VALUING THE SOCIO-ECONOMIC CONTRIBUTION OF FISHERIES AND OTHER MARINE USES IN SOUTH AFRICA

A socio-economic assessment in the context of marine phosphate mining

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THIS STUDY SERVES AS A FIRST STEP IN ASSESSING THE SOCIO-ECONOMIC POTENTIAL IMPACT OF BULK MARINE SEDIMENT MINING ON SOUTH AFRICA'S MARINE INDUSTRIES, WITH ITS PARTICULAR FOCUS ON VALUING THE COMMERCIAL FISHING SECTOR.

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EXECUTIVE SUMMARY

This paper provides a broad assessment of the socio-economic value of South Africa's commercial and, to a lesser extent, small-scale fisheries and other sustainable marine uses. As the context of this study is the granting of three prospecting rights for marine phosphate mining off the western and southern coasts of the Western Cape, we also review the potential socio-economic contribution of marine phosphate mining as well as the potential adverse effects on the marine environment. Note that this study is not intended to be a cost-benefit analysis of the various marine users.

Two approaches are used to value the commercial fishing industry. In the first approach, we use relevant economic metrics such as the wholesale value of the landed catch, export revenue, capital assets and employment. In the second approach, the linkages between the fishery sector and the rest of the economy are explored by estimating the economy-wide multiplier associated with fishery production. The main results of this analysis are provided below:

Wholesale value, exports, capital investment and employment

In 2013, total catch across all fisheries was estimated to be 427 734 tons with an associated wholesale value of R8.0 billion. In addition, exports of fish products generated R5.3 billion in 2015. Finally, direct employment across all fishery sectors is estimated to be 27 000 while indirect employment in industries linked to the fishery sector is estimated to be between 81 000–100 000.

The demersal (offshore and inshore) trawl fishery (targeting Cape hakes) and pelagic-directed purse-seine fishery (targeting pilchards, anchovy and red-eye round herring) are the largest in terms of landed tonnage and economic values. More specifically, in 2013, these two fisheries together accounted for approximately 86% of total catch and just over 65% of total wholesale value. In addition, hake and small pelagic products together account for 47% of fish exports in 2015 (with hake products being the bulk of this at 34% of exports). The hake-trawl and small-pelagic sectors are also capital intensive, with the value of insured assets totalling R76.7 billion in the deep-sea trawl fishery, R12 billion in the hake inshore trawl fishery and R2.2 billion in the small-pelagic sector. Finally, the hake-trawl and small-pelagic sectors collectively accounting for 54% of total employment (with the demersal-trawl fishery employing between 30–35% of the fishery workforce).

In terms of long-term sustainability, the stock status of the demersal-trawl and small-pelagic fisheries are estimated to range between *optimal* to *abundant*, while fishing pressure is considered to range between *light* to *optimal*. Furthermore, again signalling the long-term sustainability of the demersal-trawl sector is the industry's Marine Stewardship Council (MSC) certification (with the industry being recertified as recently as May 2015).

Direct employment across all fishery sectors is estimated to be 27 000 while indirect employment in industries linked to the fishery sector is estimated to be between 81 000–100 000.

Multiplier

The fishing industry does not exist in isolation but has multiple backward and forward linkages with other sectors in the economy. By considering these linkages, one is able to determine the total value of fishery production to the entire economy. Three models are presented here. These models have varying assumptions around which payments flow back into the domestic economy and thus contribute to the multiplier process. The intermediate model shows that for every R1 in exogenous demand for fishery products, an additional R1.60 is generated in output through the interconnecting linkages in the economy which further translates into a net increase in domestic household income of R0.70.

Overlap with fishing activity

South Africa's major fishing grounds are situated along the continental shelf between St Helena Bay and Port Elizabeth. As a result of fishery activity being concentrated in the Western Cape Province, the industry's major fishing ports, processing factories and service industries are similarly found in this region. In particular, the prospecting license areas and proposed drill sites coincide with a large share of the offshore hake-trawl footprint and one of the primary fishing grounds of the small-pelagic fishery. More specifically, between 2000 and 2014, on average, 77% of the demersal-trawl catch has fallen within one of the prospecting areas (although the proportion for 2014 is lower at 65%). The overlap with the small-pelagic sector is lower: between 2010 and 2015, on average, 10% of the pelagic catch has fallen within one of the proposed mining sites (with the proportions for 2014 and 2015 being 6% and 5%, respectively).

There are several adverse impacts associated with marine phosphate mining that could affect the fishery industry. Firstly, the negative impact on the marine environment: the drilling operation and sediment removal, associated release of sediment plumes and re-release of excess sediment at or near surface level all result in the deterioration of the water quality. Secondly, the mining operation imposes limits on access to fishing grounds through exclusion zones around the drilling vessel. Thirdly, as marine phosphate mining requires the dredging of large sections of the ocean floor, the impacts are not confined to a small area. While the range of possible impacts is well identified, there remains uncertainty regarding the significance of these impacts on fishery harvests: i.e. the combined impact resulting from the intensity, the physical extent and the duration of the impact.

In various international cases of proposed bulk marine mining (such as the Chatham Rock Project in New Zealand), the issue of uncertainty has been a critical limitation to the approval of proposed mining operations. Likewise, the issue of uncertainty is pertinent in the South African case.

Finally, while this study focuses on valuing the commercial fishing sector, we recommend further research to assist decision making on the relative contribution of marine phosphate mining and other marine industries. Firstly, we recommend scenario-planning to translate a range of impacts from marine mining on the environment into impacts for fish catches, revenue, exports and jobs. Secondly, to extend the GIS analysis to a broader ecosystem study indicating the overlap between fishery feeding and lifecycle grounds and the phosphate prospecting areas. Finally, drawing on the outputs of both the scenario-planning and comprehensive GIS analysis, we recommend a cost-benefit analysis to compare the respective costs and benefits of marine mining compared to other marine industries.

THE NEGATIVE IMPACT ON THE MARINE ENVIRONMENT: THE DRILLING OPERATION AND SEDIMENT REMOVAL, ASSOCIATED RELEASE OF SEDIMENT PLUMES AND RE-RELEASE OF EXCESS SEDIMENT AT OR NEAR SURFACE LEVEL ALL RESULT IN THE DETERIORATION OF THE WATER QUALITY.

1/ INTRODUCTION

This paper has been commissioned by the Centre for Environmental Rights (CER) with the broad aim of better understanding the socio-economic value of South Africa's commercial and small-scale fisheries and other marine uses. The context for this study is the granting of three prospecting rights for marine phosphate in South Africa's Exclusive Economic Zone by the Department of Mineral Resources.[1] The prospecting areas are off the western and southern coasts of the Western Cape.[2] At present, rights have only been granted for prospecting and not full-scale mining.

There is concern expressed by various environmental groups, organisations that represent the interests of small-scale fishing and the commercial fishery industry that marine phosphate mining will have significant adverse impacts on the environment and subsequently threaten the country's fishing industry. While a cost-benefit assessment of the benefits and negative impacts of the respective marine users is beyond the scope of this study, this paper contributes to the debate through providing a broad assessment of the socio-economic value of existing marine users – in particular, commercial fisheries.

The study proceeds as follows: Section 2 reviews the potential socio-economic contribution of marine phosphate mining as well as the likely adverse impacts on the marine environment. As marine mining has not yet commenced in South Africa, this section draws heavily on findings and estimates from other countries' impact assessments and other types of marine mining. Section 3 considers the existing marine industries in South Africa's exclusive economic zone. The section focuses on valuing the commercial fishing industry in terms of landed catch, wholesale value, export revenue and employment. Additionally, using a Social Accounting Matrix for South Africa, we explore the linkages between the fishery sector and the rest of the economy by estimating the multiplier effect across the economy from fishery production. Finally, other marine users are also briefly discussed. Section 4 summarises the key concerns for the fishery industry with regard to marine phosphate mining and section 5 discusses the uncertainty when considering the impacts of mining activities on the marine environment. Key findings as well as recommendations of areas for further research are provided in section 6.

Study caveats

This paper is a socio-economic study based primarily on desktop analysis. While this is not an Environmental Impact Assessment, Economic Impact Assessment or Cost-Benefit Analysis, the analysis/findings of this study would serve as input into further studies on this topic. In addition to the desktop component, the study has been supplemented with data provided by representatives at the Department of Agriculture Fisheries and Forestry (DAFF). All values quoted are in current prices.

ENDNOTES

1. The terms 'bulk marine sediment mining', 'marine phosphate mining', and 'marine mining' are all used interchangeably.
2. See appendix for details on prospecting areas.

WHEN COMPARING MARINE PHOSPHATE MINING TO OTHER MARINE MINING SUCH AS DIAMOND MINING, COLES ET AL. (2002) NOTES THAT, AS THE DEPOSITS ARE SO WIDELY DISPERSED, PHOSPHATE MINING REQUIRES THE MINING OF EXTENSIVE AREAS OF THE SEABED, WITH THE RESULTANT IMPACT ON THE ENVIRONMENT BEING CONSIDERABLE.

2/ MARINE PHOSPHATE SEDIMENT MINING

Phosphate is an important feedstock in fertilizer and other industrial products and has been mined *terrestrially* for many decades and in many parts of the world, including in South Africa, where phosphate is mined in Phalaborwa and on the West Coast (http://www.elandsfontein.co.za). While the marine environment is known to contain phosphate deposits, there has as yet been no marine mining of phosphate from the sea floor. As such, while this section discusses the potential socio-economic benefits and risks of marine phosphate mining, there is no direct evidence from existing sites from which to draw information. As such, this discussion is drawn from reports that infer impacts based on other types of marine mining operations combined with scientific expectations based on technology specific to phosphate mining.[3] At the outset, we note that this discussion on the benefits and risks/costs of marine phosphate mining in South Africa is unavoidably laced with a significant degree of uncertainty.

The recent interest in seabed mining is due in part to new technologies available – such as the Trailing Suction Hopper-Dredge (TSHD)[4] and other high-volume dredging equipment – which allow for bulk sediment mining of significant scale to achieve economic feasibility (Currie 2013). It is also due, in part, to the increase in the world price of phosphate which peaked in 2008 at US$430 per ton relative to a long-term base price around US$40 per ton (Figure 1, see over). While the price has since decreased, it is still above the long-term average: in February 2016 the price was US$115/ton.

The general technique involves dragging a dredge over the sea floor where the dredge head has various mechanisms (such as cutting incisors and water jets) that facilitate the loosening of hard sediments prior to them entering the suction pipe that carries the sediments to the surface. Excess water and fine sediments are at some stage released back into the water column.

Applications for seabed mining have been submitted in several countries. In Namibia, the 'Sandpiper project' involved an extensive process of consultations and environmental impact assessments. The project is currently 'on hold as the Namibian Fishing Ministry has imposed a moratorium on marine phosphate mining until the impacts on the ocean environment can be assessed' (REPRISK 2015: 3). In New Zealand, applications for phosphate mining in the Chatham Rise, 400 km east of Christchurch, were rejected (Duncan & Currie 2015). In Northern Territory Australia, an application for the marine mining of manganese ore in the 'Blue Mud Bay Project' was submitted. In 2012, in response to public concerns, the Northern Territory government placed a 3-year moratorium on seabed mining; and in 2015, a permanent ban was established on seabed mining around the coast of Groote Eylandt due to the 'great cultural and environmental importance of this area' (Australian Marine Conservation Society 2015:1).

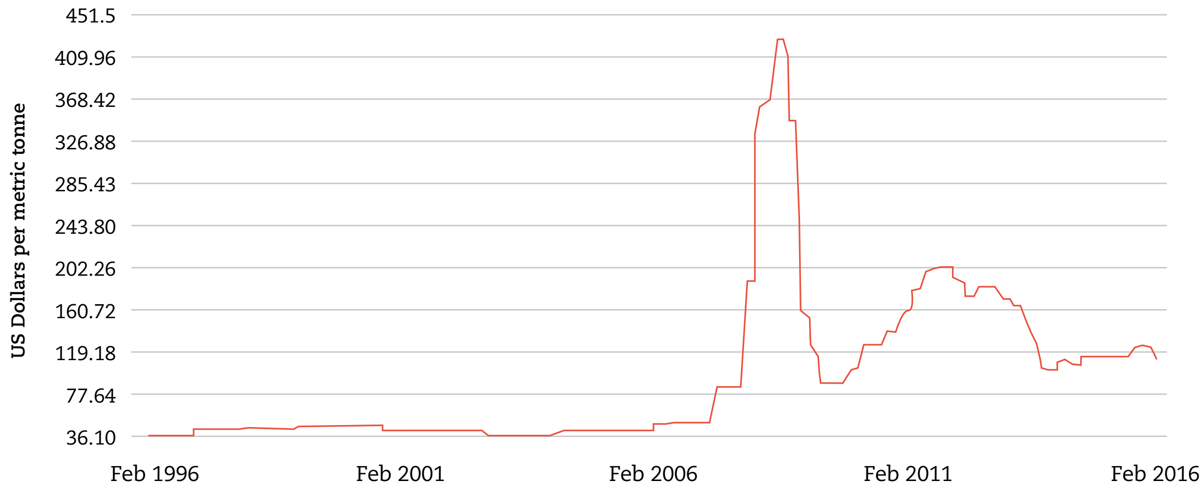
In contrast to the above mentioned cases, in Papua New Guinea, the 'Solwara 1 project' is expected to be the first commercial seabed mining operation, with the mining of sulphides, copper, nickel, cobalt and polymetallic nodules. Production is set to begin in 2018 (REPRISK 2015). And in the Clarion-Clipperton Fracture Zone, between Mexico and Hawaii, permits for seabed mining have been renewed by the National Oceanic and Atmospheric Administration (ibid).

2.1 Socio-economic contribution of marine phosphate mining

Value of resource

Compton (2013), in his Geological Report for Green Flash Trading 251's prospecting area, assesses the geological

FIGURE 1
Rock phosphate monthly world price



Source: http://www.indexmundi.com/commodities

value of the various mineral deposits off the west coast of South Africa. He estimates the composition of the greensand deposit to contain 60% glauconite (of which the 'economic element' is potassium), 20% phosphorite, 10% quartz, 5% calcite and 5% mud (ibid: 87). While noting that the variation in quality and density of the unprocessed deposits will have an impact on the economic value of the sediment, Compton (ibid: 88) estimates a maximum potential value of the order US$100 million/Mt (or US$100/ton) or 'a volume value of US$140/m^3'. This provides a base estimate of the economic value of the mineral deposits. Economic viability will however depend on several key factors: the cost of the mining operation, the processing (beneficiation) of the raw mineral deposits, the proximity to markets and, finally, the world price of phosphate and other associated minerals.

The proposed marine mining operations in South Africa would benefit from the close proximity to major industrial ports, specifically Saldanha Bay as well as Cape Town. The industrial development zone in Saldanha Bay would likewise facilitate the development of the necessary processing facilities. Another logistical benefit stems from the close proximity of agricultural areas in the Western Cape to the major ports – thus providing an end user of fertilizer products in close proximity, which would reduce transportation costs (Compton 2013). However, as terrestrial supply of phosphate in South Africa currently meets domestic fertiliser demand and significant quantities of phosphate rock processed in South Africa is exported, the need for a new phosphate source is limited.

Two disadvantages to the economic viability of the mining operation involve the high costs associated with marine mining technology and the volatility of the world price of phosphate. Coles et al. (2002: 106–107) consider different technologies for bulk marine sediment mining in Southern Africa at 'best case prices' and provide a first estimate of the annual income from the three key mineral resources depending on the volume extracted and the technology employed (see Table 1). Total annual income ranges from a lower bound of US$ 172.2 million (based

TABLE 1 **Estimates of annual mining income from key mineral deposits based on mining technology and volume of sediment extracted per day (US$ million)**

	Glauconite sand at $300/ton	Potash at $117/ton	Phosphate at $24.6/ton
Diamond mining technology			
2 250 tons	175.5	68.5	14.4
5 000 tons	390	152	40
Dragline mining technology			
1 500 tons	117	45.6	9.6
2 700 tons	210.6	82.1	17.3

Source: Adapted from Coles et al. (2002), Table 2 p107 on dragline mining technology and a daily extraction rate of 1 500 tons) to an upper limit of US$582 million (based on diamond mining technology and daily extraction rate of 5 000 tons). These estimates are clearly dependent on the global market price of minerals of which South Africa is a price taker. Furthermore, while Coles et al. (2002) only consider two mining technologies, new ones may be developed. Finally, since these estimates do not account for the costs of the chemical beneficiation process, shipping and other costs involved in getting the minerals from 'rock to market', they do not provide an indication of the likely profit.

As a comparison, the Namibian proposal for phosphate mining projected revenue to peak at US$160 million (NPA 2012),[5] which is less than the lower limit provided by Coles et al. (2002). Some of this revenue stream would be based on export sales and thus constitute a source for foreign reserves.

> While the Namibian Sandpiper proposal forecast a personnel requirement of 37 jobs on board the dredger, only 11 of these positions would be filled by local workers (Midgley 2012: 5 –3).

It should be noted that, as the revenue generated and operational costs incurred are private gains and costs that would be borne by the private enterprise, it can be reasonably assumed that the private sector would not take on the risks of such an expensive venture without reasonable assurances of privately realised economic profits. However, of interest to the wider public and decision-making authorities is the spill-over costs and gains to parties other than the direct mining rights holders.

Jobs

As unemployment is a critical developmental challenge in South Africa, any contribution to employment needs to be seriously considered. While we have not seen estimates for the likely employment to be generated in South Africa from marine phosphate mining, there is data from other countries' proposals. In New Zealand, an estimated 50 crew positions on the mining vessel would be created through the mining operation (Duncan & Currie 2015). While the Namibian Sandpiper proposal forecast a personnel requirement of 37 jobs on board the dredger, only 11 of these positions would be fill by local workers (Midgley 2012: 5 –3). Due to the highly specialised nature of marine mining, most of the offshore jobs would be filled by staff associated with the mining house (i.e. foreign workers) with only a fraction of jobs being available to workers from the host country.

The Namibian EIA considered the on-shore component associated with the mining operation which would require infrastructure for the further beneficiation of minerals. The construction of the onshore processing plant would generate temporary employment of 'between 300 and 400 workers' (Midgley 2012: 5–3). The permanent workforce thereafter was estimated at 135 persons. There is, as yet, limited information about plans for an onshore processing industry in South Africa; should one be established this would provide more jobs and contribute to GDP through beneficiation.

GDP, tax and royalties

The revenue generated from the sale of minerals would contribute to Gross Domestic Product (GDP). However, if ownership of the mines is non-South African, it would not reflect in the Gross National Income. The New Zealand proposal estimated GDP gains in the order of US$189 million per year6 of which 60% of welfare benefits would accrue to direct associates of the mining operation (Duncan & Currie 2015).

A positive contribution to government revenue would further come from the payment of company tax, income tax and mining royalties. In New Zealand, this was estimated by the applicant to be of the order of US$16 million per year.[7] Royalties could be a significant boon to the economy that would provide much needed resources for government expenditure. The South African Revenue Service (SARS) collects royalties for mineral and petroleum resources in terms of the Mineral and Petroleum Resources Royalty Act, 2008, and the Mineral and Petroleum Resources Royalty (Administration) Act, 2008. The rate for refined mineral resources is 0.5% to 5% and for unrefined mineral resources 0.5% to 7% (SARS 2013).

Additional linkages in the economy are likely to be generated both from industries supplying the marine phosphate enterprise (e.g. the provision of port infrastructure and servicing the vessel) as well as forward linkages from the potential of further processing of the commodities. In Namibia, approximately 200 indirect jobs were forecast based on outsourcing of services to Namibian suppliers (NPA 2012) and the capital cost of US$140 million required to establish the Namibian *onshore* facilities would likewise be an injection into the economy with related positive linkage effects (Midgley 2012: 5–3). On the other hand, if all capital equipment was imported and the minerals exported without any local processing, this would limit the additional linkage benefits to the domestic economy. Indeed, one of the benefits of seabed mining cited by mineral exploration companies is that the offshore nature of the industry means that much of the initial processing can be carried out at sea and then shipped to the final destination without the added cost of investment in onshore infrastructure (Exploraciones Oceanicas, 2014).

In South Africa, some indication has been given by Green Flash Trading that they could 'potentially provide additional feedstock to a Fertilizer Plant envisaged to be developed in Saldanha Bay' (Montero [no date]). Such an onshore development would be a positive economic injection for the domestic economy.

Food security

A further benefit that is frequently cited in relation to marine phosphate mining is the positive contribution such mining would make to the global supply of phosphate. Phosphate is a key mineral in the production of fertilizers which, in turn, contributes to the production of food. Estimates of reserves vary depending on demand rates, with known global phosphate reserves expected to be depleted within about 50 years 'and the remainder of the reserve base… within the next 100 years' (Department of Mineral Resources 2013). As there is no artificial substitute for phosphorous it is reasonable to expect that, as global terrestrial reserves decline, there will be increasing global demand for this mineral. Bulk marine sediment mining of phosphate would contribute to these reserves.[8] While global food security is certainly a positive objective, whether it is a domestic benefit is not as clear given that South Africa does have an established terrestrial based phosphate mining industry and this product contributes to South Africa's exports. Furthermore, the gains from increased food security from increased phosphate supply would need to be weighed up against the potential loss in food sources should the fishing industry be adversely affected.

