and survival of juveniles, eggs and larvae are effected by 1) physical disturbance of the fishing grounds and 2) sediment plumes (turbidity)**
Extent	MLA - impacts on recruitment is restricted to areas inside the mining licence area and possibly the surrounding areas up to the 25 km impact zone
Duration	Permanent (>20 yrs) - the impact will only cease once the mining activity ends after 20 years (the period for which the mining licence is issued)
Intensity	Minor effect - only a small fraction (compared to the regional extent) of juveniles and eggs and larvae occur in the MLA. Impacts will decrease in this area after mining operations cease
Probability	Improbable - mass mortality of juveniles and eggs and larvae may occur under extreme circumstances but is highly unlikely
Status (+ or -)	Neutral
Significance (no mitigation)	Low
Mitigation	No practical mitigation measures are possible.
Significance (with mitigation)	Not Applicable (no mitigation)
Confidence level	Low to medium - assumptions based on fish ecology is limited by the data available

8.4 IMPACT 4: THE IMPACT ON BIODIVERSITY/.....

8.4 IMPACT 4: THE IMPACT ON BIODIVERSITY

The living marine resources of Namibia are relatively well-known. By definition marine biodiversity is the degree of variation of marine life forms within a given ecosystem. It is a measure of the health of the ecosystem and changes in marine biodiversity are directly caused by exploitation, pollution and habitat destruction or indirectly through climate change and related perturbations of ocean biogeochemistry (Worn *et al*. 2006)

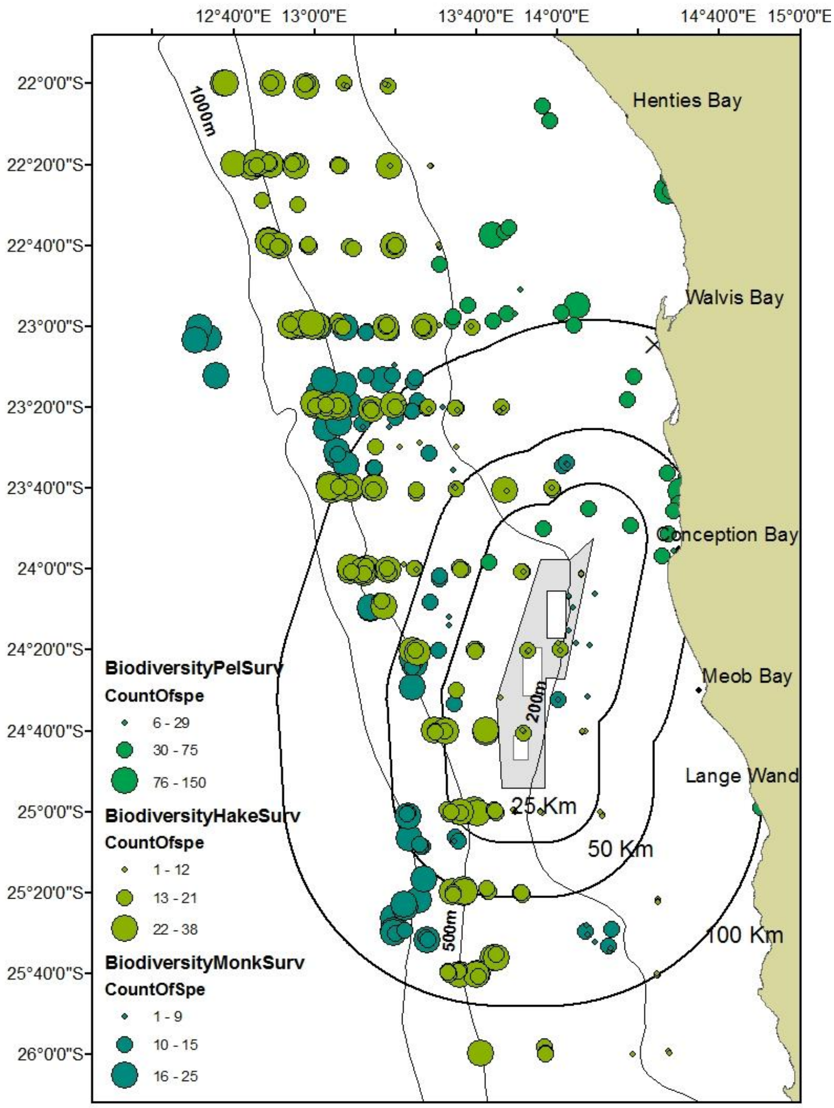

Figure 49. Dots represent number of species counted per coordinate (lat/long) from the hake-survey data, monk-survey data, and small pelagic-survey n=9116

Data on biodiversity in the Benguela ecosystem is not well documented although there are on-going initiatives to study biodiversity through the Benguela Current Commission. As a proxy for biodiversity we have used the number of species recorded in all independent surveys to gauge the relative number of species (predominantly fish) expected in and around the MLA. This should form a baseline to monitor changes in the fauna diversity in the proximity of the mining area(s). Critical to biodiversity is the permanent loss of any unique species to the area. <u>Note, the list is not intended to be exhaustive</u>. Our data are presented in the Table in Appendix 1a - 5 and spatially in Figure 49.

The survey data from the hake, monk and small pelagic research cruises are shown spatially disaggregated by survey type and station (Figure 49). Specifically within the MLA the number of stations sampled is relatively low compared to stations in deeper water towards the shelf edge. Nevertheless we conclude that the diversity of primarily fish fauna in and immediately adjacent to the MLA is comparatively low.

This crude assessment does however indicate that approximately 40 different species have been recorded in or adjacent to the MLA and that these species i.e. fish biodiversity will in some way be impacted by the mining operation. The extent of this is impact difficult to judge. Note also that the nature of the data and survey methods does not capture all species – these data are therefore only a subset (indicator) of the total biodiversity. The precautionary approach would be to permit mining under strict monitoring conditions once a biodiversity baseline for the MLA has been established. The significance of the impact is summarised in Table 7.

