STRATEGIC ENVIRONMENTAL ASSESSMENT

Identification of potential marine aquaculture development zones for fin fish cage culture

DRAFT FOR PUBLIC COMMENT

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Photo: C.L. Griffiths

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Executive Summary

This strategic environmental assessment (SEA) was undertaken on behalf of the the Directorate Sustainable Aquaculture Management: Aquaculture Animal Health and Environmental Interactions within the Department of Agriculture, Forestry and Fisheries- DAFF. The SEA, which deals with the entire South African coast, leads into a larger project that will entail undertaking Environmental Impact Assessments for two potential marine aquaculture development zones (ADZs) specific for fin fish cage farming in the sea off the Eastern Cape Province. The DAFF mariculture policy aims to promote growth in the industry, as it envisions benefits of skills-based job creation in poor coastal communities and increased seafood production to compensate for dwindling catches of wild stocks. Revision of an earlier version of this SEA undertaken by SEAS (Jooste 2009) was necessary to address shortcomings in the site selection methodology used in the earlier version commissioned by then the Department of Environmental Affairs and Tourism, Branch Marine and Coastal Management (DEAT: MCM). This report differs from the earlier SEA in that it focuses on marine finfish cage farming only, whilst the earlier report also considered mariculture of shellfish and seaweed. The site selection methodology that is the focus of this SEA is based on the application of quantitative criteria that were developed in conjunction with key industry, academic and government stakeholders and applied using Geographical Information System software.

The SEA briefly summarises the policy and legislative framework that outlines the perceived need for the declaration of ADZs and the focus on finfish farming technology. Sea cage fish farming systems are briefly described, including the logistical and environmental requirements for the most commonly used “inshore” floating cage systems and more robust “offshore” cages that are suitable for exposed sea areas. The need for sea space that is close enough to a suitable size port (<20km) and sheltered from storm sea conditions (exposure to significant wave heights of <3m) for “inshore” fin fish cages is highlighted. The authors of this report consider that the development of an offshore fin fish cage industry in South Africa in the next 5 years (during which an EIA will be valid) is unlikely, given the high risks and capital investments costs involved. The site selection process thus included a preliminary identification of potential offshore ADZs (excluding consideration of potential offshore user conflict), but recommends focusing on potential sites suitable for the development of fin fish farms using “inshore” floating plastic circle fish cages.

The potential environmental impacts of sea based finfish cage culture are briefly discussed and mitigation measures that can be partly addressed at the SEA level are identified. Potential impacts include:

- The incubation and transmission of fish disease and parasites from captive to wild populations. Mitigation relies on sound animal health management and biosecurity.
- Pollution of coastal waters due to the discharge of organic wastes. Mitigation includes the use of species and system specific feeds in order to maximize food conversion ratios, rotation of cages within a site to allow recovery of benthos, and sensible site selection (sufficient depth, current speeds and suitable sediment type).
- Escape of genetically distinct fish that compete and interbreed with wild stocks that are often already depleted. Mitigation measures include suitable design and maintenance of cages to minimize escapes and use of sufficient brood stock with similar genetic structure to local wild populations.
- Chemical pollution of marine food chains (& potential risk to human health) due to the use of therapeutic chemicals in the treatment of cultured stock and antifouling treatment of infrastructure. Recommended mitigation includes the responsible storage and use of the minimum required quantities of (preferably biodegradable) chemicals.
- Fish cages pose a physical hazard to cetaceans and other marine species that may become entangled in ropes and nets. Mitigation measures include site selection that excludes important migration, feeding or aggregation sites; and the use of correct and durable cage netting that minimizes entanglements.
- Piscivorous marine animals (including mammals, sharks, bony fish and birds) attempt to remove fish from the cages and may become tangled in nets and damage nets leading to escapes and stress or harm the cultured stock. Farmers tend to kill problem predators or use acoustic deterrents. Effective mitigation may be achieved through the use of appropriate predator mesh, proper feed storage and feeding and removal of dead fish from cages.
- Localised habitat alteration and impacts (such as changes in wave action and sediment transport). Can only be mitigated through site selection and farm design.
- User conflict due to exclusion from mariculture zones for security reasons or negative impacts on tourism and coastal real estate value due to negative aesthetic impacts of fish farms. Can be partly mitigated by site selection and consultation with other users.

The report also covers the development and application of quantitative site selection criteria under the three main logistical requirements for offshore cage culture: environmental suitability, environmental sensitivity, and user conflict. The results of the GIS analysis which identifies potentially suitable sites for the development of ADZs for fin fish cage culture are then presented. Seven inshore and twelve offshore potential ADZs were identified by application of the site selection criteria developed as part of this study. Inshore sites were then assessed in terms of the likely user conflicts (cost to other industries) by application of a cost layer that reflected the importance of areas to other marine industry sectors (including fishing, mining and petroleum) and ranked in terms of four secondary criteria (distance from port, water depth, distance from MPAs, and influence of upwelling cells). Two potential sites to the west of Mossel Bay, and two sites within Algoa Bay, were identified as having the lowest potential cost to existing industry (including wild capture fisheries, ecotourism, mining, and shipping). However, the accuracy and applicability of the cost values used in this study still need to be verified in detailed EIA studies, using higher resolution spatial data for commercial fisheries, ecotourism activities etc. Should the DAFF wish to proceed with declaring any of these sites ADZs, and EIA process will need to be undertaken. At this time, the DAFF has communicated that it wishes to proceed with establishing ADZs in the Eastern Cape Province. Based on the relative cost values, we recommend that two potential sites within Algoa Bay (Port Elizabeth/Coega 2 & 3) are subject to detailed EIA assessment with a view to declaring ADZs, with a third site in Algoa Bay (Port Elizabeth 1) and a site to the east of Cape St Francis (St Francis 1 actually off Jeffreys Bay) be considered as alternatives.

Table of Contents

List of Figures

List of Tables

Acronyms

ADZ	Aquaculture Development Zone
DAFF	Department of Agriculture, Forestry and Fisheries
DEAT	Department of Environmental Affairs & Tourism
DEA	Department of Environmental Affairs
DST	Department of Science and Technology
EA	Environmental Authorization
EIA	Environmental Impact Assessment
GIS	Geographical Information System
MCM	Marine and Coastal Management
NEMA	National Environmental Management Act
SADCO	South African Data Centre for Oceanography
SANBI	South African National Biodiversity Institute
SEA	Strategic Environmental Assessment

1 INTRODUCTION

The Department of Environmental Affairs & Tourism (DEAT), Branch Marine and Coastal Management completed a Strategic Environmental Assessment (SEA) aimed at identifying suitable land and sea space surrounding South Africa's coastal provinces for the establishment of Aquaculture Development Zones (ADZs) in 2009. The purpose of establishing the ADZs was to encourage investor and consumer confidence in the marine aquaculture industry in South Africa, and also to create incentives for industry development, provide marine aquaculture services, manage risk associated with aquaculture, and provide skills development and employment for coastal communities. Four sea-based sites were selected in the Eastern Cape as a first phase in establishing ADZs in South Africa. These were Algoa Bay, Shelly Beach, St Francis Bay and Point St Francis. In 2010, the Directorate Sustainable Aquaculture Management: Aquaculture Animal Health and Environmental Interactions, now in the Department of Agriculture, Forestry and Fisheries (DAFF), called for proposals from suitably qualified service providers to undertake an Environmental Impact Assessment (EIA) for the development of these ADZs specifically for marine **fin fish cage** aquaculture, which is relatively new to South Africa. A consortium consisting of Cape Environmental Assessment Practitioners and Anchor Environmental Consultants CC (hereafter referred to as the consultants) was appointed by the DAFF. The consultants then proceeded with the first task specified in the terms of reference, namely: a review of the existing Strategic Environmental Assessment (SEA) prepared by SEAS (Jooste 2009).

The review of the 2009 SEA undertaken by the project team identified several critical short comings that needed to be addressed prior to initiating a public participation process and field surveys at the four sites. The most important issue was that the criteria used for the actual selection of sites suitable for the development of ADZs, both in the SEA and subsequently by the DAFF (for the purposes of conducting EIAs), was not clear and transparent. As such it would have been extremely difficult to defend the selection of these sites in an open public forum as would be required in an EIA process. The project team thus proposed redoing the original SEA study by developing clear and transparent criteria for identification of areas suitable for the establishment of ADZs in consultation with key stakeholders from government, academia and industry, and applying these using a Geographic Information System (GIS) based approach to identify a new suite of potential ADZ sites. DAFF agreed to this proposal in July 2011, and the Terms of Reference for the original study were amended to allow the project team to first revise the existing SEA using the approach outlined above, prior to initiating an EIA process for the selected ADZ sites. This report constitutes the revised SEA and differs from the 2009 SEA (Jooste 2009) in two important respects:

1. This SEA is specific for marine fin fish cage culture, whilst the 2009 SEA also considered the culture of other organisms (seaweeds & invertebrates). The 2009 SEA was therefore far broader in content and only sections considered pertinent to the culture of finfish are reproduced (often edited) in this report.
2. This SEA focuses on site selection as this was determined to be the most critical issue to rectify in the 2009 SEA. Site selection for the mariculture of other marine and/or estuarine species would require the application of different and/or additional criteria to those applied in this SEA, which is specific to fin fish cage culture. Many of the spatial data layers created and used in the site selection component of this report are also applicable to the selection of sites for the culture of sea weeds and invertebrates (or a combination, termed polyculture), but application of these data layers process would require adapting and possibly adding additional criteria.

This SEA briefly summarises the policy and legislative framework, describes sea based fish farming systems, including the logistical and environmental suitability requirements; highlights the potential environmental impacts of sea based finfish cage culture and possible mitigation thereof. The report then focuses on the development and application of site selection criteria and presents the results of the GIS analysis which was used to identify potential suitable sites for the development of ADZs for fin fish cage culture.

2 POLICY AND LEGISLATIVE FRAMEWORK

The 2009 SEA (Jooste 2009) identified the following Draft Policy Documents as relevant to mariculture development in South Africa:

1. Policy and Guidelines for Fin Fish Farming, Marine Aquaculture experiments and Pilot Projects in SA. DEAT 2006, 2007.
2. Guidelines for Mariculture Ranching in South Africa. DEAT 2006, 2007.
3. Marine Aquaculture Sector Development Plan 2006, 2007.

Although it was not mentioned in the 2009 SEA, the final Marine Aquaculture Policy document was published by DEAT in 2007, namely:

"Policy for the development of a Sustainable Marine Aquaculture Sector in South Africa" (Government Gazette No. 30263 September 2007). In this policy document the rationale for the establishment of ADZs is clearly stated (pg. 6 section 4 policy considerations):

"Marine aquaculture faces competition from other land and sea use activities, both commercial as well as recreational. It is a matter of high priority, therefore, to ensure that areas (sea, land and suitable estuaries) which may be suitable for marine aquaculture development are zoned for this purpose."

The policy goes on to state that the land use planning requirements and initial environmental impact assessment will take place in advance (presumably funded by the state) with the aim of reducing the entry costs for farmers and minimizing potential environmental impacts. The policy however, also explicitly states that "The National Environmental Management Act (NEMA), Environmental Impact Assessment (EIA) requirements will still be applicable". In order to avoid possible conflicting use, the policy also makes clear that the development of an ADZ should take cognizance of other marine activities such as tourism, fishing and recreational activities, as well as area management initiatives such as MPAs. The policy also highlights the needs for research into finfish culture, and includes two of suggested research and technology development programmes that deal with this topic (pg 14):

- Finfish technology platform programme, and
- Finfish cage culture development programme

This policy therefore provides the framework for both the development of ADZs with the intention of encouraging the establishment of fin fish cage farms, and the approach used in this SEA to select potential ADZ sites.

The 2007 marine aquaculture policy gave rise to a "Marine Aquaculture Policy Implementation Plan 2009-2014" (DEAT MCM 2009), wherein the need for the establishment of aquaculture development zones was identified as one of the 11 key required implementation programmes. This SEA and subsequent EIA phase therefore falls under the Departments stated implementation plan.

Apart from the above-mentioned mariculture policy documents, a host of national legislation are also regarded as relevant to the development of ADZs and finfish farms, these are identified in Appendix 1. These numerous pieces of legislation are not integrated and are managed by a range of different regulatory bodies. A review of all the applicable legislation is beyond the scope of this SEA, but the DAFF, the lead agent for the development and management of the aquaculture sector in South Africa, recently (September 2011) called for proposals to conduct a comprehensive review of the legislation governing the aquaculture sector and to provide recommendations as to how identified shortcomings or gaps should be addressed.

3 SUMMARY DESCRIPTION OF SEA-BASED FINFISH CULTURE

The development of modern sea cage fin fish farming which began in the 1970s, occurred largely due to the growth of the salmon farming industry in countries with glaciated coastlines (e.g. Scotland, Norway, British Columbia, Chile) (Scott & Muir 2000). The number of fin fish species used in marine cage culture internationally has grown dramatically over the last three decades, however, with salmon, tuna, flatfish, kingfish, bream, Sciaenid (e.g. sea bass) and a host of other species grown in a variety of cage culture systems (Staniford 2002). Although some sea cage farming operations rely on wild caught stock e.g. southern and northern bluefin tuna farms (located largely in Australia and the Mediterranean, respectively), most farms use finfish fingerlings that are obtained from land based hatcheries, where brood stock, egg and larvae husbandry can be carried out under controlled conditions. Fingerlings are stocked into sea cages at species- and environmentally-specific optimal sizes and densities, are fed, usually with commercially available protein and lipid rich dry food, treated for diseases and parasites, graded, and harvested at the size which results in the maximum economic return.

3.1 Cage types and environmental suitability

The following summary is based on the information derived from industry on the most commonly used “inshore” gravity net cages (also referred to as net pens), and “offshore” submersible and semi-submersible cages. Early fin fish cage designs were developed for sheltered inshore waters; typically floating structures made of steel and plastic which developed into the floating, flexible, plastic circle design cages most commonly in use today (Scott and Muir 2000). From about the mid 1980s suitable sheltered sea space became increasingly limiting and this drove the development of more robust plastic circle cages and a variety of different “offshore” cage designs (Scott and Muir 2000) (Figure 1)

According to Scott and Muir (2000) pens and cages are designed with the following criteria in mind:

- To provide a stable cage shape, a stable working environment and to reduce stress on the cultured fish;
- Provide adequate circulation in the enclosure in order to remove wastes as well as cater for the metabolic needs of the fish;

- Cages must be able to absorb or deflect environmental forces and thereby maintain structural integrity;
- Provide adequate working environment for the day to day management of the stock;
- Maintain cage position in a secure location – free from navigational hazards; and
- Keep capital and operating costs to a minimum

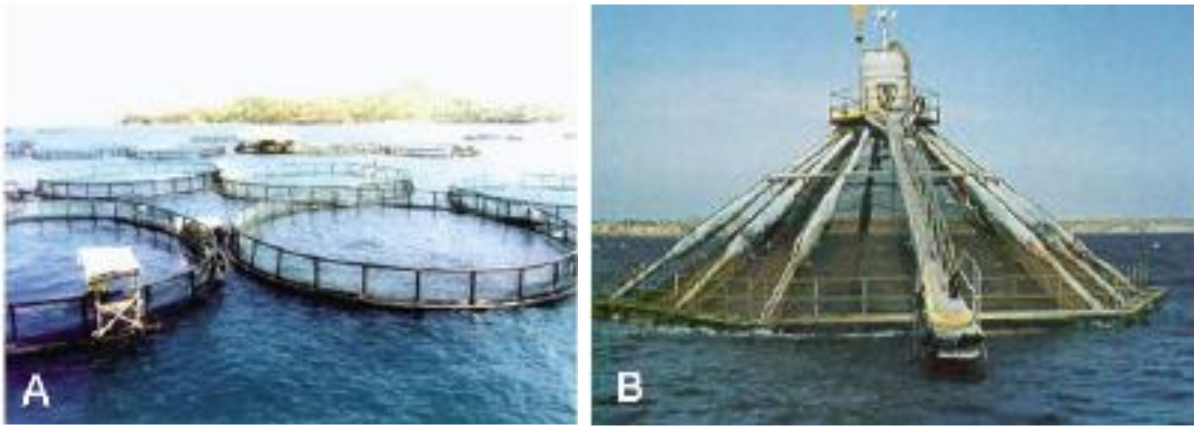

Figure 1. Examples of typical floating plastic circle finfish cages (A) and a semi-submersible "offshore" Farmocean cage (B) (source: Scott & Muir 2000).

Cages or pens have to withstand the normal, recurrent ocean forces and their effects, as well as abnormal peak or shock forces associated with storm events, which can reach breaking loads (Scott and Muir 2000, Turner 2000). Different finfish sea cages have been designed to meet a variety of different environmental conditions, with depth criteria and exposure to waves/swells usually the critical factors. Stations closer inshore and with more sheltered conditions are suitable for placement of floating gravity net pens, while exposed offshore sites may only be suited to "offshore" technology, rigid or flexible fully or semi-submersible cages.

Inshore floating pens are not suitable in areas where they may be exposed to plunging breakers associated with the surf zone (or for that matter, using these pens in areas likely to experience breaking waves during storm events). These waves transmit an enormous amount of energy to floating structures (Turner 2000) often resulting in total system collapse. According to Katavic (1999), modern floating pens such as those manufactured by Bridgestone have been thoroughly tested in offshore conditions, with considerable success. Next generation semi-submersible and fully submerged cages do not have the same amount of test time (Katavic 1999), and are therefore often still considered to be designs in pilot phases of development. These designs, however, are all well suited for more exposed areas. Risk and development cost considerations will ultimately guide potential investors towards a final selection. The focus of this SEA was on finding sites with operating conditions suitable for standard “inshore” plastic circle gravity net cages. It is doubtful whether a potential ADZ designated to be suitable only for next-generation “offshore” equipment will attract much investment interest in South Africa owing to the high costs of these structure and the high level of uncertainty that still exists with respect to culture technology in this country (e.g. spawning success, growth rates, and marketability). (See §3.3 for more details on this issue). The GIS exercise undertaken in this SEA did include a preliminary identification of areas that may suitable for “offshore” cages, but our recommendation is that only areas identified as suitable for the use of established “inshore” technology cages are considered for the EIA phase and promulgation of ADZs.

It is clear that there will be a critical need for comprehensive data on the wave climate of potential ADZ sites. Broad spatial scale wave measurement data are available for the South African coast as a whole, and comprehensive spatially explicit data is also available at specific sites where instruments have been deployed, but variations in wave and sea conditions at a smaller scale will require site-specific investigations at potential ADZs. This will need to be addressed during EIA-type assessment of individual sites through the deployment of appropriate instrumentation at these sites for extended periods, and through a thorough review of available oceanographic data relevant to the areas under consideration. For the purposes of this SEA, significant wave height and direction data were obtained from the SADCO voluntary observing ships (VOS) database and used in the quantification of the exposure criterion (see § 5.4). These data reveal that nearly the entire South Africa experiences significant wave heights in excess of 3.5 m at times. A summary of the cage types that can be used in under different wave regimes is provided by Turner (2000) (Table 1). This summary indicates that water shallower than 20m should not be considered for the development of ADZs that aim to attract investors utilizing established “inshore” cage technologies.

3.2 Work boats and suitable ports

Next to the development of offshore cage and pen technology, the most important technology required for the effective sea-based culture of fish is a suitable work boat. These vary from small service boats capable of delivering small loads, such as a few staff members and up to 200 kg of food, through to complex live-aboard feeding barges capable of carrying up to 400 t of food (Beaz-Paleo *et al.* 2000). As can be expected, the type of vessel needed to service a fish farm greatly depends on the distance travelled, size of the facility and the ocean conditions experienced. Due to the relatively rough South African sea conditions, high biofouling rates that necessitate frequent net changes, and the estimated minimum viable fish farm size (production of ~1000 tons/year), finfish farms in a South African ADZ will need to be serviced by vessels equipped with small lifting cranes. These vessels are in the region of 20 m long, limiting the type of harbour from which they can operate. Areas suitable for the development of ADZs are therefore dependent on the availability of ports that are suitable for vessels large enough to support daily (e.g. feeding) and routine (e.g. net changes) farm tasks.

Table 1 Summary of current mariculture cages with respect to the storm wave climate and the depth maxima (after Turner 2000). The shaded area corresponds to the storm wave climate along the South African coast and suggests that sea space with a water depth of less than 20m should not be considered for ADZs.

Storm wave climate	Wave period	Water Depth			
		8 – 12m	13 – 20 m	21 – 30 m	31 – 50 m
Storm H_s: 0.4<Hs<0.8 m	3.5	Square timber/steel or floating circle pens	Square timber/steel or floating circle pens	Square timber/steel or floating circle pens	Square timber/steel or floating circle pens
Storm Hs: 0.8<Hs<1.5 m	4.7	Not suitable	Square steel or plastic circle pens	Square steel or plastic circle pens	Square steel or plastic circle pens
Storm Hs: 0.8<Hs<2 m	5.5	Not suitable	Limited suitability: Square steel or plastic circle pens	Square steel or plastic circle pens	Square steel or plastic circle pens
Storm Hs: 1.0<Hs<3.5 m	7.3	**Not suitable**	**Not suitable**	Plastic and offshore plastic circles, Flex hose cages	Plastic and offshore plastic circles, Flex hose cages
Storm Hs: 1.4<Hs<4.5 m	8.1	**Not suitable**	**Not suitable**	Limited suitability: Offshore polar circles, Flex hose cages	Offshore polar circles, Flex hose cages
Storm Hs: 2.0<Hs<5.0 m	8.7	**Not suitable**	**Not suitable**	Limited suitability: Flex hose cages, Steel tubular cages and tension spar	Flex hose cages, Steel tubular cages and tension spar
Storm Hs: 5.0<Hs<8.0 m	9.6	**Not suitable**	**Not suitable**	**Not suitable**	Flex hose cages, Steel tubular cages, tension spar and semi-submersible hex cages
Storm Hs: 5.0<Hs<10 m	11	**Not suitable**	**Not suitable**	Limited suitability: Semi-submersible hex cages and new generation	New generation cages

3.3 South African finfish cage projects

In South Africa finfish cage culture is in its infancy, with only two experimental farms having operated to date. Published accounts of these experimental fish farms are unfortunately not yet available and the information presented below has been obtained from discussions with members of the SA Marine Finfish Farmer Association and from two presentations by G. le Roux given at the Critical Thinkers Platform in Aquaculture and Emerging Technologies held in Port Elizabeth 6-7 October 2011. Few details are available on the one experimental pilot project that attempted to farm Atlantic salmon in cages located near Gansbaai in the Western Cape. This project reportedly failed when the cages sunk in strong seas. The cages were rendered more vulnerable to the storm waves partly to very high biofouling of the cage mesh, a result of an inability to effectively clean the cage mesh due to inadequate equipment (specifically a suitable size work boat equipped with a crane).

A second pilot project, a public-private partnership between Irvin and Johnson (I&J), the Department of Science and Technology (DST) and Stellenbosch University, used indigenous species, namely yellowtail *Seriola lalandii* , silver kob *Argyrosomus* inodorus and dusky kob *A. japonicus* that were spawned in I&J's hatchery in Gansbaai and stocked in floating plastic circle cages in Algoa Bay (2008-2010). This pilot project was regarded as successful, with positive survival and growth rates achieved for yellowtail (Robert Landman, I&J, personal communication). The kob results were not as encouraging, with these species showing signs of stress, including reduced feeding, slow growth and high parasite loads (specifically dusky kob). This is thought to be largely the result of several rapid water temperature drops experienced at the site shortly after stocking, and below optimal winter water temperatures ((Robert Landman, I&J personal communication). Concurrently with this pilot project, I&J proceeded with an EIA process that resulted in Environmental Authorization (EA) (subject to conditions) granted on the 28 April 2009 for a proposed 3 000 ton (36 floating circle cages) kob and yellowtail farm in Mossel Bay. This EA was appealed by the local municipality, but the minister upheld the decision (Robert Landman, I&J personal communication). The matter is currently under review in the High Court. A second experimental pilot project in Port Elizabeth is planned by the University of Stellenbosch (with DST funding) for the near future. Biofouling also proved to be a serious logistical challenge during the Port Elizabeth pilot project (Figure 2) and further trials may experiment with different mesh materials and or antifouling agents (G le Roux pers.com). The use of copper alloy mesh may be one solution for South African conditions, reducing both biofouling and possibly negating the need for predator nets. Trials to experimentally determine the antifouling efficacy of copper alloy mesh types are currently underway in Saldanha Bay and Mozambique (Prof. Tom Hecht, Advance Africa, personal communication).

Figure 2. Severe biofouling of fin fish cage net used in the Algoa Bay pilot project 2008-2010. Note that no antifoulants were used on infrastructure in this pilot project, and the severity of the biofouling shown in this image was due to delayed net changes.

The very slow start and continued limited interest in sea based cage culture in South Africa appears to be the result of several factors, including but not limited to a lack of technological expertise, strong public and NGO resistance to the fish farming in general, and probably most importantly, environmental unsuitability. The exposed, very linear SA coastline has a notable lack of suitably sheltered sea area where established sea cage culture technologies can be implemented without a high degree of risk and/or capital investment in relatively expensive offshore cage systems. This was addressed in the site selection criteria for this SEA, whereby exposure to wave and storm conditions and water depth criteria were applied differently for “inshore” and “offshore” cage systems (see §5.4). Given the pioneering stage of sea based cage culture in SA and the high investments and risks associated with developing an offshore finfish cage facility off SA coast, we agree with the statement in the 2009 SEA (Jooste 2009) that traditional inshore cage systems are the type most likely to be implemented by applicants over the next 5 years (during which an environmental authorisation will be valid), and recommend only pursuing EIAs and ADZ declaration for identified inshore sites. The GIS exercise was nonetheless also conducted to identify areas that may be suitable for offshore cage technologies, should applicants wish to pioneer offshore cage culture off the SA coast in the future.