2.2 Socio-economic risks of marine phosphate mining on the marine environment

The risks posed from the *prospecting* stage of seabed mining exploration are expected to have a 'very minimal environmental impact' (World Bank 2016: 28). There is some concern related to the impact of marine seismic surveys (associated with prospecting) on marine life. In a study on the impact of seismic activity on marine organisms, the likely impact on some large marine animals (e.g. penguins and turtles) was rated 'medium to high significance in certain areas and seasons, whereas potential impacts on other marine species were considered to be negligible or low' (Atkinson & Sink 2008: 6). The impact on whales is of particular concern however as whales have good low-frequency hearing. The mitigation measure proposed for the petroleum mining industry was to avoid seismic surveying when whales were likely to be present (ibid).

Conversely, the impacts associated with the *exploitation* stage 'are expected to be severe at the mine site, and potentially permanent' (World Bank 2016: 28). In this section, we focus exclusively on the potential risks posed by the mining operation and not those from the prospecting and exploration stages.

When comparing marine phosphate mining to other marine mining such as diamond mining, Coles et al. (2002) notes that, as the deposits are so widely dispersed, phosphate mining requires the mining of extensive areas of the seabed, with the resultant impact on the environment being considerable.

Environmental impact

There are three ways that marine phosphate mining is likely to impact on the marine environment (summarised from Currie (2013)):

1. ***The breaking of the seabed floor to extract the sediments***
   This occurs at the point of the mining and involves the physical destruction of benthic communities and habitat. The mining process of breaking rocks will also generate noise.

2. ***Release of a benthic plume into the water column at source of mining***
   The process of breaking and disturbing the sediment layer of the seabed releases fine sediment plumes into the ocean column which increases turbidity and decreases light levels. As these plumes will likely be enriched in organic particles from disturbed or dredged sediments, on the one hand, this could provide an increased food source for organisms, but on the other hand, too many nutrients could cause algal blooms and hypoxia (lack of oxygen in the water). Furthermore, there is concern around concentrations of potentially toxic hydrogen sulphide, heavy metals and reduced phosphorous compounds being released (Midgley 2012: 7–12, Currie 2013).

   There is also a concern that the sediment plume will smother and bury organisms when they resettle on the seafloor. The microbial communities on the sea-floor will be impacted and there is little certainty as to how these communities may recover and what the implications are to the broader ecosystem of their removal (Currie 2013: 7). The extent of the impact from the plumes is far from certain. For example, the Namibian EIA comments that the 'plumes will disperse quickly over a short distance' (Midgley 2012: 7–11) while the New Zealand decision making committee hold that there is still much uncertainty with regard to how the sediment plumes will impact on various marine organisms (Duncan & Currie 2015).

3. ***Release of sediment waste back into the ocean at or near the surface***
   Currie (2013) highlights that the overflow or waste sediment load being re-released into the ocean would be nutrient rich and could lead to eutrophication and associated hypoxia in the water. However, a 2006 CSIR report (cited in Currie (2013)) did not find significantly lowered oxygen concentrations from surveys related to diamond mining in the Atlantic. In addition to the nutrient enrichment caused by increased turbidity, there is also concern that the sediments released back into the ocean would supplement this process as well as contain high and possibly harmful concentrations of metals from the seabed floor (Currie 2013: 4). If ingested by marine organisms, this could cause toxicity and Currie (ibid) recommends a 'detailed study' to assess the severity and scale of the impact. The re-released sediments could further contribute to the burial and smothering of the sea-floor habitat as with the benthic plumes from the sea-floor.

In addition, the Namibian EIA draws attention to the possible impact from alien marine species through the ballast water technology employed in the dredging (Midgley 2012: 7–17). There is concern that these species may displace indigenous species and the EIA recognises that there is a wide range of possible impacts from 'none' to 'serious' (ibid).

The above mentioned impacts would impact most directly and significantly on both the benthic habitat and organisms that dwell there as the mining process either destroys them or their habitat. Demersal fish species (i.e. species that live on the sea bottom) will likewise be displaced by loss of habitat. If unique species exist in these habitats there is also a loss to biodiversity. In the Namibian EIA, this impact was considered improbable and rated as having minor intensity (Midgley 2012: 9), however, in the case of the New Zealand Chatham Rise project, the decision making committee found that there were several 'potentially unique benthic communities... and at least one species protected under the Wildlife Act' (Duncan and Currie 2015:10) and the committee thus considered the loss to these environments as a 'significant matter' (ibd: 11).

Fish species and other pelagic marine organisms that inhabit the ocean columns above the mining grounds could be indirectly impacted via the noise from the mining operation and the contamination of habitat from sediments released both from the benthic plume and the waste sediments re-released from above. Underwater sound can result in behavioural impacts on ocean life, causing animals to avoid the area, interfering with their communication and even hearing loss. However, there is little knowledge to determine the intensity of the impact (Midgley 2012: 7–6). The Namibian EIA considered the impact of the displacement and/or redistribution of demersal and pelagic fish species to be of a 'moderate' intensity (ibid: 7–8), while the impact would be for the duration of the mining operation (and depending on the rate of habitat recovery for a period thereafter) the impact was limited to the immediate mining licence area.

Coles et al (2002:104) rates the various impacts from phosphate mining based on three criteria: the area impacted, the time scale of the effect and the intensity of the potential impact. The potential impact on benthic communities (destruction of species and/or habitat) is rated as 'high' being a 'near field' impact which is expected to have a long-term impact (i.e. many years before the environment rehabilitates and even in that instance it is unlikely that the terrain will be habitable by the same species to that pre-drilling). The smothering of benthic communities from sediment plumes is also given a 'high' intensity rating with the area impacted extending from the immediate point of drilling up to 1 000 m and the duration of the impact is expected to last anywhere from days to months (i.e. short to medium term). The indirect impact of light reduction (from increased sediment turbidity) depends on the distance from the drilling site and surface dumping site respectively, and is expected to have a spatial impact extending from the near field to the far field. While the immediate turbidity from the release of plumes is expected to be a short-term impact, the dispersed turbidity over mid- to far-field areas could have a longer-term impact on the environment, with an average impact rated as 'medium'. Finally, the re-suspension of heavy metals in the water column could have a damaging impact if ingested by marine biota. However, Coles et al. (2002) do not consider this a likely possibility in the case of marine phosphate mining in South Africa.

The New Zealand decision making committee, with respect to the Chatham Rock application, highlighted these environmental impacts in their decision, stating that the 'destructive impact' on the benthic communities could 'not be avoided, remedied or mitigated' and that the benthic habitat would be 'transformed wholly into soft sediment habitat' (Duncan and Currie 2015: 4). Furthermore, there was concern that the return of waste material would have 'adverse effects' on the immediate benthic habitat and the 'wider marine environment'.

Impact on fisheries

As Coles et al. (2002:108) describes: the 'waters in which the mining may occur harbour some of South Africa's richest fishing grounds and thus the potential for conflict regarding environmental issues is high'. However, there is still much uncertainty as to how the environmental impacts described above will translate into an impact on fisheries.

The concern is not only for adult fish catches but the impact the affected water quality (sediment plumes etc.) and destruction of the benthic habitat will have on all lifecycle stages of fish development. While the Namibian EIA considered the impact from marine mining on fish juveniles, eggs and larvae to have an overall 'neutral' status (Midgley 2012: 7–9), it is uncertain whether the same significance rating of this impact would apply in the South African case.

In addition to the potential impact due to changes in water quality, the Namibian EIA reports that fishing effort will be adversely impacted from the loss of habitat and increased levels of maritime traffic associated with the marine phosphate mining activities through the following avenues: (i) access restrictions to other marine users, particularly the fishing industry, who formerly may have operated in the vicinity of the now active mining area, (ii) loss of fishing area/opportunity of up to 3 km^2 of seabed per year[9] and, (iii), an exclusion zone that would be declared around the active mining area (Midgley 2012, chapter 5.4 and 7).[10]

The Namibian EIA concluded that, while the impact to Namibian fisheries will differ based on the particular fishery sector, the overall impact was estimated to be negative with a 'medium to low significance' (Midgley 2012: 7–11). Conversely, fishing industry stakeholders opposing the Namibian Sandpiper project argued that the EIA did not properly assess the risks and potential impacts on fishery resources of the Namibian fishing industry (Benkenstein 2014). Furthermore, the impact of the proposed mining activities on Namibia's main fisheries were considered as having a serious effect for the 20-year duration of the mining operation (i.e. a long-term effect) with a further long-term recovery period.

As Namibia is a close neighbour with a sizable fishing industry, the evaluation from the Namibian EIA offers valuable insights on the potential impact from marine phosphate mining. Nonetheless, these impacts would differ to a greater or lesser extent in the South-African context based on the particular local environment and fishing grounds therein.

2.3 Framework for a comparison of costs and benefits from seabed mining

While a cost-benefit analysis is beyond the scope of the current project, we include in this section a *brief* outline of costs and benefits associated with seabed mining activities that would need to be considered by the host country. A more extensive study would need to identify and quantify the specific costs and benefits given a range of different assumptions. Importantly, such an analysis would have to compare the intensity of the impact(s), the number of people directly and indirectly affected, the duration of the impact(s),[11] the physical extent of the impact(s) as well as the likelihood of the impact(s) occurring. Furthermore, the analysis would need to identify any distributional trade-offs between groups within society (i.e. net gain versus net loss). Table 2 provides a framework of factors which could be developed further into a cost-benefit analysis.

ENDNOTES

3 Inferences are drawn chiefly from the deep-water diamond mining activities offshore of the west coast of Namibia which involved vessel-based remote mining technology for locating and recovering sediments containing concentrated diamond deposits (Currie 2013).

4 The TSHD method involves the dredging of large volumes of sediments from the sea floor which are then processed on board or onshore. These vessels are able to cover large areas at a rate of 100 000 m^2 of sediment per day at depths greater than 130 m (Currie 2013).

5 N$1=US$0.066 at March 2016.

6 Converted from New Zealand dollar (March 2016 at an exchange rate of NZ$1=US$0.67).

7 Converted from New Zealand dollar (March 2016 at an exchange rate of NZ$1=US$0.67).

8 As would phosphate recycling and recovery (See Vidima and von Blottnitz (2016) for more information).

9 In the Namibian case this translated to a maximum physically disturbed area of 60 km^2 over the 20-year life of the mine.

10 In Namibia this area was envisaged to be a block 23 x 9km.

11 Existing proposals for seabed mining have timeframes of between 20 and 50 years (Midgley 2012, Duncan & Currie 2013, Exploraciones Oceanicas, 2014) and this would have to be compared, in a cost-benefit framework, to fisheries which is a renewable resource.

12 Table based on similar table in World Bank, (2016: 38, Table 5).

13 Whether this is a benefit to the host country depends on the particular circumstance and which industry one focuses on. In the case of South Africa, a phosphate-producing nation, it is not certain that this would be a net benefit since an increase in phosphate reserves could potentially lower the price of phosphate for incumbent producers. However, for countries that are not endowed with phosphate and likewise other industries such as agriculture, greater phosphate reserves at a lower price would be advantageous.

TABLE 2 Comparison of costs and benefits from deep sea mining for host country[12]

Stakeholder	*Costs*	*Indirect costs*	*Benefits*	*Indirect benefits*
Government	Cost of developing a national policy and regulatory framework	Administrative costs of monitoring, enforcing and reporting on the mining operation Some of these costs will be borne by the company per the polluter pays principle	Royalty and tax revenues	
	Any capital and operational costs if a direct participant in investment		Any direct revenues if a direct participant in the mining Investment	
Existing Marine Industries: fisheries, tourism etc.	Loss of production/ income by off-shore or coastal fisheries and tourism due to marine mining activities and their impact on the environment and exclusion areas	Loss in production/ income to secondary domestic industries through backward and forward production linkages in the economy		
Citizens/ Communities	Cost of reduction in services provided by marine ecosystems (e.g. to recreational and subsistence fishers)	Loss of cultural or spiritual value associated with pristine ocean, sense of ownership of/identification with the ocean and its resources	Income derived by host-country nationals from employment by mining project company	Value added via secondary economic activities supporting the marine mining project (backward and forward linkages)
		Reduction in well-being caused by dependency on payments from government, temporary nature of mining employment, or disruption to social fabric due to influx of foreign workers Damage to property, resources, and livelihoods caused by accidental spill of hazardous materials such as oil	Increase in phosphate reserves[13]	Human and physical capital enhancements due to investments by government (with tax and royalty revenues), or by the mining company in social welfare projects and/ or infrastructure Increased knowledge of deep sea ecosystems and geology obtained through regular monitoring and data collection during mining project

3/

MARINE INDUSTRIES IN SOUTH AFRICA'S EXCLUSIVE ECONOMIC ZONE (EEZ)

The offshore marine environment provides value to a variety of users. Extractive users fall into two categories: non-renewable in the case of mining and renewable in the case of fisheries. The fishery sector can then be further divided into large-scale commercial fisheries and all other forms of fishing (from subsistence and small-scale enterprises to recreational and aquaculture). There are also non-extractive activities that make use of the marine environment in a non-exclusive manner, for example: shipping, undersea cables, naval activities as well as tourism (Atkinson & Sink 2008). The ocean also provides important biodiversity value and ecosystem services that support the fishery and tourism sector.

The primary focus of this study is on valuing the commercial fishing industry in South Africa. More specifically, this section describes the most economically valuable industries (hake trawl and pelagic purse-seine fisheries) and the extent of fishing activity in the Western Cape Province. We also briefly review other marine users in South Africa's EEZ.

3.1 Commercial fisheries in South Africa

Catch and value

DAFF (2013 and 2015) estimate the total catch of commercial fisheries to be around 600 000 tons with an estimated value of approximately R6 billion (depending on the volatility of the pelagic catch of sardines and anchovy) (see Table 3). In terms of the wholesale value of fisheries, in 2013, total catch across all fisheries was estimated to be 427 734 tons with an associated value of R8.0 billion (DAFF, *personal communication)*.

South Africa is a net exporter of both fish and fish products: in particular, 55% of commercial trawl catches are exported and near total production of rock lobster, squid, tuna and commercial longline is exported (DAFF 2013). The value of legal exports and imports in 2008 was estimated to be approximately R3.1 billion and R1 billion, respectively (DAFF 2013). Trade data from the Department of Trade and Industry indicates that the value of all fish exports in 2012 was R3.7 billion (Department of Trade and Industry, SA annual export value). Since 2012, the value of exports has increased to R4.2 billion in 2013, R5.2 billion in 2014 and finally, R5.3 billion in 2015 (Department of Trade and Industry, SA annual export value).[14]

The demersal-trawl (hake) and small-pelagic sectors are the largest in terms of landed tonnage and economic value. In terms of exports, hake and small-pelagic products together accounted for 47% of fish exports in 2015 (hake products: 34%, small pelagic: 13%) (export data is provided in sections 3.1.2 and 3.1.3). Export value reflects beneficiation: particularly in the case of hake where there has been an increase in the export of value-added fillet products to Europe and the United States.

Table 4 provides catch and value data for the most valuable commercial fisheries. Columns 2 and 3 of Table 4 replicate the information provided by DAFF (*personal communication*) around catch and wholesale value for 2013. In addition, column 4 indicates each sector's share of the total value of the fishing industry. As previously discussed, in 2013, total catch across all fisheries was

TABLE 3 Contribution of SA commercial fisheries in terms of value, employment and exports

Category	Volume/Value	Source
Landed catch	427 734 t – 600 000 t	DAFF (2013, 2015, personal comm.)
Value	R6–8 billion	DAFF (2013, 2015, personal comm.)
Export value	2013: R4.2 billion 2014: R5.2 billion 2015: R5.3 billion	Annual export value (DTI 2016)

Sources: DAFF (2013, 2015, personal communication) and DTI (2016)

TABLE 4 Catch and value data of the most commercially valuable fisheries

	(2) 2013 Catch (t)	(3) 2013 Wholesale value (ZAR)	(4) 2013 % of total value
Demersal offshore trawl	156 645	3 512 741 000	43.8
Demersal inshore trawl	6 110	81 296 000	1.0
Small pelagic purse-seine	203 100	1 625 042 000	20.3
Squid jig	6 167	567 364 000	7.1
West Coast Rock Lobster	1 861	529 999 000	6.6
Total	373 883	6 316 442 000	79
Total (SA fishing industry)	427 734	8 022 572 000	

Sources: DAFF (personal communication) and own calculations

estimated to be 427 734 tons with an associated wholesale value of R8.0 billion (DAFF, *personal communication*). The total catch of the listed fisheries was estimated at 373 883 tons with a wholesale value of R6.3 billion. As evident from the table, these five sectors account for 79% of the total value of the fishing industry.[15]

The demersal (offshore and inshore) trawl fishery (targeting Cape hakes) and pelagic-directed purse-seine fishery (targeting pilchards, anchovy and red-eye round herring) have both the highest economic value and greatest landed tonnage (Japp and Wilkinson 2015). As evident from the table, in 2013, these two fisheries accounted for approximately 86% of total catch and just over 65% of total wholesale value.

Capital investment

The South African fishing industry is capital intensive – as illustrated by the value of harbour and land-based assets insured by rights holders provided in Table 5.

As evident from the table, the value of insured assets totals R76.7 billion in the deep-sea trawl sector, R12 billion in the inshore-trawl sector and R2.2 billion in the small-pelagic sector.

Employment

While direct employment in the fisheries sector is estimated at around 27 000 jobs, an additional 81 000–100 000 jobs are created by indirect employment in industries partially dependent on the fisheries sector (DAFF 2013, 2015).

Table 6 reflects key employment and wage figures from the 2008/2009 DAFF performance reviews (DAFF 2012a-j). While this information is less recent than the estimates from DAFF (2013, 2015), it provides a useful comparison across sectors. The table indicates that the hake-trawl and small-pelagic sectors are the most important employers, collectively accounting for 54% of total employment.

TABLE 5 Investment in harbour and land-based assets

	Insured assets	
	Harbour assets	Land-based assets
Hake deep-sea trawl	R2.326 billion	R74.4 billion
Hake inshore trawl	R6 billion	R6 billion
Hake long line	R181 million	R47 million
Small pelagics	R538 million	R1.624 billion
WC rock lobster (offshore)	R122 million	R188 million
Squid	R486 million	R51 million
Tuna pole	R253 million	R17 million
Horse mackerel	R203 million	R28 million

Source: Department of agriculture, forestry and fisheries (DAFF 2012a–2012j)
Notes: Harbour and land-based assets insured by rights holders

TABLE 6 Employment and wage figures for some of SA's commercial fisheries

	Total no. of employees in 2008	% of employment	Total wage bill in 2008	Average per-person annual salary	Average per-person daily wage
All sectors	22 106	–	R2 551 282 300	–	–
Hake deep-sea trawl	5 917	27	R765 895 613	R126 764	R1 327
Hake inshore trawl	642	3	R970 543 082	R211 864	R2 399
Hake long line	1 482	7	R55 855 865	R37 739	R920
Small pelagics	5 204	24	R401 098 384	R76 663	R 628
WC rock lobster (offshore)	1220	6	R67 606 314	R55 315	R1 467
Squid	2 999	14	R157 568 874	R52 547	R1 248
Tuna Pole	2 131	10	R37 386 434	R17 406	R1 244

Source: Department of agriculture, forestry and fisheries (DAFF 2012a – 2012j)

Notes:

- *Estimates for 2008*
- *Average per-person salary calculated by dividing average salary bill across rights holders (not replicated in this table) by average number of employees across rights holders (not replicated in this table)*
- *Average daily rate calculated by dividing average per-person salary by average number of working days. Note that the average number of working days varies across sectors. For example, in the hake deep-sea trawl fishery, average number of working days is reflected as 95.5 days in 2008.*
- *Note that the term 'salary' and 'wage' are used as synonyms*

Long-term sustainability

Another metric by which to value the fishery industry is its degree of long-term sustainability. A sustainable fishery, where fish are harvested at a sustainable rate so fish populations do not decline over time, has the potential to yield long-term benefits (in terms of revenue, employment and other indirect metrics such as food security). With respect to the demersal-trawl and small-pelagic fisheries, a DAFF (2014) assessment of the status of marine resources is provided in Table 7.