Table 7. Impact assessment table of phosphate mining on fish biodiversity

Nature of the impact	The impact of phosphate mining on species diversity. Mining operations will result a reduction or loss in biodiversity because of the **1)** actual mining operations due to dredging operations and vessel activities, **2)** the habitat destruction and the removal of substrate and **3)** sediment plumes
Extent	<u>MLA</u> – impact on species diversity is restricted to areas inside the mining licence area (ML 170) and possibly the surrounding areas up to the 25 km buffer zone
Duration	<u>Permanent (>20 yrs)</u> - the impact will only cease once the mining activity ends after 20 years (the period for which the mining licence is issued) and should persist for an indefinite period thereafter. If biodiversity is lost, the impact is permanent.
Intensity	<u>Minor effect</u> – biodiversity in the MLA is expected to be comparatively low. Loss of biodiversity in the MLA is likely although at the regional level the limited extent of the mining locations is unlikely to cause permanent loss of biodiversity. Recovery of biodiversity in the specific area of extraction within the MLA once mining has stopped is likely to be slow and will follow a natural process of ecological succession that is dependent upon the rate of recover of the substrate.
Probability	<u>Improbable</u> – consequence of diversity loss may occur under extreme conditions but are highly unlikely
Status (+ or -)	Negative
Significance (no mitigation)	Low – the impact on species diversity is not expected to influence project design provided the current area limitations are maintained. Expansion of dredging in the current or alternate lease areas without baseline monitoring of biodiversity and controls must be a prerequisite to the commencement of mining.
Mitigation	No practical mitigation measures are possible.
Significance (with mitigation)	Not applicable (no mitigation)
Confidence level	Low to medium - assumptions based on marine biodiversity in the MLA is limited to the nature of the data available.

8.5 IMPACT 5: IMPACT ON SEABIRDS AND MARINE MAMMALS

The Namibian coast supports large populations of seabirds (refer to Para. 4.1). The published literature (Cooper 1981, Wiliams and Cooper 1983, Cooper 1985, Berruti 1989, BirdLife International 2004, Hockey *et al*. 2005, Crawford *et al*. 2007, Kemper *et al*. 2007, Kemper 2007, Petersen *et al.* 2007, Pichegru *et al*. 2007, Ludynia *et al*. 2011, Sinclair *et al*. 2011). Numerous coastal seabirds are expected to be found in or near the MLA (refer to Para. 4.1). Also, Kemper (response to this EIA) suggests that using data logger technology several species of non-breeding seabirds are likely to forage well offshore. These include the species identified in Para. 4.1 (African Penguin and Cape Gannet). These species are therefore likely to be found in and around the MLA. There is also a low likelihood that Bank Comorants and seasonal pelagic species (albatrosses and shearwaters) may be found occasionally in the MLA. In addition these species are likely to be impacted by the lights of the dredging operation (Ryan 1991).

The Namibian marine mammal fauna is considered a marginal component of the broad southern Atlantic marine mammal community and includes three species of pinnepeds (seals) and roughly 40 species of cetaceans (whales and dolphin) (Griffin 1998). There has been a northerly shift (away from MLA in the south) in breeding seal populations in the last decade, which is thought to be linked to shifts in the geographical distribution of prey (Kirkman *et al*. 2007).

Baleen whales are thought to be primarily seasonal visitors to the Namibian coast (Para. 4.3 refers) although some species may support resident populations (Griffin 1998). Today most species which were once exploited remain very rare (Bianchi *et al*. 1999) and whales are now fully protected by Namibian legislation. While the Namibian breeding population of southern right whales *Eubalaena australis* is thought to have been eradicated by over exploitation (Roux *et al*. 2001 in Currie and Grobler, 2007), the historical breeding range included Walvis Bay, Conception Bay, Spencer Bay, Lüderitz Bay, Elizabeth Bay and the Sperrgebiet coast. Since 1996 calves have been sighted between Conception Bay and the Orange River, indicating the presence of a breeding population. Mother and calf pairs being recorded within 1 nautical mile of the shore in the shelter of Conception Bay and six locations to the south (Currie and Grobler 2007).

Other baleen whales (Para 4.3 refers) that occur along the Namibian coast include, but are not limited to, pygmy right whales *Caperea marginata*, fin whale *Balanoptera physalus*, minke whale *Balaenoptera acutorostrata*, humpback whale *Megaptera novaeangliae* (Bianchi *et al*. 1999). All of these species are widely distributed on a global scale but detailed records of the distribution and habitat use of these animals along the Namibian coast are not available. Toothed whales known from Namibia include sperm whale *Physeter catodon*, killer whales *Orcinus orca* and the longfinned pilot whale *Globicephala melas* (Bianchi *et al*. 1999). All of these species have wide global distributions and thought to be occasional visitors to Namibian coastal waters. A number of dolphin species, most notably the dusky dolphin *Lagenorhynchus obscurus*, bottlenose dolphin *Tursiops truncatus* and Heavisides dolphin *Cephalorhynchus heavisidii* are year round residents along the Namibian coast (Griffin, 1998).

The MLA is located in a critical area offshore – that is mid-shelf along the 200 m bathycontour. Its location is therefore close enough to the shore line to expect coastal and oceanic sea birds as well as the large migrating whales and the more localised distributions of the smaller mammals (such a common dolphins and pilot whales). It is therefore assumed that there is a likelihood that numerous mammal and bird species will be occasionally found in or near the MLA (Para. 4.3 refers). Most mammal species are naturally inquisitive and certainly, any dredging activity will attract small marine mammals e.g. dolphins and seals. Larger, mostly migrating mammals are expected to avoid areas where maritime activity is high (although this does not exclude the possibility that large mammals will occasional be found in or near the MLA).

Impacts on birds and marine mammals will nevertheless be limited to the actual mining site and immediate areas (500 m around the dredging location). Disturbance of the substrate is also likely to result in higher levels of biological activity, increased particulate matter (assumed of poor nutritional value) in the water column and at the surface. This will alter bird behaviour as they will be naturally attracted to these areas. The significance of the impact is summarised in Table 8.