4 POTENTIAL ENVIRONMENTAL IMPACTS OF FINFISH CAGE CULTURE

Environmental impacts of fin fish cage farming have been well documented and reported in international literature. A brief description of the potential environmental impacts of fin fish cage culture follows. For a more comprehensive account on this matter, the reader is referred to Stickney & McVey (2002) and Staniford (2002). In the early period of finfish farming internationally, particularly salmon farming in the pioneering countries, a lack of good environmental management and poor farming practices led to significant, negative environmental impacts occurring. This resulted in negative attitudes and opinions amongst the public and conservation organizations towards the industry. This negative sentiment towards sea cage fish farming persists to this day, despite an increasing focus on sustainability by both governments and industry. In a proactive move, the South African Marine Finfish Farmers Association of South Africa (MFFASA) has compiled their own Marine Fish farming Environmental Impact Information document (MFFASA 2010) that includes a code of conduct and identifies most of the known environmental impacts of fin fish farming. Unfortunately many of the environmental impacts of cage farming are expensive and difficult to mitigate and the opposition to industrial scale aquaculture remains strong.

Nonetheless, some of the potential impacts of finfish sea cage farming may be partially mitigated at the SEA level by selection of appropriate sites only (§ 5.2). Mitigation for other impacts can only be addressed when site and operational specific data are available, and should be implemented via an approved Environmental Management Plan (EMP) that is informed by an EIA process. The impacts of mariculture depend on the species, culture method, stocking densities, feed type, hydrography of the site and husbandry practices (Wu 1995). Environmental impacts of fin fish cage culture can be grouped under the following headings:

- Incubation and transmission of fish disease and parasites from captive to wild populations.
- Pollution of coastal waters due to the discharge of organic wastes.
- Escape of genetically distinct fish that compete and interbreed with wild stocks that are often already depleted.
- Chemical pollution of marine food chains (& potential risk to human health) due to the use of therapeutic chemicals in the treatment of cultured stock and antifouling treatment of infrastructure.
- Physical hazard to cetaceans and other marine species that may become entangled in ropes and nets.

- Piscivorous marine animals (including mammals, sharks, bony fish and birds) attempt to remove fish from the cages and may become tangled in nets, damage nets leading to escapes and stress or harm the cultured stock. Farmers tend to kill problem predators or use acoustic deterrents.
- User conflict due to exclusion from mariculture zones for security reasons or negative impacts on tourism and coastal real estate value due to negative aesthetic impacts of fish farms.

These various impacts and possible mitigation measures are addressed in more detail below.

4.1 Disease and parasites

In fish cage aquaculture, high stocking densities (typically 15-20 fish per m^3) serve as a breeding ground for disease and parasite infections (including blood, intestinal and ecto parasites). Infectious diseases and parasites are regarded as the single biggest threat to aquaculture, with the estimated losses from sea lice (genus *Caligus*) infections of salmon stock alone amounting to hundreds of millions of dollars annually (Staniford 2002, Heuch *et al.* 2005). The cultured stock is often prevented from exercising natural parasite shedding behaviours and the high number of concentrated hosts facilitates parasite and disease reproduction and transmission. This is not only a concern for the productivity of the cultured stock, but also threatens wild stocks due to enhanced transmission of parasite and diseases (Heuch *et al.* 2005, Krosek et al. 2007, Ford and Myers 2008). Transmission to wild stocks may take place by direct contact between wild fish and farmed stock as wild fish are often attracted to the cages, or simply as a result of the much higher concentration of pelagic parasite life history stages arising from fish farms.

Wild salmon in particular have suffered increased parasite infection rates due to contact with cage cultured stock (Carr and Whoriskey 2004, Heuch *et al.* 2005). Documented effects of high parasite loads on wild salmonids include increased mortality rates, reduced fecundity and delayed maturity, all of which reduce the fitness of individuals and the productivity of the wild stock as a whole (Bjorn *et al.* 2002, Carr and Whoriskey 2004, Heuch *et al.* 2005, Ford and Myers 2008). Intensive sea bass and sea bream culture in the Mediterranean has also resulted in severe disease problems in fish farms; problem diseases include *Pasteurellosis* and *Nodavirosis*, and parasitic infections include *Ichtyobodo* sp., *Ceratomyxa* sp., *Amyloodinium ocellatum, Trichodina* sp., *Myxidium leei, and Diplectanum aequans* (Agius and Tanti: 1997 cited in Staniford 2002). In Australia, experiments have revealed that Monogenean parasites, infected yellowtail up to 18 km downstream of the cages

(Chambers and Ernst 2005). Indigenous species currently under consideration for sea cage mariculture in South Africa include silver and dusky kob (*Argyrosomus inodrus* and *A. japonicus*) and yellowtail S*eriola lalandii*. The parasites and diseases infecting these (and other finfish) species in South African waters are not well studied, although both kob species are known to be infected by sea lice of the same genus (*Caligus*) that caused serious problems amongst salmonids, as well as other copepod, trematode, Acanthocephalan (parasitic worm) monogean (specifically the gill fluke *Diplectanum oliverii)*, dinoflagellates (*Amyloodinium ocellatum*) and myxozoan species (DEAT undated Grobler *et al* 2002, Christison & Vaughan 2009, Joubert et al 2009). Dusky kob are migratory and yellowtail are regarded as nomadic, whilst silver kob within the vicinity (10-100 km) of future sea cages will also likely come into contact with farmed stock, and all three species will be at an increased risk of contracting diseases and or parasites. Potential negative effects on wild stocks are particularly concerning as all three species are important in the commercial and recreational line fisheries and furthermore, both wild kob species are assessed as collapsed (Grifitths 2000). Dusky kob has recently been assessed using IUCN criteria and are considered Vulnerable in South Africa (Sink *et al.* in prep). Although treatment of cultured stock to control disease and parasite out breaks is possible (unlike wild stocks), chemical treatment is not without further environmental impacts, whilst build up of antibiotic and chemical resistance is becoming increasingly problematic (Staniford 2002).

- Mitigation involves improved or modified husbandry practises and sound animal health management, including the use of disease free spat, the wise use of chemical antibiotics and good biosecurity.

4.2 Organic pollution from sea cages

Untreated wastes resulting mainly from uneaten food and faeces of fish in sea cages are discharged directly into the sea and are not an insignificant source of nutrients (Brooks *et al*. 2002, Staniford 2002). Studies have documented increased dissolved nutrients and particular components (POC and PON) both below, and in plumes downstream, of fish cages (Pitta *et al*. 2005). These wastes impact both on the benthic environment and on the water column. Sediments and benthic invertebrate communities under fish farms usually show chemical, physical and biological changes attributable to nutrient loading. Elevations in carbon, ammonia and hydrogen sulphide concentrations are frequently observed (Carroll *et al.* 2003, Heggoey *et al.* 2005). Nutrient enrichment and resulting eutrophication of sediments under fish cages is regarded as serious issue in some areas (Staniford 2002). Impacts on benthic habitats below fish cages does, however, tend to be localized. Most studies indicate that the effect is contained within a few hundred meters (Porrello *et al.* 2005, Merceron 2002 and Kempf *et al* 2002), but one Mediterranean study was able to detect changes up to 1000 m away (Sara *et al.* 2004). The extent of contamination of the sediments under fish cages is obviously highly site and project specific. Near shore marine environments with low flushing rates and or sediments susceptible to organic loading should be avoided when selecting sites for finfish cages. Cages should also be situated in water of sufficient depth to allow flushing and reduce the build up of wastes directly below cages. Fallowing is the standard mitigation method used to allow recovery of sediments under fish cages, but recovery has been observed to take up to fifteen months after the closure of a Scottish fish farm (Black et al 2004). Feeding by wild fish on the wastes and uneaten food below cages has also been shown to mitigate the impacts of waste on benthic environments. Some studies have reported that 40-80% of the uneaten food and waste falling out of cages was eaten by wild fish (Vita *et al.* 2004, Felsing *et al.* 2005). This in turn, however, may increase the risk of parasite and disease transmission to wild stocks and may also attract piscivores to cages with the associated problems thereof discussed below.

Nutrient loading, of the water column along with the reduction of dissolved O_2 concentrations, as a result of fish cages have been implicated in conditions that stimulate harmful algal blooms, which pose a threat human health and shellfish mariculture operations (Gowen & Ezzi 1992, Berry 1996, 1999, Davies 2000, Navarro 2000, Ruiz 2001, all cited in Staniford 2002).

- Mitigation includes the use of species and system specific feeds in order to maximize food conversion ratios (and minimize waste), rotation of cages within a site to allow recovery of benthos, and sensible site selection (sufficient depth, current speeds and suitable sediment type).

4.3 Genetic impacts on wild stocks

Escape of fish from sea cages that may be established in South African is inevitable given that escape from fish farms is a common event globally. Even in countries with advanced sea cage farming industries and calm sheltered waters such as Norway, is it a regular occurrence with an estimated 1.5 million escaped salmon present in Norwegian fjords at any one time (Heuch *et al.* 2005). Given the exposed nature of the South African coast and the abundance of large piscivores, regular escapes possibly of large numbers of stock as a result of cage failure or breach, is highly likely.

Farmed fish that are typically spawned from a limited number of brood stock, have reduced genetic diversity compared to wild stocks, and will have undergone different selective pressures (will also have likely been artificially selected for traits such as rapid growth). Genetically distinct escapees may interbreed or even out-compete wild stocks, resulting in overall reductions on genetic diversity with resultant reductions in the fitness of wild populations (Hershberger 2002, Naylor *et al.* 2005 Ford and Myers 2008). The degree of genetic impacts of escaped farm fish on wild stocks is largely determined by the extent of genetic differentiation between farmed and wild stocks, the quantity of escapees compared to the size of the wild stock, and the survival and reproductive success of escaped fish (Falconer and Mackay 1996). Until reproductively sterile fingerlings are available for fish cage farming in South Africa, however, the potential genetic impacts of escapees remain a serious threat to wild stocks. The risk is further accentuated by the collapsed status of many South African fish species that will likely be used in cage farming.

- DAFF has developed genetic best practice management guidelines for marine finfish hatcheries in South Africa that recommend maintaining an effective broodstock population size of 30-150 individuals that have been sourced from the area in which grow-out will take place and also that broodstock are rotated (DAFF undated). The MFFASA environmental impact information document includes similar recommendations but also recommends reproductive sterility as the future key to eliminating the genetic impact of escaped fish on wild stock (MFFASA 2010).

4.4 Chemical pollution arising from fin fish cages

Disinfectants, antifoulants and therapeutic chemicals (medicines) are typically used in sea cage fish culture. These chemicals are often directly toxic to non target organisms and may remain active in the environment for extended periods (Kerry *et al.* 1995, Costello *et al.* 2001). Inappropriate use of medicines may lead to resistance in pathogenic organisms. Some antifoulants contain trace metals (usually copper) that can elevate environmental concentrations, can accumulate in sediments and, and can bioaccumulate in susceptible organisms (Costello *et al*. 2001). Some of the chemicals used historically on fish farms to combat sea lice infestations were carcinogenic, whilst others are known to adversely affect reproduction in salmonids (Staniford 2002, More & Waring 2001). Global bodies, (e.g. the World Health Organisation and GESAMP), have highlighted the environmental and public health threats of chemical use on fish farms (GESAMP: 1997, WHO: 1999 cited in Staniford 2002).

Due to these concerns, the salmon farming industry is moving away from the use of antibiotics and organophosphates, but numerous other potentially hazardous chemicals such as synthetic pyrethroids, artificial colorants, antifoulants, and antiparasitics and are still a serious concern (Staniford 2002).

- Future South African fin fish cage farms will almost certainly need to use chemicals to protect infrastructure and treat stock; the MFFASA code of conduct recommends avoiding hazardous chemical use, minimizing the use of agricultural, veterinary and industrial chemicals and adherence to legal requirements when these are required (MFFASA 2010).

4.5 Entanglement of cetaceans and other species

Sporadic entanglement of marine mammals and occasionally other species such as turtles and birds in fish cage infrastructure has been reported internationally (Kemper & Gibbs 2001, Wuersig 2001, Wuersig & Gailey 2002). Entanglement of cetaceans in fishing gear is a common occurrence with an estimated 300 000 mortalities annually (Read and Fernades 2003). Off the South African coast, a large and growing population of southern right whales is found, this species along with large pods of common and other dolphin species inhabit the inshore waters along the Cape coast where fin fish cage culture is likely to be developed. Southern right whales frequently become entangled in static fishing gear such as west coast rock lobster traps off the SW Cape and it appears that accidental entanglement is a real risk with future extensive fish cage developments. However, given the rarity of such accidental entanglements internationally and the encouraging statistic of zero cetacean entanglements during the pilot sea cage project undertaken in Algoa Bay (see§ 3.3), accidental entanglement in sea cage infrastructure may not be a high risk. Cetaceans and other marine animals may well be able to avoid lethal effects associated with entanglement in fish cage infrastructure, but the mere presence of sea cages may well adversely affect habitat use and may have chronic negative effects on populations (as well as ecotourism activities) (Wuersig and Gailey 2002).

- To minimise this risk, care should be taken not to site sea cages in known feeding, breeding and migration routes for cetaceans, and the use of correct and durable cage netting that minimizes entanglements.

4.6 Interactions with piscivorous marine animals

Piscivorous seals, dolphins, sharks, fish and birds are frequently attracted to the large concentrations of fish and or food in sea cages (Wuersig and Gailey 2002, Vita et al. 2004, Kloskowski 2005). Their attempts to get at the stock induce a stress response (and consequent decreased growth rates and resistance to disease) in the cultured fish and can damage nets, allowing fish to escape. The predators themselves may also become entangled in sea cage nets with potentially fatal consequences. The most effective and common response by farmers is to install top and curtain anti predator nets, although farmers will also shoot problem animals (which is usually illegal), or use acoustic deterrents (Pemberton & Shaughnessy 1993, Wickens 1995, Beveridge 1996, Wuersig & Gailey 2002). In the case of top predators, which are frequently relatively rare, lethal reactions by farmers to predation attempts may prove unsustainable, whilst acoustic deterrent devices may damage marine mammal's hearing and inferred with navigation (Wuersig and Gailey 2002). Seals, sharks and predatory sea birds are abundant along the Southern and Eastern Cape coast and interactions with fin fish sea cages are likely.

- Due to the extensive foraging range of most large marine predators interactions cannot be effectively mitigated by site selection away from colonies, rather the diligent use and maintenance of predator nets will be a necessity. Proper feed storage, feeding and removal of dead fish from cages will also help to minimize interactions with wild piscivores.

4.7 User conflict

Due to security concerns, fish farms will need to exclude other users from what was previously public sea space. As a result of the lack of sheltered sea space off South Africa's coast, most of the areas suitable for cage culture are already heavily utilised for fishing, ecotourism and other commercial and recreational activities. Indeed, the proposal by Irvin & Johnson to develop a 3 000 ton fish farm in Mossel Bay met fierce resistance from amongst others, ecotourism operators. Several important commercial fisheries also operate in areas where fish cage culture may be viable (particularly chokka squid and inshore trawl); resistance from these bodies to the declaration of exclusive ADZs is likely. In the United States of America, a large and politically powerful body of recreational fishers have also resisted mariculture developments that they perceive as detrimental to their sport (Harvey & McKinney 2002). Coastal landowners may also object to the establishment of fin fish cages within sight of the shore due to aesthetic concerns.

- Site selection should take cognisance of these potential user conflicts and avoid areas where existing recreational and economic activities take place, or at least minimise the impacts on existing activities. Consultation with other user groups during the EIA process and fish farm designs that take cognizance of other activities could also help reduce user conflict.

5 SITE SELECTION METHODOLOGY

5.1 Method overview

In order to define and spatially delineate potential finfish sea-based marine aquaculture development zones (ADZs) around South Africa, a geographical information system-based (GIS) approach was adopted. This required identifying all criteria that are unsuitable (exclusionary & precautionary criteria) and suitable (inclusionary) for ADZs so that they can be overlaid spatially into a GIS and potential areas for ADZs identified. The approach has advantages as it considers multiple criteria concurrently and is transparent and allows stakeholders to visualize and understand the logic of how different criteria (either in isolation or lumped) influence the sea-area available for ADZs. The process of selecting potential ADZs involved six chronological steps (Figure 3).

Step 1: Consultation with key industry Stakeholders was set up in two workshops that identified and defined quantitative criteria for use in the GIS analyses. The stakeholders were initially approached with a Background Information Document that provided draft site selection criteria and invited participation in criteria development workshops. The Stake holder list providing details of the people, who were invited to these workshops, or to submit comment via e-mail, is provided in Appendix 2. Minutes of stakeholder workshops that were held are given in Appendix 3. After the workshops, all identified stakeholders were emailed the workshop minutes that included the modified, draft site selection criteria and invited to comment further. Additional consultation with some of these stakeholders also took place telephonically. Criteria were developed under four main headings (see §5.2):

- Logistical considerations that would allow economically viable fish farm operation;
- Environmental suitability criteria aimed at avoiding areas unsuitable for infrastructure and stock;
- Environmental/ ecological sensitivity criteria; and
- Criteria to minimise user conflict.

Step 2: Spatial data on agreed criteria were then captured in ArcGIS 9.3 for spatial analyses. Criteria that were deemed mandatory were displayed in green in the GIS, while those that were considered exclusionary or precautionary were displayed in red and orange, respectively. Exclusionary criteria were always displayed in red and overlaid on top of the precautionary and mandatory criteria. All data were projected to the nearest meridian at the centre of the study area (i.e. a particular harbour) using the Transverse Mercator projected coordinate system, with the WGS84 reference ellipsoid. The first criterion considered was to select suitable sized harbours that can support the required size boats for servicing of mariculture cages (see §0). Following this, the Harmful Algal Bloom and Hypoxia layers were applied. This left a select number of harbours around the coastline with their surrounding areas of sea that were then analysed independently in separate GIS analyses where all remaining criteria were factored in. The use of a GIS based system allows flexibility to investigate the effects on potential site selection by altering any of the criteria relatively easily, should this be required in future.

Step 3: Regions of the sea that met all mandatory criteria and were not excluded by exclusionary criteria were spatially delineated and the coordinates of the polygon vertices defining these zones archived. This was done for both offshore and inshore potential ADZs. Areas characterised by the influence of precautionary criteria only (e.g. potential river plumes, east coast upwelling cells) were still considered for potential ADZs as we believe that with special consideration to culture species, potential still exists for their development (e.g. kob species and spotted grunter are unlikely to be negatively affected by modest level of suspended sediments).

Step 4: Each area identified as a potential ADZ from the spatial analyses was then subjected to a scoring analysis that assigned points to each site. This allowed individual potential ADZs to be ranked and compared to one another other so that those deemed the most suitable in terms of the defined secondary criteria could be identified.

Step 5: This step involved comparing and considering ADZs with the highest number of points with the cost layer that reflects importance to other industries. This GIS layer incorporates the spatial extent and intensity of 19 sectors already in operation. These industries would potentially be in conflict with fin fish cage culture. The data in this GIS layer are based on the collective effort (usage) of these industries at any location around the coastline within the Exclusive Economic Zone (see §5.6).

Step 6: The remaining areas that met all the exclusionary criteria, had the highest ranking and the lowest cost value were recommended for the EIA phase of this project with the view to declaring these areas ADZs.

5.2 Development and application of site selection criteria

The quantitative finfish ADZ site selection criteria that were developed in conjunction with key stakeholders and management are presented under the headings under which they were conceptualised below, namely logistical, environmental suitability, environmental sensitivity and user conflict.

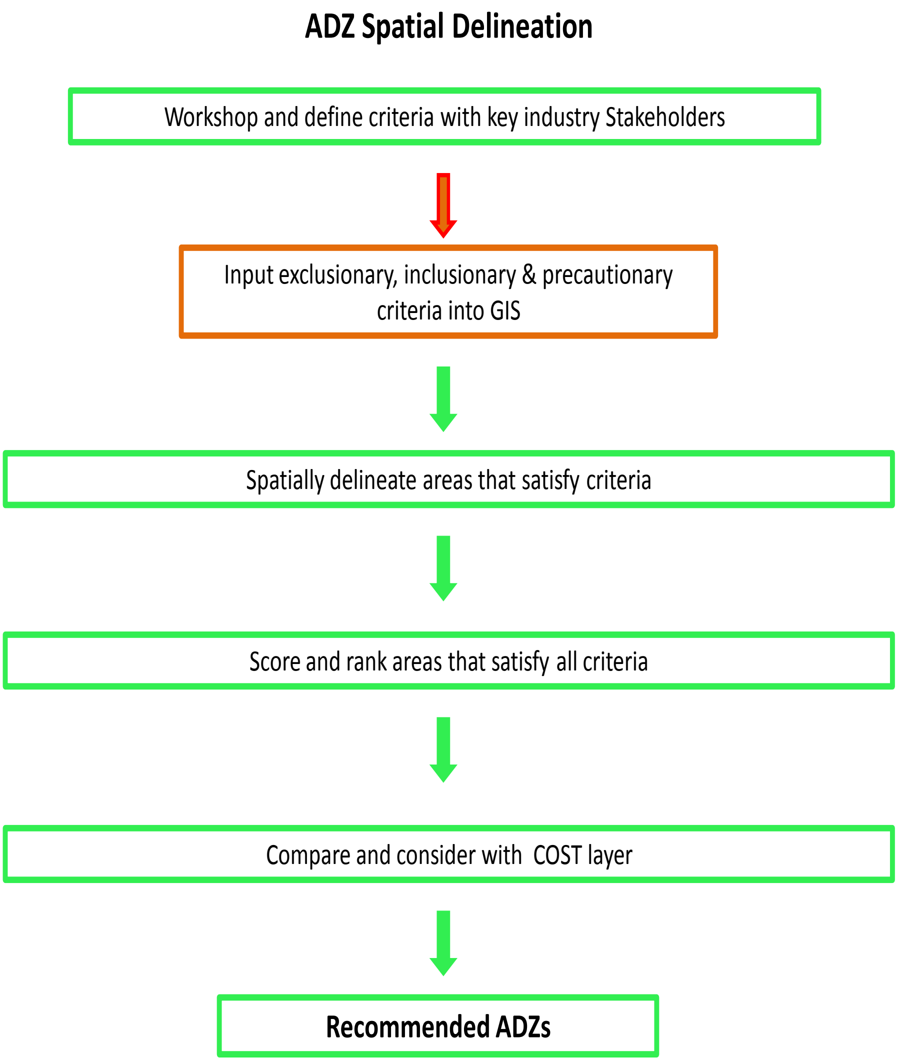

Figure 3. Six-step process used to identify potential ADZs for finfish cage culture.

5.3 Logistical criteria

5.3.1 Criterion: Distance from suitable port (exclude if >20km).

Rationale: Work boats need to be large enough to undertake routine farm tasks such as fish feeding (required daily), harvesting and net changes. Furthermore, travelling time should not exceed 2 hrs/trip. Typical work boats travel at around 7 knots limiting the maximum distance to 20 km.

Suitable ports, defined as those able to accommodate a 15 m work boat, were identified (Figure 4). The 20 km zone surrounding all suitable ports was mapped and other restrictive features around ports, e.g. the harbour area, defined shipping lanes, military or otherwise restricted areas (e.g. underwater cables, dumping grounds) have been included on this layer.

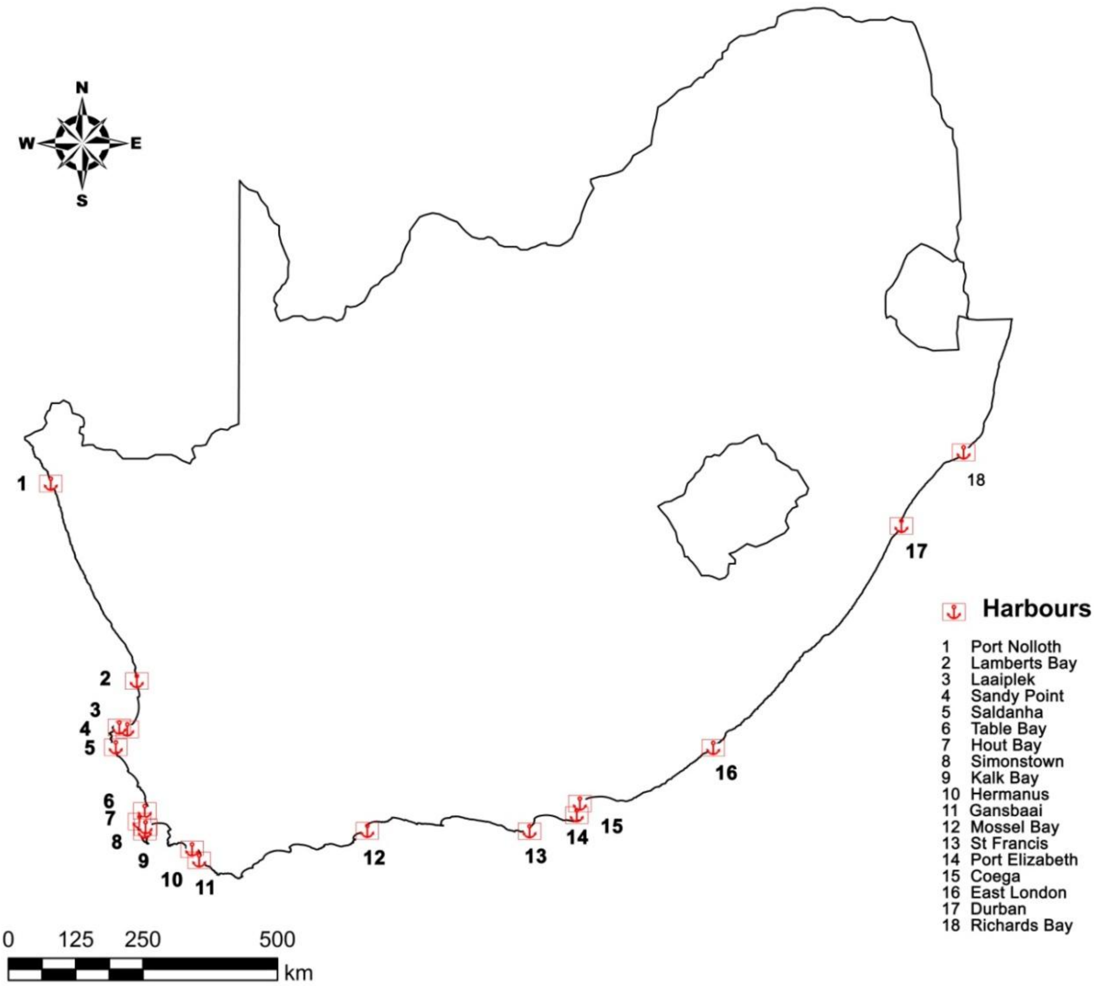

Figure 4. South African Ports considered large enough to support for marine finfish culture operations

5.3.2 Criterion: Water depth, "inshore" cages: exclude if >20m and < 60m; offshore cage systems: exclude if >30m and <150m

Rationale: A balance between the minimum required water depth for flushing of wastes (international standard is at least 5m below the bottom of the cage) and the increasing cost of mooring in deeper water.