TABLE 7 Stock status and fishing pressure in the demersal and small-pelagic fisheries

Marine resource	Stock status	Fishing pressure
Deep-water hake	Optimal	Optimal
Shallow-water hake	Abundant	Optimal
Sardine	Optimal	Optimal
Anchovy	Abundant	Light
Redeye round herring	Abundant	Light

Source: Department of agriculture, forestry and fisheries (DAFF 2014)

Furthermore, signalling the long-term sustainability of the demersal-trawl sector is the industry's Marine Stewardship Council (MSC) certification. The industry was first certified in April 2004 and recertified in March 2010 and as recently as May 2015 (Marine Stewardship Council 2016).[16]

3.1.1 *Western Cape*

While the fisheries sector contributes around 0.1% to GDP nationally, the sector contributes over 5% to Gross Provincial Domestic Product in the Western Cape (DAFF 2015). Hara et al. (2008) estimate that the Western Cape accounts for around 90% of the value of the fisheries sector, 95% of deep-sea and inshore hake catches (the most commercially valuable sector), 71% of industry employment and nearly 72% of industry income. In terms of contribution to exports, the Western Cape accounted for 85% of South Africa's total fish exports in 2012 (WESGRO 2014).

Figure 2 depicts the South African coastline (with main fishing ports) while Figure 3 illustrates the spatial distribution of South Africa's main commercial fisheries (with main fishing ports). As evident from Figure 3, the major commercial fishing grounds are situated along the continental shelf between St Helena Bay and Port Elizabeth (Kaiser Associates 2012, FAO2010). Japp and Wilkinson (2015), in Table 8, provide the main *areas of operation* for each of the main commercial fishing sectors. The table further confirms that the majority of fishing activity takes place along the west and south coasts.

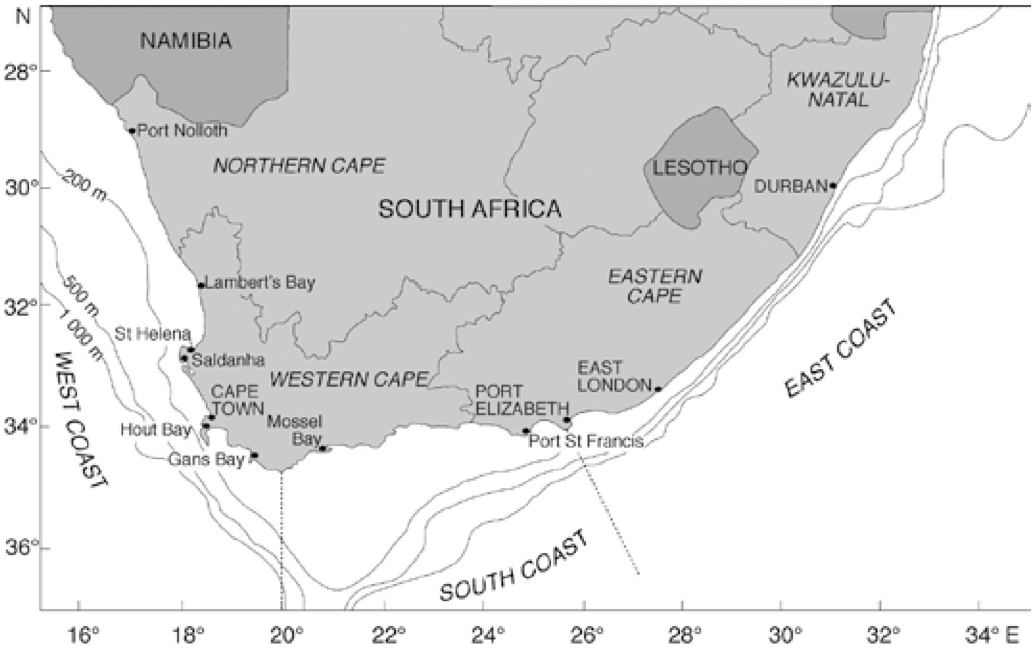
As a consequence of the major fishing grounds being situated along the west and south coast, the main fishing ports, processing factories and service industries are found in the Western Cape Province. Japp and Wilkinson (2015) also provide the main ports, in order of priority, for South Africa's commercial fishing sectors (Table 8, maps are provided in Appendix B).[17] This table confirms that, outside of the Western Cape, the only 'significant fishery activity occurs in the Eastern Cape (Port Elizabeth and

Port St Francis) where the squid fishery is based and a small proportion of South Africa's sardine, inshore trawl and linefish catch are landed' (Kaiser Associates: 109).

In terms of value-added activities, pelagic-fish processing factories, which produce canned sardines and fishmeal, are largely based at the fishing harbours of Laaiplek, St Helena Bay, Hout Bay and Gansbaai (Kaiser Associates 2012). In addition, the processing of deep-water demersal hake occurs at major factories located at the Cape Town and Saldanha Bay harbours (where the fish are processed into various products – for example, head and gutted,

FIGURE 2

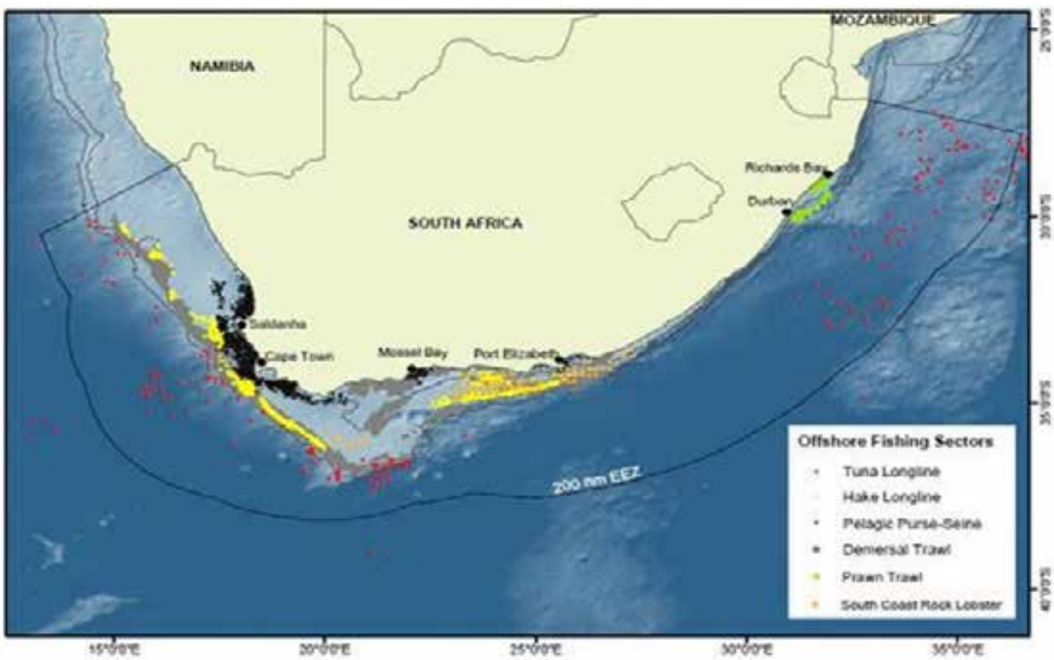
South African coastline with main fishing harbours



Source: FAO (2001)

FIGURE 3

Distribution of main commercial fisheries in South Africa with main fishing harbours



Source: FAO (2010) and Kaiser Associates (2012) fillets and value-added products) (Kaiser Associates 2012). Finally, fishery-related services, including vessel and fishing equipment, diving services, packaging, cold storage, electronics, engineering, clothing, are pre-dominantly based in Cape Town (Kaiser Associates 2012).

In the case of demersal hake, Figure 4 depicts the spatial footprint of the demersal hake-trawl fishery. Offshore vessels operate along the west and south coast: from the Namibian border, southwards to the south coast and up to Port Alfred (Sink et al. 2012, Andrews et al. 2015). The inshore trawl fishery operates along the south coast from the ports of Mossel Bay and Port Elizabeth (Andrews et al. 2015). Figure 5 overlays the Green Flash Trading prospecting areas (GFT 251 and GFT 257) with the offshore trawl footprint (1970s to 2007). As discussed by Currie (2013), the licence areas and proposed drill sites coincide with a large share of the offshore trawl footprint.

With respect to the small pelagic fishery, Figure 6 provides the distribution of sardine catches in 2012 as well as the location of current and historical processing factories (Hutchings et al. 2015). The figure highlights that there are three main fishing grounds for this fishery: west of Cape Agulhas, off Mossel Bay and off Cape St Francis (Port Elizabeth). Hutchings et al. (2015) note that more than 50% of the catch was taken west of Cape Agulhas. A comparison of the spatial distribution of catches to the Green Flash Trading prospecting areas (Figure 12 and Figure 13 in Appendix A) suggest some overlap between these prospecting areas and the small pelagic footprint west of Cape Agulhas.

The proceeding subsections provide more detailed information on the hake and pelagic fisheries.

3.1.2 *Hake trawl sector*

The hake fishery comprises the offshore trawl, inshore trawl, longline and handline sectors. Offshore trawling does the processing of fish both at sea (i.e. sea-frozen) and ashore, i.e. lands both fresh and frozen hake, while the other three sectors land almost exclusively fresh fish (Japp and Wilkinson 2015).

The annual total allowable catch (TAC) across all sectors targeting hake was 144.671 tons in 2012 (DAFF 2014) and 156 075 tons in 2013 (Japp and Wilkinson 2015).

As evident from Table 9, since 2009, hake caught from both the offshore and inshore trawl sectors accounts for 93% of the annual catch (with the handline and longline sectors accounting for the balance) (Stats SA 2015). Furthermore, offshore trawl accounts for 88% of catches in this sector.

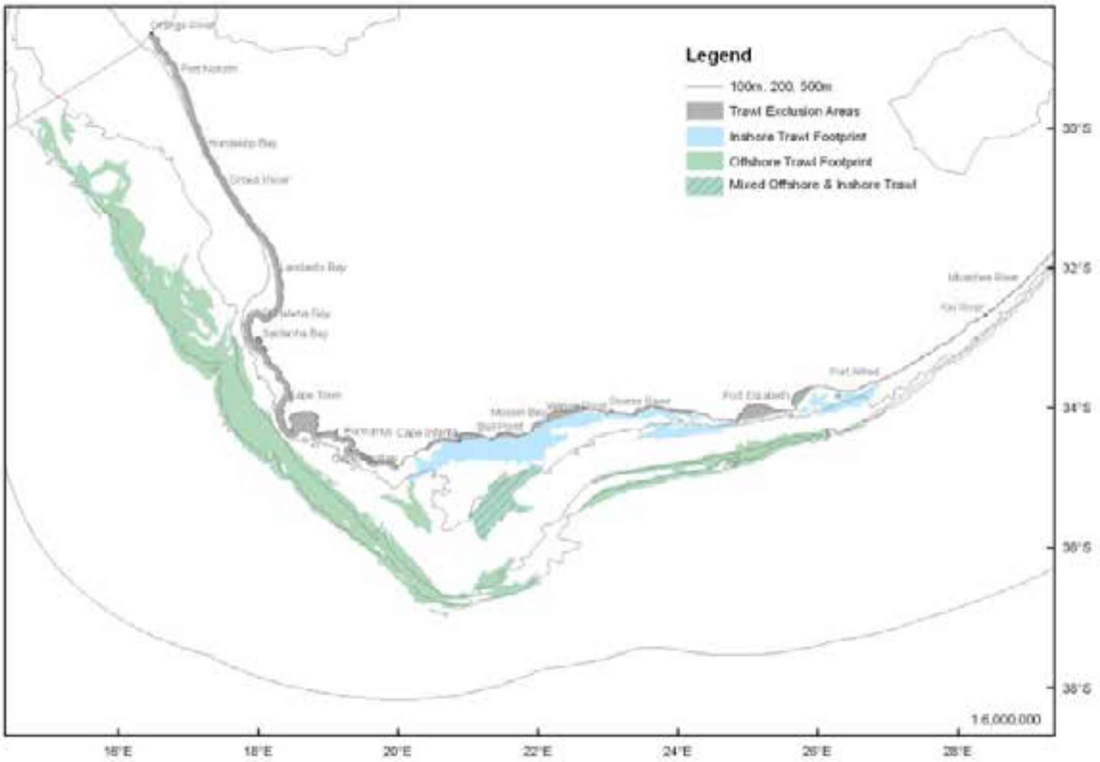
TABLE 8 South African commercial fishing sectors

Sector	Areas of operation	Main ports in priority
Tuna pole	West Coast, South Coast	Cape Town, Saldanha
Pelagic long-line	West Coast, South Coast, East Coast	Cape Town, Durban, Richards Bay, Port Elizabeth
Mid-water trawl	South Coast	Cape Town, Port Elizabeth
Small pelagics	West Coast, South Coast	St Helena Bay, Saldanha, Hout Bay, Gansbaai, Mossel Bay
Hake long-line	West Coast, South Coast	Cape Town, Saldanha, Mossel Bay, Port Elizabeth, Gansbaai
Hake hand-line	West Coast, South Coast	All ports, harbours and beaches around the coast
Traditional line fish	West Coast, South Coast, East Coast	All ports, harbours and beaches around the coast
Demersal shark long-line	South Coast	Cape Town, Hout Bay, Mossel Bay, Plettenberg Bay, Cape St Francis, Saldanha Bay, St Helena Bay, Gansbaai, Port Elizabeth
Hake deep-sea trawl	West Coast, South Coast	Cape Town, Saldanha, Mossel Bay, Port Elizabeth
Hake/ sole inshore trawl	South Coast	Cape Town, Saldanha, Mossel Bay
West coast rock lobster	West Coast	Hout Bay, Kalk Bay, St. Helena
South coast rock lobster	South Coast	Cape Town, Port Elizabeth
Crustacean trawl	East Coast	Durban, Richards Bay
Squid jig	South Coast	Port Elizabeth, Port St Francis

Source: Japp and Wilkinson (2015)

FIGURE 4

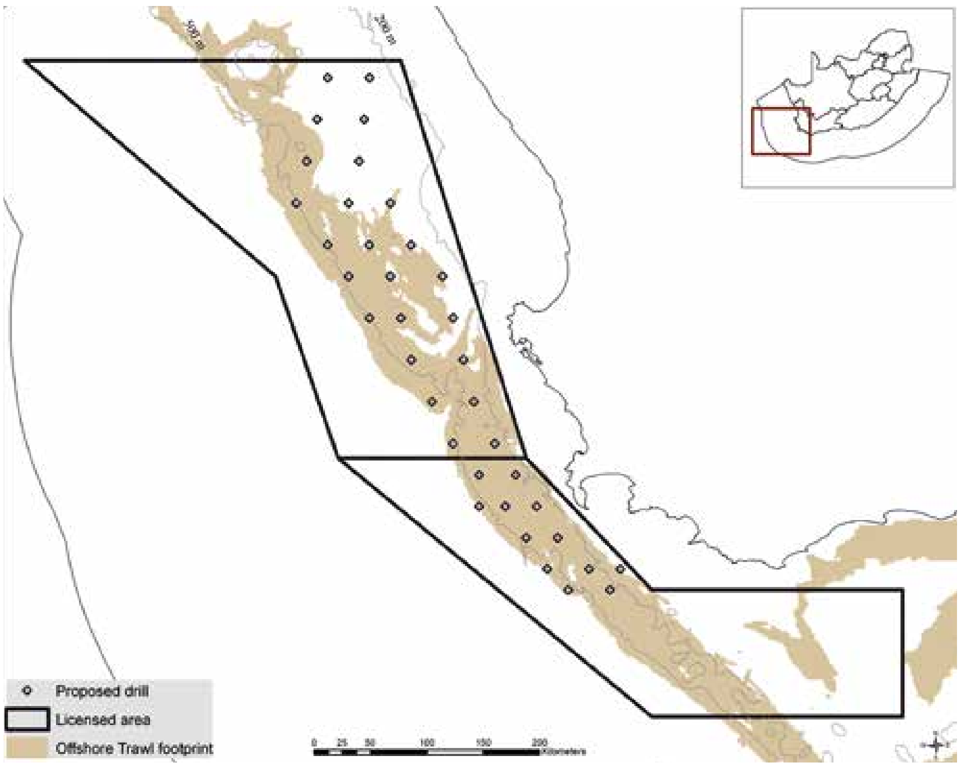
Trawl footprint of the South African hake trawl fishery



Source: Sink et al. (2012)
Note: mapped by Wilkinson and Japp (2008)

FIGURE 5

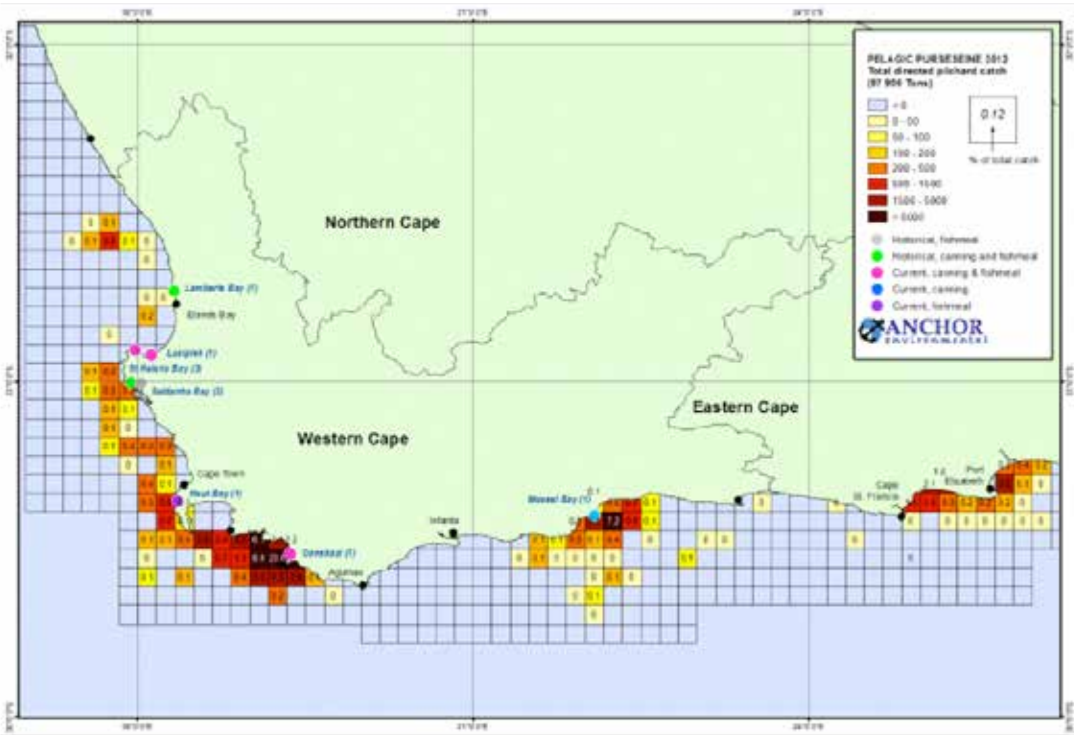
Commercial demersal trawl footprint overlaid by the GFT 251 and GFT 257 prospecting license areas



Source: Currie (2013)
Note: mapped by Wilkinson and Japp (2008)

FIGURE 6

Distribution of sardine catches in 2012 and the location of the current and historical processing factories



Source: Hutchings et al. (2015)

Value

The South African hake fishery is the most economically important fishing industry, accounting for between 45% (DAFF *personal communication*) (Table 4) and 50% (Cooper 2015) of the overall value of SA fisheries.

In terms of the value of the fishery, Peterson et al. (2010) value landed catch at about R2.5 billion in 2008. Estimates from DAFF indicate a wholesale value of R3.3 billion and R3.6 billion in 2012 and 2013, respectively (Table 4).

Lallemand et al. (2016) estimate the value of the domestic hake market and export market to be R915.3 million and R1.95 billion, respectively, with a total fishery value in 2012 of R2.871 billion (see Table 24 in Appendix D). In terms of the breakdown across sectors, the deep-sea trawl sector is estimated to account for 90.8% of this value, the inshore trawl sector for 2.5% and, finally, the longline and handline sectors together for 6.7%. Finally, the authors estimate that around 70% of the total catch is exported (leaving 30% for the domestic market).

Lallemand et al. (2016) note that the valuation of R2.871 billion in 2012 is a conservative estimate given that only 87.9% of the TAC was caught in that year (due to a short-term shortage of fleet capacity). In the following year, the entire TAC was caught. When repeating the valuation exercise for 2012 but assuming that 100% of the TAC was caught, the authors find the estimated value of the fishery to be in line with the 2012 value estimate from the Department of Agriculture, Fisheries and Forestry of R3.3 billion.

We replicate this market valuation using 2014 catch data from the 2015 Fishing Industry Handbook. For the 2014 exchange rate, we take an average of the daily R/$ rates over the period 1 Jan–31 Dec 2014.[18] For the price of fillet and non-fillet products as well as the split of domestic/export and fillet/not-fillet, we retain the assumptions of Lallemand et al.'s (2016) baseline valuation model (Table 24 in Appendix D). When incorporating the updated catch and exchange rate information, the value of the domestic industry is estimated to be R1.2 billion, the export market estimated at R2.6 billion and, finally, estimated turnover for the sector as a whole is calculated at R3.8 billion (Table 25 in Appendix D). This is consistent with the 2013 estimate provided by the Department of Agriculture, Fisheries and Forestry of R3.6 billion (DAFF personal communication) (Table 4).