Table 8. Table of assessment of Impact 5 summarizing the likely impact of phosphate mining on the seabirds and mammals around the MLA.

Nature of the impact	**The impact of phosphate mining on seabirds and marine mammals. Mining operations might result in the displacement and/or redistribution of seabirds and mammals because of 1) disturbance of the ecosystem and availability of feed and 2) physical disturbance of the dredgers including noise pollution**
Extent	MLA - impact on seabirds and mammals is restricted to areas inside the mining licence area (ML 170) and possibly the surrounding areas including Zone 1
Duration	Medium term – The impact on sea birds and mammals will be for the term of the exploitation. Occasional interaction between the dredging operations and mammals and seabirds is likely although the actual level cannot be determined without more specific information on these groups for the MLA and Zone 1. Once mining ceases these groups will no longer be affected by the presence of the dredger although the alteration of behaviour of some species due to possible loss of foraging options cannot be determined.
Intensity	Minor effects - Trophic disturbances could have an impact on the behaviour of seabirds and marine mammals. Noise pollution is a consideration for marine mammals whose acoustic communications may be affected resulting in avoidance of the area. Night strikes of birds due to deck lights are likely.
Probability	Probable - consequences of trophic interaction disturbances and noise pollution is highly likely.
Status (+ or -)	Negative
Significance (no mitigation)	Medium – Most sea birds and mammal species found in the area will be affected but at a low level due to the limited extent of the mining operations.
Mitigation	Maintain a bridge watch for large mammal species. Although the dredger will have limited manoeuvrability a protocol to limit interaction should be followed – in this regard JNCC guidelines are recommended. Lighting control to minimise night strikes of birds.
Significance (with mitigation)	Low
Confidence level	Medium - information based on seabirds and mammals was provided by scientific specialists, however spatial data is limited. Baseline applies to the whole Namibian coast for most bird and mammal species – confidence relating to impact in the actual MLA is therefore low.

9 ASSESSMENT OF LIKELY FISHING ACTIVITY IN THE MLA AND ZONE 1

This section is an addition to the original draft EIA submission. It was requested that the levels of expected fishing effort in the MLA be described. Refer also to Para. 6.2 and 8 and Tables 1a and 1b.

Ideally to be able to estimate the historical movements of fishing vessels in and around the MLA, start and end positions of trawls and gear sets is required. The data provided however was limited to single set locations for trawls, longlines and other gear types.

Broad assumptions of our fishing assessment are as follows :

1. We assume that fishing effort is located around the central point of each of the proposed areas to be mined (SP-1, SP-2 and SP-3);

2. On average a trawler (monk or hake) will tow for about three hours at a speed of 3-4 knots;

3. We acknowledge that this may not always be the case, such as for longer tows at night, midwater trawls etc. The objective is to give a **broad indication** of effort levels in the mined and adjacent areas;

4. As we have no end positions, we assume therefore that the fishing will occur in a radius around the central points of each mined location. This radius approximates 19.4 km;

5. These radii are illustrated in Figure 50.

6. We have also had to approximate the number of vessels operating in each fishery. This was extracted from the MFMR website (www.mfmr.gov.na) which provided data for 2009 (so current vessel quantities are assumed the same). Note this is only to obtain a broad estimate as we were only provided with the actual effort hours in Tables 1a-b.

7. For the fisheries in which we were provided data on vessel displacement (GRT) we also estimated the levels of effort in GRT groups so that the vessel size historically active in the MLA and Zone 1 could be gauged.

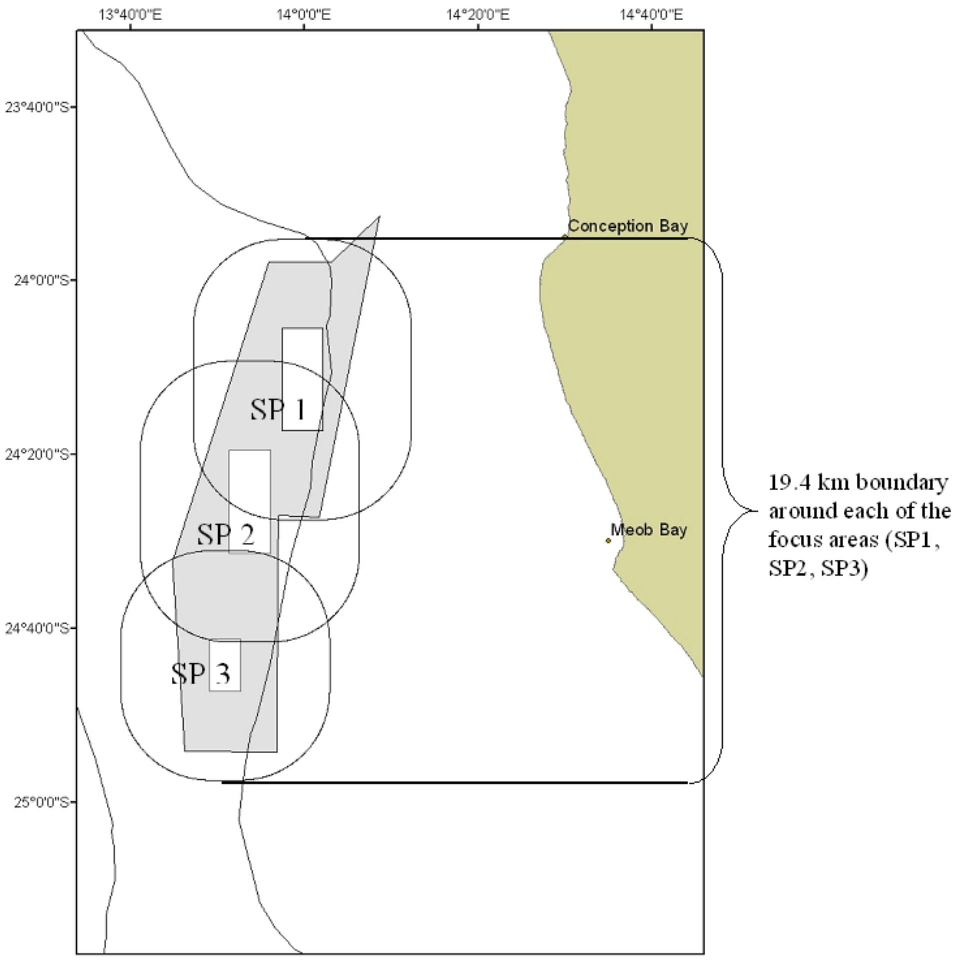

Figure 50. Areas identified to estimate fishing vessel activity in the mined and adjacent areas.