Bathymetry contours within the defined distance from suitable Ports were created by interpolating between depth points from digital South African Navy (SAN) chart data. These contour maps were then used to define the suitable areas for traditional floating cages (20-60 m depth) and offshore technology cages (30-150 m depth). Note that a proposed 12 m inshore depth criterion was requested at the Cape Town stakeholder workshop (primarily to allow the inclusion of Saldanha Bay) is only considered suitable in areas with significant wave heights of less than 2 m (see Table 1). This excludes most areas of the South African coast, with the exception of possibly Saldanha Bay and Richards Bay harbour. As a result, the originally proposed minimum depth criterion of 20 m with exceptions in the case of the two above mentioned bays was applied.

5.4 Environmental suitability

5.4.1 Criterion: Water temperature was proposed as a secondary ranking criterion that allocated higher scores to sites with mean annual water temperatures of 15-24°C, than sites with cooler or warmer mean annual temperatures.

Rationale: Optimal growth of likely SA species (kob, yellowtail, grunter), trade off against parasite/disease prevalence.

Stakeholders felt that this criterion should not be used at all in the site selection process given the early stage of sea cage farming in SA. It was felt that future entrants to the industry may wish to utilize species with different temperature requirements. For example, the sustainable aquaculture policy does not rule out the use of alien species (Government gazetted No 30263, pg 13) and the state has previously allowed a pilot salmon farm. Stakeholders did, however, request that the information on average water temperature should be included in the SEA report. AquaMODIS satellite data were analysed at a 4 km^2 resolution to provide the average long term (last 9 years) sea surface temperature (Figure 5). It is clear that sites within the temperature range that was considered suitable for the indigenous species which have been used in pilot sea based and commercial land based projects to date, all lie between Cape Agulhas and East London. Potential future fish farmers are, however, already considering indigenous fish species that can tolerate both cooler (e.g. white stumpnose) and warmer (e.g. Cobia) water temperatures (MFFASA members, pers. com).

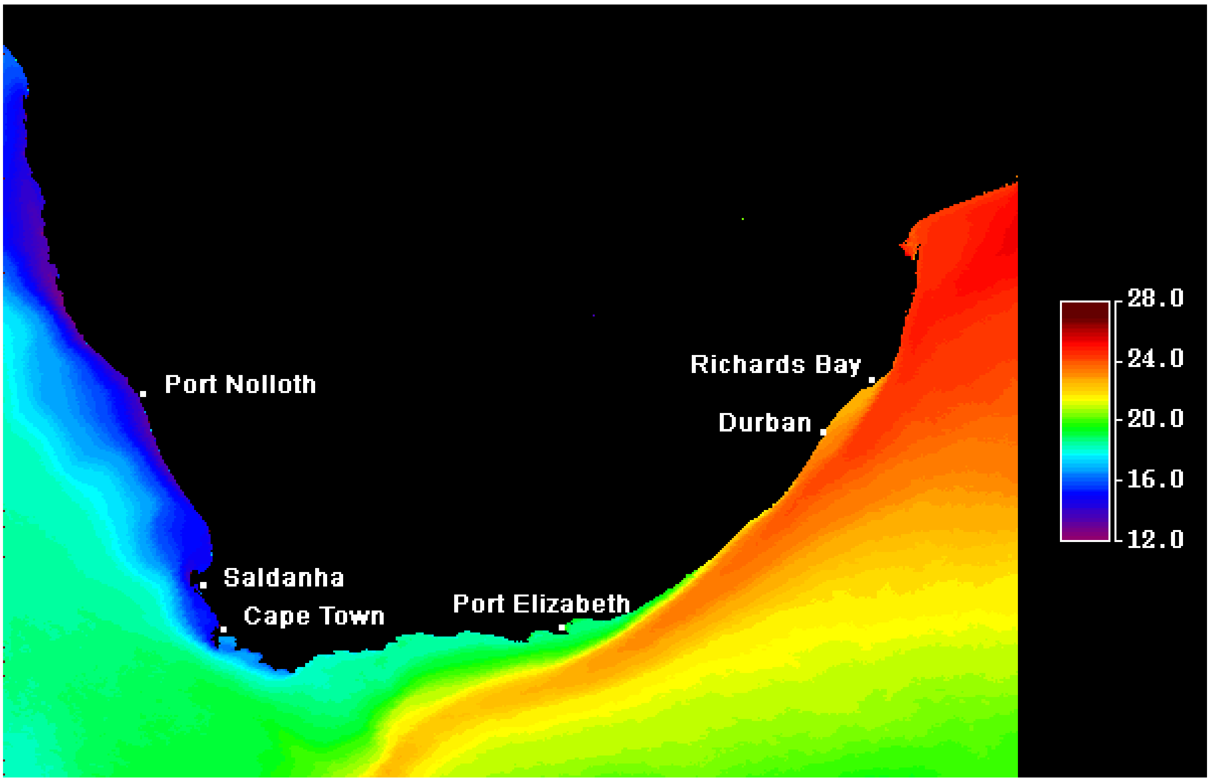

Figure 5 **Long-term (last 9 years) average sea surface temperature based on AquaMODIS satellite data (4km ^{2} resolution).**

5.4.2 Criterion: Upwelling cells, exclude areas within the spatial influence of regular, known cells west of Cape Agulhas, precautionary highlight of upwelling cells along the east coast.

Rationale: Temperature shocks will negatively impact growth rate and health of cultured stock.

Through the use of published studies (Lutjeharms & Meeuwis 1986, Schumann *et al.* 1982, 1988, 1995, Goschen & Schumann 2011) and expert input (Prof. L Hutchings, Department of Environmental Affairs), the project team developed a GIS shape file that defines the average spatial extent of coastal upwelling cells along the South African coast (Figure 6). In terms of our criterion, upwelling cells along the West Coast (west of Cape Agulhas) will be excluded as potential ADZs, whilst those along the east coast will receive a negative weighting when assessing proposed sites. Areas downstream of upwelling cells, particularly along the south east coast between Tsitsikamma and Knysna are often subject to sudden large temperature drops when recently upwelled water is driven onshore by winds or currents. Even within bays, such as Algoa Bay some distance downstream of upwelling cells (which tend to occur off headlands during the summer months, in this case Woody Cape), sudden, significant drops in water temperature associated with the south and westward propagation of cool upwelled water are fairly common (Goschen & Schumann 2011). Future participants in sea cage farming off the cape south and east coast should be aware that the impacts of coastal upwelling may be apparent even outside of the areas mapped as upwelling cells in this SEA report.

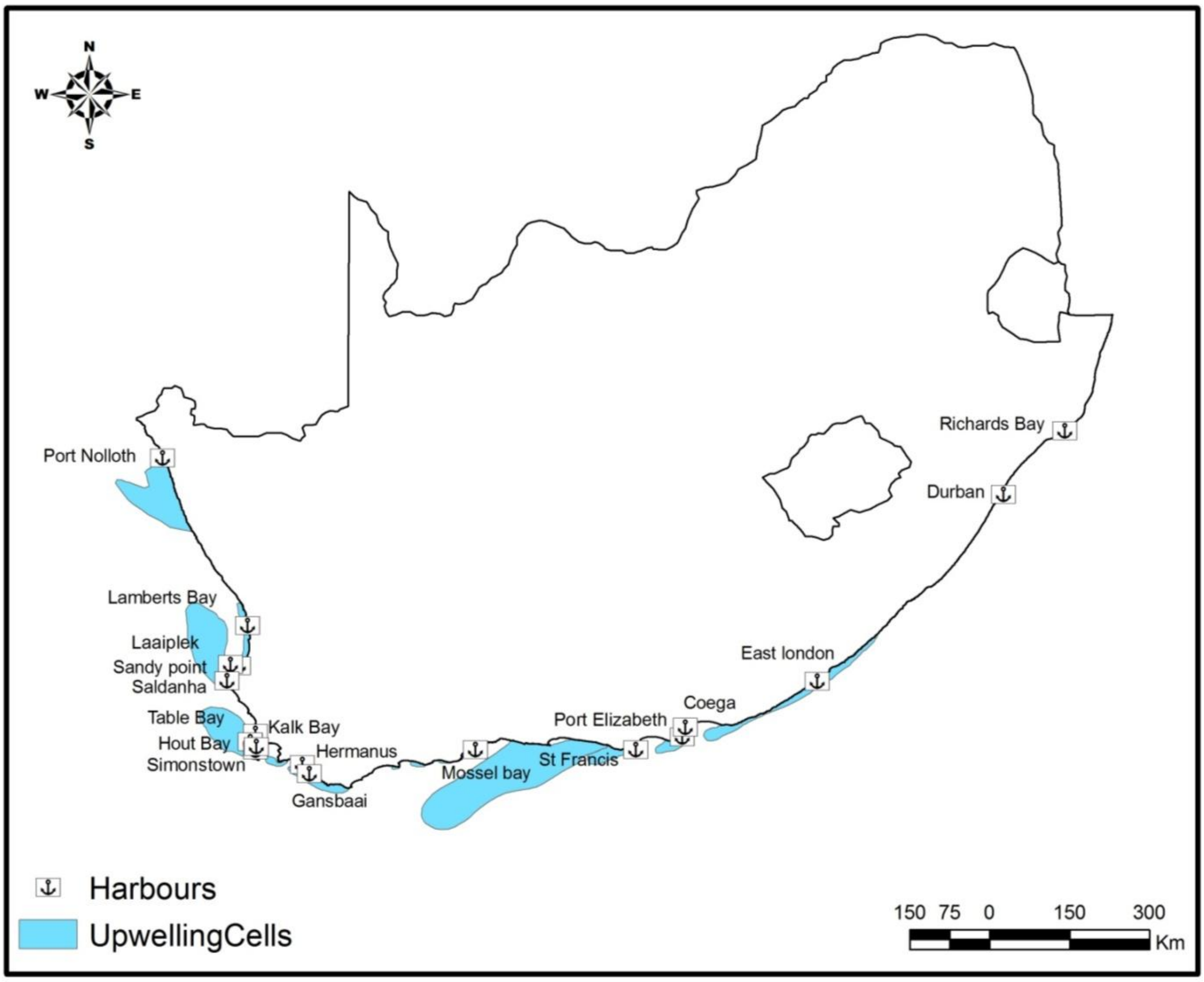

Figure 6. Nominal spatial extent of upwelling cells along the SA coast. Note that sudden temperature drops associated with the coastal movement of upwelled water may also occur outside of these identified cells.

5.4.3 Criterion: Exposure to waves, exclude areas exposed to more than 40% of the swells with significant wave heights greater than 3.5m.

Rationale: Exposure to dominant storm sea conditions could damage cages and will decrease frequency at which cages can be serviced.

Data on wave height and direction were obtained from voluntary observing ships (VOS) for a thirty year period (1980-2010) around the coastline (obtainable from SADCO). In total, 199 242 values of wave heights and directions were analysed. The coast was split up into 3 x 3 degree blocks and all data within each analysed separately. Wave roses depicting the swell direction, frequency and significant wave height were constructed for eight different blocks covering the South African coast (Figure 7). Data on waves that were greater or equal to 3 m were extracted as waves of this size range are considered to be potentially destructive for traditional floating mariculture pens and also prevent the servicing of cages. Frequency distributions of these waves (i.e. those greater or equal to 3m) according to their directions (bearings) for each assessment block were produced using bin sizes of ten degrees. The ten-degree bins were then ranked according to their percentage frequency values (i.e. the percentage of waves occurring at that direction). Finally, the percentage frequency values were added starting with those bin categories with the highest values until 66% of waves were accounted for (Table 2).

Table 2. An example of how the range of bearings from waves occurring 66% of the time were determined. In the example below the yellow highlight indicates the data accounting for 66% of waves and the bearing range is 170 to 210 degrees. Therefore areas that are exposed to waves coming from between 170 to 21 degrees should be avoided.

Bearing	% occurrence	Cumulative % occurrence
200	18.9	18.9
180	18.1	37.0
190	11.5	48.6
170	11.1	59.7
210	7.8	67.5
40	4.5	72.0
160	4.5	76.5
140	4.1	80.7
150	4.1	84.8
50	2.5	87.2
60	2.5	89.7
80	2.5	92.2
70	1.6	93.8
90	1.6	95.5
100	1.2	96.7
120	1.2	97.9
130	1.2	99.2
110	0.8	100.0

The range of bearings associated with this 66% of waves was then recorded. The rationale behind selecting 66% of waves greater or equal to 3 m translates directly into 2 out of 3 days when the swell is over 3 m that cages cannot be serviced and takes into consideration large waves that can damage and destroy sea cages. The GIS analysis then displayed two lines indicating the maximum and minimum bearings from swell 3 m or larger that occurs two thirds (i.e. 66%) of the time. Areas that were not exposed to waves greater or equal to 3 m two-thirds of the time (due to being within bays and within shelter from headlands) during rough sea conditions (i.e. when waves are 3 m or larger) were then classified as sheltered and deemed suitable for potential inshore aquaculture development zones. These swell bearings were mapped in GIS to display sheltered areas within the defined 20 km distance from suitable ports. It must be noted that these "sheltered" sites will still occasionally experienced waves with significant heights greater than 3 m from uncommon swell bearings and cage infrastructure will need to be able to withstand these conditions.

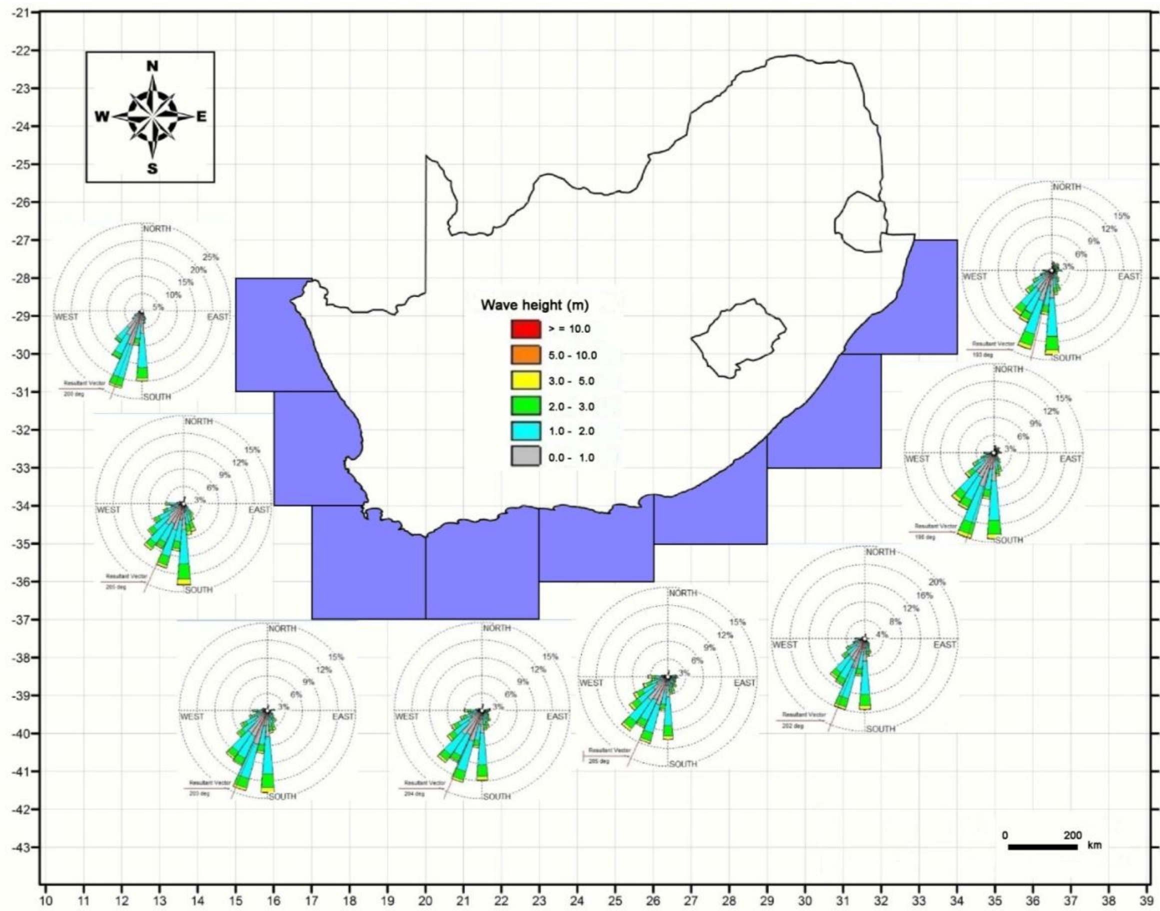

Figure 7. **Wave roses showing the frequency of significant wave heights and direction for three degree blocks around the SA coast based on SADCO Voluntary Observing Ships data.**

This criterion differed depending on whether the method was to identify ADZs suitable for the use of "Inshore" or "Offshore" fish cage systems (see Section 3.1). In short, Inshore ADZ identification considered wave climate as an exclusionary criterion while “Offshore” ADZs did not. Offshore ADZ identification, which is not limited by the wave climate criterion, was incorporated as an additional analysis as it was felt by stakeholders that in view of the envisaged limited number of suitable areas for Inshore ADZs, that potential existed in future for the necessary technologies to support alternative offshore fish cage infrastructure.

5.4.4 Criterion: Turbidity and pollutants associated River Mouths – create a precautionary buffer.

Rationale: Decreased salinity, high turbidity, poor water quality may negatively impact growth rate and health of cultured stock.

Google Earth was used to measure the visible plume extent of a range of different size rivers. These visible plumes depict the river water mixing zone with respect to suspended sediments only, and it is noted that the region of altered (reduced) salinity is likely to be somewhat larger than this. Data on the extent of reduced salinity water is however scarce and much of what is available relates to the effects of floods on SA’s largest River (the Orange). During extreme flood events in the Orange River (> annual MAR in a flood event) a 5 PSU reduction in salinity has been measured as much as 200 km either side of the River mouth (Shillington *et al*. 1990). This salinity reduction may cause chronic effects on fin fish that are not tolerant of euryhaline water (e.g. yellowtail), but is substantially outside of the lowest observed effect concentration for euryhaline fin fish such as dusky kob. Under non-flood (baseline wet season conditions) the zone of salinity reduction of >1 PSU around the mouth of the Orange River is very similar to the visible plume extent i.e. about 20 km radius.

We used the approach of estimating and mapping the “typical” maximum extent of the river plume under “normal” (i.e. not extreme flood event) conditions. The rationale for this being that extreme flood events are transient conditions that may temporarily affect farm productivity, but should not cause a catastrophic loss of stock provided that the farm is situated outside of the “normal” condition buffer zone. Where visible plumes were measurable in more than one satellite image captured at different times, the average value was plotted against MAR (Figure 8). Mean annual runoff data was obtained from the National Spatial Biodiversity Assessment (Turpie 2004). This relationship was used to calculate expected plume dimensions for all rivers within the 20 km radius of ports identified as suitable to support marine finfish farm operations. These buffers were then scaled according to the Estuarine Health Index Water Quality Score (Harrison *et al.* 2000), whereby the dimensions of the buffer was increased by 20% for estuaries with a “Very poor” (Water quality

Index value =1-3) and by 10 % for estuaries rated as having a “Poor” water quality class (WQI = 3-5). The buffer around estuaries with a WQI value greater than 5 i.e. “Fair”- “Very Good” was left unchanged from that predicted by the relationship between MAR and visible plume dimensions.

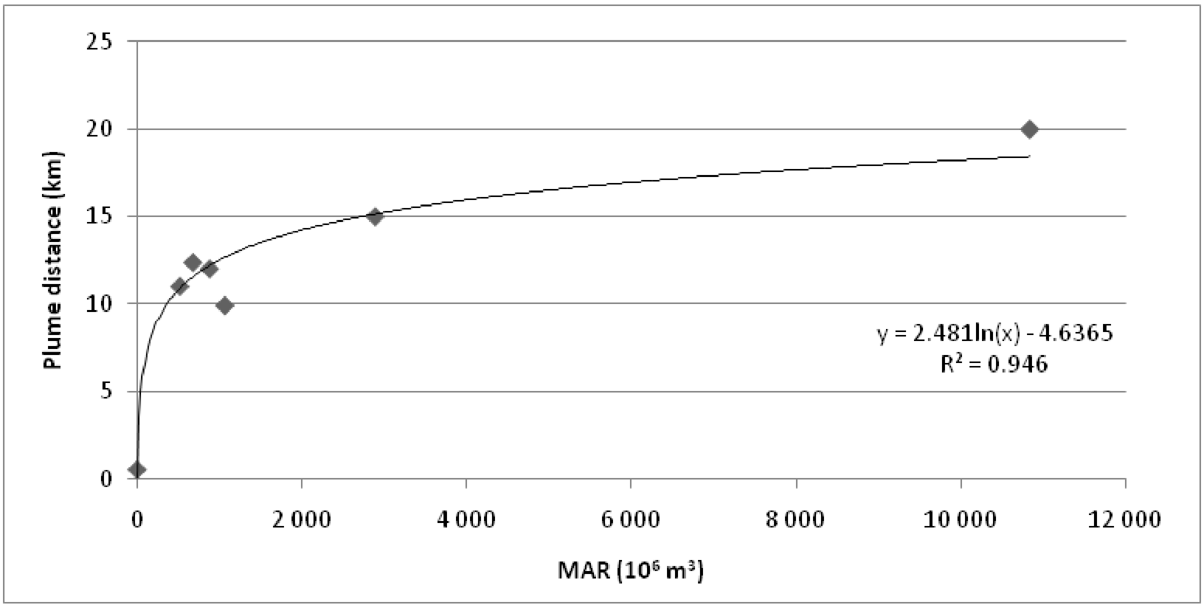

Figure 8. **The relationship between Mean Annual Runoff (MAR) and visible river plume extent was best described by a logarithmic function.**

5.4.5 Criterion: Point source pollution, create a 500m default safety buffer, or buffer the maximum known plume extent

Rationale: Pollutants may negatively impact growth rate, health and of marketability of cultured stock.

It was not possible, within the timeframe of this SEA to obtain data, even on the coordinates of waste pipelines for much of the country (with exception of the KZN coast). This will have to be a secondary analysis confined to shortlisted sites. It will be necessary to ascertain the type of pollutants and dilution rates at the pipe end and then create meaningful buffers in each instance. Sourcing and interpreting data for areas selected as potential ADZs will have to be undertaken during the EIA phase of this project.

5.4.6 Criterion: Currents, exclude areas that regularly experience current speeds greater than 150 cm.sec^{-1}

Rationale: Current speeds greater than 150 cm.sec^{-1} can deform cages and damage moorings.

This criterion is only applicable where interaction with the Agulhas current is likely. As the current does meander and exhibits several shear edge features, the approximate inshore boundary of the Agulhas current was mapped using a combination of published current data (Roberts *et al.* 2010) and long term (last 9 year average) satellite sea surface temperature data (Figure 9).