Transformation and employment

Information on the South African Deep-Sea Trawling Industry Association website (SADSTIA 2016) indicates that the labour-intensive deep-sea trawling industry employs 6 653 people with a total wage bill of

TABLE 9 Annual catches of Cape hakes ('000 tons)

	Catch				Total catches	% Total trawl	% Offshore trawl
Year	Offshore trawl	Inshore trawl	Long-line	Handline			
1990	126	10	0	0	137	99	92
1991	129	8	3	1	141	97	91
1992	130	9	2	1	142	98	92
1993	132	9	0	0	141	100	94
1994	135	10	2	0	147	98	92
1995	128	11	2	1	141	98	91
1996	142	11	4	2	159	96	89
1997	133	9	4	1	148	96	90
1998	142	8	2	2	154	97	92
1999	119	9	7	3	137	93	87
2000	131	11	7	6	155	92	85
2001	134	12	6	7	159	92	84
2002	124	10	11	4	147	90	84
2003	130	10	12	3	155	91	84
2004	133	10	10	2	154	93	86
2005	125	8	11	1	144	92	87
2006	118	6	9	0	133	93	89
2007	126	6	8	0	141	94	89
2008	117	5	6	0	128	95	91
2009	96	6	7	0	109	93	88
2010	99	5	7	0	112	93	88
2011	109	6	8	0	123	93	88
2012	128	7	10	0	145	93	88

Source: Stats SA (2015)

R931 million per year. Note that these figures are broadly comparable with the DAFF (2012a) figures of 5 917 (employment) and R766 million (wage bill). Finally, the hake-trawl fishery is estimated to create 65 jobs for every thousand tons landed (SADSTIA 2016).

Lallemand (2014) notes that employees in the hake trawl industry are well paid relative to the rest of the industry with salaries ranging from R130 000 to R150 000 per year for a skilled worker (these figures are consistent with the information provided in Table 6 for hake trawl sectors).

As indicated by Table 6, the hake trawl sectors together account for 30% of total direct employment in the fishing industry. Lallemand et al. (2016) provide a larger estimate of 35%. More so, basic conditions of employment in the hake trawl industry are regulated via a Collective Agreement:

> *'Although most seafarers in South Africa do not enjoy, in law or practice, the provisions of the Basic Conditions of Employment Act of 1997, a unique labour relations framework has been established for seagoing workers in the deep-sea and inshore trawl fisheries… A Collective Agreement, which sets out basic conditions of employment for workers in these two fisheries… has been in effect since 2 May 2003. The basic conditions include set daily wages for each category of worker, set hours of work and regulated rest and leave periods. Workers who are permanently employed are also provided with pension/provident funds; life assurance; medical assistance; regular paid shore leave and annual holidays' (South African Deep-Sea Trawling Industry Association website).*

Lallemand (2014) conducts an analysis of employment in the hake deep-sea trawl industry using a combination of existing literature as well interviews conducted with representatives from the trawling sector. We provide a summary of this analysis (the employment estimates are replicated in Table 10). The author similarly assumes that approximately 65 jobs are created per 1000 ton of catch landed and, furthermore, that around 3 shore-based jobs are created for every 1 sea-based job. As evident from

TABLE 10 Employment numbers in the hake deep-sea trawl sector, 2012–2014

	%	2012	2013	2014
Effective Employment Tonnage for HDST		134 722	145 272	144 601
Overall Employment in '1000 FTE quota tons		65	65	65
Total Employment		**8 757**	**9 443**	**9 399**
Sea based	25	2 189	2 361	2 350
Shore based	75	6 568	7 082	7 049
Employment breakdown				
Admin and management	4	350	378	376
Marketing	2	175	189	188
Sea going	19	1 664	1 794	1 786
Shore based	25	2 189	2 361	2 350
Processing	50	4 378	4 721	4 700
Female	75% of processing	3 284	3 541	3 525

Source: Lallemand (2014)

Table 10, admin, management and marketing account for 6% of employment within the sector; processing accounts for around 50% of employment. Around 92% of employees are previously disadvantaged individuals and 75% of employees involved in processing are female. Not only are 97% of employees in permanent full-time employment, but all employees in the sector have fixed salaries with benefits; in addition, sea-going employees earn commission in addition to their regular salaries.

Exports

Cooper (2015) notes that about a third of the demersal trawl catch is processed and frozen in large factory ships at sea. Alternatively, hake can be landed fresh and sold as premium quality gutted head-on fresh fish or fresh fish fillets. Finally, the fish can be landed fresh and processed before freezing in large, land-based, capital-intensive processing plants – the outcome is value-added products such as crumbed fillets, fishcakes etc.

Cooper (2015) notes that hake export volumes have shifted from fresh to frozen products and, increasingly to value-added products. She estimates that, from 2005 to 2012, between 60 and 70% of the hake TAC has been exported. Furthermore, the domestic market takes around 30% of domestic catch in addition to imports (which are equivalent to another 15% of TAC)).

In this section, we estimate the value and volume of hake exports for the period 2012–2015 using trade data from the Department of Trade and Industry. Export products are classified according to the Harmonised System (HS) export codes. In terms of volume, the statistical unit of reporting is kg. Products are reported as netweight. Table 26 in Appendix E lists the HS codes and associated product description. For the product description, we have sourced information from the Department of Trade and Industry trade portal (www.thedti.gov.za) and the 2016 United States International Trade Commission Harmonized Tariff Schedule (USITC 2016). We have further cross-referenced this with the descriptions used by Lallemand (2014).[19]

The export volume and values are replicated in Table 11. The export volume for 2012 of 39 412 112 kg is comparable with the 2012 export volume of 37 001 769 kg reported by Lallemand (2014).

The value of non-fillet and fillet exports is calculated at R599 million and R1.2 billion in 2015, respectively. Overall, total exports are valued at R1.8 billion in 2015.

Lallemand (2014) indicates that South African hake is largely designated for European countries: in 2011, Southern European countries (including Italy, Portugal and Spain) accounted for 75% of total hake exports; in 2012, these same countries accounted for 65% of total exports (despite them maintaining their import volumes) as new markets in Australia (7.5% of exports in 2012), Northern Europe (15.7%) and the USA (2.2%) accounted for the balance. Lallemand (2014) notes that South Africa is expanding into new markets where hake is sold at higher prices in the form of value-added products.

> The deep-sea trawling industry employs 12 000 people and generates approximately R4 billion in revenue annually. It has operated sustainably for approximately 120 years, creating thousands of jobs, within the area where the prospecting rights have been granted and could continue to do so in perpetuity.
>
> *Johann Augustyn, Secretary, South African Deep-sea Trawling Industry Association*

As illustrated in Table 11, the volume of non-fillet product exports has decreased by 19% between 2012 and 2015 (down from 22 619 tons in 2012 to 18 221 tons in 2015). Conversely, the volume of filleted product exports has increased by 31% over the same period (increasing from 16 794 in 2012 to 22 003 tons in 2015). The volume of total hake exports increased from 39 412 tons in 2012 to 42 672 tons in 2014 and then declined to 40 225 tons in 2015.

3.1.3 *Small pelagic purse-seine*

The small pelagic fishery is the largest South African fishery by volume and the second most important in terms of value (Japp and Wilkinson 2015). The three main targeted species are sardine, anchovy and redeye round herring which together account for 90% of the total catch (DAFF 2014, Japp and Wilkinson 2015). The Department of Agriculture, Forestry and Fishing emphasizes the importance of the pelagic fishery to the economy for the following reasons: (i) the sector is the second most important in terms of value (second only to the hake fishery), (ii) pelagic fish are a high-quality source of protein: fish meal and oil are used as protein supplements in both agriculture and aquaculture, (iii) direct employment and employment in related industries is large and, finally, (iv) energy produced by plankton is transferred to large-bodied predatory fish, marine mammals and seabirds by pelagic fish (DAFF 2014).

Anchovy and round herring are processed into fishmeal and fish oil while the sardine catch is mostly canned (for human and pet consumption) with some packed whole for bait or filleted for human consumption (DAFF 2014, Japp and Wilkinson 2015). Canned sardines are consumed domestically and exported to regional southern African markets; likewise, frozen sardines are sold in both domestic and international markets (mostly to the East or Mauritius) (Hutchings et al. (2015).

The total combined catch of anchovy, sardine and round herring in 2012 was 485 000 t, an increase of over 60% from 2011 – largely due to a substantial increase in anchovy catch from 120 000 t in 2011 to over 300 000 t in 2012 (DAFF 2014) (Table 12). The combined catch for 2013 declined to just over 200 000 t (well below the long-term average annual catch of 335 000 t). This decline in the combined catch was driven by a large

TABLE 11 Export volumes and values of SA hake, 2012–2015

	2012		2013		2014		2015	
HS code	Volume (kg)	Value (R)	Volume (kg)	Value (R)	Volume (kg)	Value (R)	Volume (kg)	Value (R)
Fish, fresh or chilled (excluding fish fillets and other fish meat of heading 0304)								
H030254	7 589 278	156 240 818	4 888 869	123 089 680	4 063 155	115 926 003	2 749 974	86 132 880
H030259	225 071	6 347 924	39 728	1 409 205	32 384	501 908	3 608	210 251
	7 814 349	162 588 742	4 928 597	124 498 885	4 095 539	116 427 911	2 753 582	86 343 131
Fish, frozen (excluding fish fillets and other fish meat of heading 0304)								
H030366	12 245 585	280 158 541	12 927 706	337 866 115	14 047 325	426 415 405	14 541 789	488 641 050
H030369	2 558 598	28 875 992	880 624	13 897 243	1 086 675	24 222 854	925 909	24 337 138
	14 804 183	309 034 533	13 808 330	351 763 358	15 134 000	450 638 259	15 467 698	512 978 188
Non-fillet	22 618 532	471 623 275	18 736 927	476 262 243	19 229 539	567 066 170	18 221 280	599 321 319
Fish fillets and other fish meat (whether or not minced), fresh, chilled or frozen								
H030444	477 299	17 947 137	686 973	32 281 901	490 199	26 309 958	671 519	36 025 018
H030453	27 595	587 979	85	4 553	27	86 490	0	0
H030474	15 977 839	667 505 623	18 069 823	898 725 799	22 215 394	1 240 827 287	20 773 856	1 139 233 235
H030479	301 544	16 368 496	259 510	15 537 927	200 412	11 083 580	141 990	9 459 612
H030495	9 303	275 399	396 535	10 842 777	536 130	16 593 821	415 864	12 922 239
	16 793 580	702 684 634	19 412 926	957 392 957	23 442 162	1 294 901 136	22 003 229	1 197 640 104
Fillet	16 793 580	702 684 634	19 412 926	957 392 957	23 442 162	1 294 901 136	22 003 229	1 197 640 104
Total	**39 412 112**	**1 174 307 909**	**38 149 853**	**1 433 655 200**	**42 671 701**	**1 861 967 306**	**40 224 509**	**1 796 961 423**

Source: Department of Trade and Industry

TABLE 12 Sardine and anchovy catch and TAC

	2011	2012	2013
Combined catch	291 000 t	485 000 t	200 000 t
Sardine TAC	90 000 t	100 595 t	90 000 t
Sardine catch	–	98 000 t	–
Anchovy TAC	390 291 t	472 718 t	450 000 t
Anchovy catch	120 000 t	300 000 t	80 000 t

Sources: DAFF (2014) and Oceana Group Scientific Reports (Oceana 2013, 2014, 2015)

and unexpected reduction in anchovy catch to less than 80 000 t in 2013 (despite a TAC of 450 000 t).

The majority of the fleet of 101 vessels operate from St Helena Bay, Laaiplek, Saldanha Bay and Hout Bay with fewer vessels operating on the South Coast from the harbours of Gansbaai, Mossel Bay and Port Elizabeth (Table 8) (Japp and Wilkinson 2015). Figure 6 illustrates the distribution of sardine catches in 2012 and, as previously mentioned, the figure highlights that there are three main fishing grounds: west of Cape Agulhas, off Mossel Bay and off Cape St Francis (Port Elizabeth) (Hutchings et al. 2015). More than 50% of the 2012 catch was taken west of Cape Agulhas.

The majority of sardine catch is landed at Western Cape ports: in 2012: 63% of the sardine catch was landed at St Helena Bay (including Laaiplek), 15% in Mossel Bay and 11% was landed and processed at Eastern Cape ports (St Francis and Port Elizabeth) (Hutchings et al. 2015). Approximately 85% of the sardine catch is canned, whilst the remainder is frozen and packed in boxes for local and international bait markets (nearly all sardines caught by right's holders in the Eastern Cape are frozen and packed for the bait market) (Hutchings et al. 2015).

Valuation of the small pelagic fishery

Peterson et al. (2010) estimated the landed value of the sector to be 1.5 billion in 2008. In terms of more recent estimates, DAFF estimates the wholesale value of the sector to be around R1.6 billion in 2013, accounting for just over 20% of the overall value of SA fisheries (Table 4).

Hutchings et al. (2015) estimate the value of the s mall pelagic sector via interviews with 38 industry participants, including rights holders, vessel owners and processors. Their sample accounted for over 90% of the sardine TAC. In terms of processors, all six processors that produce canned sardines were surveyed (five of which also produce fishmeal and fish oil) as well as 11 processors that produce frozen sardines (only 12 were active in 2013). Very much in line with the 2013 DAFF valuation, the authors estimate the total wholesale value of processed small pelagic fish (canned and frozen sardines, fishmeal and fish oil) to be approximately R1.55 billion in 2013. We provide a brief summary of this valuation – for more information, the reader is referred to Hutchings et al. (2015):

Landed value

The landed catch price of small pelagic fish comprises the catching fee and a rights usage fee (Table 13). The vessel used to catch small pelagic fish is paid a catching fee by the processor per ton of sardine or industrial fish (used for fishmeal: anchovy, sardine bycatch and round herring). The catching fee is a function of the quality of the fish delivered as well as fluctuations in the international fishmeal price. Average catching fees in 2013 (derived from survey data collected by the authors) were R1 895 per ton of sardine and R1 289 per ton of industrial fish (Table 13). Average rights usage fees for 2013 were R1 961 per ton of sardine and R313 per ton of anchovy (round herring and other industrial fish as non-quota species have no rights usage fee and are valued at the catching fee for industrial fish). As such, the average 2013 landed catch values are R3 856 per ton of sardine and R1 602 per ton of anchovy.

The 2013 landed catch value of the current TAC of 90 000 tons of sardine is therefore R347 000 000. Industrial fish catches (of anchovy, sardine bycatch and round herring) over the last ten years have not matched the catch limits, but the average annual landed catch of industrial fish over the period 2003–2012 was 285 431 tons. Using the 2013 landed catch price, the 2013 landed catch value of industrial fish was R457 million. Finally, the total landed catch value in 2013 is estimated to be 804 million at the current minimum sardine TAC and the last decades' average annual industrial fish catches (Table 13).

Wholesale value

In terms of value added, sardines are delivered to the cannery where they are headed and gutted and packed into cans via an automated process. Thereafter, the fish in cans are precooked, sauced, sealed, steam autoclaved, labelled and packed in cartons. Sardine offal, which comprises on average 45% of the whole weight, is used for fishmeal. During processing, fish oil, a valuable by-product, is pressure extracted. The yield of canned sardine is around 55 cartons per ton of raw fish input, although this varies between processors and depends on the raw fish quality and size composition. The fishmeal yield is around 23% and the fish oil yield about 1.5% of the total volume of raw fish processed.

The production of frozen sardine products is also labour intensive: fish are hand graded and packed into 5 kg (and less frequently 1 kg) cardboard boxes. The fish are blast frozen as rapidly as possible and stored in holding freezers prior to dispatch.

TABLE 13 2013 total landed value of the small pelagic sector

Catching fees	R/t	Rights usage fees	R/t	2013 landed catch values	R/t
Sardine	1 895	Sardine	1 961	**Sardine**	**3 856**
Industrial fish	1 289	Industrial fish	313	**Anchovy**	**1 602**
Landed value:					
Sardines	R347 000 000				
Industrial fish	R457 000 000				
Total landed catch value in 2013:					
R804 000 000					

Source: Hutchings et al. (2015)

Notes:

- *Landed value of sardines calculated assuming a 90 000 t TAC*
- *Landed value of industrial fish calclated assuming average annual landed catch (2003–2012) of 285 431 t*

Using production and price data collected from canneries and frozen sardine and fishmeal processors, Hutchings et al. (2015) estimate that the six canneries produced around 4.5 million cartons of canned sardines, 33 000 tons of fishmeal and 1 960 tons of fish oil in 2013, with a combined wholesale value of R1.4 billion (Table 14). The eleven producers of frozen sardines produced 15 553 t of boxed sardines worth R149 million (Table 14).

As such, the total wholesale value of processed small pelagic fish (canned and frozen sardines, fishmeal and fish oil) is approximately 1.55 billion, thus adding about 50% to the estimated landed value.

Potential implications of reduced minimum sardine TAC of 75 000 t

Hutchings et al. (2015) consider the potential implications of a reduction in the sardine TAC to 75 000 t. Assuming that prices are determined externally and that the price of sardines does not increase, the authors estimate that the total landed value of sardines (at 2013 prices) will decrease from R347 million to R289 million (decrease of R58 million). While there would be a compensatory increase in industrial fish catch as processing capacity in factories is freed up, this would only generate around R2 million additional landed catch value resulting in a net loss of R56 million.

Export volumes and values

Table 27 in Appendix F lists the HS codes for sardine/pilchard, anchovy and herring exports. In addition to descriptions from the Department of Trade and Industry trade portal (www.thedti.gov.za) and the 2016 United States International Trade Commission Harmonized Tariff Schedule (USITC 2016), we also provide descriptions from the SARS Tariff Book (SARS. 2012). Table 15 [see over] provides the export data. In 2015, exports of pelagic-related products generated R684 million in export revenue.

3.2 Economy-wide modelling of the Fishery industry

When understanding the socio-economic contribution of one sector (in this case the fishery industry), it is useful to think about the entire economy as a dynamic circular flow diagram where all sectors are interlinked.