9.1 RESULTS

The results of this assessment are summarised in Tables 9 and 10.

In Table 9 we calculated an average number of times vessels from the different fisheries were reported in the MLA and Zone 1 (this differs slightly from the areas shown in Figure 50). Note that this relates only to the data provided and does not include possible passage through the area when no fishing or when no catch log data is recorded.

Table 9 is self explanatory giving a breakdown by vessel power group. Note that the smaller vessels are in the hake longline group, hake trawl sectors include large freezers and smaller wetfish vessels and the horse mackerel vessels are the largest. No vessel power data was provided for the monk and small pelagic trawls. It could be assumed that the monk fishery uses mostly smaller vessels with an approximate power similar to the smaller hake trawl groups.

Table 9. Breakdown of fleet composition by gross registered tonnage (GRT)

Hake longline			Hake			Horse mackerel			Monk	Small pelagics
GRT	Number of times this GRT group entered the MLA + Zone 1 (cumulative to 25km)	Average for all the years 2006 2010	GRT group	Number of times this GRT group entered the MLA + Zone 1 (cumulative to 25km)	Average for all the years 2004 2009	GRT	Number of times this GRT group entered the MLA + Zone 1 (cumulative to 25km)	Average for all the years 1997 2011	Number of trawls in the MLA+ Zone 1 (cumulative to 25 km)	Number of shoots in the MLA+ Zone 1 (cumulative to 25 km)
100	50	10	100	630	105.00	4000	57	3.80	3872	185
200	378	75.6	200	430	71.67	5000	350	23.33		
300	255	51	300	378	63.00	6000	19	1.27		
400	246	49.2	400	87	14.50	8000	16	1.07		
500	127	25.4	500	285	47.50	Total	442			
Total	1056		600	323	53.83					
			700	119	19.83					
			800	277	46.17					
			900	9	1.50					
			1000	229	38.17					
			1200	11	1.83					
			1300	25	4.17					
			1500	525	87.50					
			1600	11	1.83					
			1700	40	6.67					
			Total	3379						

Table 10 refers specifically to the areas designated in Figure 50. The table shows SP-1, SP-2 and SP-3 and the expected effort for each of the four fisheries for which we had adequate data:

a) Our historical data is from 2008 to 2010

b) We have the number of vessels in each sector for 2009 and 2008 but for 2010 we have assumed the 2009 values;

c) The column “records per year” is the actual number of times these vessels reported in their catch logs to be in each area;

d) We also used the total effort hours reported for each fishery to estimate the expected time per day each vessel would trawl in the areas designated. Note that this does not mean that the vessel will move from the area. Typically vessels remain in an area if fishing is good.

9.2 CONCLUSIONS

The data shown here is a further refinement of the analysis done in Para. 6.3. We stress that these are approximations of the effort and vessels expected in the area based on the data available to us.

Table 10. A summary of the number of vessels, records and hours a vessel was in an area per day for each of the four fisheries.

MONK	Year	Number of vessels (Ministry of fisheries 2009 annual report))	Number of records in each area per year	MFMR DATA records of total hours in each area per year	Expected average time per vessel in each area per day
SP1*	2010	16	31	505.65	16.31
	2009	16	96	1763.62	18.37
	2008	25	39	684.27	17.55
SP2*	2010	16	152	2613.97	17.20
	2009	16	264	4759.82	18.03
	2008	25	205	3572.67	17.43
SP3*	2010	16	228	4110.88	18.03
	2009	16	182	3285.05	18.05
	2008	25	262	4726.32	18.04
HAKE TRAWL	**Year**	**Number of vessels (Ministry of fisheries 2009 annual report))**	**Number of records in each area per year**	**MFMR DATA records of total hours in each area per year**	**Expected average time per vessel in each area per day**
SP1*	2009	71	35	486.28	13.89
	2008	91	115	1660.37	14.44
	2007	87	238	3055.83	12.84
SP2*	2009	71	61	884.28	14.50
	2008	91	176	2765.97	15.72
	2007	87	222	3069.28	13.83
SP3*	2009	71	24	366.22	15.26
	2008	91	101	1633.68	16.18
	2007	87	33	484.48	14.68
HAKE LONGLINE	**Year**	**Number of vessels (Ministry of fisheries 2009 annual report))**	**Number of records in each area per year**	**MFMR DATA records of total hours in each area per year**	**Expected average time per vessel in each area per day**
SP1*	2010	18	0	NO DATA	NO DATA
	2009	18	0		
	2008	18	9		
SP2*	2010	18	33		
	2009	18	41		
	2008	18	153		
SP3*	2010	18	30		
	2009	18	37		
	2008	18	98		
HORSE MACKEREL	**Year**	**Number of vessels (Ministry of fisheries 2009 annual report))**	**Number of records in each area per year**	**MFMR DATA records of total hours in each area per year**	**Expected average time per vessel in each area per day**
SP1*	2011	0	0	0	0
	2010	0	0	0	0
	2009	9	5	49.50	9.90
	2008	10	8	99.17	12.40
SP2*	2011	0	0	0	0
	2010	0	0	0	0
	2009	0	0	0	0
	2008	0	0	0	0
SP3*	2011	0	0	0	0
	2010	0	0	0	0
	2009	0	0	0	0
	2008	0	0	0	0

* SP1, SP2, SP3 + 19.4 km boundary (boundary area calculated by multiplying speed of trawler (3.5nm) by time (3 hours) to get distance (19.4 nm))

** Assumed number of vessels according to previos year (2009)

10 CONCLUSIONS

Overall we emphasize that our assessment of fish resources, fisheries, marine mammals and birds is based on the best available data. In the case of fisheries, data have been provided by the Ministry of Fisheries and Marine Resources. The analyses undertaken using these data are aimed only at informing the EIA as best possible regarding the risks of the proposed mining. We wish to stress also that with respect to the impact on commercial fisheries, our assessment equates more to a broad operational impact rather than an environmental one.