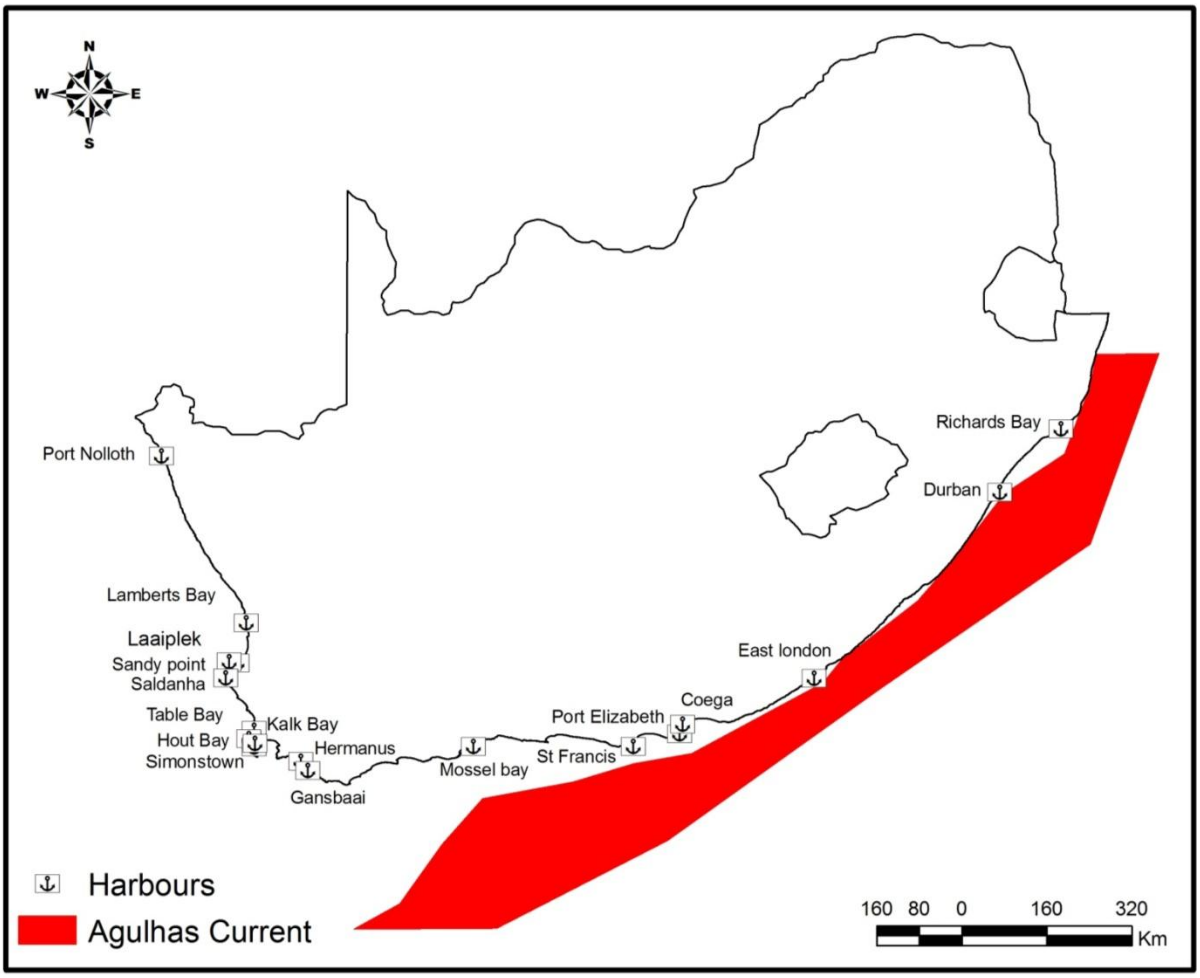

Figure 9. Approximate inshore boundary of the Agulhas current based on published current measurements and satellite imagery. note that the offshore boundary is beyond the area under consideration for ADZs and was not defined.

5.4.7 Criterion: Harmful algal blooms (HABs) and anoxia, exclude areas under the regular influence of these events

Rationale: HABs and anoxia may negatively impact survival, growth rate and health of cultured stock.

Stakeholder discussions and expert knowledge (Drs G Pitcher and T. Probyn, DAFF) led to the exclusion of all areas of the west coast to the north of Cape Columbine due to the perceived high risk of HAB or low oxygen events (Figure 10).

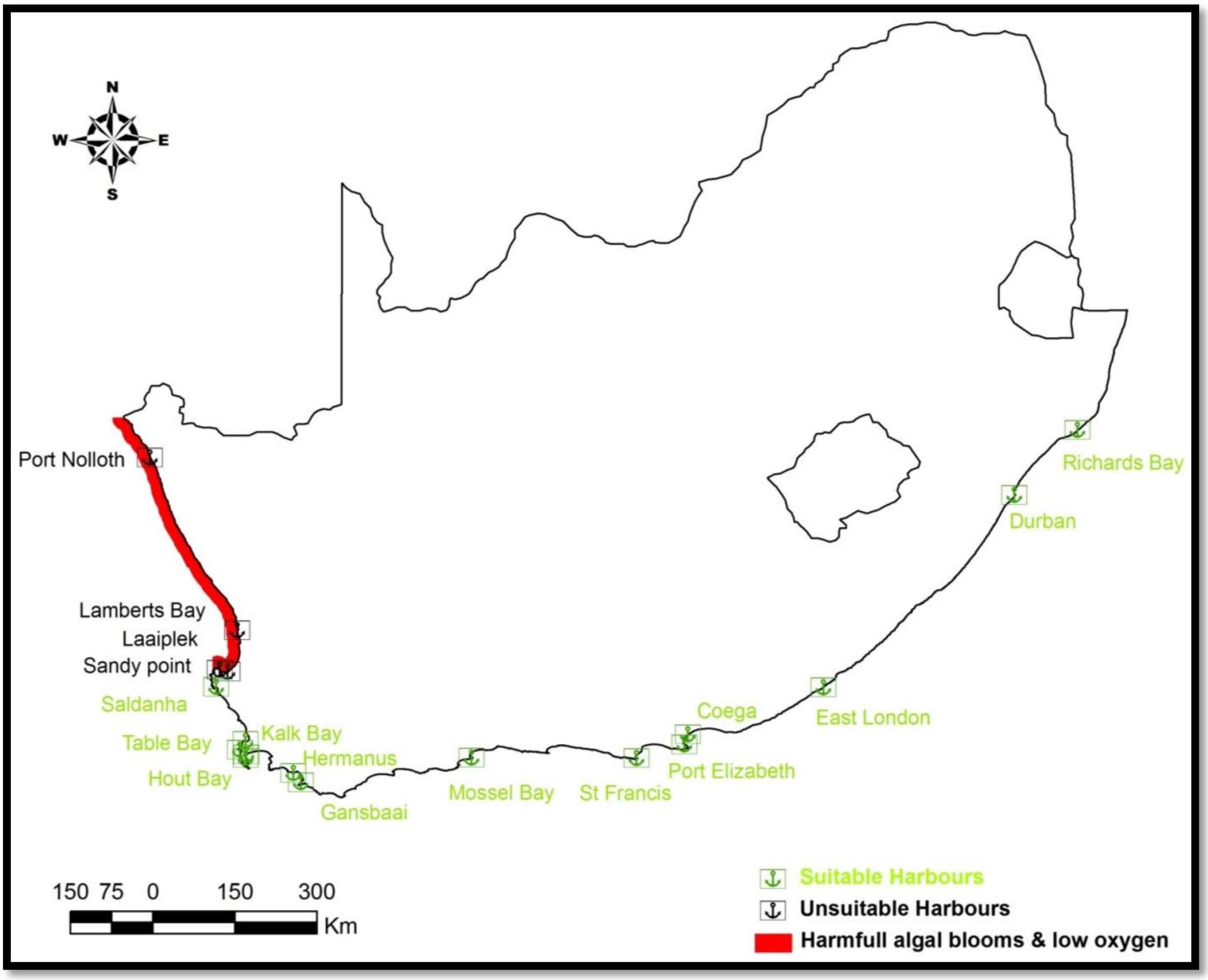

Figure 10. Map of South Africa showing remaining suitable ports after west coast north of Cape Columbine is excluded due to the high risk of harmful algal blooms and or low oxygen water.

5.5 Environmental sensitivity

5.5.1 Criterion: Exclude known reef areas and other sensitive marine habitats.

Rationale: Reefs are regarded as sensitive habitats likely to be more severely impacted by farm effluent than sandy substrate. Avoiding Critically endangered and endangered habitats was in an attempt to minimize the environmental impacts of marine fish farms.

The South African National Biodiversity Institute (SANBI) marine ecosystem threat status layer was acquired for use in this project (Figure 11). This threat status map and accompanying GIS layer was constructed based on extensive mapping of defined coastal and marine habitats (136) and pressures (27 pressures on coastal and marine biodiversity). The habitat classification incorporated several key drivers of marine biodiversity patterns including terrestrial and benthic-pelagic connectivity, substrate, depth and slope, geology, grain size, wave exposure and biogeography. Note that this layer includes the only national scale data on seabed habitat types e.g. reefs. It was decided to exclude critically endangered and endangered habitat for potential ADZs, as these areas should not be considered as suitable for fin fish mariculture. Critically endangered habitats are those that have very little of their original extent left in natural or near-natural condition. Any further loss of natural habitat or deterioration in condition of the remaining healthy examples of these habitats must be avoided, and the remaining healthy examples should be the focus of urgent conservation action. Endangered habitats are close to becoming critically endangered and as such any further loss of natural habitat or deterioration of condition in these habitat types should be avoided

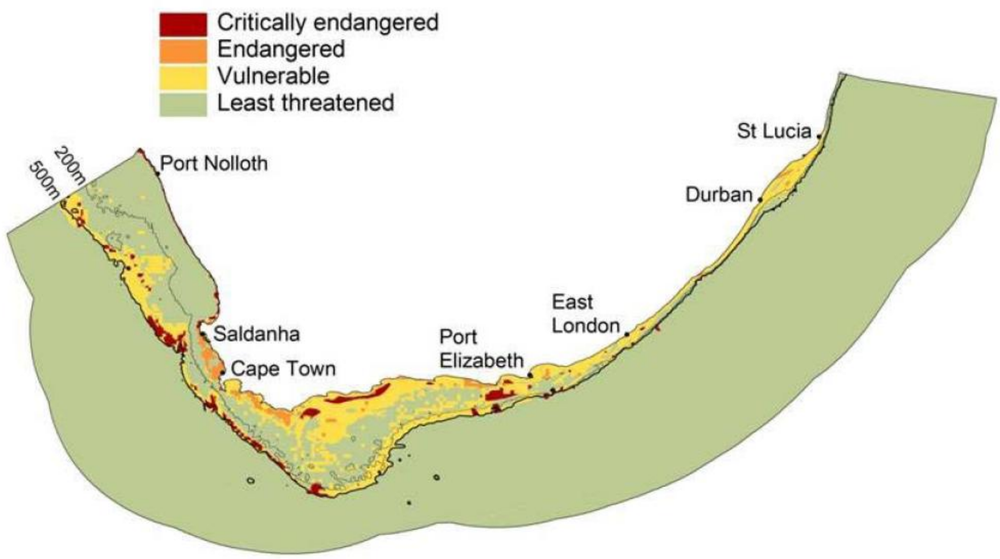

Figure 11. Marine ecosystem threat status as determined by the South African National Biodiversity Institute as part of the 2011 National Spatial Biodiversity Assessment (Sink *et al.* in prep). Endangered and critically endangered habitats were not considered for finfish cage ADZs.

5.5.2 Criterion: Exclude Marine Protected Areas

Rationale: Marine Protected Areas (MPAs) fulfil numerous conservation, research and socio-economic roles and should remain as pristine as possible.

A recently developed GIS shape file showing current and proposed (advanced planning stage) MPAs was obtained from SANBI. This is the most up to date spatial data on South African MPAs and was used to exclude MPAs for selection as potential ADZs. Note that focus areas for offshore biodiversity protection through MPAs and other spatial management measures have recently been identified (Sink *et al*. 2010) but these have not been included.

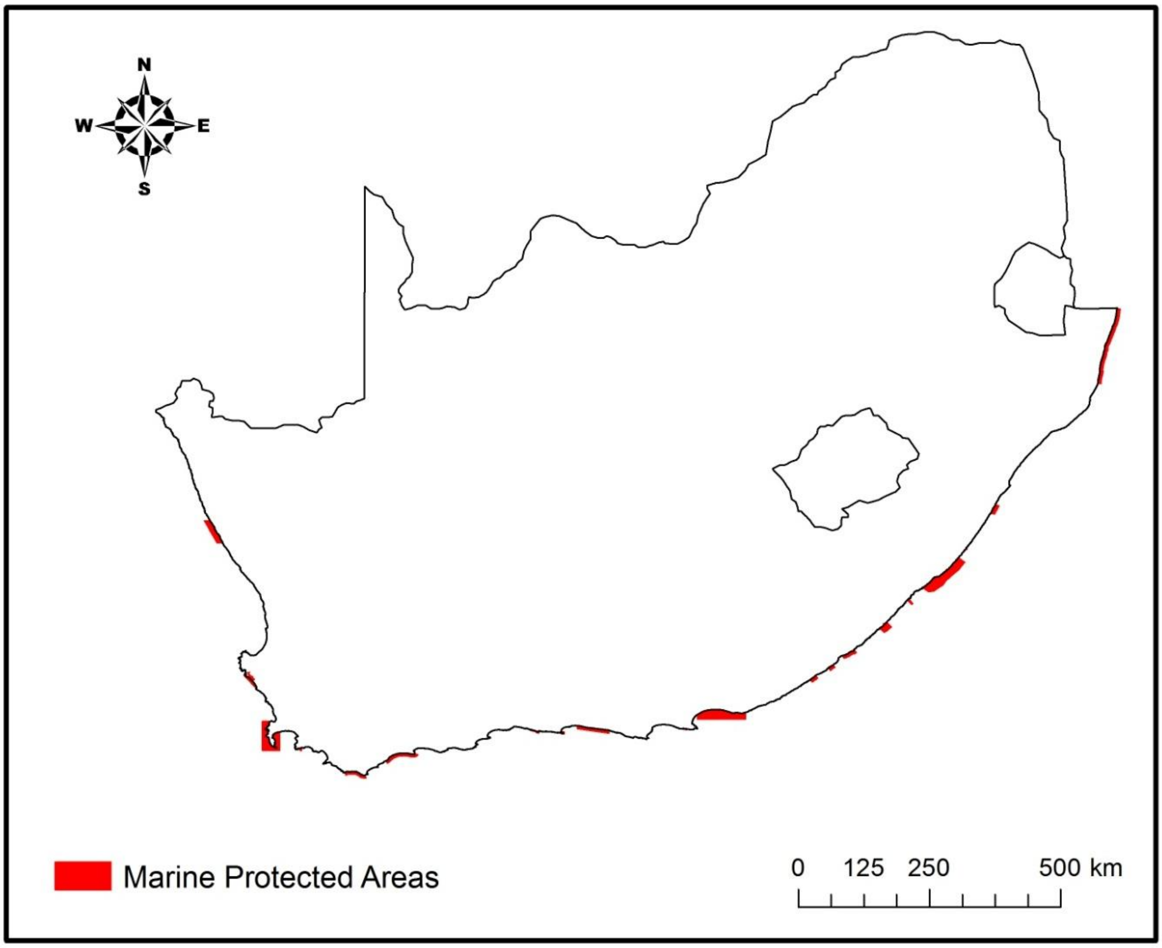

Figure 12. Current and planned coastal Marine Protected areas of South Africa (Source SANBI)

5.5.3 Criterion: Avoid archaeologically important shipwrecks

Rationale: Mooring/anchoring and deposits from fish farms may damage archaeologically important sites.

This will be considered as a secondary analysis during the EIA phase as it appears likely that comprehensive information on the location of shipwrecks does not yet exist. The South African Heritage Resources Agency (SAHRA) will be approached with the coordinates of potential ADZs and asked to provide input on potential risks to underwater archaeological heritage resources in these areas. Should any previously unknown shipwrecks be discovered during the EIA phase field surveys, SAHRA officials will be contacted.

5.6 User conflict

5.6.1 Criterion: Avoid areas that are important to existing commercial activities (e.g. fishing, mining, shipping).

Rationale: Mariculture development should not unduly impact existing economic activities.

The use of the SANBI Offshore Marine Protected Areas (OMPA) project cost layer, which includes spatial data on all commercial activities, was secured for use in this project. Although Sink et al. (2010) used this layer to minimize the impact of planned MPAs and other types of spatial management on industry sectors, it has application in spatial planning where the aim is to minimize impact on industry and impact all other sectors equally. A brief description of the spatial data contained in the cost layer was drawn from Sink *et al.* (2010):

"Systematic planning software was used to meet a series of targets whilst minimising the impact of identified priority areas on industry. This was operationalised by developing a "cost metric". The cost metric reflects the relative overall importance of an area to industry and included commercial fisheries, oil and gas, diamond and other minerals mining and shipping. The metric was calculated based on the following principles: Each industry sector was given equal weighting, for example each fishery and each mining sector. If a sector consisted of several subsectors, this was weighted according to the importance of that subsector, based on expert opinion. For example in the small pelagics fishery, there are three target species; red eye, anchovy and sardine, and the assigned weighting used 10/40/60 according to the estimated relative importance of each of these three species to the overall fishery (considering the value of catch species and the past, current and projected total allowable catches). The cost value for each industry in a planning unit was based on its relative importance to that industry. For many industries it was just the presence of that sector e.g. a mining lease, while for others, such as fishing industries, cost was assessed by relative effort or catch. Each cost value was standardised by dividing the value by the summed value (across all planning units).

A simplified version of the of the cost equation used to calculate the cost metric is shown below:

General costs = Crustacean trawl effort (hours) + demersal inshore trawl effort (hours) + Demersal offshore trawl effort (hours) + Midwater trawl effort (hours) + Commercial linefish effort (no. of boat days) + Hake longline effort (total hooks) + Shark directed longline effort (hooks) + Sharknets (no.) + (0.6*Tuna pole (Albacore) + 0.4*Tuna pole (Yellowfin)) + Large pelagics effort (Hook no.) + (0.5* Small pelagics:Pilchard Catch + 0.4* Small pelagics: Anchovy Catch + 0.1* Small pelagics:Redeye Catch) + South coast Rock lobster effort (total traps) + West coast Rock lobsters Effort (total traps) + Squid Effort + (0.66*Diamond mining Lease type:Mining + 0.17*Diamond mining Lease type:Prospecting + 0.17*Other minerals Lease type:Application) + (0.3*Petroleum lease status:Exploration + 0.6*Petroleum lease status:Production + 0.1*Petroleum lease status:Tech Co-op Permit) + Petroleum Oil and gas wellheads status:Suspended + Shipping intensity"

It is clear that this GIS layer is invaluable for spatial planning and can be used to avoid potentially user conflicting the marine environment. This layer took a substantial amount of time (years) to develop after acquiring, mapping and integrating data representing 19 sectors It is highly unlikely that such a comprehensive product could have been developed from scratch within the time constraints for the SEA revision. The distribution of cost values as categorical divisions – (e.g., low, medium & high cost categories arbitrarily based on three catergories are shown in Figure 13. The absolute relative cost values will be used to rank potential ADZ sites that met all other primary site selection criteria. It should be noted that the SANBI cost layer theoretically only took account of industry activities taking place in waters deeper than 30m depth. However, data for any activities that also occurred shallower than 30m were included in the cost layer The mapping resolution of 7km by 9km therefore assigned a cost value to areas shallower than 30m and certainly the cost value assigned to a block straddling the 30m depth contour is likely to be applicable to the 20-60m depth zone that was considered for inshore mariculture. During the EIA phase, the actual impact on any industries active in any potential ADZ will need to be quantitatively assessed using finer spatial scale data (e.g. commercial fishery catch returns).

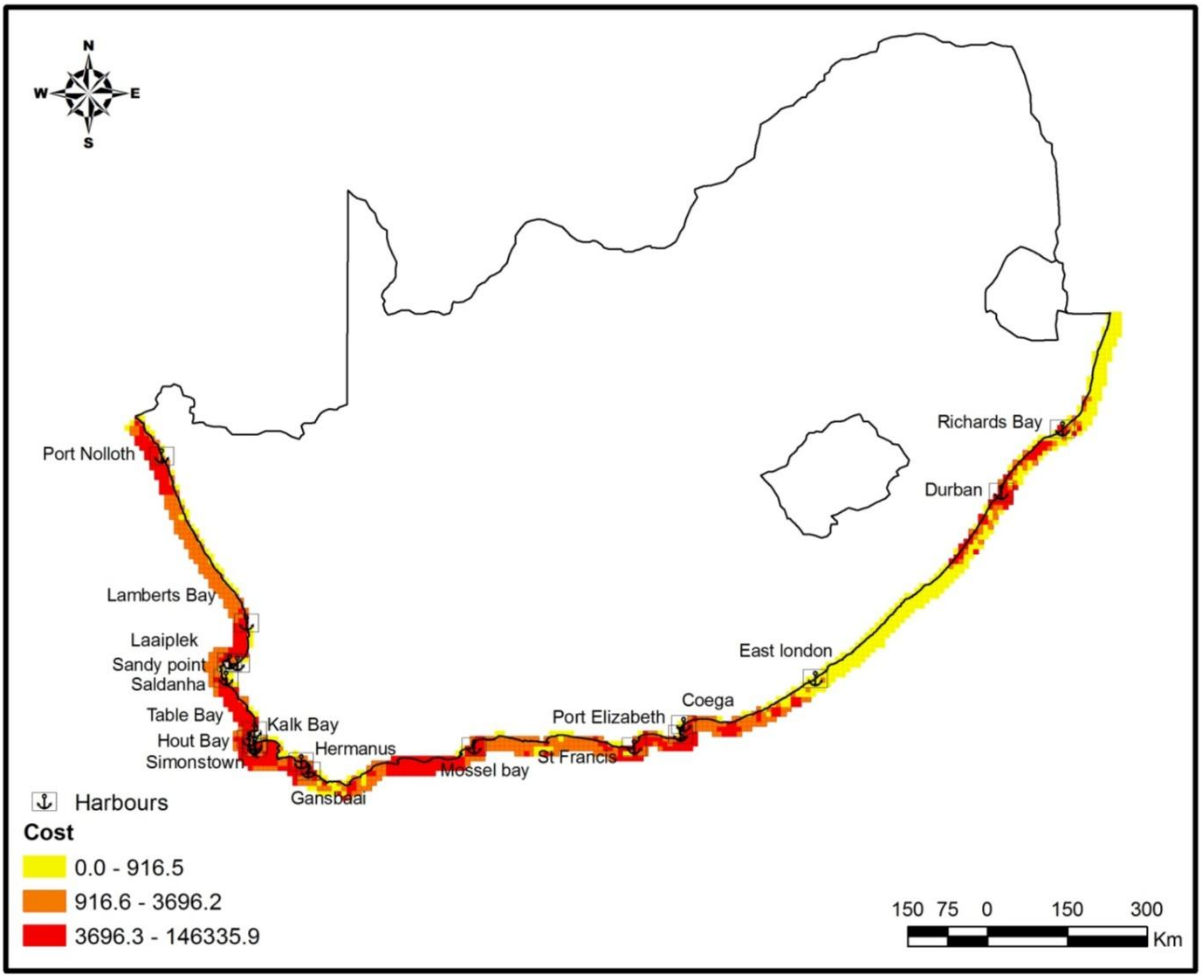

Figure 13. Graphical representation of the cost layer, arbitrarily displayed using three catergories. The absolute cost values were used to assess sites that met all other exclusionary criteria.

5.6.2 Criterion: Avoid popular recreational areas & important marine ecotourism activities.

Rationale: Mariculture development should not unduly impact existing ecotourism and recreational activities.

These potential user conflicts are not included in the cost layer developed to support offshore MPA planning (Sink et al. 2011) because most coastal recreational activities will not be impacted by MPAs. Data on the spatial extent of white shark cage diving concessions were obtained from DEA and these areas were excluded from consideration as potential ADZs. Boat-based whale watching concessions cover much of the Cape coast and data on the coordinates of whale sightings by operators was not available within the time frame of this project. The whale sanctuary area off Walker Bay was excluded, and the core area of the southern right whale breeding and calving area off De Hoop is also excluded by default as it is a declared MPA. Other important whale and dolphin habitats that may lie within identified potential ADZs will still need to be defined during the EIA phase and avoided. Data on the spatial distribution of other recreational activities e.g. sailing regattas, kite surfing, sea kayaks will be sourced for areas selected as potential ADZs in this primary analysis and addressed during the EIA phase of this project

These site selection criteria as applied in the GIS exercise are summarised in Table 3.

Table 3. **Criteria considered in the GIS-based analysis as inclusionary, exclusionary or precautionary for Inshore and Offshore ADZs.**

Criteria (Include if)	Inshore ADZ	Offshore ADZ	Data Source	Comment
Harbour can accommodate vessels ≥ 15m	Yes	Yes	Stakeholder discussions	
Within 20km from suitable harbour			Stakeholder discussions	
Wave climate suitable	Yes	NA	SADCO – Voluntary observing ships (VOS)	See definition of suitable wave climate in Section 5.2
Depth between 20-60m	Yes	NA	Stakeholder discussions	The minimum depth criterion was reduced to 12m for Saldanha and RichardsBay Inshore ADZs
Depth between 30-150m	NA	Yes	Stakeholder discussions	
Criteria (Exclude if)				
In Shipping lanes	Yes	Yes	South African Navy (SAN) Charts	
Over dredged areas	Yes	Yes	SAN Charts	
In anchorage area	Yes	Yes	SAN CHarts	
Over dumping grounds	Yes	Yes	SAN Charts	
Over sub cables	Yes	Yes	SAN Charts	
Over sub pipelines	Yes	Yes	SAN Charts	
Influenced by harmful algal blooms and or hypoxia	Yes	Yes	Expert knowledge	
In a Protected Area	Yes	Yes	SANBI MPA GIS layer	
In a proposed Protected Area	Yes	Yes	SANBI MPA GIS layer	
In critically endangered or endangered ecosystems	Yes	Yes	SANBI ecosystem threat status GIS layer	
White shark cage diving zone	Yes	Yes	DEA	
In intense upwelling cells	Yes	Yes	Expert knowledge	**
In current of ≥ $150 cm.S^{-1}$	Yes	Yes	Aghulas Current (Roberts et al. 2010 & Average SST)	
Within influence of waste outfalls & industrial waste	Yes	Yes	B. Newman, CSIR	
Criteria (Precautionary)				
Within influence of river plume	Yes	Yes	Plume extent modelling, mean annual runoff & water quality index (Google Earth, Harrison *et al*. 2000)	Depends on fish species farmed. E.g. avoid for Yellowtail
East coast upwelling cells	Yes	Yes	Expert knowledge	**
Military practice area	Yes	Yes	SAN Charts	
Administered harbour area	Yes	Yes	SAN Charts	

6 IDENTIFIED POTENTIAL ADZ SITES

The coordinates defining potential inshore and offshore ADZs are provided in Appendix 4. The final GIS layers showing only identified potential inshore and offshore ADZs associated with suitable ports are shown below, arranged in order from west to east around the South African coast. In order to keep this report as succinct as possible, the GIS layers showing each of the criteria that were mapped independently are included in the Appendix 5. Appendix 5 also includes GIS products for ports where no suitable ADZ space was found within the 20 km buffer. A summary of the potential inshore sites, including the SANBI cost values and secondary ranking scores are given in §6.9.