The circular flow of income in the economy can be understood as linkages between different economic players in a continuous cycle of transactions. In the production of goods and services, intermediate inputs are purchased from other sectors and factor payments are made to owners of land, labour, and capital. Final goods and services are purchased by households,

TABLE 14 2013 total wholesale value of the small pelagic sector

	Sardine cartons/t	Value (Rm)	Fishmeal (t)	Value (Rm)	Fish oil (t)	Value (Rm)	Other products (t)	Value (Rm)	**Total (Rm)**
Canneries	4 557 289	976	32 792	398	1 960	27	–	–	**1 401**
Pack and freeze	15 553	149	–	–	–	–	6 372	76	**149**

Source: Hutchings et al. (2015)

Notes:

- *Sardine production volumes and wholesale value provided by six canneries and 11 frozen sardine processors. Cannery volumes and values are for 2013. Pack and freeze volumes and values are a mix of 2012 and 2013 figures.*
- *Fishmeal production values are also provided by survey respondents and includes sardine inputs and industrial fish (anchovy and red eye).*

TABLE 15 Exports volumes and values of sardine, anchovy and herring export products

	Volume (kg)	Value (R)	Volume (kg)	Value (R)	Volume (kg)	Value (R)	Volume (kg)	Value (R)
	2012	2012	2013	2013	2014	2014	2015	2015
H0302: Fish, fresh or chilled (excluding fish fillets and other fish meat of heading 0304)								
H030241	41 198	790 756	98 039	5 384 507	30 076	2 436 954	91 170	11 623 132
H030242	2 234	47 506	967	26 630	1 647	26 468	6 167	131 998
H030243	176 890	1 441 311	185 164	1 779 984	9 364	187 239	11 298	278 404
H0303: Fish, frozen (excluding fish fillets and other fish meat of heading 0304)								
H030351	346	14 180	621	34 438	1 518 131	17 799 691	1 687 504	27 095 043
H030353	10 338 722	83 596 363	10 613 609	108 782 162	9 985 516	130 226 562	7 964 957	141 794 825
H0304: Fish fillets and other fish meat (whether or not minced), fresh, chilled or frozen								
H030449	2 817 219	63 415 572	1 113 553	29 155 569	708 280	23 661 274	282 576	9 763 372
H030459	172 405	3 132 203	128 018	3 248 799	83 954	2 804 541	74 512	3 315 674
H030489	342 303	20 723 834	459 486	28 224 732	441 238	26 806 583	553 364	30 256 551
H030499	1 538 396	92 004 307	780 883	37 916 712	1 915 163	31 449 930	1 619 152	48 586 920
H0305: Fish, dried, salted or in brine; smoked fish, whether or not cooked before or during the smoking process; flours, meals and pellets of fish, fit for human consumption								
H030539	43 493	623 278	17 244	606 066	12 182	368 522	14 538	2 060 257
H030549	876 417	41 916 768	641 538	36 388 942	931 327	47 702 913	688 677	38 212 397
H030559	237 543	24 953 370	269 669	19 443 022	159 827	15 140 749	100 107	14 855 977
H1604: Prepared or preserved fish; caviar and caviar substitutes prepared from fish eggs								
H160412: Herrings								
H16041210	1 086 511	2 228 232	239 829	2 157 376	25 232	933 899	8 680	361 698
H16041290	147 658	4 471 500	17 904	788 643	97 498	4 837 595	129 466	4 642 757
H160413: Sardines, sardenella and brisling or sprats								
H16041305	578 615	18 065 220	513 393	14 554 287	591 537	17 833 330	206 627	8 948 898
H16041310:	150 202	3 629 033	119 483	3 049 450	43 918	1 095 538	35 783	931 418
H16041312	46 912	1 635 797	42 694	843 195	11 884	678 691	280 603	9 107 445
H16041315	208 499	4 762 807	5 397	206 228	73 534	1 853 041	9 779	323 357
H16041317	4 348 146	80 268 639	5 071 612	125 361 769	6 527 179	166 394 515	4 937 593	147 521 982
H16041320	2 900 060	64 219 222	1 943 023	58 152 910	1 520 664	54 768 998	729 013	21 091 882
H16041380	24 535	248 474	39 686	523 700	35 484	1 054 379	7 138	307 494
H16041390	141 256	3 827 208	226 743	6 088 350	67 335	1 931 053	32 608	1 024 500
H160416: Anchovies								
H16041600	6 932	332 831	2 833	214 752	5 154	297 787	7 098	268 790
H160420: Other prepared or preserved fish								
H16042010	169 194	3 815 948	42 264	1 248 221	76 675	2 913 376	25 249	1 012 808

continued >

TABLE 15 Exports volumes and values of sardine, anchovy and herring export products

	Volume (kg)	Value (R)	Volume (kg)	Value (R)	Volume (kg)	Value (R)	Volume (kg)	Value (R)
	2012	2012	2013	2013	2014	2014	2015	2015
H16042020	175 468	3 847 262	47 421	1 248 970	39 908	1 210 212	31 696	1 321 877
H16042030	1 463	30 703	853	20 958	1 678	60 686	2 338	84 541
H16042035	199 894	4 794 453	178 207	6 069 103	430 251	12 128 677	470 756	15 829 265
H16042040	952 223	13 280 491	594 543	12 904 454	1 100 928	31 440 730	667 418	19 004 829
H16042080	2 174 942	108 027 417	2 228 373	130 716 923	1 436 761	113 612 688	1 656 038	90 586 294
H16042090	847 131	15 355 168	418 397	10 062 698	618 795	21 820 232	902 891	33 928 184
Total	**30 746 807**	**665 499 853**	**26 041 446**	**645 203 550**	**28 501 120**	**733 476 853**	**23 234 796**	**684 272 569**

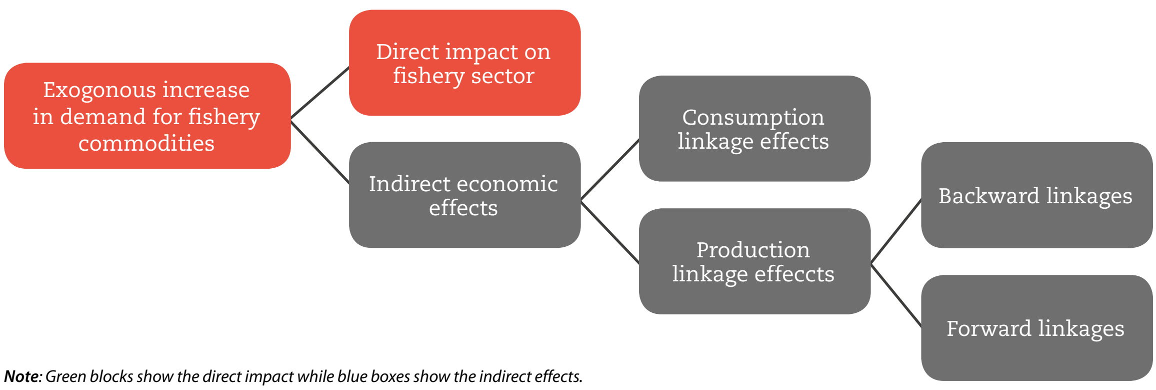
Source: Department of Trade and Industry

government, investors and foreigners and also by other sectors as part of their productive activity. By understanding the economy as circular flow, each expenditure by one agent in the economy is equally another agent's income. For example, households' expenditure on food commodities provide income for food producers; this income is in turn used to continue production which involves payments for other commodities as well as payments to labour and for capital. These payments then become the source for expenditure on other goods and services and so the cycle continues.

This analysis on economic linkages seeks to capture the indirect value of one sector on other related sectors in the economy. In the fishery sector we will see that there are other sectors that provide inputs that support the harvesting, processing and retail of fishery commodities. For example, fishermen need gear, bait, nets, vessels and a crew. All of these activities are paid for by sales made to fish produce buyers who are, in turn, also consumers (such as food manufacturers and wholesalers). These buyers also purchase other inputs, employ workers and maintain equipment which are paid for by sales to retailers and final consumers. The benefit of increased fishery output to sectors consuming fishery products (along the value chain) are termed forward production linkages, while the downstream businesses that benefit indirectly from sales in fish commodities, are called backward linkages in the production process. Consumption linkage effects capture the effect from household expenditure, i.e. the income earned by workers (shipping crew, processing factory workers, retailers etc.) is fed back into the economy through expenditure on consumer goods and services (see Figure 7).[20]

The Social Accounting Matrix (SAM) is an accounting framework which captures all income-expenditure flows in the economy.[21] It is a useful tool for understanding how sectors and economic agents are interlinked. Furthermore, multiplier analysis (see below) allows one to estimate the value from one activity once all possible linkage effects have been taken into consideration. The most recently available SAM for South Africa is for 2009 (Human Sciences Research Council (HSRC) & International Food Policy research Institute (IPFRI) 2014) and is publically available

FIGURE 7
Direct and indirect linkages in the economy



Note: *Green blocks show the direct impact while blue boxes show the indirect effects.*

on the IFPRI website (www.ipfri.org).[22] We use the SAM to firstly explore the basic linkages between the fishery sector and other sectors/agents in the economy, following this we report the results of the multiplier analysis which capture the round by round direct and indirect linkages associated with the fishery sector.

Basic data analysis

The SAM disaggregates the South African economy into 49 economic activities and 85 commodity groupings. The fishery industry is represented as one of these economic sectors and fisheries comprise one of the commodity groupings.

In 2009, the fishery sector contributed 0,4% to GDP where GDP is measured as value added in terms of factor income. For comparison purposes, the largest sectors in the economy by GDP were the government sector (15.7%), wholesale and retail trade (9.5%) and the service sectors (financial services (7.1%), real estate (6.3%) and other services (8.5%)). The primary sector as a whole contributed 12.1% to the economy and is dominated by mining (9.1%), followed by agriculture (2.5%), fisheries (0.4%) and forestry (0.1%).

The fishery sector is relatively capital-intensive with 80% of factor earnings accruing to capital (see Table 16). It is the most capital-intensive of all primary sectors – no doubt because of the vessels and equipment required. The majority of labour payments accrue to persons with a primary school level of education or less (8.4%).

TABLE 16 Fishery sector: factor payments

Factor	% share
Labour: Primary school or less	8.4
Labour: Completed middle school	4.5
Labour: Completed secondary school	5.5
Labour: Some tertiary education	1.7
Capital	79.9
GDP factor cost	**100.0**

Source: 2009 South African SAM

To get a sense of the linkages between the fishery sector and the rest of the economy, it is useful to identify the backward linkages associated with the fishery sector. These are the most important intermediate commodities that are purchased by the fishery sector. The main commodities that comprise around 20% of expenditure each are: basic chemicals (a category of products including plastics in primary forms and synthetic rubber products)[23], transport services and animal feeding commodities. Then comprising less than 10% of intermediate demand are commodities such as petroleum products (9%), agricultural products (3.5%), metal products (3,9%), health and social services (4.5%), pharmaceutical products (3.1%) and made-up textile articles (2.6%). As can be seen from Table 17, there are many more sectors that are linked to the fishery sector in smaller ways, with the 'other' category comprises another 24 commodities which contribute to – and receive payments from – the fishery sector.

TABLE 17 Percentage breakdown of expenditure by the fishery sector on intermediate demand commodities

Commodity	% of intermediate demand
Basic Chemicals	20.3
Transport services	18.9
Animal feeding	18.4
Petroleum products	9.0
Health, social services	4.5
Metal products	3.9
Agriculture and live animals	3.5
Pharmaceutical products	3.1
Made-up textile, articles	2.6
Electricity distribution	1.8
Insurance, pension	1.7
Motor vehicles, parts	1.6
Financial services	1.5
Other services n.e.c.	1.4
Metal ores and other minerals	1.3
Special machinery	0.9
Lifting equipment	0.7
Other	5.0
	100.0

Source: 2009 South African SAM

The 2009 SAM indicates that imported fishery commodities constitute only 1% of total demand for fishery products. This means that when it comes to supplying the domestic market South African fisheries do not face much competition from abroad.

63% of demand for fishery products comes from other domestic industries – of which the most important of these is the food industry (comprising 52% of domestic demand) and to a much lesser degree restaurants and hotels (2%), general manufacturing (2%) and 'other services' (6%). Households consume 18% of fishery products followed by the foreign market (17%). Fishery exports contribute 0.13% towards South Africa's total export earnings.

Table 18 shows that fishery products are consumed across all income groups with expenditure on fish products increasing as income increases. This most likely reflects the positive correlation between household income and the size of the food budget as well as the fact that there are a variety of fish products and higher

TABLE 18 Share of fishery consumption amongst South African households (income percentiles)

hhd-0	hhd-1	hhd-2	hhd-3	hhd-4	hhd-5	hhd-6	hhd-7	hhd-8	hhd-9	Total
1	3	4	4	4	7	10	8	18	41	**100%**

Source: 2009 South African SAM

income consumers would be able to afford more expensive varieties. On average, households spend 0.06% of their income on fishery products.

Multiplier analysis

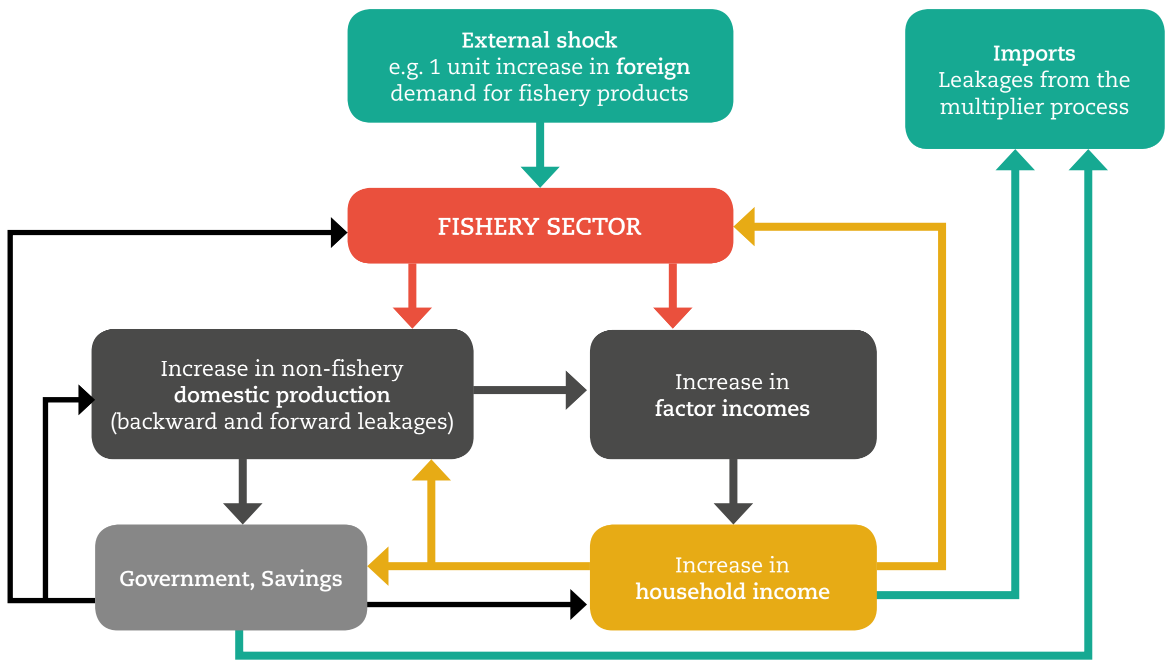
Multiplier analysis is a useful tool in capturing the total value to the domestic economy once all production linkages and consumption linkages in the economy have been accounted for. That is, we consider the total benefit to the economy – beyond the fishery sector – that arises from an exogenous increase in demand for fishery products. This is done through assessing the various backward and forward production linkages (expenditure by the fishery sector on intermediate goods and services and benefits to sectors that make use of fishery commodities) and forward consumption linkages (expenditure on other goods and services by final consumers). The multiplier analysis considers multiple rounds of economic activity: the first round constitutes the direct exogenous shock (a 1-unit increase in demand for fishery commodities), the second round captures payments to related sectors, these payments then ripple through the economy generating further impacts on interlinked sectors and so forth until the payments are small enough to be inconsequential.

This circular flow of income and payments is illustrated in Figure 8 which shows how an exogenous increase in demand from the foreign market for fishery products flows through the domestic economy.

While SAM multiplier analysis is effective at capturing the multiple linkages in the economy, there are a number of important assumptions imbedded in the modelling technique. Firstly, it assumes that prices in the economy are fixed and thus any change (increase or decrease) in demand will result in *output* changes rather than prices. This in turn assumes that resources are unlimited, that supply is perfectly elastic such that any increase in demand can be addressed through an increase in supply. Secondly, the model holds structural relationships constant meaning there is no allowance for behavioural change. Thus input coefficient patterns between sectors (e.g. purchases of intermediate goods), and between final users and their commodity purchases continue indefinitely.

In reality these are restrictive assumptions that only hold in specific circumstances such as in the case of small exogenous shocks and within a limited time horizon. As a result, multipliers typically *overestimate* the impact of linkage effects. In reality, supply is seldom

FIGURE 8
Circular flow of income in the multiplier process (model 1: where only the foreign sector is treated as exogenous)



infinite, natural resources such as fisheries and mineral deposits have natural limits that cannot be automatically increased in response to demand and the more common response to an increase in demand is an increase the commodities price. Furthermore, increasing production in one sector may involve a reallocation of resources from one activity to another. Another consideration is that final users may not necessarily spend 'new' money (i.e. money generated from payments received from an exogenous shock in demand) as they did before, thus historical patterns of consumption may not always be reliable forecasts of expenditure.

One way to compensate for the overestimation of the multiplier is by imposing limits on the flows of payments that *re-enter* the cyclical flow. By defining certain final users as 'exogenous' it indicates that while these agents still receive payments from the domestic economy, the payments do not re-enter the system and thus do not contribute to the multiplicative process. The payments to exogenous agents are thus considered leakages from the domestic economy and moderate the multiplier. In Figure 8 the only exogenous agent is the foreign sector and thus payment for imports are considered leakages from the domestic system while all other payments (e.g. wages to households, taxes to the government etc.) stay in the domestic economy and produce additional rounds of economic activity.

For the purpose of this study, we provide three models which select different components of final demand to be exogenous. Model 1 provides the largest multiplier where the only leakage from the domestic economy is to the foreign sector while all other payments to final consumers trickle-down back into the economy. Model 1 is thus our upper estimate on the multiplier contribution of the fishery sector.

Conversely, Model 3 presents a lower-bound estimate of the multiplier. In this model we set all final demand users as exogenous meaning that any income to households, government, etc. does not re-enter the domestic economy. Consequently, the multipliers in model 3 capture just the inter-sectoral linkages and are much smaller than the multipliers in model 1.

Model 2 presents an intermediate position where most categories of final demand are exogenous (i.e. the rest of the world, government, enterprises and investment accounts) but households are endogenous. This means that payments to households flow back into the economy while all other final demand components do not.[24]

The 'output multiplier' consists of the direct shock (set as a 1-unit increase in final demand for fishery commodities) as well as the indirect linkage effects. It captures the increase in total production across all sectors of the economy that stem from the exogenous shock in demand for fishery commodities. Model 1 (the most expansive model) provides an output multiplier of 8.6 indicating that for every R1 million increase in demand for fishery products an extra R7.5 million is generated in domestic production once all rounds of backward and forward linkages and considered. In model 2, where households are endogenous and contribute to successive rounds of economic activity, a more realistic multiplier of 2.6 is observed. Finally, the most constrained model (Model 3) (where all final users are exogenous) presents a much smaller multiplier of 1.5 which indicates that for every R1 million increase in exogenous demand for fishery products, an extra R500 000 is generated across the economy.

The 'GDP multiplier' reported in Table 19 illustrates the total increase in factor income payments to labour and capital and, like the output multiplier, reflect factor payments from both the fishery sector as well as all related industries. Similar to the discussion above, the GDP multiplier is largest in Model 1 and smallest in Model 3. Finally, the 'income multiplier' ranging

TABLE 19 Multiplier results

	Model 1 Upper limit	Model 2 Intermediate position	Model 3 Lower limit
Exogenous components of final demand	Foreign sector	Foreign sector Government Savings-Investment Enterprises	Foreign sector Government Savings-Investment Enterprises Households
Output multiplier	**8.6**	**2.6**	**1.5**
Direct shock	1.0	1.0	1.0
Indirect linkage effects	7.6	1.6	0.5
GDP multiplier	**3.9**	**1.3**	**0.9**
Income multiplier	**3.2**	**0.7**	**0.5**

Source: 2009 unconstrained South African SAM between 3.2 and 0.5 indicates the net effect on domestic household income as a result of the exogenous shock in demand for fishery commodities. It is smaller than the other multipliers due to various leakages such as to imports and taxes.

The economy-wide model illustrates that the value of the fishery sector to the South African economy extends beyond the fishery sector. The indirect output linkage effects to the rest of the economy, estimated between 0.5 and 7.6 (depending on the model's assumptions), imply that a direct boost to fishery industry has a cascading positive effect throughout the economy. Conversely, should the fishery industry suffer a decline this too would negatively ripple through the rest of the economy.

A study by the Bureau for Economic Research (BER) reported in a presentation by Lallemand et al. (2008: P14) provides an employment multiplier for the fishery sector of 10.7, meaning that an increase in fishery output of R1 million would be associated with an extra 10.7 jobs in the fishery sector and in the wider economy.[25] Similarly, a loss in fishery production would be associated with a decline in employment.

3.3 Small-scale fisheries in South Africa

Subsistence fishers, whose catch is predominantly eaten by their household, and small-scale commercial enterprises have in common their use of simple technology, labour intensive catch methods and low capital gear (Sowman 2006). Furthermore, the communities that are supported through these efforts generally have poor living standards. The main fishing methods are intertidal collection, beach and seine nets and line fishing. In the west coast communities, near shore harvesting from boats is also undertaken. In addition to fish, rock lobster, abalone and bait organisms are also harvested.

A 2000 DEAT study estimated the total value of subsistence fishing to be around R16 million with the vast majority from line fishing (Hara et al. 2008: 52). Line fishing is defined as being a 'low earning and labour intensive sector' (DAFF 2014: 25) and is important from a human livelihood perspective with 85% of subsistence fish harvests based on this fishing method.[26] Subsistence fisheries are a feature of coastal communities, where intertidal and shallow-water resources are an important source of food (DAFF 2013). In terms of the scale of subsistence and small-scale fishing, around 147 fishing communities and 29 000 individuals have been identified as genuine subsistence fishers with many more individuals being dependent on these fishermen (DAFF 2013). These communities were found to be poor with only half of the households having access to wage employment and most households being defined as food-insecure (spending between 66% and 89% of their income on food). While small-scale fisheries contribute less than 1% to South Africa's GDP, the importance of this sector is in its provision of employment and food security – particularly protein – to poor coastal communities (Isaacs and Hara 2015).

While South African legislation allows for subsistence fishing permits and the exclusive use of certain coastal zones by subsistence fishers (Hara et al. 2008), there is a general lack of clarity in the law and the lack of uptake in permits results in many subsistence fishing activities being classified as illegal (Hara et al. 2008). The allocation of limited commercial fishing rights to hundreds of small scale fishing enterprises has impacted positively on these fishermen's socio-economic circumstances, with reports that 18.6% of the TAC for west coast rock lobster and 29% of the abalone TAC were allocated to the limited commercial sector (DEAT 2004 cited in Sowman 2006:67).