With respect to the risk assessment of the impact on the broader ecosystem, the assessment is "data poor" and inadequate to fully assess the likely impacts of dredging on the Namibian marine environment (including biodiversity and trophic ecology). We stress however that this uncertainty could apply equally to other exploited marine resources (such as fishing and diamond mining) where there is much uncertainty regarding ecosystem impacts and the extent to which anthropogenic activities (historical and current) may already have altered the marine environment.

Five critical impacts have been identified.

The impact on Namibian fisheries will vary depending on the fishing sector.

The operations of all fisheries will in some way, and at different levels of intensity, be impacted. Overall however the significance is considered to be negative and medium to low primarily because the area to be mined (annually up to 3 km^2 and for the 20 year mining lifespan up to 60 km^2) is a small fraction of the overall Namibian fishing grounds. This fraction may however increase significantly if mining of this nature is to be expanded or alternative mine sites introduced.

Of the main commercial fisheries, the monk-directed trawl fishery will be most impacted. The species exploited (monk) prefers muddy/sandy substrate of which the dredging operation as proposed, will remove 60 km^2 for the duration of the mining licence. The monk-directed catch and effort data and trawling locations from 2005-2010 suggest that about 1% of the total monk fishing grounds in SP-2 will be lost, 0.08% in SP-3 and zero % in SP-1 i.e a direct impact in the actual mined site. Further, 19.75 % of the monk fishing grounds in the MLA + Zone 1, may be indirectly impacted. The actual nature and intensity of the impact away from the actual mined sites cannot be definitively stated and is also likely to vary and be reduced in intensity further away from the mining operation. The primary effects of the dredging operation is expected to be disturbance and removal of the preferred monk substrate resulting in either displacement of monk to adjacent ground or actual mortality of monk that may be caught in the dredging process.

Similarly the hake trawl and longline fisheries will also lose fishing grounds although this is unlikely to happen in the first phase of mining as the data provided suggest effort in these fisheries has not been directed in the SP-1 mining target area. Expansion of the dredging into the other areas (SP-2 and SP-3) will however increase the exposure of these fisheries to the dredging operations.

Of the other main fisheries, which include horse mackerel and other small pelagic species, the mining area does not overlap significantly with the grounds fished (horse mackerel = 0.32% of catch taken in the MLA and 0.05% in SP-1). Further, unlike with trawling and demersal longling, the nature of the gear deployed by mid-water and purse seine, is such that these fisheries will be less impacted. The normal operations of these fisheries will however be affected by any statutory maritime exclusion safety zones around the dredging operations. Availability of small pelagic resources (such as horse mackerel and sardine) may also be affected by the likely sediment plumes created by the dredging operations. The nature of this impact cannot be definitively stated – it is assumed that these species are likely to avoid such plumes and will be displaced to adjacent areas.

Considering the impact of the proposed mining on the broader ecosystem, in particular the fish fauna, the impact will on average be moderate. The mining will displace fish resources and remove essential habitat occupied by these fish resources (such as monk, gobies, hake and others). In particular, gobies have been identified as a key forage feeder in the mining area and are also a key trophic species (bottom-level). There is therefore expected to be significant alteration of the ecosystem characteristics in the **immediate mining area**. This alteration of the ecosystem will be very localised and is unlikely to impact the broader marine ecosystem. This rating (unlikely) assumes that the mining is contained within the proposed areas inside the MLA and that the extent remains a very small fraction of the ecosystem in the Namibia Exclusive Economic Zone and of the total areas fished.

Any expansion of the dredging may significantly alter the potential to impact on the broader ecosystem.

With regard to the third impact identified, that is the impact on fish recruitment, we consider the impact to be low relative to the total recruitment area available to fisheries resources in Namibian waters. There is an obvious impact in the immediate area of the mining which is serious and likely to be permanent (or at least > 15 years) – that is the physical removal and destruction of substrate. The expected low relative impact on recruitment to fisheries resources is however not equal for all fisheries. In particular, monk recruitment is likely to be impacted at a much higher level than other fisheries, although the significance and extent is difficult to state conclusively. Sediment plumes are not expected to significantly affect recruitment as, similar to the expected impact on fisheries, the mining operation is proportionately a small fraction of known fishing grounds in the Namibian EEZ. Further, the plumes are likely to disperse quickly over a short distance. Data provided suggest that spawning and egg and larval abundance of the main exploited fish resources are not concentrated in or near the mining lease area. Hake juveniles (pre-recruiting sizes to the fisheries) are abundant in the depth range of the MLA, however their mobility will allow them to avoid the disturbed areas thus reducing possible mortality and recruitment to the hake fisheries (unlike monk that are less mobile). We stress that our data are based on the best available information (mostly surveys) that do not necessarily represent the biological situation throughout a full year.

With regard to the fourth impact identified, biodiversity – the impact in the immediate mining area will be severe and will result in loss of flora and fauna. However we have no evidence to suggest that the mining will result in a permanent loss of biodiversity, assuming there are no species unique to the area to be mined. The approach here however should be precautionary since little is known of the biodiversity in the MLA.

The final impact relates to seabirds and marine mammals. Mining, although localised, will result in modification of behaviour of mammals and seabirds in the mined area. Small marine mammals will most likely be attracted to the disturbed area, although this behaviour is unlikely either to persist or to be negative once operations cease. Large marine mammals, most of which are transient, will occur in the area but are also likely to avoid the mining area due to the disturbance created by the dredging. Noise levels from the dredging may also affect mammal and bird behaviour, but we have no firm conclusion on this impact which requires a specialist response.