6.1 Inshore ADZs

6.2 Saldanha Bay

Two inshore zones, Saldanha 1 in Big Bay is 461 ha in extent, and Saldanha 2 is 147 ha (Figure 14). Both zones are in relatively shallow water, 12-20m in depth. Zone 2 lies within the Saldanha Bay port area. This area may not be acceded to by the Port authorities as it will probably interfere with shipping movements, particularly as tugs need to manoeuvre bulk ore and crude oil carriers for loading and offloading at the iron ore and oil jetty. Furthermore, environmental monitoring of Small Bay has detected the presence of industrial and domestic pollution and although shellfish mariculture is currently undertaken in the area, it may be undesirable to develop fin fish farms in this area (Anchor Environmental 2010). Should the DAFF wish to pursue mariculture development within Saldanha Bay; industry, military, recreational and conservation (including SAN Parks who manage the adjacent terrestrial and marine protected areas) stakeholders would need to be engaged during an EIA process, as is the case with any other potential site identified in this SEA. The 2011 National Biodiversity assessment indicated that Langebaan, South Africa's only lagoon ecosystem is vulnerable and recommended that this habitat should not be placed under any additional anthropogenic pressure.

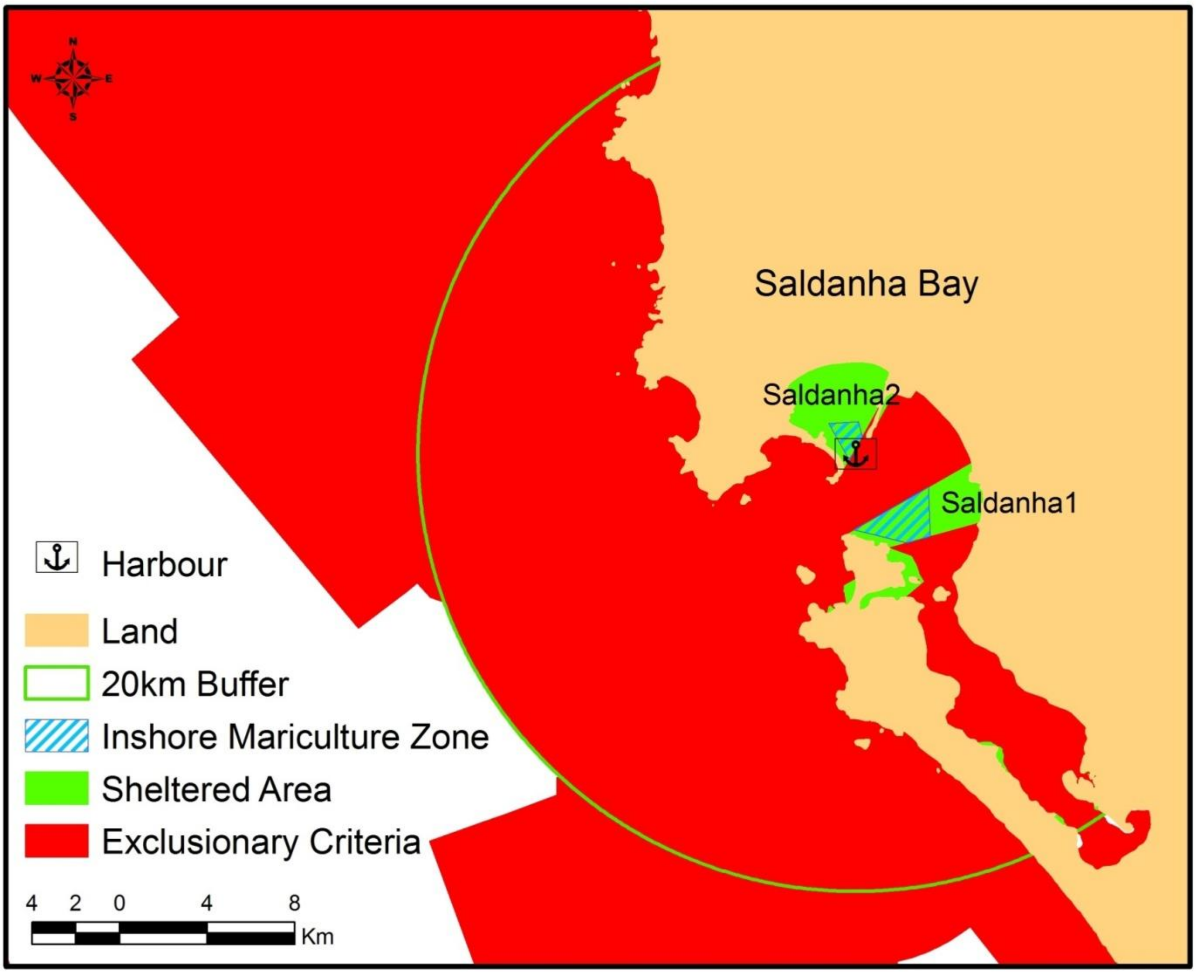

Figure 14. Areas that met the site selection criteria for potential finfish aquaculture development zone using inshore cage technology within a 20 km radius of Saldanha Bay.

6.3 Mossel Bay

Three potential zones meet the selection criteria in Mossel Bay; Zone 1 is approximately 5 200 ha and starts just 2 km from the port entrance. The proposed I&J yellowtail and kob farm falls within this potential ADZ (see §3.3). Zones 2 and 3 are to the west of Cape St Blaize, 511 ha and 1 200 ha in extent, respectively. These zone are located much further from the harbour (15-20 km away) but probably have lower cost to competing users (see §6.8).

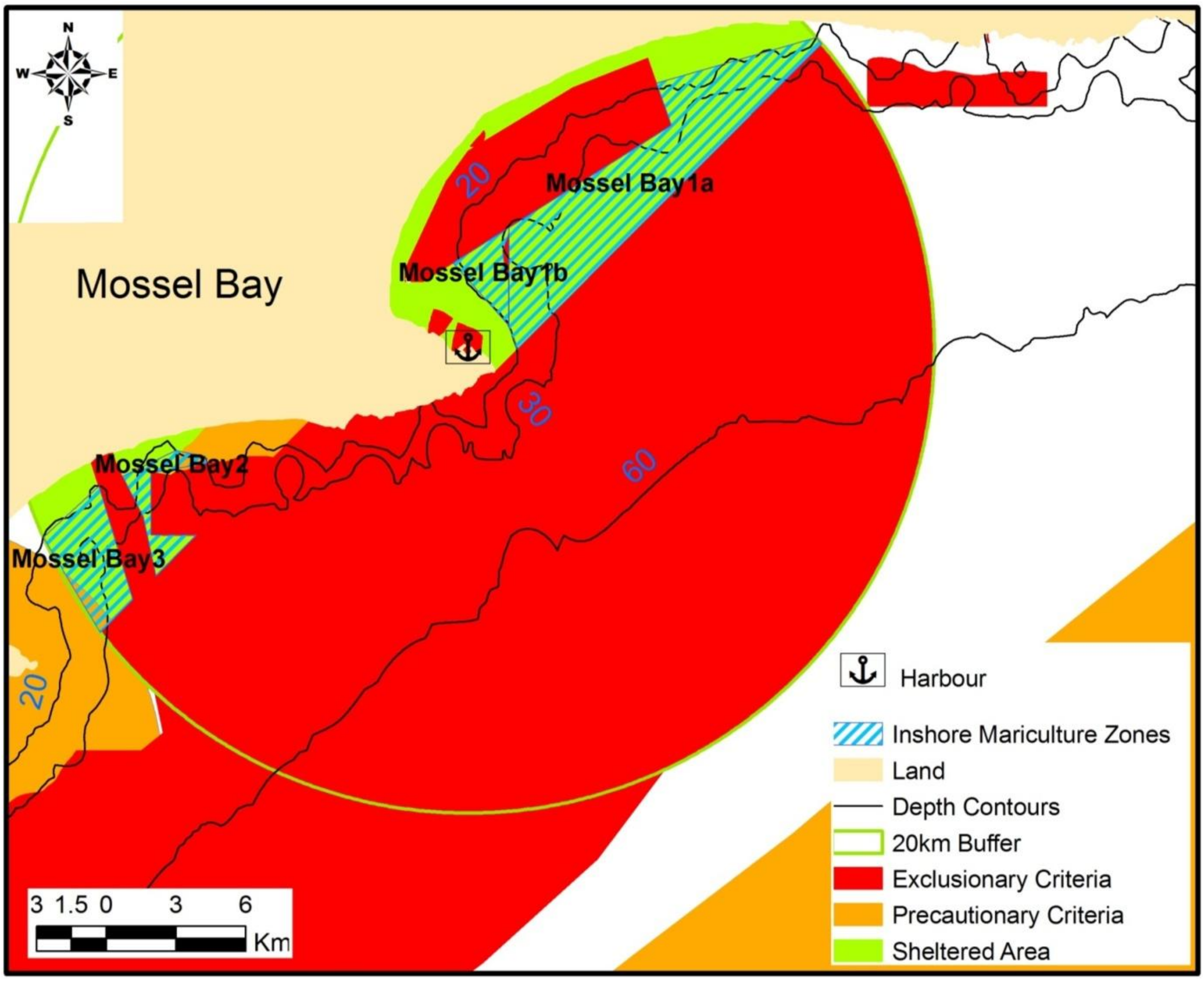

Figure 15. Areas that met the site selection criteria for potential finfish aquaculture development zone using inshore cage technology within a 20 km radius of Mossel Bay.

6.4 St Francis

Two potential ADZ sites were identified in St Francis Bay. Zone 1 is 1 474 ha in extent, and starts 14 km from the harbour entrance (actually within Jeffery's Bay). Zone 2, is only 47 ha in extent and, although it starts only 2.7 km from port entrance is not large enough to function as an ADZ (may accommodate a single small fish farm).

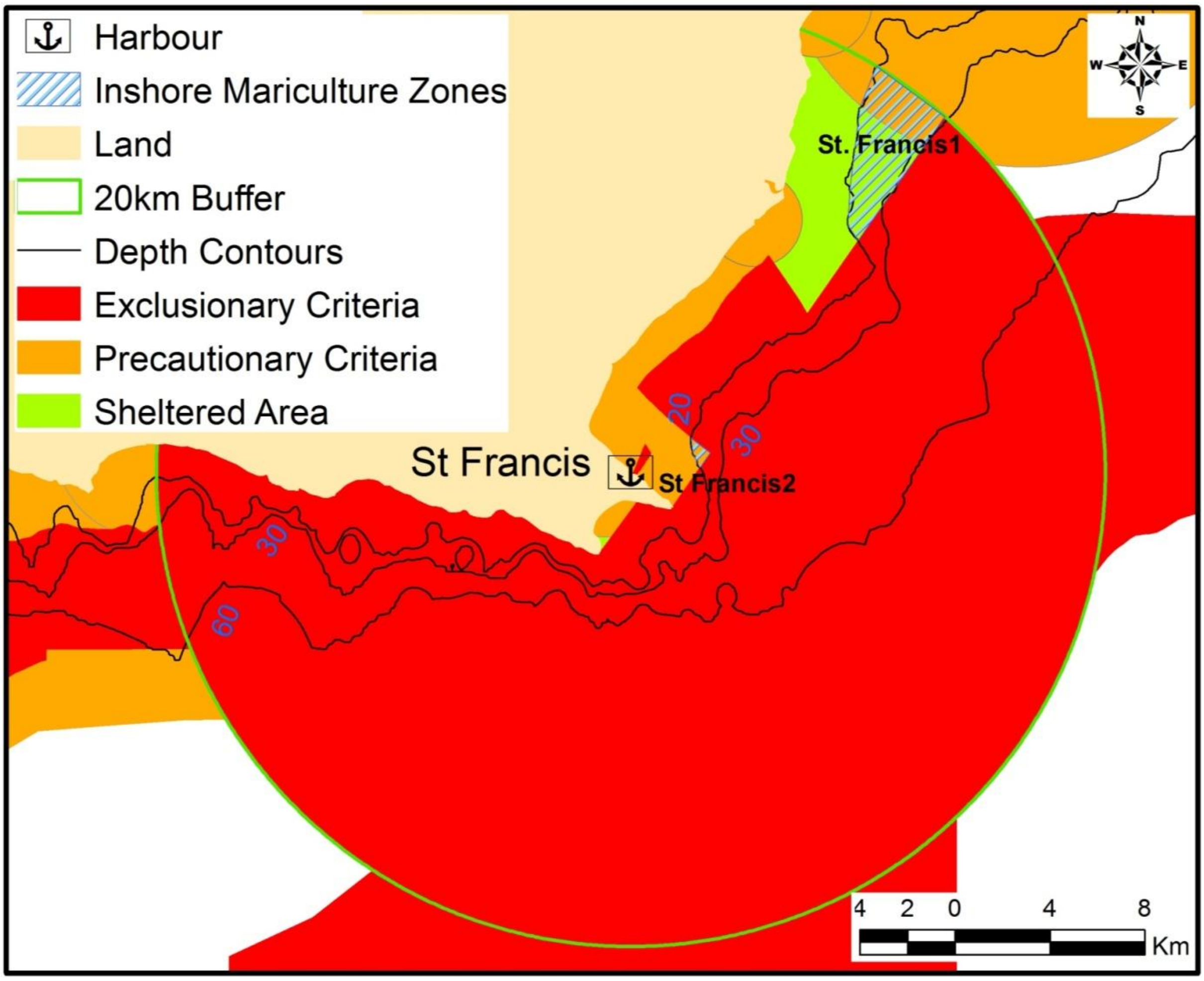

Figure 16. Areas that met the site selection criteria for potential finfish aquaculture development zone using inshore cage technology within a 20 km radius of Port St Francis.

6.5 Port Elizabeth/Coega

Three potential inshore ADZs were identified within Algoa Bay. Zone 1, Zone 2 and Zone 3 can be accessed from either Port Elizabeth or Coega harbours. Zone 1 is slightly smaller if the 20 km buffer from Coega is applied (509 ha vs. 665ha), and it is much closer to the PE harbour entrance (4 km vs. 16 km). Zones 2 and 3 are 279 ha and 542 ha in extent respectively and lie between 6 km and 12 km from the port entrances, respectively. Defined shipping lanes and anchorage areas limit much of the available sheltered sea space within Algoa Bay; the remaining areas are nonetheless suitably large to function as ADZs.

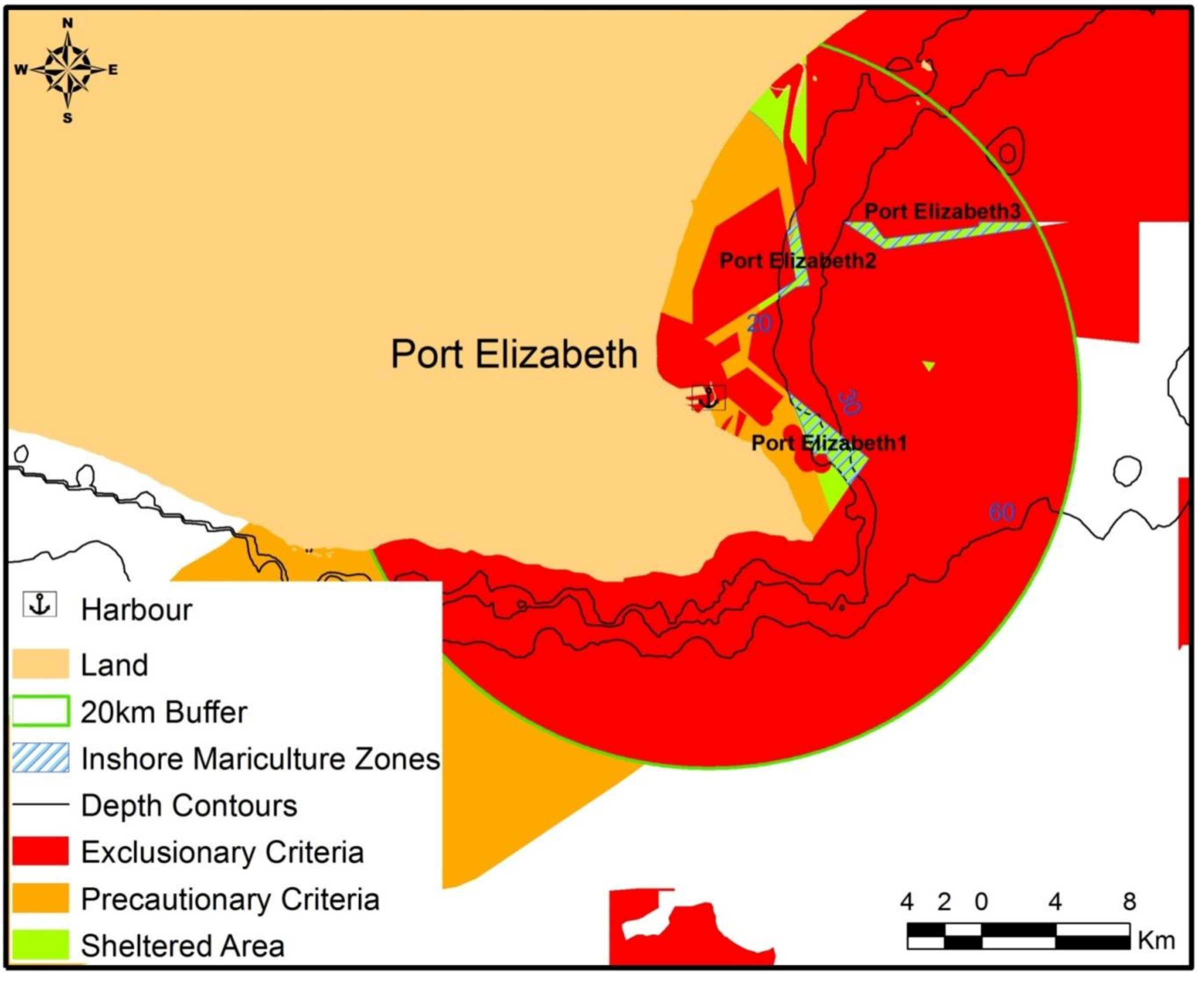

Figure 17. Areas that met the site selection criteria for potential finfish aquaculture development zone using inshore cage technology within a 20 km radius of Port Elizabeth and Coega harbours.

6.6 Offshore ADZs

Potential offshore ADZs that were identified using the criteria described above are shown in Appendix5. These potential ADZs are only suitable for sea cage technologies that can withstand severe storm events (the wave exposure criterion has not been applied at all). We do not recommend pursuing declaration of these areas as ADZs at the present time, as substantial research and development and capital investment would be required before viable fish farms could be developed in offshore waters in South Africa. Potential offshore ADZs would also require further investigation into the cost to other industry (the relative cost to other industry was not taken into account). These potential areas have been identified here simply to assist DAFF with decision making should applications be received in the future from companies wishing to undertake offshore fish cage culture in South Africa.

6.7 Scoring of potential inshore ADZs

Potential inshore ADZ sites were scored according to the criteria shown in Table 4. If a potential zone lay partly within a known upwelling cell east of Cape Agulhas, it was allocated a score of minus 1. It was noted where potential zones may be under the influence of river mouths with associated decreased salinity and increased turbidity but were not negatively scored as these conditions may not adversely affect some potential mariculture species.

Table 4. Secondary ranking criteria applied to shortlisted potential inshore ADZs.

Criterion	**Points**				
	-1	0	1	2	3
Logistical considerations					
Distance from a suitable port			10-20km	5-10km	0-5km
Water depth (traditional sea cages)			50-60m	30-50m	20-30 m
Water depth (submersible cages)			100-150m	60-100 m	30-60 m
Environmental considerations					
Distance from MPA		0-500m	500-1000m	1000-1500m	>1500m
Environmental suitability					
Upwelling cells	If within				
Turbidity/River mouths	Not allocated points as may be suitable to some fish species				

Results of the secondary criteria scoring exercise are presented in Table 5. Two of the sites, Saldanha 2 and St Francis 2 (that received a favourable score based on these criteria) are probably too small to be considered for the development of ADZs (a 200 ha area was considered by stakeholders to be the minimum suitable size for the development of an ADZ). These two small sites have been included here as stakeholders felt strongly that no identified sea space should be ignored and may be suitable for single use farms. In terms of these criteria, the remaining sites had similar scores, with the one Algoa Bay site (PE/Coega 1) and two of the Mossel Bay sites scoring highest.

Table 5. **Results of the secondary ranking exercise applied to shortlisted potential inshore ADZs. The two sites highlighted in red font are probably too small to be considered for the development of ADZs.**

Potential ADZ	Logistical Considerations		Environmental Considerations	Environmental Suitability		Total Score
	Distance from harbour	Water Depth	Distance from MPA	Upwelling Cells	River Plumes	
Saldanha 1	3	3	0	o	no	3
Saldanha 2	3	0	1	o	no	4
Mossel Bay 1	3	2	3	o	most of it not	8
Mossel Bay 2	1	3	3	-1	no	6
Mossel Bay 3	1	3	3	o	most of it not	7
St Francis 1	1	3	3	o	most of it not	7
St Francis 2	3	3	3	o	all of it	9
Port Elizabeth 1	3	3	3	o	no	9
Port Elizabeth /Coega 2	2	3	1	o	most of it not	6
Port Elizabeth/Coega 3	1	2	0	o	no	3
Coega 1	1	3	3	o	no	7

6.8 Comparison with industry cost layer

An industry cost layer (Sink et al. 2010) was overlaid on identified potential inshore ADZs in Arc View 9.1. In cases where more than one cell (7 by 9 km) in the cost layer applied to an identified potential ADZ the average cost value was calculated based on the proportional area of the ADZ within each different value cost cells. The cost layer was developed for industries active mostly in water deeper than 30 m and was therefore not applied to the potential Saldanha ADZs that are entirely in water shallower than this. The results of this exercise, along with other information on identified potential ADZs are presented in Table 6. The two potential sites to the west of Mossel Bay (2 & 3), and the two sites closest to the port of Coega in Algoa Bay (PE/Coega 2 & 3), rank highest in terms of having the least cost to other industries. The site that ranks most favourably in terms of the secondary criteria (PE/Coega1) unfortunately ranks poorly in terms of cost to other industries (probably indicating the conflicting spatial requirements of many commercial marine activities). The cost values presented here give an indication of the likely cost of declaring any of these sites ADZs to other existing marine industries, but we do emphasise that this layer does not take into account all potential user conflicts. The cost values need to be further investigated using finer spatial scale and more comprehensive data that accounts for other inshore coastal sectors i.e. supplemented with data to reflect ecotourism activities, recreational areas etc, and via engagement with stakeholders during the public participation phase of any site specific EIA that would need to be undertaken prior to declaration of an ADZ.. The two sites highlighted in red font may be suitable for single operators, but are probably too small to be considered for the development of ADZs.

Table 6. Summary information on identified potential ADZs suitable for finfish cage culture using "inshore" technology. The sites are ranked both in terms of the cost per unit area and based on the secondary criteria.

Potential Inshore ADZ	Area (Ha)	Distance from Port (km)	SANBI Cost value	Rank based on cost/unit area	Secondary criteria score	Rank based on Secondary criteria
Saldanha1	461	3	NA		6	5
Saldanha2	147	0	NA		7	6
Mossel Bay1(a+b)	5197	2	5439	5	8	2
Mossel Bay2	511	15	209	2	6	4
Mossel Bay3	1200	20	28	1	7	3
St Francis1	1474	14	3013	6	7	3
St Francis2	48	2.7	840	9	9	1
Port Elizabeth1 (similar to Coega1)	665	4.3	2829	7	9	1
Port Elizabeth (&Coega) 2	279	6.5 (6.3)	167	3	6	4
Port Elizabeth (&Coega)3	542	12 (7.5)	380	4	3	5
Coega1 (Similar to PE1)	509	16	2295	8	7	3

6.9 The way forward: recommended process for future ADZ declaration

We are of the opinion that of the seven inshore sites that are suitably large and meet all the exclusionary criteria, those that are ranked as having the lowest relative cost to other industries, should be the ones selected to undertake EIAs with a view to declaring them ADZs. The DAFF has indicated that it wishes to prioritize the Eastern Cape Province for the declaration of the first ADZs. Based on the criteria applied in this SEA, only four potential inshore sites are identified within the Eastern Cape Province (Table 6). Based on the relative cost values, we recommend that two potential sites within Algoa Bay (Port Elizabeth/Coega 2 & 3) should be prioritised for further investigation (detailed site specific investigations of the physical and biological environmental characteristics, potential user conflict etc). The third site in Algoa Bay (Port Elizabeth 1) and a site to the east of Cape St Francis (St Francis 1, actually off Jeffreys Bay) should be considered as alternatives in an EIA process, as the detailed investigations of these sites may well identify issues that were not covered by the site selection criteria applied in this SEA. The basic details of these four sites are given in Table 6 above, the GIS maps are shown in Figure 16 & Figure 17 and the coordinates defining the site boundaries are presented in Appendix 4.

We also recommend that prior to initiating an EIA phase with a view to declaring any identified potential site an ADZ, the availability of this SEA is advertised widely and made available to Stakeholders for comment. Public input/comment on the SEA should be considered and the SEA be revised if necessary. The DAFF however, remains the delegated Authority and may use this SEA as they see fit to inform future decisions.