In contrast to subsistence and small scale commercial fishing enterprises, recreational fishing is a sport/leisure activity. It is estimated that between 700 000 (Baust et al. 2015:141) and 1 million (Hara et al. 2008:29) people are involved in recreational angling activities in South Africa. The main species targeted are line fish and west coast rock lobster. By definition, fish caught from recreational fishing cannot be sold, bartered or traded. In the sport, anglers usually engage in catch-and-release practices. The majority of recreational fishers are shore-based anglers but other methods engaged in are estuarine anglers, boat based anglers and spear fishers. Legally, recreational fishers require a permit. Catch is limited to bags per day, fishing is only allowed at specified times of the year and certain areas are closed during the year to support the growth of fish stocks (Hara et al. 2008).

In considering the value of the recreational fishing sector by catch Baust et al. (215:143) estimate the value in weight to be on average less than 1% that of the commercial sector. Leibold & van Zyl (2008: 4) look at expenditure by recreational fishers (e.g. on equipment, transport, accommodation etc.) and estimate expenditure effects at R15.9 billion. However, this figure includes freshwater in addition to marine recreational activities

Aquaculture refers to the farming (breeding, rearing and harvesting) of fish species, with mariculture a subcategory referring specifically to such activities that take place in salt water. In South Africa, the mariculture component of aquaculture comprises around 48% of volume and 95% of value (Hara et al. 2008: 47) and in 2006 the industry employed 810 people (Hara et al. 2008). Aquaculture is currently considered an underdeveloped sector in the South African fishing industry and projections are that it could grow from 3 543 tons (R218 million) to more than 90 000 tons (R2.4 billion) over the next 10 to 20 years

(WESGRO 2014: 3). As such, under the Government's Operation Phakisa, Aquaculture is targeted as a key growth area for the ocean economy. The focus of aquaculture is on high value species such as abalone, mussels and oysters. The Western Cape is the main province involved in aquaculture both in terms of number of farms and production. The value of aquaculture is estimated by DAFF to be R504 million in 2013 (DAFF *personal communication*).

The small scale fishing sectors whether commercial or subsistence are important beneficiaries of marine resources. Given that these groups operate mainly close to shore[27] there is less direct overlap with marine phosphate prospecting regions, compared with the demersal trawl sector for example. However, the oceanic environment is fluid and complex and adverse impacts on the water quality in one area (e.g. increased turbidity from mining operations) can have a far reaching geographical extent. Similarly, while the location of the catch for small scale fisheries may be closer to shore, fish (and their food sources) are mobile and move around the ocean during different life cycle stages. Accordingly, there could be indirect effects to the extent that the mining activities disrupt breeding grounds, or otherwise disrupt food chains that impact nearshore resources. There is thus concern by small-scale and aquaculture groups that an adverse impact on the integrity of marine ecosystems caused by bulk marine sediment mining would impact their catch.

3.4 Other marine users

Non-consumptive users

Tourism and recreational activities are non-consumptive uses of marine resources. Besides the significant coastal tourist industry there are a variety of ways the offshore marine environment lends itself to tourism: from deep sea diving to boat-based activities. Whale watching (land-based or from on-board a vessel) is centred around Hermanus on the southern coast and is estimated to generate R45 million in tourism expenditure (DEAT study reported in Hara et al. (2008:58).[28] In recent years, shark diving has also developed a presence in the marine tourism space.[29]

South African ports receive a variety of shipping vessels (including bulk carriers, container vessels, cargo vessels, tankers, cruise ships and a number of several smaller vessel types). There is a range of legislation regarding safety distances between vessels and to the cost as well as to certain landmarks such as the Mossgas production platform (Atkinson & Sink 2008). While 'non-extractive', shipping vessels impact on the environment particularly when accidents occur as well through the dumping of waste material.

An increase in fishery output of R1 million would be associated with an extra 10.7 jobs in the fishery sector and in the wider economy. Similarly, a loss in fishery production would be associated with a decline in employment.

There are a number of undersea cables in South Africa's EEZ that are laid on the seabed (Atkinson & Sink 2008). While the economic benefits of submarine cables are difficult to quantify, the communication links these networks provide are critical to any modern economy (see Atkinson & Sink (2008) for more information). Conflicts can arise when other vessels (shipping or fishing) inadvertently damage cables with their anchors or other equipment. Anchoring and trawling are prohibited within one nautical mile of these.

The South African Navy uses the marine environment for various practices testing of weapons (Atkinson & Sink 2008). While there are reports of conflict between some fishing sectors and concern around the impact on some marine protected areas, the impact is generally considered small scale and local.

Scientific research in southern African waters has grown over the years and there are a several scientific research cruises taking place each year. There are no serious concerns of impacts on biodiversity nor conflicts with other marine industries.

Extractive users

Offshore exploration of oil and gas in South African waters has been going on for several decades with over 300 wells drilled for exploration (Atkinson & Sink 2008:3), and the majority of South Africa's EEZ is subject to some form of right or lease for exploration or production (Petroleum Agency SA 2016). Several oil and gas wells have been drilled on the Agulhas bank (Oribi/Orynx, Sable oil fields and F-A gas field & satellites (Petroleum Agency SA 2016)) and on the west coast feasibility studies have being undertaken for the extraction of oil and gas from the Ibhubesi Gas. As of 2008, offshore oil and gas extraction provided approximately 7% of South Africa's oil requirement (Atkinson & Sink 2008: 5). The conflict between the petroleum and gas drilling operations with fishing activities is similar to the discussion in section 2.2, with Atkinson & Sink (2008) highlighting the loss of fishing grounds due to exclusion zones and interference with fishing equipment from drilling infrastructure and regarding abandoned or lost equipment left on the sea floor (and vice versa). The exploration process involves seismic studies which have the potential to interfere with the behaviour of sea animals. The drilling process causes the destruction of benthic substrates and dispersion of sediments, and excess sediments, from the drilling is further discharged from the surface vessel (Atkinson & Sink 2008:6). While information on the impacts on the environment and the fishery industry are limited and variable based on particular environmental conditions, most studies show that 'drilling impacts are relatively localised' (Atkinson & Sink 2008:7).

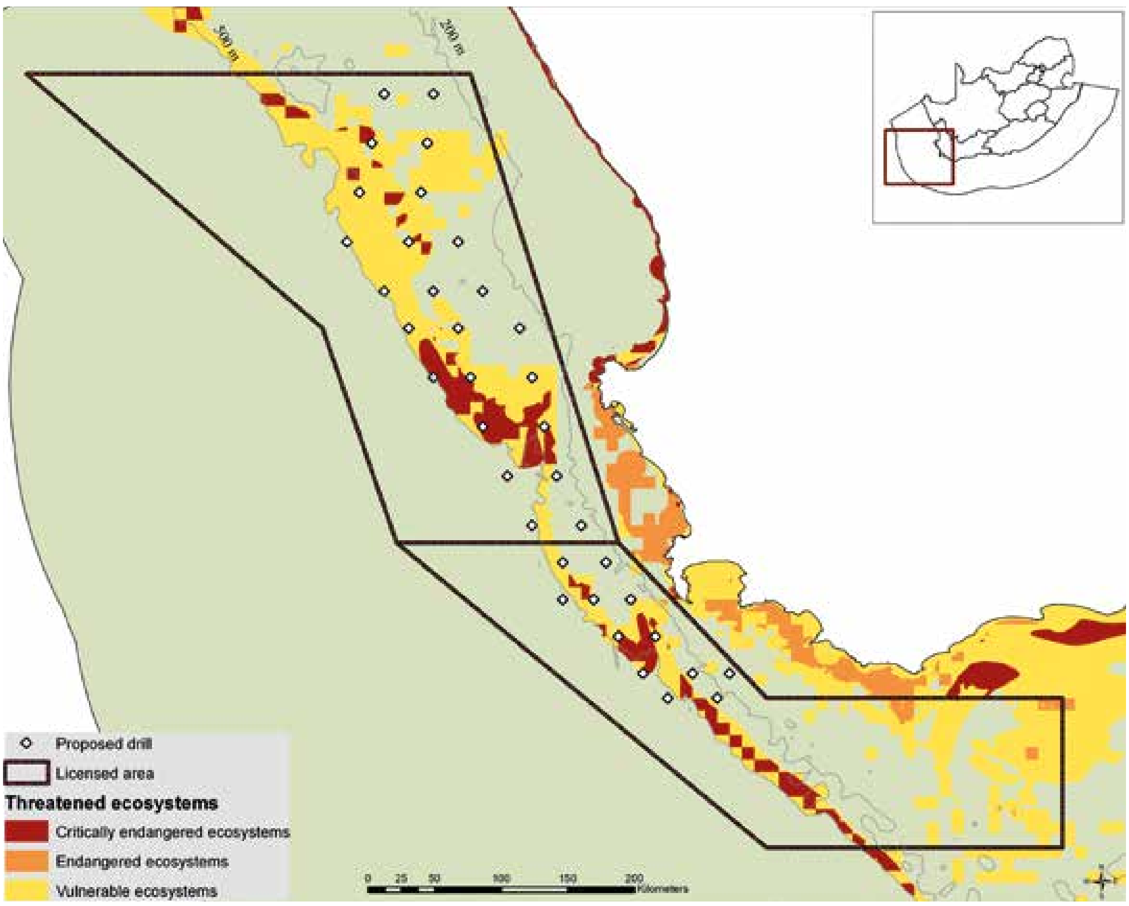
Marine diamond mining has been occurring off the west coast of South Africa since the 1960s (Atkinson & Sink 2008). In the 1990s an environmental impact assessment (EIA) was conducted and concluded that the impacts were 'not of sufficient significance to preclude continuation of mining' (Roos (2005) in Atkinson & Sink (2008:12)), due in part to the localised nature of many of the impacts. Adverse environmental impacts were associated with the disturbance of sediment from the sea bed at the point of drilling and then from the re-lease of excess material at the sea surface (for more information regarding these impacts see Atkinson & Sink (2008:12–13)). There is little conflict between the demersal trawl fishery sector and mining operations as there is no direct area overlap between the mining and fishing grounds. There is some concern relating to the impact on the rock lobster industry.

Various exploratory surveys and prospecting expeditions have been conducted for other mineral deposits including heavy metals (off the coast of Kwa Zulu Natal) and Manganese (off the west and south coasts of South Africa). The conclusions from these initiatives was that the expense of the deep sea mining operation was not economically viable given current circumstance. For more information, see Atkinson & Sink (2008:14).

3.5 Ecosystem value

South Africa is a signatory to the Reykjavik Declaration (Currie 2013:11), which prescribes an Ecosystem Approach to Fisheries management. Such an approach recognises the importance of maintaining a healthy ecosystem for the sustainable management of the fishery industry. While not of direct economic value, the surrounding marine ecosystem - from the benthic habitat and water quality to food sources for fish - plays a critical indirect

FIGURE 9
Map illustrating the ecosystem threat status for benthic habitats overlaid by the GFT 251 and 257 prospecting licence areas.



Source: Currie (2013:10)

role in supporting the viability of fishing resources. While a full eco-system analysis related to the fishing industry is beyond the scope of this study, it is important to highlight the interconnected roles of habitat and food sources with respect to all stages of the fishery lifecycle. The deterioration of the supportive ecosystem has the potential for far reaching consequences. In Figure 9, Currie (2013) draws attention to status of benthic ecosytems, particularly as they relate to the Greenflash Trading prospecting areas. As can be seen, there are a range of vulnerable and critically endangered ecosystems that fall within this area.

3.6 Option value

Two other abstract values are worth mentioning – even though assigning an economic or monetary value to them is near impossible. The first is the 'option value' associated with preserving a natural resource for the use of future generations. It implies that there may be value (economic, health, cosmetic etc.) associated with a resource that is as yet unknown and, if the resource is lost or destroyed, this potential value would not be realised. On the one hand the potential benefits could come from the benthic habitat and species that rely on this ecosystem that face destruction or severe deterioration as a direct consequence of bulk marine sediment mining. On the other hand, there could be as yet unknown value in the mineral deposits on the seabed such as with the Rare Earth Elements (World Bank, 2016: 17).

The second is the 'existence value', which speaks to the value derived from the knowledge that a particular environment or species exists (even if no direct or indirect benefit is received from it). Such a value could be considered in this case if there were unique ecosystems or biodiversity regions that would be severely impacted by the proposed mining.

ENDNOTES

14 To these can be added the illegal exports of Abalone and Rock Lobster. While locally important, no verifiable estimates are available.

15 Note that aquaculture (not mentioned here) is included in this valuation and accounts for 6.3% of the total value of the fishing industry. Thus, the five sectors mentioned here and aquaculture account for 85.3% of the total value.

16 In addition, environmental benefits directly linked to the MSC certification include a significant reduction in seabird mortalities from the introduction of bird-scaring lines and the charting of trawl grounds to ring-fence historically intensively trawled areas so as to prevent damage to lightly trawled areas (Marine Stewardship Council 2014).

17 This information is similarly confirmed in Table 23 in Appendix C (FAO 2010).

18 Sourced from the South African Reserve Bank: https://www.resbank.co.za/Research/Rates/Pages/SelectedHistoricalExchangeAndInterestRates.aspx.

19 Note that Cooper (2015) finds discrepancies between South African export data and the corresponding import data of importing countries – indicating that either exports are under-reported or export/import codes do not coincide.

20 Note that SAM multipliers tend to be larger than traditional input-output multipliers because they capture production as well as consumption/income linkages.

21 The SAM is an extension of the input-output model.

22 For more information on how the South African SAM is constructed and primary data inputs see Davies & Thurlow (2013).

23 The SAM (2009) database groups three 'basic chemical' products together including (i) fertilizers and pesticides, (ii) plastics in primary forms and (iii) synthetic rubber. For more information, see The Central Product Classification CPC Version 1.1 (2002), groups 346, 347 and 348. Unfortunately, the data cannot be disaggregated any further but it is most likely that the input gear used by the fishery industry is supplied by the plastics and synthetic rubber industry.

24 The multiplier values from model 3 are most similar to fishery output multiplier values from international studies which range from 1.45–1.92 (see Kruse et al. 2011:P8 for a brief summary of fishery multiplier values).

25 Unfortunately, we could not ascertain the assumptions of their model.

26 The total value of line fishery in South Africa was estimated to be in excess of R2.2 billion per annum (DAFF 2014:25) and is employed by commercial, recreational and subsistence fishers.

27 And in the case of aquaculture: often inshore.

28 Chalmers et al. (2009) estimate the direct value of boat based whale watching along the Garden Route Coast at R15 million.

29 In the Namibian Final Scoping Report on the terrestrial component of the mining operation, several possible impacts on tourism were listed for further consideration (Enviro Dynamics cc 2012). However, as there is no information regarding the land-based features of the South Africa operation, further analysis would have to wait until more information is provided.

4/

KEY CONCERNS FOR THE FISHING INDUSTRY

The key concerns for the fishing industry with respect to marine phosphate mining are as follows:

The overlap between fishing grounds and prospecting areas

As discussed in Section 3.1.1, given that South Africa's major fishing grounds are situated along the west and south coasts, there is some overlap between the commercial fishing footprint and the prospecting areas. As previously discussed, Figure 5 indicates that the license areas and proposed drill sites coincide with a large share of the offshore trawl footprint and Figure 6 suggests at least some overlap between the prospecting areas and the small-pelagic footprint west of Cape Agulhas. Given this overlap, a direct impact on fishing activity is likely to stem from exclusion zones around the mining area (which translates into loss of fishing grounds).

Figure 10 overlays the annual demersal-trawl catch per block for the period 2000–2014 and the proposed mining sites. The catch data is plotted using the co-ordinates for the centre of each block. The figure confirms that there is substantial overlap between historical trawl activity and the proposed mining sites.

Table 20 tabulates this information. The variables reflected in Table 20 are as follows:

- *Total Catch (t)*: The total catch in tons per year (across all blocks)
- *GFT 251 Catch (t)*: total catch in tons that falls inside the Green Flash Trading 251 prospecting area
- *GFT 257 Catch (t)*: total catch in tons that falls inside the Green Flash Trading 257 prospecting area

- *DF Int. Catch (t)*: total catch in tons that falls inside the Diamond Fields International prospecting area
- *% GFT 251*: The percent of the total catch that falls inside the Green Flash Trading 251 prospecting area
- *% GFT 257*: The percent of the total catch that falls inside the Green Flash Trading 257 prospecting area
- *% DF Int.*: The percent of the total catch that falls inside the Diamond Fields International prospecting area

Given that the catch data was plotted using the co-ordinates for the centre of each block, when calculating the proportion of catches that fell within each mining area, a search distance of 10 km was used (i.e. the catch was included if it fell within 10km outside of the block). Furthermore, given the overlap between the Green Flash Trading 257 and Diamond Fields International prospecting sites, to avoid double counting of demersal-trawl catch, any catch that fell within both these areas was only incorporated into the total catch for Green Flash Trading 257 (*GFT 257 Catch (t)*).

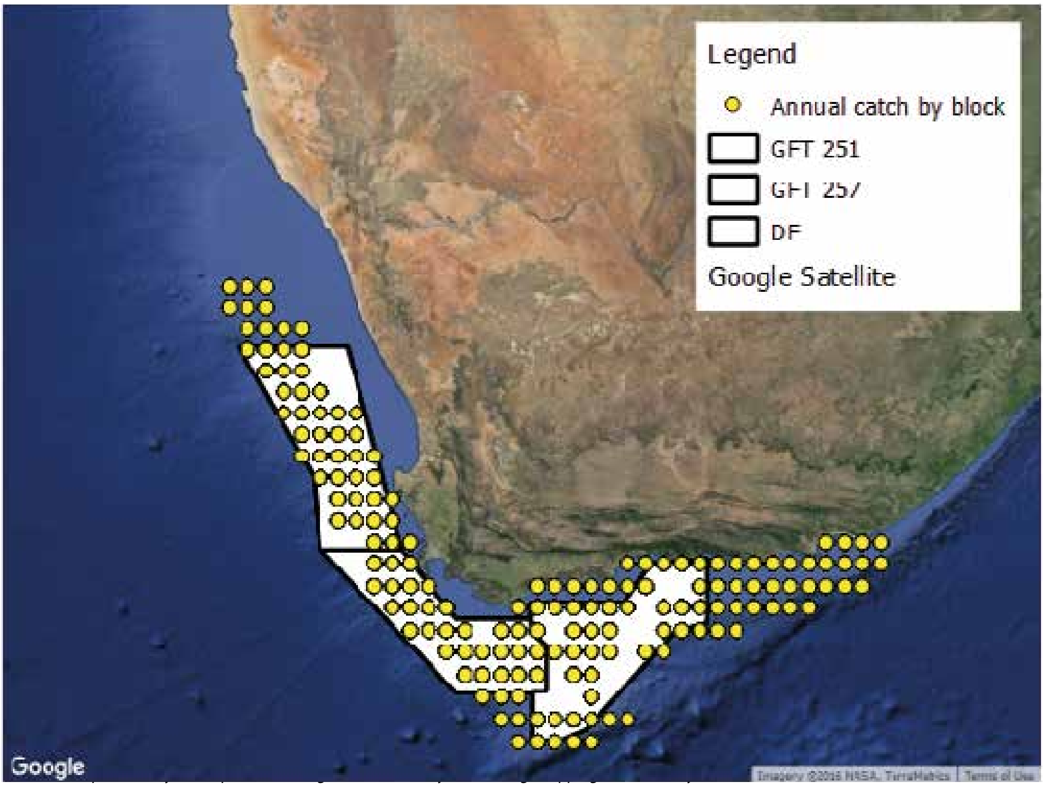
As evident from Table 20, between 2000 and 2014, on average, 77% of the demersal-trawl catch has fallen within one of the prospecting areas (although the proportion for 2014 is lower at 65%).

Figure 11 overlays the annual small-pelagic catch per block for the period 2010–2015 with the proposed mining sites. Once again, the catch data is plotted using the co-ordinates for the centre of each block and a search distance of 5 km was used.[30] As before, to avoid double counting of small-pelagic catch, any catch that fell within the overlap section was only incorporated into the total catch for Green Flash Trading 257 (*GFT 257 Catch (t)*). Table 21 tabulates this information using the now familiar catch variables. As evident from the table, between 2010 and 2015, on average, 10% of the pelagic catch has fallen within one of the proposed mining sites (with the proportions for 2014 and 2015 being 6% and 5%, respectively).