Seabirds will also interact with the mining. The exact nature and extent of this interaction cannot be determined conclusively due to data paucity, but will certainly result in behavioural changes associated with the disturbance created by the dredging operations. For this reason we rate the impact on birds and mammals as negative but cannot judge the likely intensity or significance. Bird mortality associated with bird strikes will require mitigation.

With regard to maritime traffic in general and specifically the likely fishing vessel activity in or adjacent to the MLA. The monk fishers are expected to be the most active. To a lesser extent the hake trawl, horse mackerel, small pelagic and hake longline fisheries will also be active in the MLA and surrounding area.

11 RECOMMENDATIONS

11.1 MITIGATION

The information presented in this assessment has been provided by NatMIRC. The spatial assessment provided here is a first attempt, based on the information provided, to assess the risk associated with the proposed dredging for phosphates. We advise that there is a need for the establishment of a baseline for the MLA. This can be based on the available data, but where considered critical, additional data collected for a baseline prior to mining commencing.

To mitigate loss of fishing grounds there are no realistic options in our view. The only possible exception is the accommodation of the needs of the monk fishery through a mutually agreed access operational plan.

For mammals and seabirds protocols for minimising deck light intensity should be introduced as well as following JNCC standards for minimising interactions with marine mammals (similar to those followed by seismic survey vessels).

11.2 MONITORING

Due to the small scale of the proposed dredging operations in the context of the larger ecosystem and extent of the marine resources it is unlikely to be able to discriminate a clear signal relating to ecosystem change as a result of dredging (primarily due to variability within the ecosystem).
In the short term both MFMR and the mining lease operator should establish appropriate monitoring line (s) through the Mining Licence Area to monitor the effects of dredging on a real-time basis (possibly coinciding with established surveys).

Given the number of industrial mineral EPLs that have been granted in the area between Walvis Bay and Lüderitz consideration should be given to requesting that the Benguela Current Commission incorporate into their Strategic Environmental Assessment of the mineral sector of the Benguela ecosystem a study of the potential impacts of dredging.

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APPENDICES

Appendix 1a-1 Seabirds of southern Namibia

SPECIES	STATUS*	RELATIVE ABUNDANCE	SEASONALITY	CONSERVATION STATUS (IUCN)
African Penguin *Spheniscus demersus*	B, inshore (<100km)	Common	All year	Endangered
Black-necked Grebe *Podiceps nigricollis*	AM, inshore	Locally common	Winter, summer	
Wandering Albatross *Diomedea exulans*	SM, offshore (>100km)	Rare	Winter, summer	Vulnerable
Shy Albatross[a] *Thalassarche cauta*	SM, offshore	Uncommon	All year	Near threatened
Black-browed Albatross *T. melanophris*	SM, offshore	Common	Winter, summer	Endangered
Grey-headed Albatross *T. chrysostoma*	SM, offshore	Rare	Vagrant	Vulnerable
Yellow-nosed Albatross[a] *T. chlororhynchos*	SM, offshore	Common	Winter, summer	Endangered
Northern Giant Petrel *Macronectes halli*	SM, In/offshore	Common	All year	Least concern
Southern Giant Petrel *M. giganteus*	SM, In/offshore	Uncommon	All year	Least concern
Pintado Petrel *Daption capense*	SM, offshore	Common	Winter	
Antarctic Fulmar *Fulmarus glacialoides*	SM, offshore	Rare	Winter	
Antarctic Prion *Pachyptila desolata*	SM, offshore	Common	All year	
Great-winged Petrel *Pterodroma macroptera*	SM, offshore	Uncommon	All year?	
Atlantic Petrel *P. incerta*	SM, offshore	Rare	Summer	Endangered
Soft-plumaged Petrel *P. mollis*	SM, offshore	Uncommon	Winter, summer	
White-chinned Petrel *Procellaria aequinoctialis*	SM, offshore	Common	Winter, summer	Vulnerable
Grey Petrel *P. cinerea*	SM, offshore	Rare	Winter	Near threatened
Spectacled Petrel *P. conspicillata*	SM, offshore	Rare	Winter, summer	Vulnerable
Manx Shearwater *Puffinus puffinus*	NM, offshore	Rare	Summer, winter	
Great Shearwater *P. gravis*	SM, offshore	Uncommon	Summer passage	
Sooty Shearwater *P. griseus*	SM, offshore	Common	Winter, summer	Near threatened
Cory's Shearwater *Calonectris diomedea*	NM, offshore	Common	Summer	
European Storm Petrel *Hydrobates pelagicus*	NM, offshore	Common?	Summer, winter	
Wilson's Storm Petrel	SM, offshore	Common	Winter, summer	

SPECIES	STATUS*	RELATIVE ABUNDANCE	SEASONALITY	CONSERVATION STATUS (IUCN)
Oceanites oceanicus				
Leach's Storm Petrel *Oceanodroma leucorhoa*	NM, offshore	Uncommon	Summer	
Band-rumped Storm Petrel *Oceanodroma castro*	NM; offshore	Uncommon	Summer	
Black-bellied Storm Petrel *Fregetta tropica*	SM, offshore	Rare	Winter	
White-bellied Storm Petrel *F. grallaria*	SM, offshore	Rare	Winter	
White-faced Storm Petrel *Pelagodroma marina*	SM, offshore	Rare	Winter	
Great White Pelican *Pelecanus onocrotalus*	B, inshore	Rare	All year	
Cape Gannet *Morus capensis*	B, In/offshore	Common	All year	Vulnerable
Cape Cormorant *Phalacrocorax capensis*	B, inshore	Common	All year	Near threatened
Bank Cormorant *P. neglectus*	B, inshore	Rare	All year	Endangered
Crowned Cormorant *P. coronatus*	B, inshore	Uncommon	All year	Near threatened
White-breasted Cormorant *P. carbo*	B, inshore	Uncommon	All year	
Red (Grey) Phalarope *Phalaropus fulicarius*	NM, offshore	Uncommon	Summer	
Parasitic Jaeger *Stercorarius parasiticus*	NM, In/offshore	Common	Summer, winter	
Pomarine Jaeger *S. pomarinus*	NM, offshore	Common	Summer, winter	
Long-tailed Jaeger *S. longicaudus*	NM, offshore	Common	Summer	
Subantarctic Jaeger *Catharacta antarctica*	SM, offshore	Common	Winter, summer	
Sabine's Gull *Xema sabini*	NM, In/offshore	Common	Summer	
Kelp Gull *L. dominicanus*		Common	All year	
Hartlaub's Gull *L. hartlaubii*	B, inshore	Common	All year	
Grey-headed Gull *L. cirrocephalus*	B, inshore	Rare	All year	