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APPENDIX1: Legislation Applicable to the Establishment of Aquaculture Development Zones in South Africa

- Agricultural Pests Act (Act 36 0f 1983)
- Development Facilitation (Act 67, 1995)
- Marine Living Resources Act, 1998 (Act No. 18 of 1998)
- Fertilizers, Farm Feeds, Agriculture Remedies and Stock Remedies Act, 1947 (Act No.36 of 1947)
- The Animal Diseases Act, 1984 (Act No. 35 of 1984)
- The Genetically Modified Organisms Act, 1997 (Act No. 15 of 1997)
- The Animal Improvement Act, 1998 (Act No. 62 of 1998)
- The National Environmental Management Act, 1998 (Act No. 107 of 1998)
- The National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
- The National Environmental Management: Protected Areas Act, 2003 (Act No. 10 of 2003)
- The National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008)
- The National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)
- The Sea Birds and Seals Protection Act, 1973 (Act No. 46 of 1973)
- The Health Act, 1977 (Act No. 63 of 1977)
- The Medicines and Related Substances Control Act, 1965 (Act No. 101 of 1965)
- The Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972)
- The Water Services Act, 1997 (Act No. 108 of 1997)
- The National Water Act, 1998 (Act No. 36 of 1998)
- The National Regulator for Compulsory Specifications Act, 2008 (Act No. 5 of 2008)
- Standards Act, 2008 (Act No. 8 of 2008)

APPENDIX 2: List of Key Stakeholders Invited to Attend Site Selection Criteria Development Workshops

Organization	Physical	Contact	e-mail
Industry			
Buffalo Bull Farming	Mooiplaas, Eastern Cape	Andre De Wet	andre@greenharvest.co.za
Espadon Marine	East London IDZ, Eastern Cape	Liam Ryan	liam@espadonmarine.co.za
Irvin & Johnson	Gansbaai, Western Cape	Robert Landman	RobertLa@ij.co.za
Pure Ocean Aquaculture	East London IDZ, Eastern Cape	Andre Bok	andre@pureocean.co.za
	Pure Ocean Aquaculture	Hitesh Baba	
Mtunzini Aquaculture Projects	Mtunzini, KZN	Gavin Carter	gavin@thefishfarm.co.za
Blue Cap Trading Pty Ltd	Paternoster, Western Cape	Ingo Beckert/Marais Smith	ingobeckert@gmail.com
Wild Coast Abalone	Marsh Strand, Eastern Cape	Sanet Petschel / Richard Clark	admin@wcabalone.co.za
Aquastel	Stellenbosh University, Western Cape	Gert Le Roux	glr@sun.ac.za
Itakane Aquaculture	East London, Eastern Cape	Trevor Page	thepages@webmail.co.za
HIK Abalone Farm	Hermanus, Western Cape	Gavin Johnstone	gavin@hik.co.za
Research & Management			
DIFFS	Grahamstown	Tom Hecht	t.hecht@ru.ac.za
DIFFS	Grahamstown	Pete Britz	P.britz@ru.ac.za
DAFF	Foretrust Building Cape Town	Trevor Probyn	TrevorP@daff.gov.za
DAFF	Foretrust Building Cape Town	Grant Pitcher	grantP@daff.gov.za
DAFF	Foretrust Building Cape Town	Chris Wilke	chrisw@daff.gov.za
DAFF	Foretrust Building Cape Town	Sven Kerwath	SvenK@daff.gov.za
DAFF	Foretrust Building Cape Town	Fatima Samodien	fatimasa@nda.agric.za
DAFF	Foretrust Building Cape Town	Asanda Njobeni	AsandaN@nda.agric.za
DAFF	Foretrust Building Cape Town	Michele Pretorius	MichellePR@nda.agric.za
DAFF	Foretrust Building Cape Town	Zuko Nkomo	ZukoN@nda.agric.za
DAFF	Foretrust Building Cape Town	Andrea Bernatzeder	AndreaB@daff.gov.za
CES	East London	Alan Carter	alancarter@iafrica.com
UCT (Marine Linefish Research Group)	Rondebosch, Cape Town	Colin Attwood	colin.attwood@uct.ac.za
Management/State?NGO			
ECDC	East London	Rory Haschick	rhaschic@ecdc.co.za
WWF	Newlands, Cape Town	Eleanor Yeld	eyeld@wwf.org.za

APPENDIX 3 MINUTES OF STAKEHOLDER WORKSHOPS HELD ON 3 AND 5 AUGUST 2011

Two key stakeholder workshops to refine draft site selection criteria for marine fin fish aquaculture development zones were held in Cape Town on the 3 August 2011 and in East London on the 5th of August 2011. The minutes from these meetings are provided below. At these workshops, the nineteen preliminary criteria to be used for ADZ site selection that were previously provided to key stake holders in a Background Information Document, were presented and discussed. The preliminary criteria were either accepted unchanged, edited or discarded as consensus was achieved and several additional criteria/considerations were identified. Major changes to the draft selection criteria include:

1. Decreasing the water depth criterion to 12m minimum for traditional cage culture
2. Increasing the water depth criterion to 150 m and running a separate analyses to identify areas for deployment of new technology, submersible offshore cages.
3. Increasing the minimum vessel size to 15m in length.
4. Dropping the water temperature criterion, simply qualify identified zones in terms of the prevailing water temperature.
5. Combining upwelling cells, low oxygen water and HAB criteria with the result that the west coast north of Cape Columbine is excluded.
6. Altering the exposure criterion to area specific swell direction data (excluding areas that are exposed to 80% of the swells over 3.5m significant wave height as determined from SADCO VOB data), only using this criterion for identifying areas suitable for traditional floating cages, not for submersible cages.
7. Exclude areas around important archaeological wrecks
8. Exclude areas important to existing marine ecotourism operations (>15% of activity)
9. Exclude areas with known currents >1.5m/sec (traditional floating cages) >2m/sec for submersible cages.

Stakeholders are encouraged to please comment on these sites selection criteria and the minutes, highlighting any corrections that are needed. However, due to project deadlines and the need to finalize the GIS mapping comments received after the 14 September 2011 may not be taken into account. Please send any comment to Ken@anchorenvironmental.co.za

Proceedings of The Key Stakeholder Workshop Held in Tokai on 3 August 2011.

VENUE: Offices of Anchor Environmental, Steenberg Office Park, Tokai, Cape Town
TIME: 9h00 – 13h00

Reference:	12/08/2011		
Circulation:	All	**Compiled by:**	BM Clark

Document Type:	**Minutes of a Stakeholder Workshop**
Title:	**Strategic Environmental Assessment to Identify Potential Sites for Finfish Marine Aquaculture Development Zones in South Africa**
Date:	**12 August 2011**

No.	Item	Discussion
1.	**Welcome and apologies**	• Barry Clark welcomed the participants and thanked them for taking the time to attend the meeting. He explained the purpose of the meeting and what the project team hoped to achieve at the meeting. All participants were asked to introduce themselves and indicate their affiliations. • Dr Clark explained that not all participants had been able to make this workshop and that a second workshop had been scheduled in East London the next day to allow the project team to capture their inputs as well. • He also noted that a copy of the draft criteria to be considered in this workshop had been circulated prior to the meeting and that he hope that all participants had had an opportunity to study these.
2.	**Attendance**	• Asanda Njobeni DAFF • Michelle Pretorius DAFF • Zuko Nkomo DAFF • Trevor Probyn DAFF • Grant Picher DAFF • Barry Clark Anchor • Ken Hutchings Anchor • Sean Porter Anchor • Louise Maree van Zyl Cape EPrac • Gert le Roux Aquastel/Stellenbosch University • Marais Smith Blue Cap Trading Pty Ltd • Robert Landman I&J
	Apologies	Colin Attwood UCT Ingo Beckert Blue cap Trading Eleanor Yeld WWF

No.	Item	Discussion
3.	**Presentation on background to the project**	• Ken Hutchings delivered a MS Powerpoint presentation which provided information on the background to the study, project objectives and the purpose of this meeting. • Dr Hutchings explained that this project was focussing on the identification of potential MADZ sites suitable for fin culture in South Africa, and that 4 sites had been identified in the Eastern Cape for which the project team had been commissioned to apply for environmental authorisation. • He explained that the project had started with a review of the Strategic Environmental Assessment in which the four potential sites had been identified. The review had highlighted a number of important efficiencies in the existing SEA report including the fact that only one of the sites for which EIA were required was rated as being a primary MADZ site (suitable for finfish culture by multiple operators), criteria used in the SEA process were non-quantitative and thus could not be interrogated, and final selected sites did not seem to conform with the identified criteria. The project team thus felt uncomfortable going into a public participation process as they could not justify the selection of the sites or any alternative. DAFF had thus agreed to all the project team to redo the SEA within the framework of the project. • A suite of quantitative criteria had been identified by the project team for application in a GIS based SEA process that the project team wanted to workshop with key stakeholders from the mariculture industry. • Criteria were categorised as being primary or secondary in nature - primary criteria being used to determine whether or not a particular site is suitable for fin fish aquaculture and to rate the relative suitability of the site, and secondary criteria being used only to rate the relative suitability of a particular site and were only to be applied in areas that meet minimum requirements for all primary criteria. Criteria were also classified as being of a logistical, environmental nature or related to user conflicts.
4.	**Criterion #1: Suitable port** • **Primary and Secondary Logistical criterion**	• It was suggested that a port that could accommodate vessels up to 10 m in length would be required within a minimum specified distance of any proposed MADZ site. Ports should also be ranked as follows: 10-15 m vessel capacity = 1 point, 15-20 m = 2 points, >20 m = 3 points. • Potential ports complying with these criteria included the following: Port Nolloth, Hermanus, Lamberts Bay, Gansbaai, Laaiplek, Mossel Bay, Sandy point, Knysna?, Saldanha, St Francis, Table Bay, Port Elizabeth, Hout Bay, Coega, Simonstown, East London, Kalk Bay, Durban, Gordons Bay, Richards Bay • Gert le Roux noted that farms use a variety of vessels and that 10 m was the minimum size for a harvesting vessel. He suggested that the project team also consider vessel draft. • Robert Landman agreed that 10 m was a minimum size for start-up but as farms increased in size larger vessel would need to be

No.	Item	Discussion
		accommodated • Ken Hutchings suggested that this could possibly accommodate through a ranking system with ports that could accommodate larger vessels being allocated higher scores • Participants all agreed with this suggestion. Gert le Roux suggested that ports that were currently underutilised should also score higher. • Marais Smith also suggested introducing a weighting system for all criteria and that vessel size should be considered a low priority.
5	**Criterion #2: Distance from a suitable port** • **Primary and Secondary Logistical criterion**	• It was proposed that 2 h running (or 15 km) should be considered a maximum viable running time to a site. This criterion should also include a ranking system as follows: 10-15 km = 1 point, 5-10 km = 2 points, 0-5 km = 3 points. • Gert le Roux noted that tuna farms in Australia are mostly located within 10-16 km from port, and suggested extending the exclusionary distance to 20 km • Robert Landman agreed with Gert le Roux, and note that in some instances operators moored boats on site for a period of time (e.g. during harvesting) or have permanently manned barges on site (e.g. in Chile, Norway, Canary Islands). He also noted though that economic factors dictated that sites should be located as close to a suitable port as possible especially given the high level of uncertainty for a new industry • Gert le Roux agreed that it was highly likely that a similar approach would be followed here in SA (i.e. barges moored on site).
6	**Criterion #3: Other port logistics (e.g. Offloading facilities, Cold storage/ice maker, Processing facilities, Fuel)** • **Secondary Logistical criterion**	• It was proposed that this be considered a secondary criterion only and that 1 point be allocated for each availability of each service • Gert le Roux agreed that this was a “nice to have” but was of low priority. Should possibly also consider distance to airport, road infrastructure, and availability of land for support infrastructure as these are also important. • Ken Hutchings also noted that sea areas under control of Transnet NPA should also be flagged as there may be conflicts in respect of vessel traffic or anchoring
7	**Criterion #4: Water depth** • **Primary and Secondary Environmental criterion**	• It was proposed that only areas between 20 and 60 m water depth be considered. Dr Hutchings explained that the rationale for this was to achieve a balance between minimum required water depth for flushing of wastes (i.e. 20 m minimum depth) and cost of mooring in deeper water (i.e. 60 m maximum depth. • Gert le Roux agreed that depth was an important consideration but noted that the minimum distance required between the bottom of the cages (nets) was 5 m to ensure minimal risks to the fish in the cages. As such he indicated that the minimum depth should be reduced to 15 m. • Trevor Probyn indicated he was in agreement with this based on international best practice • Grant Pitcher expressed concern that a 15 m minimum depth

No.	Item	Discussion
		criterion would exclude most of Saldanha Bay and queried whether this was realistic. He suggested reducing this to 12 m. • It was agreed that this was acceptable to all provided a minimum distance of 5 m was maintained between the cage bottom and the substratum and would thus be suitable for small most likely experimental cages only. • Dr Hutchings then queried if the 60 m maximum depth criterion was realistic. • There was general agreement that this was the case given the increased costs of mooring cages in deeper water.
8.	**Criterion #5: Water temperature** • **Primary and Secondary Environmental criterion**	• It was proposed that mean water temperature at a site needed to fall within the range 14-24°C. The rationale for this was that optimal for growth of likely indigenous fish species (the current DAFF policy) (e.g. silver kob, yellowtail, grunter), and that this had to be traded off against possible increased parasite/disease prevalence at higher temperatures. • Trevor Probyn agreed with this sentiment stating that there would likely be strong opposition within DAFF to the use of potentially invasive, non-indigenous species. The risks of introducing alien species into SA water was considered too high at this stage. • Gert le Roux expressed concern that such a policy would exclude salmon from being farmed in this country for which culture technology was well established. He noted that technology was also available to ensure minimum risk to the environment (e.g. farming with sterile triploid individuals). • Robert Landman noted that temperature requirements are species specific and that while the range proposed was considered optimal for species currently under consideration (i.e. silver kob, yellowtail, grunter) other species (e.g. hake, kingklip, white stumpnose, pompano, river gurnard, tuna) may be able to tolerate a wider or different range of temperatures • Dr Hutchings queried whether it was worth retaining this criterion then? • It was agree that information on average temperature should be included as a layer in the SEA but should be used as an information layer only (i.e. not as a criterion for ranking sites)
9.	**Upwelling cells** • **Primary and Secondary Environmental criterion**	• It was proposed that sites within the known precinct or vicinity of upwelling cells be excluded, the rationale for this being that temperature shocks will negatively impact growth rate and health of cultured stock. • Grant Pitcher noted that if this criterion was invoked that it would exclude the entire coast north of Dwarskersbos and queried whether this was realistic. • Marais Smith agreed that this was probably realistic given their experience in respect of impact of temperature spikes on growth • Robert Landman agreed, noting that even their experimental cages moored next to PE harbour experienced severe thermal shock on occasion sufficient to impact on growth and the health

No.	Item	Discussion
		of their kob stock but that this was not such a problem for yellow tail. He noted that it would depend on the rate at which water temperature might change. • Grant Pitcher noted that spikes in the order of 10-16°C can be expected close to major upwelling cells • Gert le Roux acknowledged that such a spike would be a severe problem and suggested that one would have to rule out any areas where large temperature spikes occur but that it would probably be necessary to apply different criteria on the S and SW coasts as opposed to the W coast. He also noted thought that some species are probably resilient to fairly large temperature spikes, especially those (such as tuna) that undergo natural diel vertical migrations. • Trevor Probyn observed that cold newly upwelled water was also often deficient in oxygen which would also have a severe negative impact on fish stocks. • Grant Pitcher agreed and raised the concern that hypoxia and anoxia had not been included in the draft list of criteria for the SEA. • Barry Clark suggested that the project team map the known precinct of all upwelling cells in the country and that these areas be excluded from consideration. This would have to be done with expert knowledge as detailed information on temperature was not available at present. • There was general agreement on this suggestion
10.	**Point source pollution** • **Secondary Environmental criterion**	• In terms of this criterion, it was proposed that all sites within 500 m radius or maximum known plume extent be excluded, the rationale being that pollutants may negatively impact growth rate, health and of marketability of cultured stock • There were no objections to including this criterion
11.	**Turbidity and river mouths** • **Secondary Environmental criterion**	• In terms of this criterion, it was proposed that a buffer proportional to mean annual runoff sediment load be established around all river mouths the rationale being that decreased salinity and high turbidity in these areas may negatively impact growth rate and health of cultured stock • Trevor Probyn suggested that it may be useful to follow criteria used in dredging EIA where a level of 80 mg/l for silt is considered a maximum permissible level and that 20 mg/l a level where negative impacts can be anticipated. • Barry Clark noted that sediment plumes around the Orange River mouth had been well studied and could possibly be used to establish a relationship between flood volume, TSS levels and plume extent
12.	**Wave exposure** • **Secondary Environmental criterion**	• In terms of this criterion, it was proposed that data on swell direction and size at positions around the coast be used to establish the extent of exposure along the coast and be used to identify suitably protected areas on the coast. The rationale for this was that exposure to storm sea conditions could damage cages and will decrease frequency at which cages can be serviced. Cages can thus only be located in sheltered areas.It

No.	Item	Discussion
		was acknowledged that robust cage can be obtained but that these would probably be prohibitively expensive for a fledging mariculture industry. • Gert le Roux acknowledged that most of the SA coast is prohibitively exposed and that they had experienced problems in achieving sufficient sea days in Algoa Bay right next to the harbor. • Other participant agreed that this was correct but indicated that it was difficult to conceptualize without actual data and an indication of the amount of sheltered habitat available.
13	**Harmful Algal Blooms (HABs)** • **Secondary Environmental criterion**	• In terms of this criterion, it was proposed that areas where known extreme events occur with a frequency >1:10 yr be excluded from consideration as potential sites and that a weighting system be introduced in areas with less frequent events (1:25 y = 1 point, 1: 50 = 2, >1:50 =3). • Grant Pitcher expressed the concern that there are a lot of different species that are included under the name of HABs and that information on their impacts on fish is generally lacking. • Gert le Roux noted that HABs are a real problem for shellfish aquaculture as insurance companies would not provide cover for anyone operating in an area with known HAB occurrence. HABS can also cause fish mortalities. • Ken Hutchings asked if there was general consensus to drop this criterion? • There was general agreement that this criterion should be dropped but Gert le Roux suggested that it might be necessary to retain areas affected by black tides (i.e. hydrogen sulphide events caused by extreme HAB blooms). • Grant Pitcher suggested that it would make most sense to group the black tide events with hypoxia/anoxia. He noted that there had been only 1 black tide event in St Helena Bay in the last 30 yrs and that it was mostly localized to shallow water <10 m depth. Lobster walkout in this area mostly associated with seasonal anoxia rather than black tides per se. From Dwaskersbos northwards there is a narrow zone along the coast where black tide events are more common.14
14	**Bottom type** • **Secondary Environmental criterion**	• In terms of this criterion, it was proposed that all areas with hard substrata (i.e. reef) be excluded from consideration, the rationale being that reefs are regarded as sensitive habitats likely to be more severely impacted by farm effluent than sandy substrate. • Dr Hutchings noted that there was limited information on substratum type for the whole country and that this would probably only be addressed when individual sites were assessed. • Gert le Roux noted also that it is more difficult to anchor on rocky ground and that it was also a logistical constraint. He explained that the mooring footprint of a cage was minimum 150 m for water depth in the range being considered (i.e. 12 m depth upwards). • Trevor Probyn noted that a 50 m buffer would probably be

No.	Item	Discussion
		adequate from an environmental perspective and as such the operational constraint was a bigger issue.
15	**Marine Protected Areas** • **Primary and secondary Environmental criterion**	• In terms of this criterion, it was proposed that all areas MPAs be excluded from consideration, the rationale being that MPAs fulfill numerous conservation, research and socio-economic roles and should remain as pristine as possible. The DEA MPA working group had taken a position that no mariculture be permitted within MPAs in South Africa. Dr Hutchings questioned whether this was official DEA/DAFF policy and whether it was necessary to distinguish between no-take and sanctuary zones. • Gert le Roux suggested that mariculture facilities can be an important tourist attraction (this was certainly the case in PE) and as such their inclusion in MPAs should be encouraged. • Grant Pitcher suggested that the project team consult with DEA on this issue to obtain and official position. • Trevor Probyn suggested that the public would most likely support the exclusion of mariculture from MPAs and the establishment of a suitable buffer zone.
16	**Heritage resources** • **Primary or Secondary Environmental criterion**	• In terms of this criterion, it was proposed that all areas that include heritage resources (i.e. mainly important shipwrecks) be excluded from consideration. The rationale for this was that mooring/anchoring and deposits from fish farms may damage archaeologically important sites. It was acknowledged that while it would be ideal to use this as a primary criterion this may not be possible due to the sensitivity of such information. It might be necessary to use it as a secondary criterion – i.e. submit potential MADZ sites to SAHRA for approval rather than requesting information on all ship wrecks in SA water which they would be reluctant to release. The need for a suitable buffer around such sites was also acknowledged. • There were no objections to the inclusion of this criterion
17	**Biodiversity hotspots** • **Primary Environmental criterion**	• Identified high biodiversity/conservation worthy sites/threatened ecosystems should be excluded from consideration based on information included in the National Spatial Biodiversity Assessment • Dr Hutchings indicated that the project team were waiting for this information to be released by SANBI. • Louise-Marie van Zyl suggested that the team should make provision to include it in the SEA at a later stage if necessary.
18	**Fishing areas** • **Primary User Conflict criterion**	• In terms of this criterion, it was proposed that any area in which >5 % catch/effort of any documented fishery is expended be excluded from consideration. The rationale for this was that mariculture development should not unduly impact existing fisheries. • Gert le Roux expressed the opinion that it might not be necessary to exclude an entire area and that establishing a buffer zone around cages may be sufficient. • Ken Hutchings questioned whether this would give rise to security concerns for the farms and whether other vessels

No.	Item	Discussion
		should not be excluded from the MADZ in its entirety. • Gert le Roux confirmed that a 1km exclusion zone should be adequate for this purpose. • Barry Clark suggested using VMS data from DAFF to establish the primary fishing grounds and identify if any overlap exists between the primary fishing grounds and potential MADZs • Trevor Probyn noted that there was no legal basis for establishing an exclusion zone around the cages and noted that this had been a problem in Kleinbaai off Danger Point, with experimental cages erected in these areas • Barry Clark expressed the opinion that if this criterion was not retained that the fishing industry would not hesitate in taking DAFF to court if they felt that the establishment of an MADZ in a particular area was likely to compromise their rights or ability to catch fish.
19	**Marine ecotourism** • **Primary or Secondary User Conflict criterion**	• In terms of this criterion, it was proposed that any area in which >15 % activity of any documented recreational activity is undertaken should be excluded from consideration. • Gert le Roux reiterated the position that cages are often an important tourist attraction rather than being considered a problem. • Ken Hutchings responded to say that this was not always the case, especially in the case of marine ecotourism (e.g. whale, dolphin watching). This issue caused a great deal of conflict in Mossel Bay for example.
20	**Shipping Lanes** • **Primary User Conflict criterion**	• This criterion was related to the need to keep shipping lanes as indicated on the SAN charts adjacent to major commercial ports free from obstructions. • It was agreed by all that this was not really negotiable.
21	**Mining and Military Zones** • **Primary User Conflict criterion**	• This criterion was linked to the potential need to exclude defined military and mining zones from MADZs due to user conflicts. • Barry Clark noted that oil and gas concession areas covered the entire EEZ and that most of the west coast was covered with diamond mining concessions. • Gert le Roux noted diamond mining activities were winding down on the west coast and that most of the concession holders were actively viewing mariculture as an alternative use for these concession areas. He acknowledged that this was mostly shore based concessions though. • Ken Hutchings suggested that existing mining infrastructure (e.g., well heads, pipelines etc.) be demarcated on the SEA maps along with the concession areas and that exclusion zones be established around these areas.
14	**Strong Currents** • **Primary Environmental criterion**	• The need to avoid areas with strong currents >1.5 knots was raised by Gert le Roux as these can deform the cages particularly those with a hanging bag-type structure. • Grant Pitcher agreed with this sentiment but noted that there was little information on the position of such currents except possibly for the Agulhas current.

No.	Item	Discussion
		• Ken Hutchings indicated that the project team would find a way to include this in the SEA
	Other comments	• Trevor Probyn asked if the project team had considered user conflicts relating to other recreational activities and the potential loss of recreational amenity – e.g. sailing, boating. He suggested that it might be necessary to identify primary areas used by yachts and other pleasure craft (e.g. in the proximity of yacht basins and marinas) and establish a buffer around these areas • Ken Hutchings indicated that the project team would look into this issue further • Barry Clark questioned whether there was any requirement to take the SEA through a broader public consultation process. • Assanda Njobeni indicated that he did not think there were any legal requirements per se but felt that it would be good practice to involve the public as far as possible in this process (not just in the EIA process for individual sites). • Louise-Marie van Zyl indicated that she would take this up with DAFF after the meeting
	Closure	• Barry Clark closed the meeting at 13h00, thanked all participants for the constructive inputs and invited them to partake in lunch before heading back to their respective offices.

Minutes from the Key Stakeholder Workshop Held in East London on 5 August 2011.

Present

Prof Tom Hecht, Advance Africa Management Services

Andre Bok, Pure Ocean Aquaculture

Rory Haschick, Eastern Cape Development Corporation

Ken Hutchings Anchor Environmental Consultants

Apologies:

Andre De Wet, Buffalo Bull Farming

Liam Ryan, Espadon Marine

Trevor Page, Itakane Aquaculture

Alan Carter, Coastal Environmental Services

Workshop summary

The workshop was held at the ECDC offices in East London at 12:30 on the 5 August 2011 and Rory Haschick is thanked for making this venue available. Ken Hutchings gave a presentation showing the draft site selection criteria with changes made during the Tokai workshop, edited the slides at the time and recorded brief notes on the discussion around site selection criteria. Comments are summarized in point form and are not attributed to individuals, but rather the consensus view that arose from discussion.