This discussion has highlighted the overlap between the points of catch from the most commercially important fisheries and the prospecting areas. In the case of

FIGURE 10

Distribution of annual demersal-trawl catches and proposed mining sites for the period 2000–2014



Notes:

- *Catch data is for the period 2000–2014*
- *Data provided for the following species: hake, Agulhas sole, monk and kingklip*

TABLE 20 Total annual demersal-trawl catch and catch per mining area

(1) Year	(2) Total Catch (t)	(3) GFT 251 Catch (t)	(4) GFT 257 Catch (t)	(5) DF Int. Catch (t)	(6) GFT 251 %	(7) GFT 257 %	(8) DF Int. %	(9) Total %
2000	122 762	43 209	46 350	12 417	0.35	0.38	0.10	0.83
2001	124 314	40 448	54 085	9 564	0.33	0.44	0.08	0.84
2002	115 753	39 646	43 157	12 192	0.34	0.37	0.11	0.82
2003	135 376	42 658	48 100	16 576	0.32	0.36	0.12	0.79
2004	137 771	40 860	39 668	19 231	0.30	0.29	0.14	0.72
2005	132 716	46 540	41 080	14 068	0.35	0.31	0.11	0.77
2006	127 414	36 126	45 634	14 484	0.28	0.36	0.11	0.76
2007	137 036	44 648	54 933	14 391	0.33	0.40	0.11	0.83
2008	118 999	34 121	49 862	8 068	0.29	0.42	0.07	0.77
2009	104 974	24 465	50 690	6 847	0.23	0.48	0.07	0.78
2010	111 950	37 310	40 340	7 692	0.33	0.36	0.07	0.76
2011	129 400	29 331	5 9699	8 274	0.23	0.46	0.06	0.75
2012	125 568	30 229	55 760	11 305	0.24	0.44	0.09	0.77
2013	125 768	32 176	48 690	8 182	0.26	0.39	0.07	0.71
2014	124 197	21 762	50 662	8 674	0.18	0.41	0.07	0.65

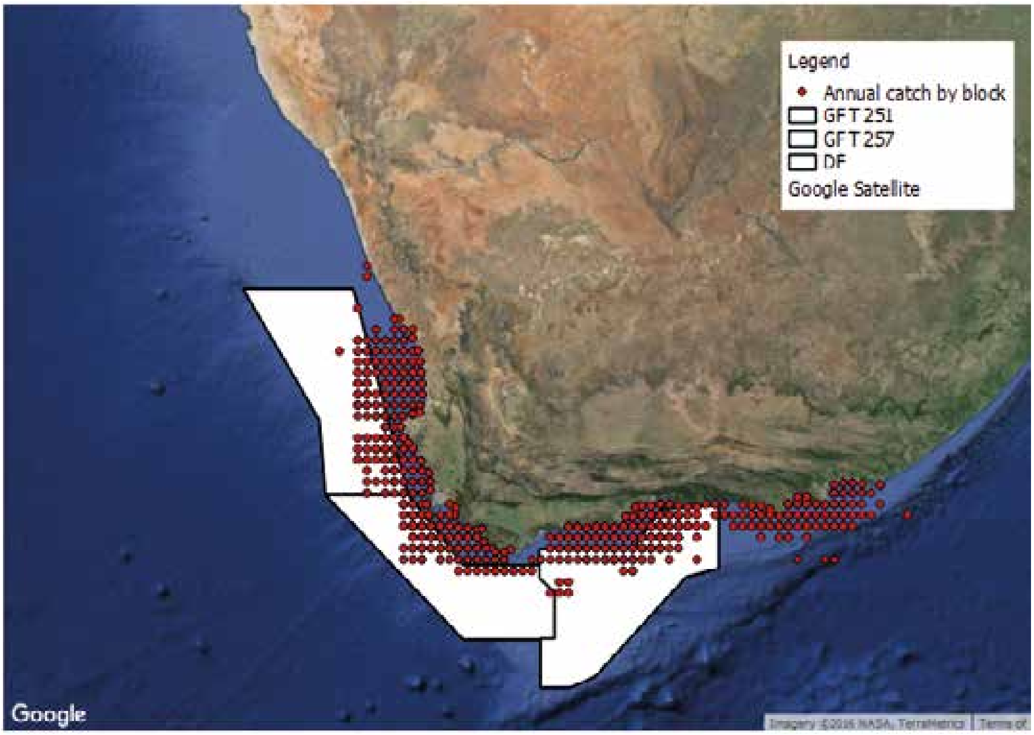
Source: Data provided by the Department of Agriculture, Forestry and Fishing

Notes:

- *Demersal trawl fishing sector*
- *Data provided for the following species: hake, Agulhas sole, monk and kingklip*

FIGURE 11

Distribution of annual small-pelagic catches and proposed mining sites for the period 2010–2015



Source: Data provided by the Department of Agriculture, Forestry and Fishing, Mapping conducted by UCT GIS Lab

Notes:

- *Catch data is for the period 2010–2015*
- *Data provided for the following species: anchovy, bycatch sardine, directed sardine, horse mackerel, round herring and chub mackerel*

TABLE 21 Total annual small-pelagic catch (t) and annual catch (t) per mining area

Year	Total Catch (t)	GFT 251 Catch (t)	GFT 257 Catch (t)	DF Int. Catch (t)	GFT 251 %	GFT 257 %	DF Int. %	Total %
2010	422 928	29 047	26 167	11 480	0.07	0.06	0.03	0.16
2011	307 883	10 758	19 029	9 359	0.03	0.06	0.03	0.13
2012	487 277	7 041	19 158	628	0.01	0.04	0.00	0.06
2013	202 486	7 489	15 506	3 784	0.04	0.08	0.02	0.13
2014	374 962	969	11 875	7 883	0.00	0.03	0.02	0.06
2015	349 700	2 168	11 978	4 709	0.01	0.03	0.01	0.05

Source: Data provided by the Department of Agriculture, Forestry and Fishing

Notes:

- *Catch data is for the small-pelagic sector*
- *Data provided for the following species: anchovy, bycatch sardine, directed sardine, horse mackerel, round herring and chub mackerel*

demersal trawl, this overlap is substantial with an average 77% of harvests being caught in the prospecting zones.

The deterioration in the water quality from the bulk marine sediment mining operations (see section 2.2)

Firstly, there is concern that the deteriorated water quality will have adverse effects on fish stock due to the breakdown in linkages in the ecosystem that provide spawning and breeding grounds as well as food sources for the harvested fish species. While these effects could be far reaching, the quantification of this impact is unknown.

Secondly, there is concern that deteriorated water quality will increase toxicity levels in the fish – and ultimately negatively impact both exports and MSC certification.

With respect to potentially detrimental effects on exports, should the level of toxicity be in breach of EU legislation regulating the levels of contaminants in food, the commercial fishing industry would be directly impacted given the large share of hake exports destined for EU markets. As evident from Table 22, in 2012, around 81% of hake exports were designated for European markets (Lallemand et al. 2014).

With respect to MSC certification, Lallemand (2016) calculates the loss to the hake fishing industry in the event of loss of MSC certification. The losses estimated from the author's three most conservative scenarios range between R812 million (28% of the 2012 value of R2.871 billion) to R860 million (54%). This loss is caused by declining export prices amid the loss of the MSC-associated price premium, shifting of exports away from premium markets which demand MSC certified products (Australia, the US and Northern Europe) to Southern Europe and a shift in product type from value-added fillets to non-fillet products (Table 22) (Lallemand 2016, Lallemand et al. 2014).

There is concern that the deteriorated water quality will have adverse effects on fish stock due to the breakdown in linkages in the ecosystem that provide spawning and breeding grounds as well as food sources for the harvested fish species.

ENDNOTES

30 The demersal grid is double the size of the small-pelagic grid.

TABLE 22 Export markets and product mix of South African hake in 2012

	Southern Europe	Northern Europe	USA	Australia	Rest of the world
% of SA hake exports	65.4%	15.7%	2.2%	7.5%	9.1%
Product mix as					
% Fillet	44.8%	90.2%	84.5%	96.9%	30.1%
% Non-fillet	55.2%	9.8%	15.5%	3.1%	69.9%

Source: Lallemand (2016) and Lallemand et al. (2014)

Notes:

- *Total exports in 2012 estimated by Lallemand et al. (2014) at 37 002 t*

5/ ADDRESSING UNCERTAINTY

Any assessment of the potential benefits of marine phosphate mining as well as the impact on fisheries is clouded by uncertainty.

A number of factors contribute to uncertainty around the benefits and viability of bulk marine sediment mining. Firstly, as the price of phosphate is determined on the global market, the domestic industry will be subject to the prevailing international price and exchange rate. Secondly, the profitability of the operation will depend on the quality of minerals found as well as the costs of extraction, transport and processing. Thirdly, there is no indication as yet of the number of jobs likely to be created as well as the nature of this employment (for example: permanent versus temporary, local versus foreign skills), the links to other domestic industries and the distribution of the benefit for South Africa (through taxes and royalties).

For the fishing sector there are likewise many unknowns: if fish populations decline, will the decline be short-term and localised at the point of drilling or permanent and far reaching? Will fish populations recover once the mining activity moves on or could long-term sustainable yields fall given the removal of the benthic layer? These unknowns are further magnified by uncertainty around the dredging of the seabed: for example, if the seabed were to be mined in narrow strips could it recover quicker than if it were dredged in wide swathes? While the likely impacts on the marine environment caused by marine phosphate mining can be identified (section 2.2), how they will translate into impacts for the fishery sector is a critical area of uncertainty. Further consideration must be given to the fact that, for bulk marine mining to be profitable, it must be conducted at scale.

If marine mining operations reduce the capacity for fishing production, this impact is termed a 'negative

externality' and describes the situation when an activity by one agent imposes a cost on another party which interferes with that party's ability to operate optimally. Importantly, this cost is not internally accounted for by the agent causing the adverse impact (the phosphate mining company in this case). The size of the negative externality in the context of marine mining is unknown and could range from inconsequential and/or temporary to significant and/or permanent.

One way to narrow the uncertainty gap is to ensure that, just as the private mining companies seek more clarity on the viability of the mining operation through the prospecting process, there is likewise a process of scientific monitoring that gathers information on the marine environment and fish harvests at various stages to better understand the potential impact of the mining operation. Examination of the marine environment would need to be undertaken at various temporal intervals and at various distances from the point of drilling. With more information available, more advanced analytical tools can then be employed – such as Cost-Benefit Analysis which allows for the weighting and comparison of key decision making factors (for example revenue, employment, linkages etc.). We add the caveat that, whether is practically feasible, depends on both the cost and complexity of such a monitoring operation.

While full knowledge of all gains and losses is always sought, uncertainty in such complex cases is often unavoidable. In the Namibian Sandpiper and New Zealand Chatham Rock projects, proposals for marine phosphate mining were rejected based largely on the degree of uncertainty. In the case of the Namibian Sandpiper project, opposition groups argued that the environmental impacts of proposed seabed mining on the marine ecosystem was clouded by uncertainty (Benkenstein 2014). Similarly, with regard to the proposed Chatham Rock project, in addition to concerns around the negative environmental impacts associated with the proposed mining, the decision making committee felt there was lack of certainty about the negative impacts of the project on both the environmental and existing interests (i.e. commercial fishing) ((Duncan & Currie 2015). Finally, the Northern Territory Government (Australia) placed a moratorium on marine mining given the lack of information on the actual/potential impacts on the environment and related industries as well as methods for managing (mitigating) these impacts (Australian Marine Conservation Society 2015). Such decision-making strategies by these authorities embodies the 'precautionary principle' which refers to a management approach guided by caution until more knowledge is available that will allow for better assessment of the respective costs and benefits.[31] Given the 'overwhelming uncertainty' (World Bank, 2016: 33) concerning the impact of seabed mining on a range of social, environmental and economic factors, the global convention has been to apply the precautionary approach to phosphate mining operations.

ENDNOTES

31 The precautionary principle was adopted by the 1992 Rio Convention as an approach to risk management and states that 'if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus that the action or policy is not harmful, the burden of proof that it is not harmful falls on those taking an action' (World Bank, 2016:33).

6/

CONCLUSION

The context for this study is the active interest in marine phosphate mining off the west and southern coasts of South Africa. Two prospecting licences have been granted to Green Flash Trading 251 and Green Flash Trading 257 respectively, and one to Diamond Fields International. As these prospecting areas overlap with some of South Africa's key fishing grounds, there is great concern from the fishery sector as well as other environmental groups that such mining activities will negatively impact the marine environment and associated ecosystem services and adversely affect South Africa's fishing industry and other marine users.

This study's primary goal has been to gauge the socio-economic value of the fishing industry in South Africa. The fishing sector is diverse, including both large-scale commercial fishing enterprises and small-scale and subsistence fisherman as well as recreational activities. Against this background, our main focus has been on (i) valuing the commercial fishing industry and, (ii), analysing the linkages between the fishery sector and other sectors in the economy through an economy-wide multiplier analysis.

There are several metrics that can be used to gauge the value of the commercial fishery sector in South Africa. In terms of wholesale value, the industry is estimated to be worth between R6-8 billion. With respect to access to international markets, export of fish products generated R5.3 billion in 2015. Finally, direct employment across all fishery sectors is estimated to be 27 000 while indirect employment in industries linked to the fishery sector is estimated to be between 81 000–100 000.

The five most valuable fishery sectors (ranked according to 2013 value) are: demersal offshore and inshore trawl (hake), small pelagic purse-seine, squid jig and West Coast Rock Lobster. These five sectors account for 79% of the total value of the commercial fishing industry. Of these five sectors, the demersal trawl and small pelagic fisheries have the highest economic value and landed tonnage. More specifically, the demersal trawl and pelagic fisheries collectively account for 86% of the total catch (2013), 65% of the total value (2013) and 47% of export revenue (2015). More so, the demersal trawl and pelagic fisheries together account for 54% of direct employment in commercial fisheries.

In addition to employing between 30-35% of the fishery workforce, the demersal trawl fishery is unique in that a Collective Agreement regulates the basic conditions of employment for workers in both the deep-sea and inshore trawl sectors (for example, daily wage, work hours and leave).

The fishing industry does not exist in isolation but has multiple backward and forward linkages with other sectors in the economy. The multiplier analysis shows that for every R1 in exogenous demand for fishery products, an additional R1.60 is generated in output through the interconnecting linkages in the economy which further translates into a net increase in domestic household income of R0.70.[32]

South Africa's major fishing grounds are situated along the continental shelf between St Helena Bay and Port Elizabeth. As a result of fishery activity being concentrated in the Western Cape Province, the industry's major fishing ports, processing factories and service industries are similarly found in this region. There is considerable overlap between the marine phosphate prospecting areas, which are situated off the west and south coasts of the Western Cape Province, and the fishing industry footprint. In particular, the prospecting license areas and proposed drill sites coincide with a large share of the offshore hake trawl footprint.

There are several adverse impacts associated with marine phosphate mining that could affect the fishing industry. Firstly, the negative impact on the marine environment from the drilling operation and sediment removal, associated release of sediment plumes and re-release of excess sediment at or near surface level all result in the deterioration of the water quality. Secondly, the mining operation imposes limits on access to fishing grounds through exclusion zones around the drilling vessel. Thirdly, as marine phosphate mining requires the dredging of large sections of the ocean floor, the impacts are not confined to a small area. While the range of possible impacts is well identified, there remains uncertainty regarding the significance of these impacts on fishery harvests: i.e. the combined impact resulting from the intensity, the physical extent and the duration of the impact.

In various international cases of proposed bulk marine sediment mining, the issue of uncertainty has been a critical limitation to the approval of proposed mining operations. In response to the proposed Chatham Rock project, the Environmental Protection Agency in New Zealand explicitly mentioned the uncertainties that stem from (i) the proposed project being a world first and (ii) the heavy reliance on 'insufficiently validated modelling to predict the impacts of the project' on both the environmental and existing interests (commercial fishing) (Duncan & Currie 2015:4). These issues of concern are likewise relevant to the South African case.

6.1 Recommendations

This study serves as a first step in assessing the socio-economic potential impact of bulk marine sediment mining on South Africa's marine industries, with its particular focus on valuing the commercial fishing sector. We do however recommend further studies to better inform and guide decision making:

i. **Scenario planning**
Given the range of uncertainties associated with bulk marine sediment mining, a useful next step would be to consider various possible impacts from mining operations on the marine environment and then extrapolate what each scenario could mean for fishery harvests and then for related fishery revenue, exports and jobs. Such a study would be a collaborative process involving marine scientists, fishery experts and economists.

ii. **Cost-benefit analysis (CBA)**
A CBA is a valuable decision making framework as it allows for the systematic estimation of the strengths and weaknesses of alternative uses of a given resource, in this case the competing industries of fisheries verses marine mining with regard to the use of the marine environment. This type of analysis is data intensive and given the range of uncertainties would draw heavily on the scenario planning study. In the CBA framework, all costs and benefits over different time frames are monetised and expressed in their present value. The CBA thus accounts for long-term versus short-term gains.

iii. **The GIS analysis provided in this study shows the catch data of the most commercially important fishing sectors in relation to the prospecting regions.**
It is however a limited study as it does not reflect other fisheries, the location of other stages of the fishery lifecycle nor the ecosystem services that support fishery development. A broader ecosystem study could support a more representative GIS analysis of the overlap between fishery grounds and the prospecting areas for bulk marine sediment mining.

iv. **An in-depth analysis into coastal communities and their dependence on marine resources using survey data**.

ENDNOTES

32 This is based on the assumptions for the intermediate model 2 from section 3.2.

7/

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APPENDIX A

Green Flash Trading 251 (Pty) Ltd has a prospecting right over an area of approximately 63 637 km^2 located off the West Coast of South Africa between the Groen River and Cape Town (Figure 12). Green Flash Trading 257 (Pty) Ltd has a prospecting right over an area of approximately 44 389 km2 located off the Southwest Coast of South Africa between Cape Town and Cape Infanta (Figure 13). The Green Flash Trading 251 and 257 prospecting rights were granted on 4 January 2014 for a period of 60 months (Shene-Verdoorn 2014). Diamond Fields International Ltd is a Canadian company that has also been granted a marine phosphate prospecting right in an area extending over 47 468 km2 and forms part of the eastern Agulhas Bank which is offshore Mossel Bay (see Figure 14). Diamond Fields International Ltd lodged the prospecting right application on 19 December 2012 and publicly announced that the right had been granted in a Canadian media release dated 13 January 2014.