SPECIES	STATUS*	RELATIVE ABUNDANCE	SEASONALITY	CONSERVATION STATUS (IUCN)
Common Tern *Sterna hirundo*	NM, inshore	Common	Summer	
Arctic Tern *S. paradisaea*	NM, offshore	Uncommon	Summer passage	
Sandwich Tern *S. sandvicensis*	NM, inshore	Common	Summer	
Swift Tern *S. bergii*	B, inshore	Common	All year	
Damara Tern *S. balaenarum*	B, inshore	Uncommon	All year	Near threatened
Caspian Tern *S. caspia*	B, inshore	Rare	All year	
Black Tern *Chlidonias niger*	NM, inshore	Rare	Summer	

** B: breeding resident; AM: African migrant; SM: Southern Ocean migrant; NM: northern hemisphere migrant.*
[a] *Recent taxonomic divisions not taken into account.*

Appendix 1a-2. Distribution and seasonal abundance of Mysticete (baleen) whales in southern Namibian waters

SPECIES	SEASONALITY	DISTRIBUTION	CONSERVATION STATUS
Blue whale (*Balaenoptera musculus*)	Migratory	Pelagic	Endangered
Fin whale (*B. physalus*)	Migratory	Pelagic – some association with the shelf edge	Vulnerable
Sei whale (*B. borealis*)	Migratory	Pelagic	Endangered
Minke whale *(B. acutorostrata*)	Migratory / year round	Pelagic / Neritic	
Bryde's whale (*B. edeni*)	Migratory	Probable pelagic	
Humpback whale (*Megaptera novaeangliae*)	Migratory / year round (some summer residency)	Pelagic / Neritic (uses coastal waters as migratory corridors)	Endangered
Southern right whale (*Eubalaena australis*)	Migratory	Neritic – extreme inshore	Vulnerable
Pygmy right whale (*Caperea marginata*)	Migratory	unknown	

Appendix 1a-3. Distribution and seasonal abundance of odontocetes (toothed whales and dolphins) in southern Namibian waters

SPECIES	SEASONALITY	DISTRIBUTION
Sperm whale (*Physeter macrocephalus*)	Some migration	Pelagic
Pygmy Sperm whale (*Kogia breviceps*)	Unknown	Pelagic
Cuvier's beaked whale (*Ziphius cavirostris*)	Unknown possibly year round	Pelagic
Layard's beaked whale (*Mesoplodon layardii*)	Unknown though stranding data suggest a strong autumn seasonality	Pelagic
Gray's beaked whale (*M. grayii*)	Unknown	Pelagic
Killer whale (*Orcinus orca*)	Year round	Cosmopolitan
False killer whale (*Pseudorca crassidens*)	Year round	Pelagic
Pygmy killer whale (*Feresa attenuata*)	Unknown	Pelagic
Long finned pilot whale (*Globicephala melas*)	Unknown	Pelagic
Risso's dolphin (*Grampus griseus*)	Unknown	Pelagic – some association with the shelf edge
Common dolphin (*Delphinus delphis / capensis?*)	Unknown	Pelagic
Dusky dolphin (*Lagenorhynchus obscurus*)	Year round	Neritic
Heaviside's dolphin (*Cephalorhynchus heavisidii*)	Year round	Neritic
Southern right-whale dolphin (*Lissodelphis peronii*)	Year round	Pelagic / Neritic (localised)
Bottlenose dolphin (*Tursiops truncatus*)	Year round	Pelagic

Appendix 1a-4. Datasets provided by the Namibian Ministry of Fisheries and Marine Resources (MFMR) for this impact assessment.

DATASET	DATES	SPECIES
Hake commercial trawl data	2004-2009	Hake (*Merlucius paradoxus* and *M. capensis*)
Hake commercial longline data	2006-2010	Hake (*Merlucius paradoxus* and *M. capensis*)
Horse mackerel commercial mid-water trawl data	1997-2011	Horse mackerel (*Trachurus trachurus*)
Monk commercial trawl data	2005-2010	Monk (*Lophius vomerinus* and *L. vaillanti*)
Small pelagics commercial data	2000-2011	Anchovy (*Engraulis encrasicolus*)
		Sardine (*Sardinops sagax*)
		Round herring (*Etrumeus whiteheadi*)
Hake survey data	1995-2010	Horse mackerel
		Snoek (*Thyrsites atun*)
		Goby (*Sufflogobius bibarbatus*)
		Monk
		Hake
		Sole (*Austroglossus microlepis*)
Monk survey data	2007-2010	Monk
		Goby
		Orange roughy (*Hoplostethus atlanticus*)
		Sole
Small pelagic survey data	2002-2011	Horse mackerel, anchovy, sardine and round herring
Hake length-frequency survey data	1995-2010	Horse mackerel juveniles (<21cm)
		Hake juveniles (<21cm)
		Monk juveniles (<21cm)
Pelagic length-frequency survey data	2002-2011	Horse mackerel, anchovy, sardine and round herring juveniles (<8cm)
Hake maturity survey data	1995-2010	Hake stage 4 (spawning stage)
Hake, monk and small pelagics survey data combined	1995-2011	All species counted per sample station
Pelagic egg and Larvae from Spanish survey data		Anchovy eggs and larvae
		Sardine eggs and larvae
Pelagic egg and Larvae from Nansen survey data	1999-2005	Sardine eggs
		Horse mackerel eggs and larvae
Pelagic egg from SWAPELS survey data	1978-1985	Sardine
		Anchovy eggs
Mesopelgic egg survey	Aug 2006	Lightfish
		Lanternfish
		Red eye