- It was agreed that each site selected as a possible MADZ should be categorized with respect to water temperature and suitable fish species.
- Upwelling sites on the SA east coast should only be used to rank sites, not exclude them, as for the west coast.
- The importance of monitoring anthropogenic pollutants at selected MADZ was highlighted. It was noted that to access export markets future operators would require an Environmental Management Plan that included monitoring of pollutants such as *E. coli* , heavy metals, PCBs, PAH,s, dioxins etc.
- A realistic scale of finfish mariculture operation for an economically viable farm was estimated to be the production of at least 1000 tons of fish per annum, with some participants feeling that around 4 000 tons was more suitable, and a workboat of at least 45ft (15m) was required. This point was raised during discussion about the suitable

minimum size work boat, where some participants at the earlier Cape Town work shop had maintained that smaller operations would not require large work boats. The East London workshop participants were of the opinion that defining a MADZ that could not grow to this minimum viable economic size was not worthwhile.

- The point was made that the preliminary depth and exposure criteria were applicable to traditional, floating finfish cages, and this should be specified. It was suggested that the analysis also be conducted using criteria applicable to new technology, offshore rigid or semi rigid submersible cages. This resulted in an additional water depth criterion of between 30-150m specific to offshore cage technology. The exposure criterion would then not be applied when considering offshore cages.
- It was noted however, that that current speed still needs to be considered and that this should not exceed 4 knots max for submersible cages. It was acknowledged that the spatial resolution of existing current data (particularly sub-surface) was not sufficient for the nationwide GIS mapping exercise, but that areas of known strong current e.g. The Agulhas should be excluded on these grounds.
- There was quite a lot of discussion about the issue of biofouling of cage structures, particularly about the extremely high rates of biofouling experienced at pilot sea cage fish culture projects attempted to date in temperate SA waters (Gan baai and PE). It was suggested that the use of copper alloy cages may be the most effective way to deal with biofouling and to address the high risk of predator impacts on fish cages.
- It was suggested that the reef bottom criterion only needs to be applied to cages moored in less than 120m of water using a traditional mooring grid. It was proposed that cages using single point moorings in water deeper than 120m would not have a significant negative impact on the benthos.
- It was noted that the currently underway National Spatial Biodiversity Assessment is mapping threatened ecosystems rather than high biodiversity/ conservation worthy sites. It was suggested that excluding the former was illogical, but excluding the latter was acceptable.
- There was strong consensus that existing commercial fishing grounds should be excluded.
- It was noted that there is currently exploration for natural gas underway in Algoa Bay and that this might produce useful data for MADZ site selection (on e.g. bottom type).

Participants were thanked for their time and the workshop was closed with lunch provide by the ECDC (many thanks!)

Andre Bok took Ken Hutchings on a tour of Pure Ocean Aquaculture’s land based fish farm under construction in the East London IDZ.

APPENDIX 4: COORDINATES, AREA AND DISTANCE TO PORT FOR POTENTIAL INSHORE AND OFFSHORE ADZS.

Potential Inshore ADZs	Latitude	Longitude	Area (Ha)	Distance from harbour (km)
Saldanha1	-33.047	18.015	461.4	2.9
	-33.067	18.016		
	-33.065	17.979		
	-33.070	18.005		
Saldanha2	-33.036	17.977	147.4	0
	-33.026	17.983		
	-33.020	17.981		
	-33.021	17.967		
Mossel Bay1a	-34.131	22.167	4722.6	1.9
	-34.169	22.167		
	-34.178	22.171		
	-34.059	22.312		
	-34.057	22.310		
	-34.075	22.235		
	-34.091	22.242		
Mossel Bay1b	-34.133	22.167	474.3	1.9
	-34.140	22.164		
	-34.149	22.165		
	-34.151	22.167		
	-34.169	22.167		
	-34.145	22.141		
	-34.131	22.167		
Mossel Bay2	-34.250	22.021	510.6	14.9
	-34.266	22.002		
	-34.243	21.996		
	-34.227	21.987		
	-34.217	22.011		
	-34.219	22.025		
	-34.222	22.026		
	-34.226	22.000		
	-34.250	22.000		
Mossel Bay3	-34.275	21.991	1199.5	19.8
	-34.231	21.976		
	-34.251	21.950		
	-34.288	21.976		
St Francis1	-34.096	24.955	1474.2	13.7
	-34.048	24.995		
	-34.029	24.964		
	-34.045	24.956		
	-34.076	24.951		
	-34.090	24.950		
St Francis2	-34.176	24.888	47.6	2.7
	-34.170	24.879		
	-34.176	24.879		
	-34.182	24.883		
Port Elizabeth1	-33.547	25.689	665.1	4.3
	-33.990	25.736		

	-34.004	25.724		
	-33.988	25.710		
	-33.988	25.704		
Port Elizabeth2 (Coega2)	-33.908	25.684	279.4	6.5
	-33.913	25.683		
	-33.907	25.694		
	-33.906	25.701		
	-33.870	25.693		
	-33.881	25.688		
	-33.903	25.693		
Port Elizabeth3 (Coega3)	-33.875	25.721	541.5	12
	-33.875	25.738		
	-33.883	25.745		
	-33.878	25.800		
	-33.875	25.800		
	-33.875	25.832		
	-33.878	25.830		
	-33.888	25.745		
Coega1	-33.957	25.689	509.0	16.1
	-33.989	25.734		
	-33.992	25.714		
	-33.988	25.710		
	-33.988	25.704		
Coega2 (Port Elizabeth2)	-33.908	25.684	279.4	6.3
	-33.913	25.683		
	-33.907	25.694		
	-33.906	25.701		
	-33.870	25.693		
	-33.881	25.688		
	-33.903	25.693		
Coega3 (Port Elizabeth3)	-33.875	25.721	541.5	7.5
	-33.875	25.738		
	-33.883	25.745		
	-33.878	25.800		
	-33.875	25.800		
	-33.875	25.832		
	-33.878	25.830		
	-33.888	25.745		

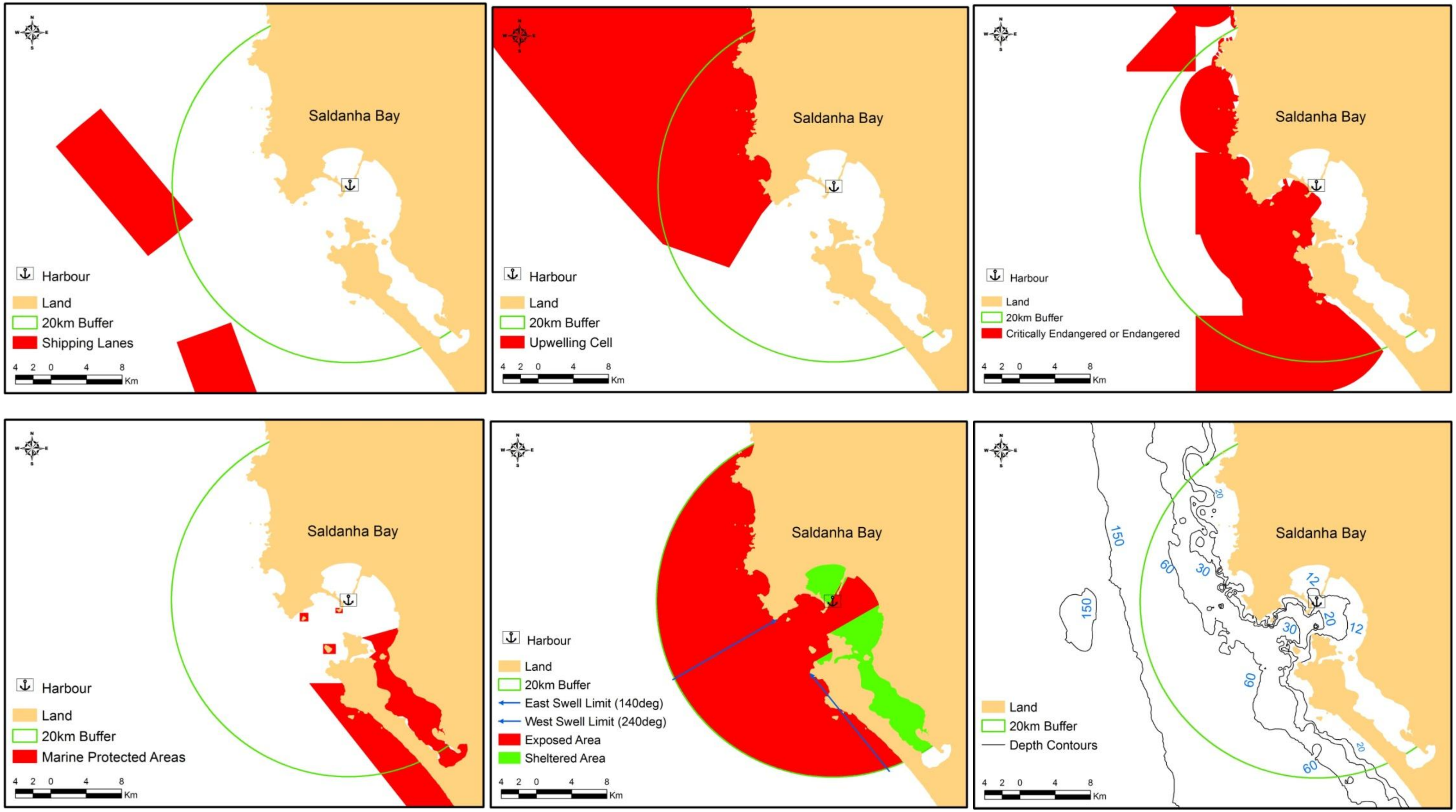
Potential Offshore ADZs	Latitude	Longitude	Area (Ha)	Distance from harbour
Saldanha3	-33.094	17.778	4216.5	14.6
	-33.120	17.863		
	-33.149	17.889		
	-33.167	17.890		
	-33.166	17.836		
	-33.132	17.801		
Simonstown1	-34.172	18.557	11816.5	11.1
	-34.167	18.599		
	-34.141	18.616		
	-34.133	18.644		
	-34.238	18.645		
	-34.337	18.557		
Kalk Bay1	-34.171	18.557	9551.5	10.9
	-34.168	18.598		
	-34.132	18.628		
	-34.133	18.668		
	-34.182	18.658		
	-34.243	18.618		
	-34.283	18.558		
Hermanus1	-34.442	19.167	13446.9	1.2
	-34.500	19.167		
	-34.500	19.250		
	-34.563	19.250		
	-34.583	19.256		
	-34.583	19.302		
	-34.539	19.329		
	-34.491	19.327		
	-34.445	19.255		
Gansbaai1	-34.500	19.167	12735.7	3.4
	-34.500	19.250		
	-34.563	19.250		
	-34.583	19.256		
	-34.583	19.299		
	-34.541	19.330		
	-34.491	19.327		
	-34.445	19.256		
	-34.444	19.204		
	-34.476	19.167		
Mossel Bay4	-34.250	21.998	21340.1	3.1
	-34.320	22.015		
	-34.260	22.111		
	-34.124	22.355		
	-34.066	22.309		
	-34.129	22.172		
	-34.185	22.193		
	-34.230	22.084		
	-34.250	22.083		
St Francis3	-34.049	24.996	38228.4	4.0
	-34.083	24.966		
	-34.125	24.974		
	-34.171	24.894		
	-34.217	24.896		

	-34.236	24.833		
	-34.249	24.833		
	-34.246	24.751		
	-34.267	24.659		
	-34.333	24.730		
	-34.255	24.917		
	-34.255	24.888		
	-34.250	24.888		
	-34.250	24.917		
	-34.265	24.917		
	-34.278	25.000		
	-34.314	25.000		
	-34.271	25.039		
	-34.225	25.021		
	-34.221	25.000		
	-34.178	24.974		
	-34.162	24.996		
	-34.091	25.014		
	-34.087	25.035		
Port Elizabeth4	-33.929	25.833	25256.6	9.1
	-33.950	25.833		
	-33.942	25.766		
	-33.984	25.800		
	-34.029	25.800		
	-34.029	25.750		
	-34.000	25.749		
	-33.990	25.736		
	-33.998	25.730		
	-34.007	25.738		
	-34.061	25.735		
	-34.072	25.584		
	-34.084	25.583		
	-34.083	25.500		
	-34.058	25.500		
	-34.057	25.460		
	-34.101	25.506		
	-34.137	25.601		
	-34.134	25.701		
	-34.086	25.798		
	-34.003	25.853		
	-33.944	25.856		
Coega4	-33.943	25.767	928.7	16.0
	-33.973	25.791		
	-33.950	25.832		
East London1	-33.205	27.872	41613.5	1.6
	-33.101	28.059		
	-33.012	28.131		
	-32.931	28.098		
	-33.148	27.758		
Durban1	-29.696	31.123	19210.0	4.5
	-29.769	31.095		
	-29.842	31.122		
	-29.862	31.103		
	-29.889	31.152		

	-29.809	31.256		
	-29.738	31.205		
Richards Bay1	-28.828	32.230	25741.0	7.8
	-28.987	32.053		
	-28.986	32.141		
	-28.967	32.198		
	-28.854	32.287		
	-28.816	32.301		
	-28.713	32.269		
	-28.801	32.175		

APPENDIX 5: GIS PRODUCTS SHOWING APPLICATION OF INDEPENDENT SITE SELECTION CRITERION FOR ALL HARBOURS

Saldanha Bay



Identified potential inshore and offshore ADZs shown in main report Figure 14-Figure 18.

Table Bay

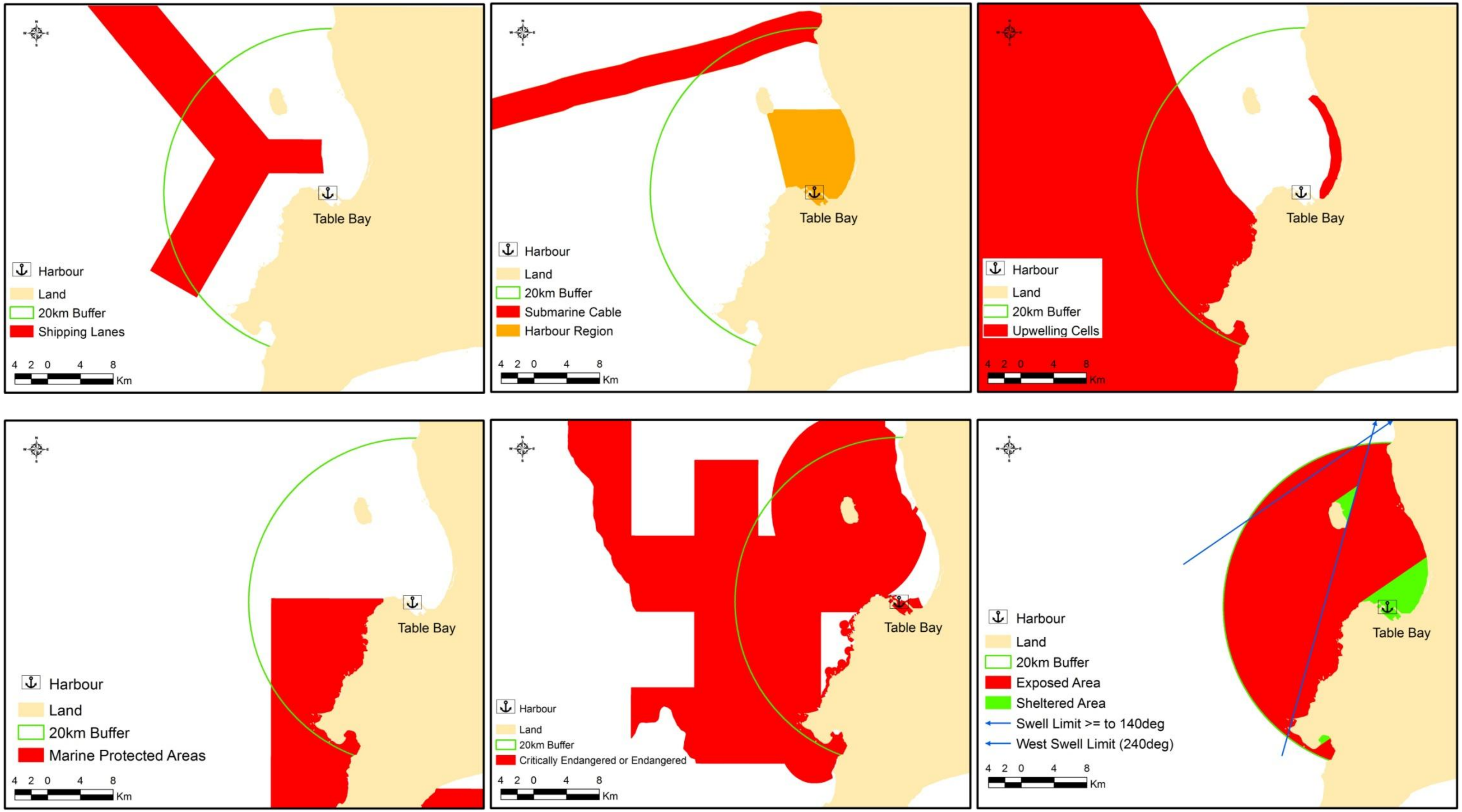
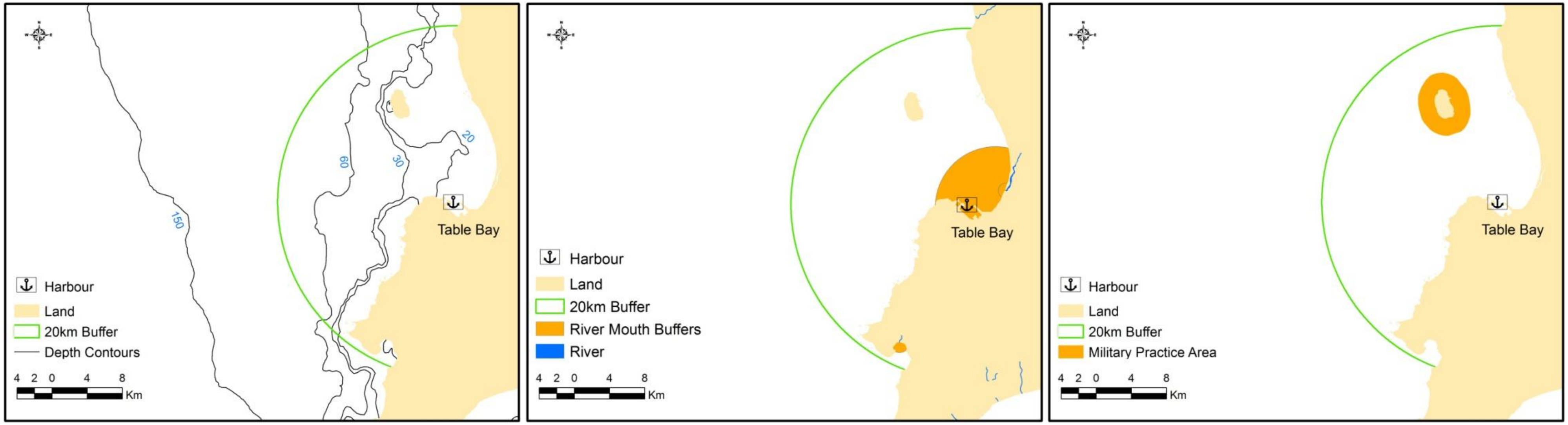
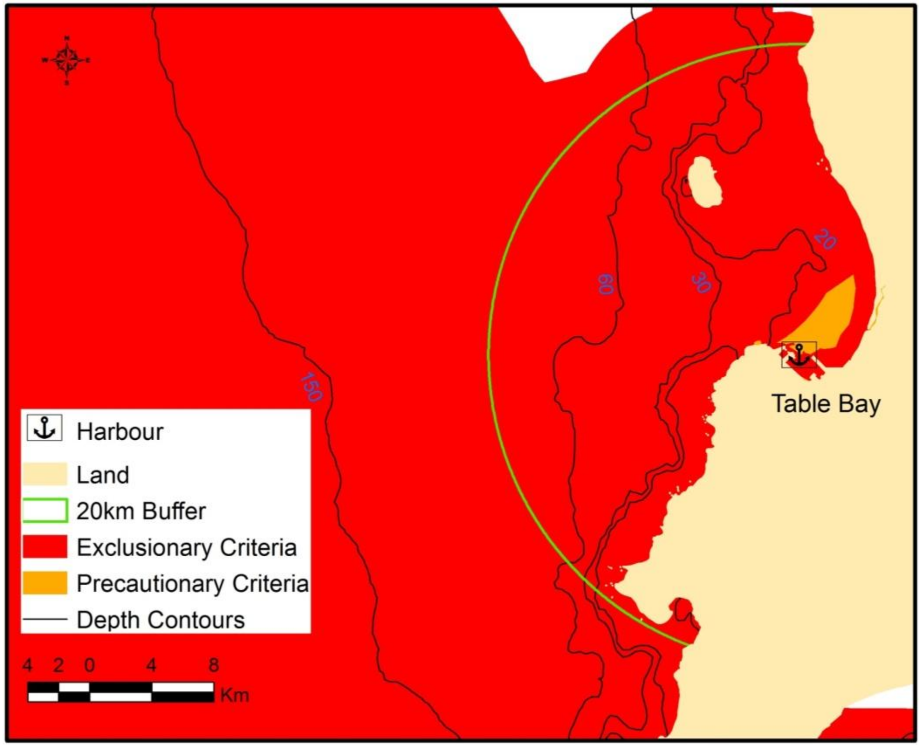


Table Bay
Harbour
Land
20km Buffer
Shipping Lanes
4 2 0 4 8
Km
Table Bay
Harbour
Land
20km Buffer
Submarine Cable
Harbour Region
4 2 0 4 8
Km
Table Bay
Harbour
Land
20km Buffer
Upwelling Cells
4 2 0 4 8
Km
Table Bay
Harbour
Land
20km Buffer
Marine Protected Areas
4 2 0 4 8
Km
Table Bay
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km
Table Bay
Harbour
Land
20km Buffer
Exposed Area
Sheltered Area
Swell Limit >= to 140deg
West Swell Limit (240deg)
4 2 0 4 8
Km

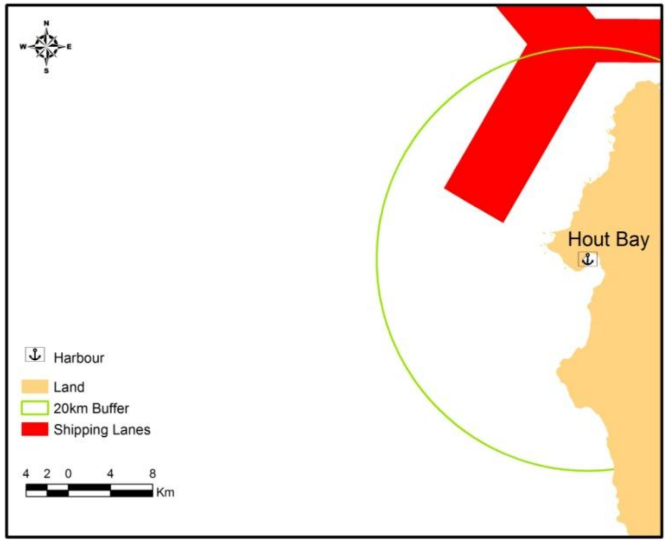


20
30
60
150
Table Bay
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km
Table Bay
Harbour
Land
20km Buffer
River Mouth Buffers
River
4 2 0 4 8
Km
Table Bay
Harbour
Land
20km Buffer
Military Practice Area
4 2 0 4 8
Km

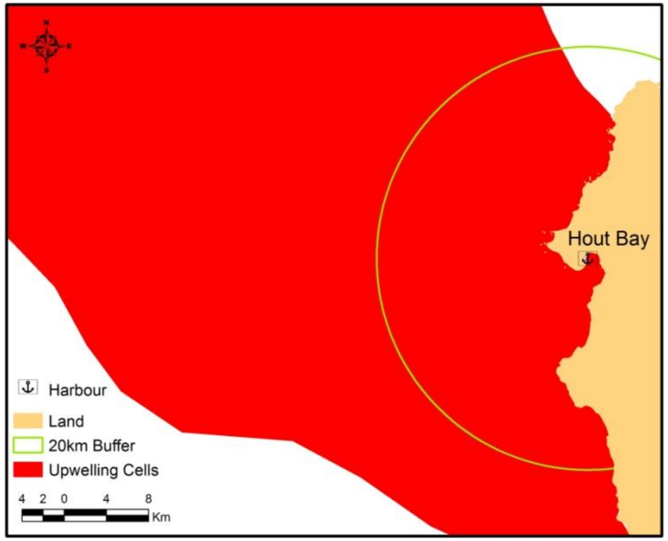


Inshore and offshore finfish ADZ (no zones)