FIGURE 12

Prospecting area for prospecting right WC 30/5/1/1/2/10023 PR Green Flash 251 Trading (Pty) Ltd

FIGURE 13

Prospecting area for prospecting right WC 30/5/1/1/2/ 10024 PR Green Flash Trading 257 (Pty) Ltd

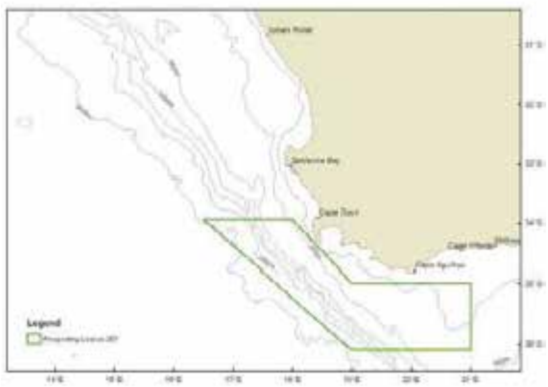
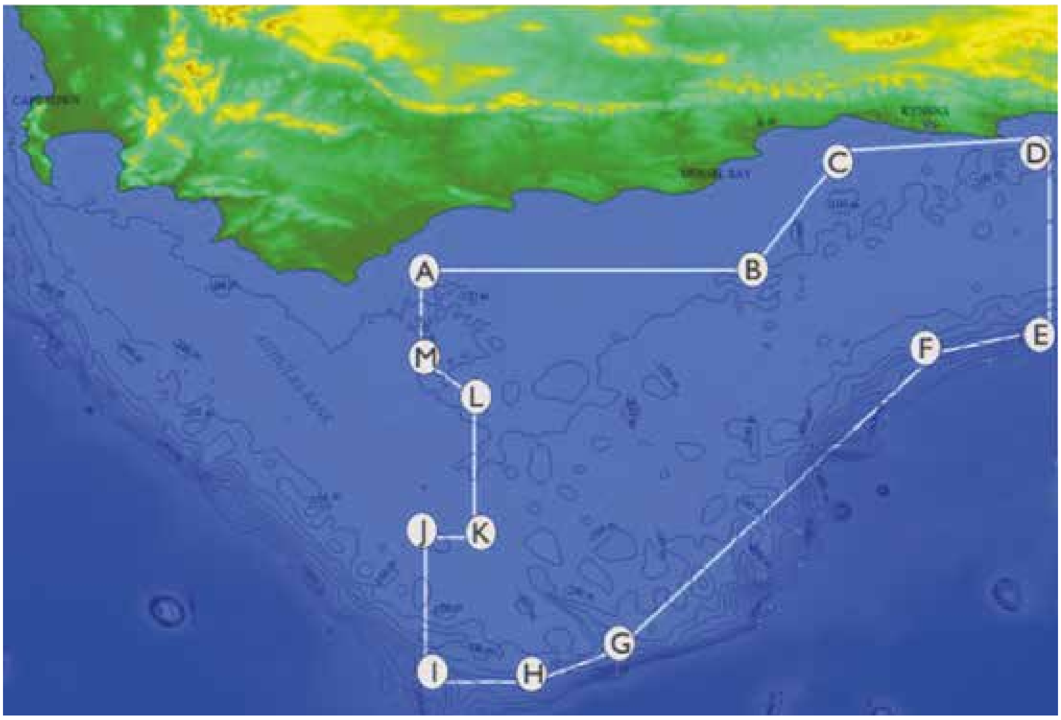


FIGURE 14
Prospecting area for Diamond Field International Ltd prospecting right



APPENDIX B

FIGURE 15
South African coastline with fishing harbours

FIGURE 16
Fishing harbours in the Western Cape Province

Source: Kaiser Associates (2012)

APPENDIX C

TABLE 23 Fishery landings and associated ports

Target species	Annual catch	Gear/Fishery	Main bycatch	Main Ports in priority
Cape Hake	TAC 2009: 119 000 t Cath 2008: 126 000 t	Bottom trawl, longline, handline	Kingklip, monk, snoek, dory, horse mackerel, sole	Cape Town Saldanha Mossel Bay Port Elizabeth Gansbaai
Sardine	TAC 2009: 90 000 t Catch 2008: 126 000 t	Purse seine	Anchovy, red eye pilchard and juvenile horse mackerel	St Helena Bay Saldanha Hout Bay Gansbaai Mossel Bay
Anchovy	TAC 2009: 569 000 t Catch 2008: 400 000 t	Purse seine	Sardine, red eye pilchard and juvenile horse mackerel	St Helena Bay Saldanha Hout Bay Gansbaai
Horse Mackerel	Precautionary Catch Limit 2009: 48 000 t	Midwater Trawl	Ribbon fish	Cape Town Port Elizabeth
West Coast Rock Lobster	TAC 2007: 2 895 t	Traps and hoops		Hout Bay Kalk Bay St Helena Bay
South Coast Rock Lobster	TAC 2009: 733 t (whole mass)	Bottom set traps	Octopus	Cape town Port Elizabeth
Squid	Catch 2008: 4 500 t	Jig with deck boats		Port Elizabeth Port St Francis
Shrimp	Catch 2007: 44 t			Durban Richards Bay
Tuna Bait and Pole	Albacore catch 2007: 3 582 t Yellowfin catch 2007: 19.1 t	Pole and line	Yellowfin Tuna, Bigeye tuna shark, yellowtail	Cape Town Saldanha
Large Pelagic	2007 Yellowfin Tuna catch: 958 t 2007 Bigeye Tuna catch: 571 t Swordfish catch 2007: 388 t Shark catch 2007: 753 t	Pelagic Longline	Albacore Tuna, Mako Shark, Blue Shark	Cape Town Durban Richards Bay Port Elizabeth
Linefish	Snoek 2007 catch: 2 741 t Cob 2007 catch: 312 t Geelbek 2007 catch: 426 t Yellow Tail 2007 catch: 461 t	Handline	Shark and other linefish	All ports, harbours and beaches around the coast

Source: FAO (2010) and Kaiser Associates (2012)

APPENDIX D

Lallemand et al. (2016) used 2012 COMTRADE and MSC data to estimate the export weight and associated price per kg of both fillet and non-fillet hake products. The 2012 value of the hake industry (domestic and exports) is based on the following assumptions:

- Total catch of hake in 2012 of 127 974 t
- The conversion factor for conversion of GWt to non-fillet product weight is 0.72.
- The conversion factor for non-fillet to fillet product weight is 0.6.
- $/R = 10.4
- Proportion of GWt sold domestically as fillet and non-fillet products is equal to the proportion in the export market
- The domestic price of non-fillet products is equivalent to the Nambian export price to South Africa

TABLE 24 Hake market valuation: baseline model

Assumptions	Baseline scenario
Exchange rate	
R/$ = 10.4	
Volume	
2012 catch (t greenweight)	127 974 t
% TAC exported	70%
% TAC sold domestically	30%
Non-fillet products (greenweight equivalent) (% of TAC)	37%
Domestic market	11%
Export market	26%
Fillet products (greenweight equivalent) (% of TAC)	63%
Domestic market	19%
Export market	44%
Weighted average price (US$/t)	
Domestic price: non-fillet products	3 137.9
Domestic price: fillet products	5 264.7
Export price: non-fillet products	2 302.9
Export price: fillet products	5 499.0
Value	
Value of domestic market	R915.3 million
Value of export market	R1.95 billion
Overall hake market value	R2.871 billion

Source: Lallemand et al. (2016)

***Note**: COMTRADE data used to determine the volume and price of exported fillet and non-fillet products; local volume calculated as the TAC less exports; MSC data used to estimate the price of local fillet products; domestic price of non-fillet products assumed to be equivalent to the Namibian export price to South Africa.*

TABLE 25 Hake market valuation: baseline model using 2014 data

Assumptions	Baseline scenario		
Exchange rate			
$/R	**10.8475**		
Conversion rates from GWt			
Non-fillet	0.72		
Fillet	0.432		
Volume	%	GWt	NWt
2014 deep-sea trawl catch	–	154 650	–
2014 inshore trawl catch	–	6 281	–
2014 total trawl catch	–	160 931	–
% TAC exported	70%	112 652	–
% TAC sold domestically	30%	48 279	–
Non-fillet products (greenweight equivalent) (% of TAC)	37%	59 544	42 872
Domestic market	11%	17 702	12 746
Export market	26%	41 842	30 126
Fillet products (greenweight equivalent) (% of TAC)	63%	101 387	43 799
Domestic market	19%	30 577	13 209
Export market	44%	70 810	30 590
Weighted average price	US$/t		
Domestic price: non-fillet products	3137.9		
Domestic price: fillet products	5264.7		
Export price: non-fillet products	2302.9		
Export price: fillet products	5499.0		
Value (calculated using NWt)			
Value of domestic market	US$	ZAR	
Non-fillet products	39 994 842	433 844 054	
Fillet products	69 542 562	754 362 941	
Total	109 537 404	1 188 206 995	
Value of export market	US$	ZAR	
Non-fillet products	69 377 818	752 575 876	
Fillet products	168 213 115	1 824 691 764	
Total	237 590 932	2 577 267 640	
Overall hake market value (2014)	US$	ZAR	
	347 128 337	3 765 474 635	

Source: Lallemand et al. (2016), Fishing Industry Handbook 2015 and own calculations

APPENDIX E

TABLE 26 Hake export HS codes extracted from the Department of Trade and Industry

HS code	Department of Trade and Industry	United States International Trade Commission	Lallemand 2014
H03	**Fish and crustaceans, molluscs and other aquatic invertebrates**		
H0302	Fish, fresh or chilled (excluding fish fillets and other fish meat of heading 0304)		
H030254	Hake (*Merluccius spp., Urophycis spp*)	Hake (*Merluccius spp., Urophycis spp*): Scaled (whether or not heads, viscera and/or fin have been removed, but not otherwise processed) in immediate containers weighing with their contents 6.8 kg or less.	
H030259	Other	Other: Scaled (whether or not heads, viscera and/or fins have been removed, but not otherwise processed), in immediate containers weighing with their contents 6.8 kg or less Other (Pollock, Other)	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae, excluding livers and roes. Includes hake and other white fish species. For South African exports can be assumed that the vast majority of fish trading in this category is hake.
H0303	Fish, frozen (excluding fish fillets and other fish meat of heading 0304)		
H030366	Hake (*Merluccius spp, Urophycis spp.*)	Hake (*Merluccius spp., Urophycis spp.*)	Frozen hake
H030369	Other	Other	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae, excluding livers and roes. Includes hake and other white fish species. For South African exports can be assumed that the vast majority of fish trading in this category is hake.

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TABLE 26 Hake export HS codes extracted from the Department of Trade and Industry

HS code	Department of Trade and Industry	United States International Trade Commission	Lallemand 2014
H0304	Fish fillets and other fish meat (whether or not minced), fresh, chilled or frozen		
H030444	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae: Cod (Atlantic Cod, Other), Haddock, Pollock, Hake, Other	
H030453	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae: Cod (Atlantic Cod, Other), Haddock, Pollock, Hake, Other	Includes hake and other white fish species. For South African exports can be assumed that the vast majority of fish trading in this category is hake.
H030474	Hake (*Merluccius spp., Urophycis spp*):	Hake (*Merluccius spp., Urophycis spp.*): Skinned, whether or not divided into pieces, and frozen into blocks each weighing over 4.5 kg, imported to be minced, ground, or cut into pieces of uniform weights and dimensions.	Hake, frozen fillets (excluding livers and roes)
H030479	Other	Skinned, whether or not divided into pieces, and frozen into blocks each weighing 4.5 kg, imported to be minced, ground or cut into pieces of uniform weights and dimensions. Pollock other than Alaska Pollock, Whiting (*Merluccius spp.*) and Other.	
H030495	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae (excluding Alaska Pollack (Theragra chalcogramma))	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae, other than Alaska Pollock (Theragra chalcogramma) In bulk or in immediate containers weighing with their contents over 6.8 kg each: Minced (Surimi, Other [Cod, Other]) Other (Cod, Haddock, Pollock, Other), Other	Includes hake and other white fish species. For South African exports can be assumed that the vast majority of fish trading in this category is hake.
H0305	Fish, dried, salted or in brine; smoked fish, whether or not cooked before or during the smoking process; flours, meals and pellets of fish, fit for human consumption:		

...continued

TABLE 26 Hake export HS codes extracted from the Department of Trade and Industry

HS code	Department of Trade and Industry	United States International Trade Commission	Lallemand 2014
H030532	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae	Fish of the families: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae: Cod, Other	
H030569	Other	Cusk, haddock, hake (Urophycis spp.) and Pollock. Whole; or processed by removal of heads, fins, viscera, scales, vertebral columns or any other combination thereof, but not otherwise processed.	

Sources: Department of Trade and Industry web portal, United States International Trade Commission Harmonized Tariff Schedule (USITC 2016) and Lallemand (2014)

APPENDIX F

TABLE 27 Small pelagic export HS codes extracted from the Department of Trade and Industry

HS code	Department of Trade and Industry	International Trade Commission	South African Revenue Service
H03	**Fish and crustaceans, molluscs and other aquatic invertebrates**		
H0302	Fish, fresh or chilled (excluding fish fillets and other fish meat of heading 0304)		
H030241	Herrings (*Clupea harengus, Clupea pallasii*)	Herrings (*Clupea harengus, Clupea pallasii*), anchovies (*Engraulis, spp.*), sardines, (*sardina pichardus, Sardinops spp.*) sardinella (*Sardinella spp.*), brislings or sprats (*Sprattus sprattus*), Mackerel (*Scomber scombrus, Scomber australasicus, Scomber japonicus*, jack and horse mackerel, (*Trachurus spp.*), cobia (*Rachycentron canadum*) and swordfish (*Xiphias gladius*), excluding livers and roes: H030241: Herrings (*Clupea harengus, Clupea pallasii*) H030242: Anchovies (*Engraulis spp.*) H030243: Sardines (*Sardina pilchardus, Sardinops spp.*), sardinella (*Sardinella spp.*), brisling or sprats (*Sprattus sprattus*)	Herrings (*Clupea harengus, Clupea pallasii*)
H030242	Anchovies (*Engraulis spp.*)		Anchovies (Engraulis spp.)
H030243	Sardines (*Sardina pilchardus, Sardinops spp.*), sardinella (*Sardinella spp.*), brisling or sprats (*Sprattus sprattus*)		Sardines (*Sardina pilchardus, Sardinops spp.*), sardinella (*Sardinella spp.*), brisling or sprats (*Sprattus sprattus*)
H0303	Fish, frozen (excluding fish fillets and other fish meat of heading 0304)		
H030351	Herrings (Clupea Harengus, Clupea Pallasii)	Herrings (*Clupea harengus, Clupea pallasii*), sardines (*Sardina pichardus, Sardinops spp.*), sardinella (*sardinella spp.*), brisling or sprats (*Srattus sprattus*), mackerel (*Scomber scombrus, Scomber australasicus, Scomber japonicus*)*…continued*	Herrings (*Clupea Harengus, Clupea Pallasii*)

…continued

TABLE 27 Small pelagic export HS codes extracted from the Department of Trade and Industry

HS code	Department of Trade and Industry	International Trade Commission	South African Revenue Service
H030351	Herrings (*Clupea Harengus, Clupea Pallasii*)	… jack and horse mackerel (*Trachurus spp.*), cobia (*Rachycentron canadum*) and swordfish (*Xiphias gladius*), excluding livers and roes: H030351: Herrings (*Clupea harengus, Clupea pallasii*) H030353: Sardines (*Sardina pilchardus, Sardinops spp.*), sardinella (*Sardinella spp.*), brisling or sprats (*Sprattus sprattus*)	Herrings (*Clupea Harengus, Clupea Pallasii*)
H030353	Sardines (*Sardina pilchardus, Sardinops spp.*), sardinella (*Sardinella spp.*), brisling or sprats (*Sprattus sprattus*)		Sardines (*Sardina pilchardus, Sardinops spp.*), sardinella (*Sardinella spp.*), brisling or sprats (*Sprattus sprattus*)
H0304	**Fish fillets and other fish meat (whether or not minced), fresh, chilled or frozen**		
H030449	Other		Other: Anchovies (*Engraulis spp.*); herrings (*Clupea harengus, clupea pallasii*) Other
H030459	Other		Other: Anchovies (*Engraulis spp.*); herrings (*Clupea harengus, clupea pallasii*) Other
H030489	Other		Other: Anchovies (*Engraulis spp.*): Blocks, rectangular, of a mass of 7 kg or more but not exceeding 8 kg, free of interleaving plastics (excluding blocks containing bones) Other
H030499	Other		Other: Anchovies (*Engraulis spp.*); herrings (*Clupea Harengus, Clupea Pallasii*); blocks, rectangular, of a mass of 7 kg or more but not exceeding 8 kg, free of interleaving plastics (excluding blocks containing bones), Other
H0305	**Fish, dried, salted or in brine; smoked fish, whether or not cooked before or during the smoking process; flours, meals and pellets of fish, fit for human consumption**		
H030539	Other	Other: Herrings, in immediate containers weighing with their contents 6.8 kg or less each	Other: Anchovies (*Engraulis spp.*) Other
H030542	Herrings (*Clupea Harengus, Clupea Pallasii*)	Herrings (*Clupea harengus, Clupea pallasii*) Whole or beheaded but not otherwise Processed; Other (boneless, other)	Smoked fish, including fillets, other than edible fish offal: Herrings (*Clupea Harengus, Clupea Pallasii*)
H030549	Other		Other: Anchovies (*Engraulis spp.*) Other

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TABLE 27 Small pelagic export HS codes extracted from the Department of Trade and Industry

HS code	Department of Trade and Industry	International Trade Commission	South African Revenue Service
H030559	Other		Dried fish, other than edible fish offal, whether or not salted but not smoked: Anchovies (*Engraulis spp.*) Other
H030561	Herrings (*Clupea Harengus, Clupea Pallasii*)	Herrings (*Clupea harengus, Clupea pallasii*): In immediate containers weighing with their contents 6.8 kg or less each	Fish, salted but not dried or smoked and fish in brine, other than edible fish offal: Herrings (*Clupea Harengus, Clupea Pallasii*)
H030563	Anchovies (*Engraulis spp.*)	Anchovies (*Engraulis spp.*)	Fish, salted but not dried or smoked and fish in brine, other than edible fish offal: Anchovies (*Engraulis spp.*)
H1604	Prepared or preserved fish; caviar and caviar substitutes prepared from fish eggs		
H160412	Herring		Herrings (frozen or other)
H160413	Sardines, sardenella and brisling or sprats: H16041300: Sardines, sardenella and brisling or sprats H16041305: Sardines (*Sardine Pilchardus*), in oil, in airtight metal containers H16041306: Sardines, sardenella and brisling or sprats H16041310: Sprats (*Sprattus Sprattus*), in oil, in airtight metal containers H16041312: Sardinella (*Sardinella spp.*), in airtight metal containers for human consumption H16041315: Other, sardinella (*Sardinella spp.*), in airtight metal containers H16041317: Sardines (pilchards) (*Sardinops spp.*), in airtight metal containers for human consumption H16041320: Other, sardines (pilchards) (*Sardinops spp.*), in airtight metal containers H16041329: Sardines, sardenella and brisling or sprats H16041355: Sardines, sardenella and brisling or sprats H16041380: Other, frozen H16041390: Other H16041394: Sardines, sardenella and brisling or sprats		Sardines, sardenella and brisling or sprats: Sardines (*Sardine Pilchardus*), in oil, in airtight metal containers Sprats (*Sprattus Sprattus*), in oil, in airtight metal containers Sardinella (*Sardinella spp.*), in airtight metal containers for human consumption Other, sardinella (*Sardinella spp.*), in airtight metal containers Sardines (pilchards) (*Sardinops spp.*), in airtight metal containers for human consumption Other, sardines (pilchards) (*Sardinops spp.*), in airtight metal containers Other, frozen Other

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TABLE 27 Small pelagic export HS codes extracted from the Department of Trade and Industry

HS code	Department of Trade and Industry	International Trade Commission	South African Revenue Service
H160416	Anchovies		Anchovies
H160420	Other prepared or preserved fish: H16042000: Other prepared or preserved fish H16042010: Fish paste H16042020: Homogenised composite food preparations H16042030: Other anchovies H16042035: Other sardines (pilchards) (*Sardinops spp.*) and sardinella (*Sardinella spp.*.), minced, in airtight containers for human consumption H16042040: Other sardines (pilchards) (*Sardinops spp.*), mackerel and horse mackerel (*Trachurus Trachurus*), in airtight metal containers H16042080: Other, frozen H16042090: Other		Other prepared or preserved fish: Fish paste Homogenised composite food preparations Other anchovies Other sardines (pilchards) (*Sardinops spp.*) and sardinella (*Sardinella spp.*), minced, in airtight containers for human consumption Other sardines (pilchards) (*Sardinops spp.*), mackerel and horsemackerel (*Trachurus Trachurus*), in airtight metal containers Other, frozen Other

Sources: Department of Trade and Industry web portal, United States International Trade Commission Harmonized Tariff Schedule (USITC 2016) and SARS (2012)

SAFEGUARDING OUR SEABED PROJECT

In response to concerns that unsustainable seabed mining will soon be authorised in South Africa, the Centre for Environmental Rights (CER), with its partner WWF-South Africa, began working on the Safeguarding our Seabed (GT439), a three-year WWF-Nedbank Green Trust funded project. A key objective of the project is to achieve a moratorium on bulk marine sediment mining in South Africa.

THE SAFEGUARD OUR SEABED COALITION

In 2015 a group of organisations that shared the common interest in pursuing a cautious approach towards seabed mining formed a coalition. The Safeguard our Seabed Coalition includes organisations that represent the interests of commercial and small scale fishing and environmental and environmental justice organisations. The Safeguard our Seabed Coalition is made up of 11 organisations:

1	The Responsible Fisheries Alliance (RFA)	www.rfalliance.org.za
2	Food and Allied Workers Union	www.fawu.org.za
3	Fish SA	www.fishsa.org
4	South African Deep-Sea Trawling Industry Association (SADSTIA)	www.sadstia.co.za
5	WWF-South Africa	www.wwf.org.za
6	BirdLife South Africa	www.birdlife.org.za
7	Masifundise Development Trust	www.masifundise.org.za
8	Centre for Environmental Rights	www.cer.org.za
9	AfriOceans Conservation Alliance	www.aoca.org.za
10	International Ocean Institute – Southern Africa	www.ioisa.org
11	Institute for Poverty, Land and Agrarian Studies (PLAAS)	www.plaas.org.za

IMAGES
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Centre *for* Environmental Rights
Advancing Environmental Rights in South Africa

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The **WWF Nedbank Green Trust** is a funding organisation that supports programmes with a strong community-based conservation focus. The Trust was co-founded by Nedbank and the world's largest independent conservation organisation, World Wide Fund South Africa (WWF-SA) in 1990, with the aim to bring together conversation and community development in order to promote the ideal of people living and working in harmony with one another and the environment.

WWF NEDBANK GREEN TRUST WWF

The **Responsible Fisheries Alliance** is a non-profit body made up of like-minded organisations working together to ensure that healthy marine ecosystems underpin a robust seafood industry in southern Africa. Formed in 2009, the Alliance members continue to contribute resources and time towards the sharing of information, expertise and competencies to positively effect responsible fishing while influencing policy and fishery governance.

WWF | RESPONSIBLE FISHERIES ALLIANCE – WORKING TOGETHER TOWARDS RESPONSIBLE FISHING | OCEANA GROUP | VIKING | Sea Harvest | I&J | BirdLife South Africa | PIONEER FISHING

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WWF
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International Ocean Institute Southern Africa
PLAAS Institute for Poverty, Land and Agrarian Studies

SAFEGUARD OUR SEABED COALITION