Appendix 1a-5. List of species included in the biodiversity assessment

SPECIES INCLUDED IN THE BIODIVERSITY ASSESSMENT			
Acanthurus monroviae	*Cruriraja parcomaculata*	*Melanocetus johnsoni*	*Raja wallacei*
Aequorea sp.	*Cynoglossus capensis*	*Melanostomias sp.*	*Riparidae (family)*
Alepocephalus (family)	*Cynoglossus zanzibarensis*	*Merluccius capensis*	*Salps*
Alepocephalus australis	*Deania calcea*	*Merluccius capensis (big)*	*Sardinops ocellatus*
Allocyttus verrucosus	*Dicrolene intronigra*	*Merluccius paradoxus*	*Schedophilus huttoni*
Aphrodite pol	*Diogenidae (family)*	*Miscellaneous fishes*	*Scorpaena stephanica*
Aquorea aquarea	*Ebanania costaecanari*	*Mola mola*	*Selachophidium guentheri*
Aristeus varidens	*Echinorhinidae*	*Molluscs*	*Sepia australis*
Arnoglossus imperialis	*Engraulis capensis*	*Monolene microstoma*	*Sepia elegans*
Astronesthes sp.	*Epigonus denticulatus*	*Moroteuthis robsoni*	*Sergestidae (family)*
Austroglossus microlepis	*Epigonus telescopus*	*Muraenidae (family)*	*Serrivomer beanii*
Bivalves	*Etmopterus branchyurus*	*Mustelus palumbes*	*Shark eggs*
Bajacalifornia megalops	*Etrumeus whiteheadi*	*Myxine sp.*	*Shrimp mix*
Bassanago albescense	*Galatheidae (family)*	*Naucrates ductor*	*Shrimps, small, non comm.*
Bathynectes piperitus	*Galeus polli*	*Neocyttus rhomboIdalis*	*Snapper shrimp (Alpheus sp.?)*
Bathyraja smithii	*Gastropods*	*Neoharriotta pinnata*	*Solenocera africana*
Bathyuroconger vicinus	*Gempylidae*	*Neolithodes capensis*	*Sponges*
Benthodesmus tenuis	*Genypterus capensis*	*Nephropsis atlantica*	*Sqaulus megalops*
Bothus sp.	*Glyphus marsupialis*	*Nezumia micronychodon*	*Squatina oculata*
Brachioteuthis picta	*Gobiidae*	*Nezumia milleii*	*Squilla acuelata calmani*
Brama brama	*Gonostoma elongatum*	*Nezumia sp.*	*Squilla sp.*
Caelorinchus braueri	*Gymnura sp.*	*Notacanthus sexspinis*	*Starfish, mixed*
Caelorinchus simorynchus	*Helicolenus dactylopterus*	*Octopus vulgaris*	*Stomias boa boa*
Callanthias (family)	*Heterocarpus grimaldii*	*Ommastrephes pteropus*	*Stromateus fiatola*
Callionymidae	*Hexanchus griseus*	*Ophistoteuthes agassizi*	*Sufflogobius bibarbatus*
Calloryhnchus capensis	*Hoplostethus cadenati*	*Ophiuroidea*	*Symbolophorus boops*
Caristius groenlandicus	*Hoplostethus melanopus*	*Opostomias micripnis*	*Synapturichthys kleini*
Centrophorus granulosus	*Hoplostetus atlanticus*	*Panulirus sp.*	*Todarodes angolensis*
Centroscyllium fabricii	*Jellyfish*	*Parapaguridae (family)*	*Todarodes sagittatus*
Centroscymnus crepidater	*Laemonema laureysi*	*Parapenaeus longirostus*	*Todaropsis eblanae*

Chaceon maritae	*Lamprogrammus exutus*	*Paronchelius stauchi*	*Torpedo nobiliana*
Chatrabus melanurus	*Lepidopus caudatus*	*Perulibatrachus rossignoli*	*Trachipteridae*
Chelidonichthys capensis	*Lithodes ferox*	*Photonectes braueri*	*Trachurus capensis*
Chlamydoselachus anguineus	*Lithognathus mormyrus*	*Plesionika martia*	*Trachurus trachurus capensis*
Chlorophthalmus agassizi	*Lobotes surinamensis*	*Plesiopenaeus edwardsianus*	*Trachyrincus acanthiger*
Chlorophthalmus atlanticus	*Lophius vaillanti*	*Polychaelidae (family)*	*Trachyrincus scabrus*
Chloroscombrus chrysurus	*Lophius vomerinus*	*Pontinus leda*	*Trachyscopia capensis*
Chlorothalmus punctatus	*Lophius vomerinus (juvenile)*	*Psychrolutes macrocephalus*	*Trachyscorpia eschmeyeri*
Chrysaora spp	*Lycodes agulhensis*	*Psychroniyidae spp*	*Trigla lyra*
Coelorinchus acanthiger	*Lycoteuthis lorigera*	*Pterothrissus belloci*	*Tripterophycis gilchristi*
Coelorinchus coelorhinchus polli	*Macrouridae (family)*	*Raja caudaspinosa*	*Turbo sp. Gastropods*
Coelorinchus matamua	*Malacocephalus laevis*	*Raja clavata*	*Unidentified mix*
Coloconger scholesi	*Malacosteidae*	*Raja confundens*	*Vitreledonella richardi*
Coryphaenoides macrolophus	*Malecocephalus occidentalis*	*Raja leopardus*	*Yarrella blackfordi*
Cranchia scabra	*Maurolicus muelleri*	*Raja pullopunctate*	*Yarrella sp.*
	Megalocranchia sp.	*Raja spinacidermis*	*Zeidae*
		Raja straeleni	*Zeus capensis*