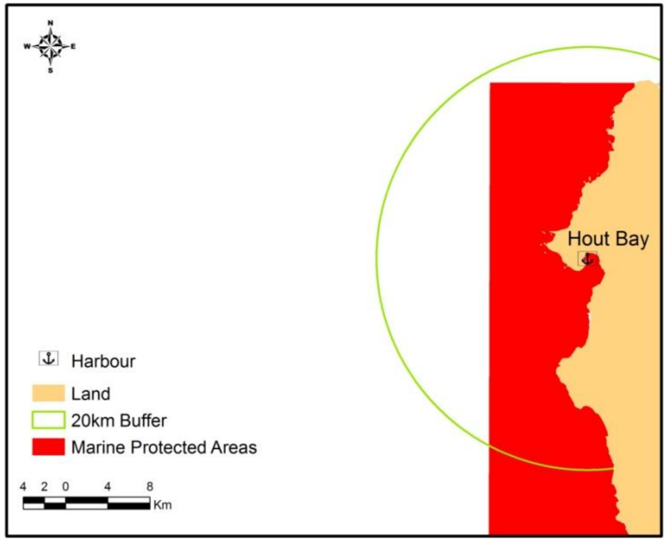
Hout Bay



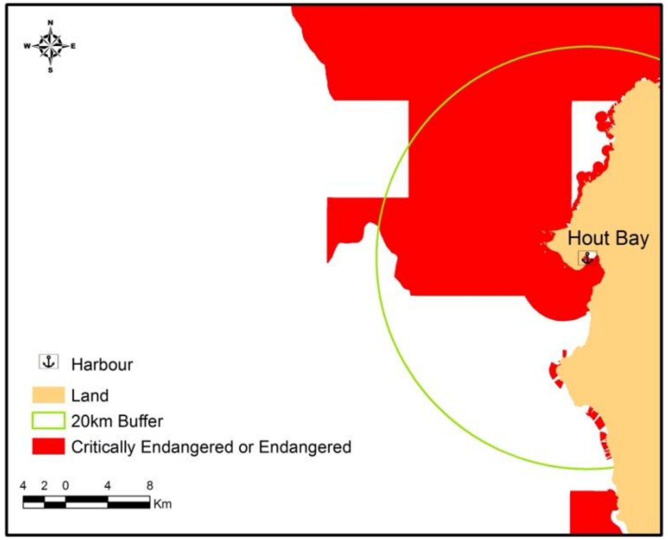
Hout Bay
Harbour
Land
20km Buffer
Shipping Lanes
4 2 0 4 8
Km



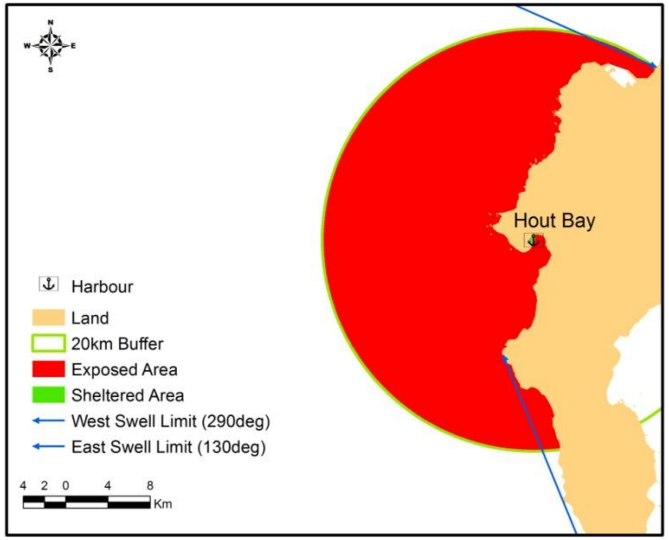
Hout Bay
Harbour
Land
20km Buffer
Upwelling Cells
4 2 0 4 8
Km



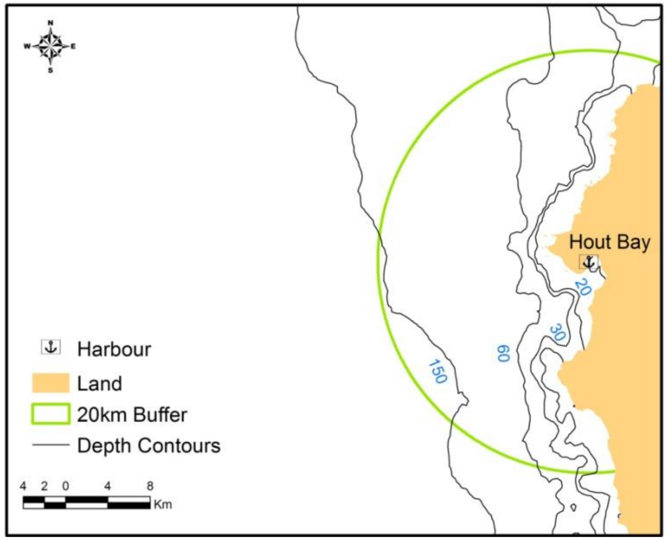
Hout Bay
Harbour
Land
20km Buffer
Marine Protected Areas
4 2 0 4 8
Km



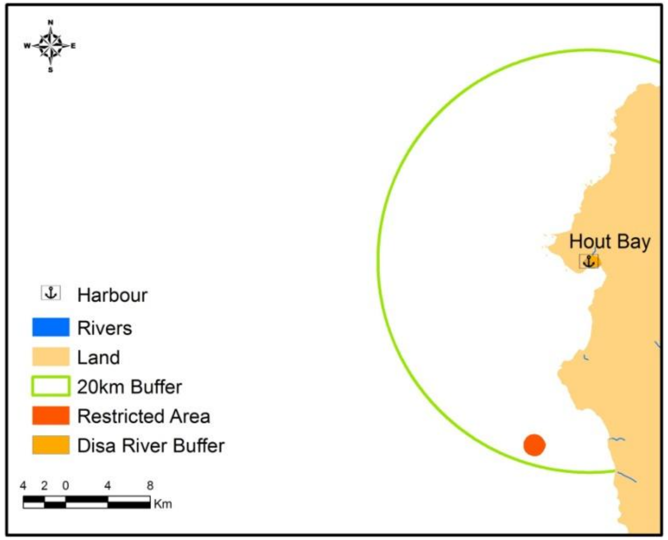
Hout Bay
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km

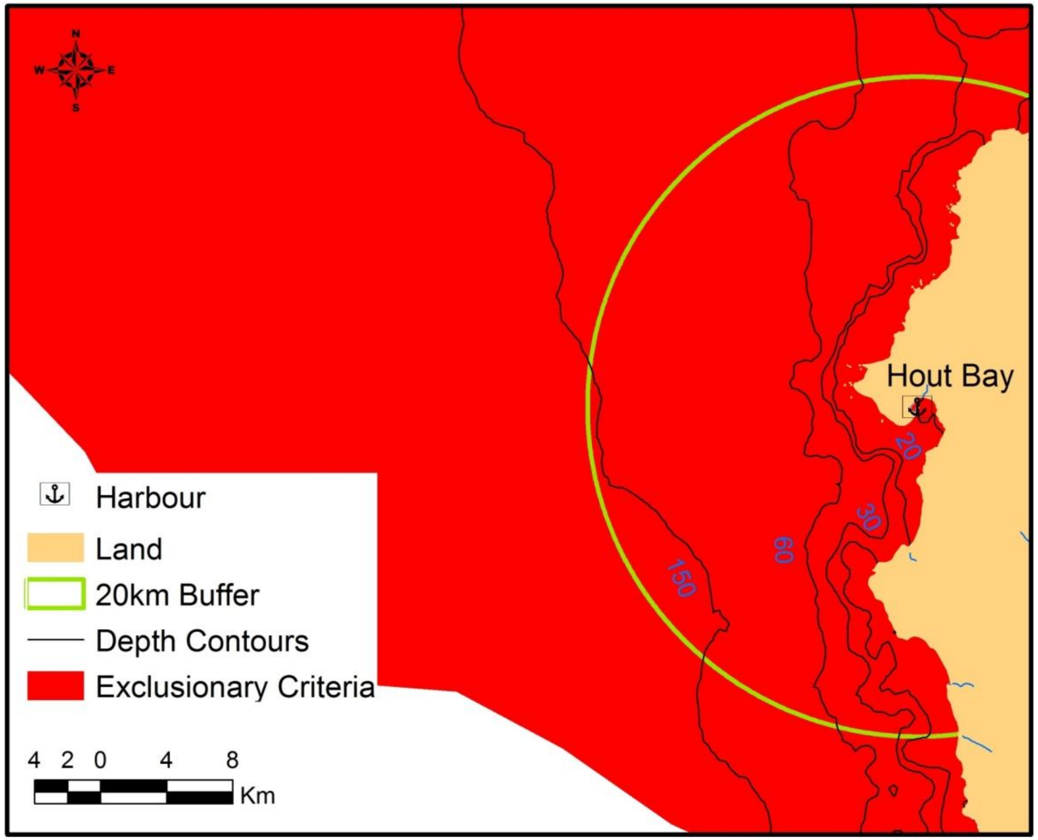


Hout Bay
Harbour
Land
20km Buffer
Exposed Area
Sheltered Area
West Swell Limit (290deg)
East Swell Limit (130deg)
4 2 0 4 8
Km



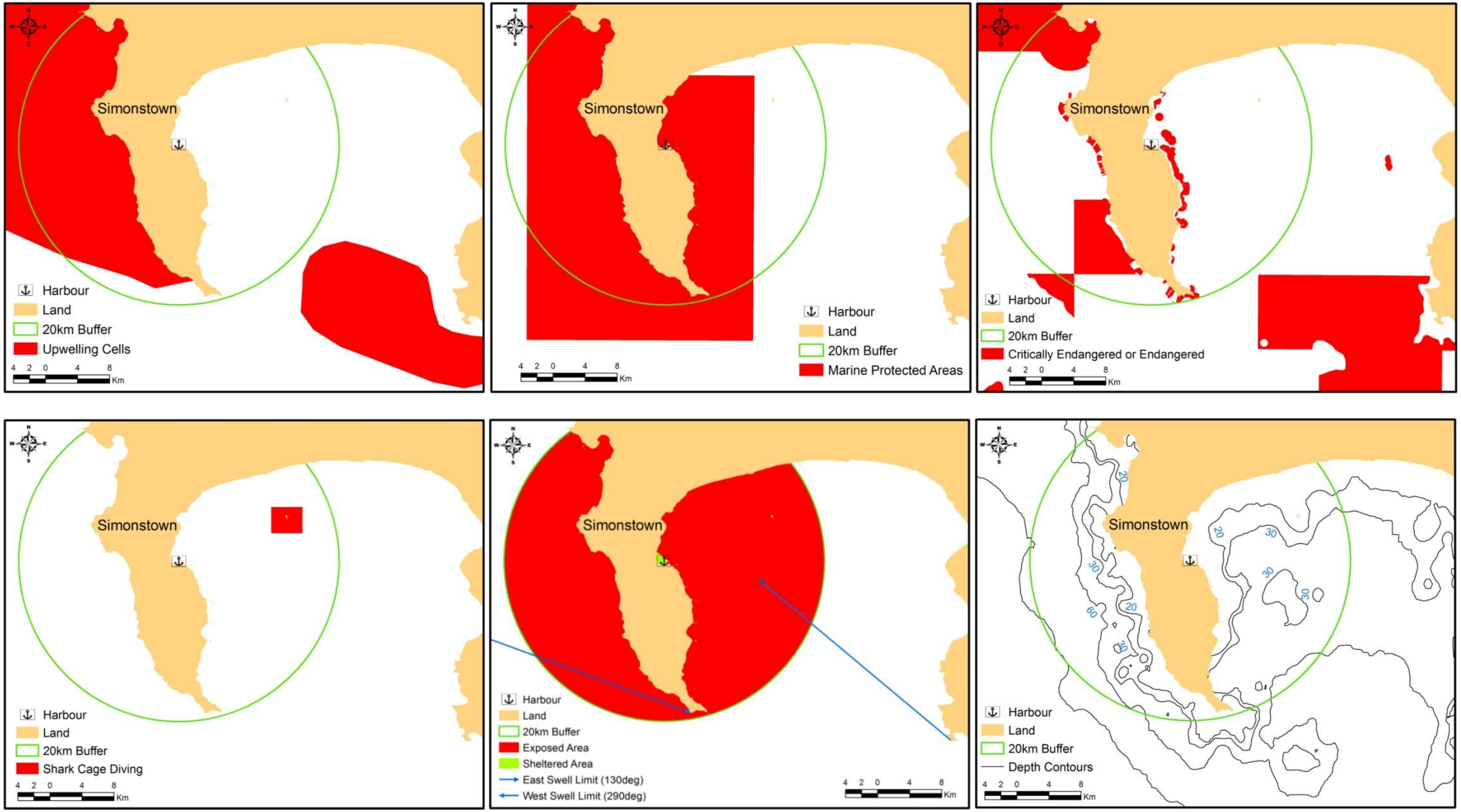
Hout Bay
20
30
60
150
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km

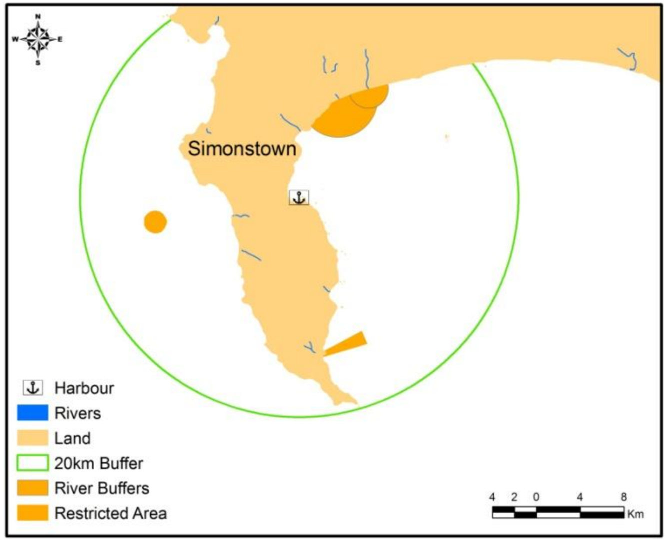


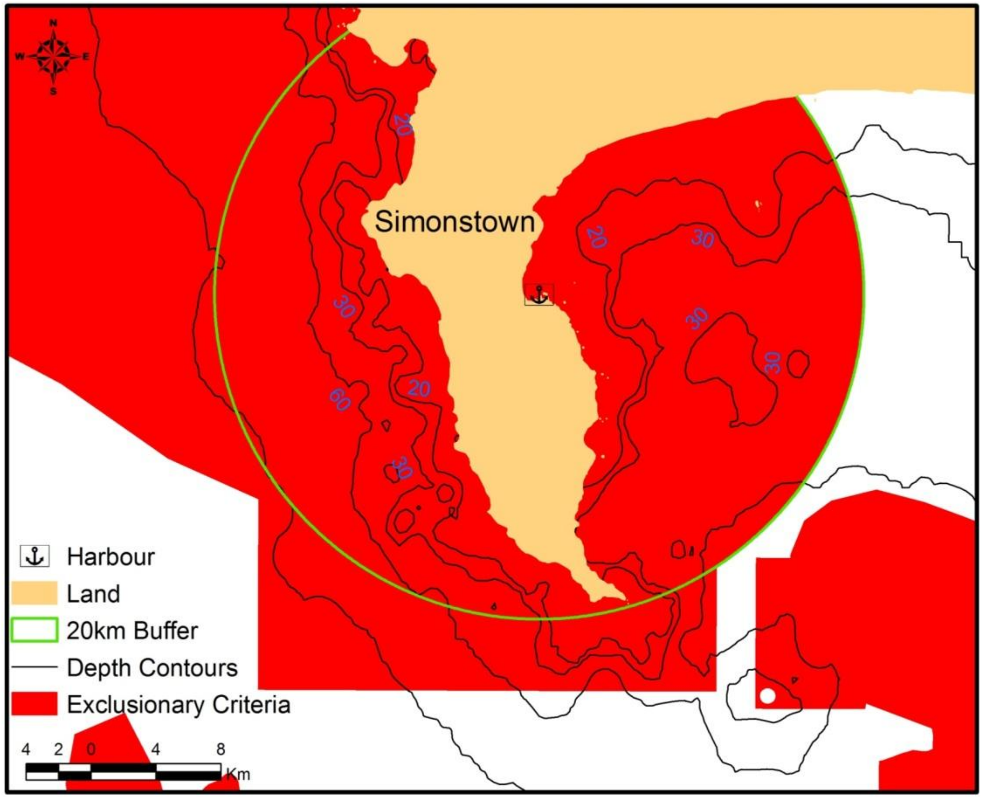


Result same for both inshore & offshore mariculture (no zones).

Simonstown

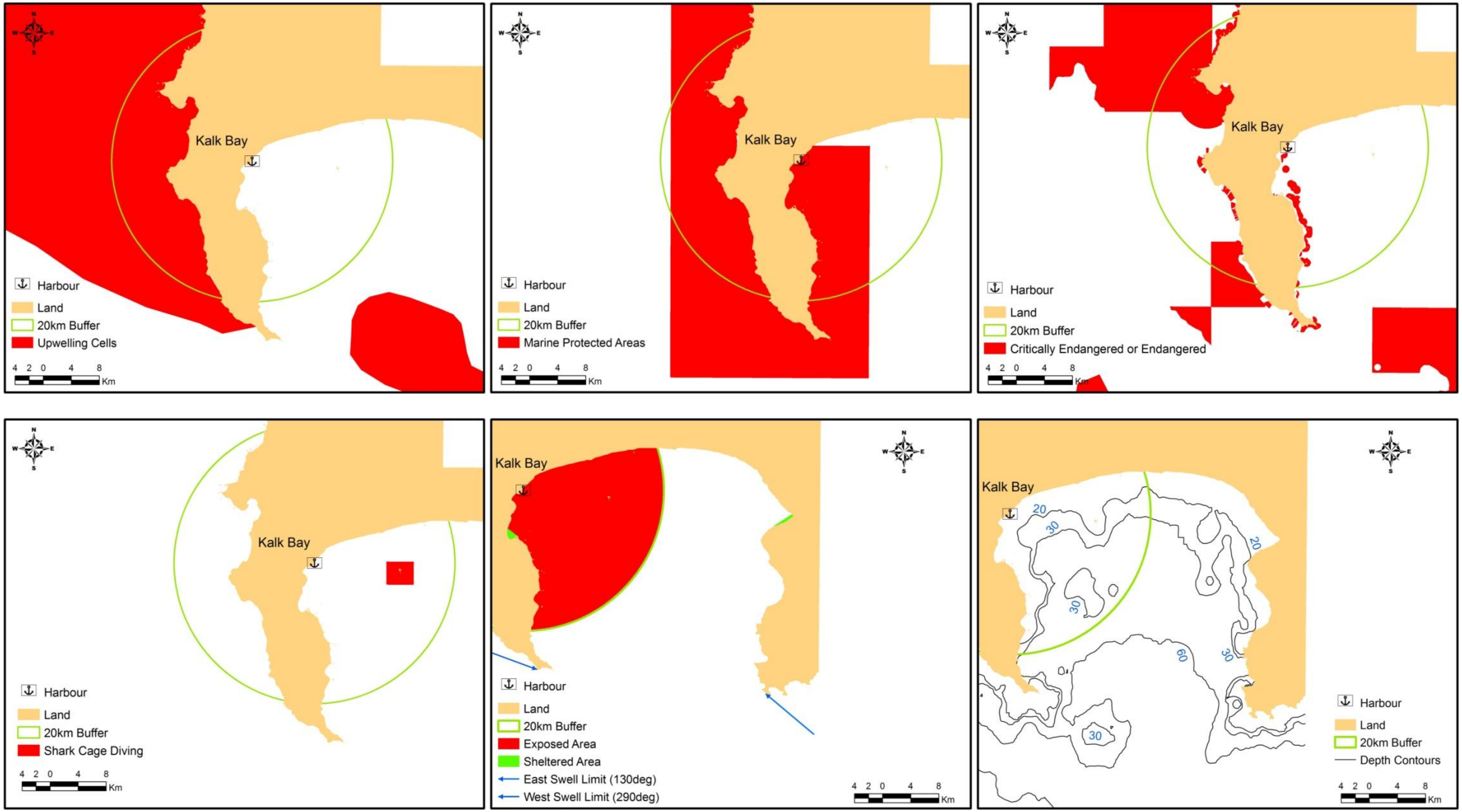

Simonstown
Harbour
Land
20km Buffer
Upwelling Cells
4 2 0 4 8
Km
Simonstown
Harbour
Land
20km Buffer
Marine Protected Areas
4 2 0 4 8
Km
Simonstown
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km
Simonstown
Harbour
Land
20km Buffer
Shark Cage Diving
4 2 0 4 8
Km
Simonstown
Harbour
Land
20km Buffer
Exposed Area
Sheltered Area
East Swell Limit (130deg)
West Swell Limit (290deg)
4 2 0 4 8
Km
Simonstown
20
30
60
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km

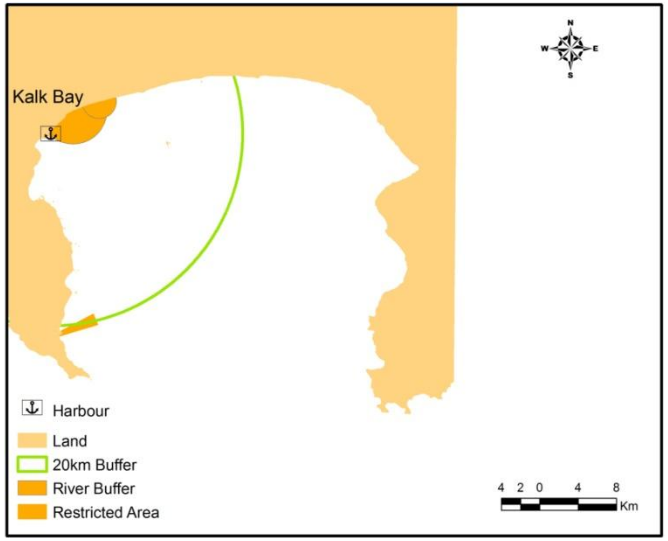


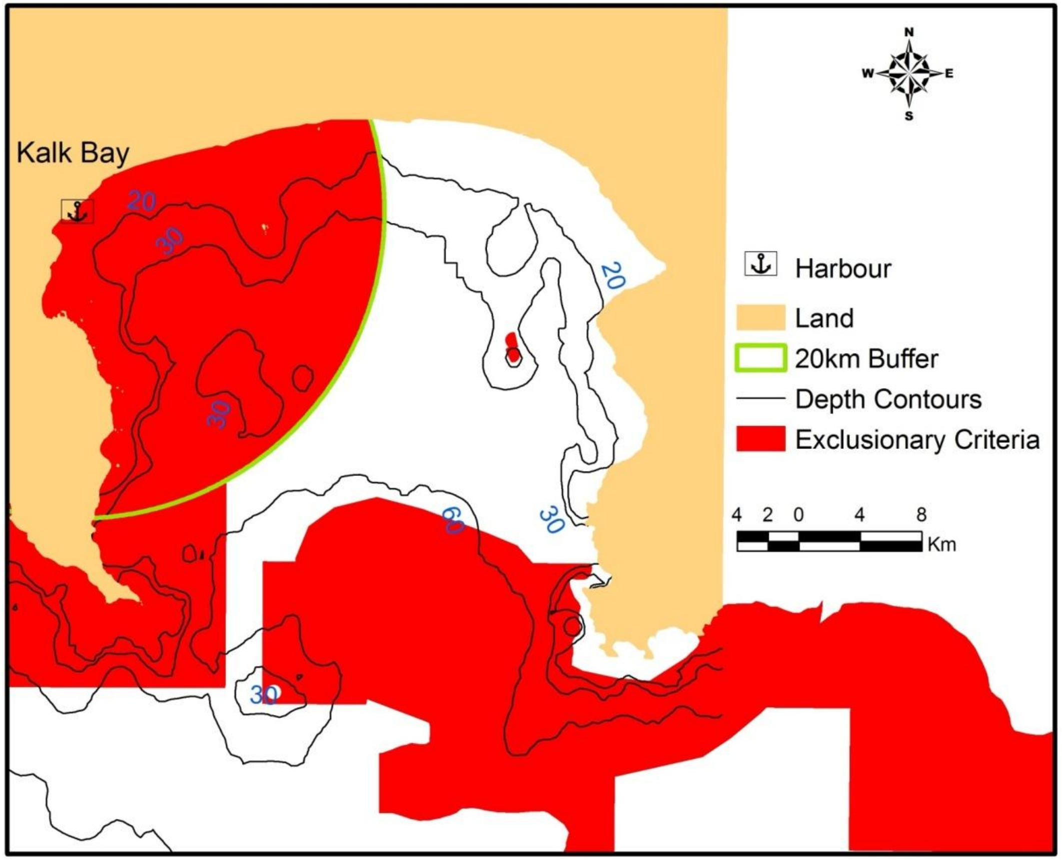


No potential inshore ADZ no zones, identified potential offshore finfish ADZ shown in Figure 19

Kalk Bay

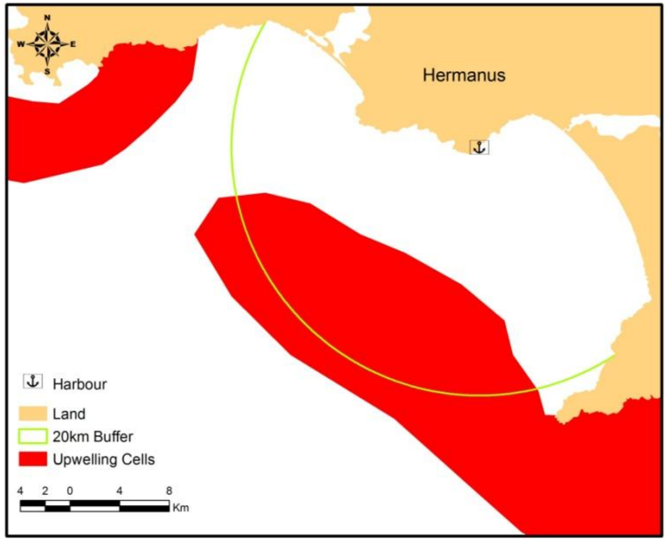

Kalk Bay
Harbour
Land
20km Buffer
Upwelling Cells
4 2 0 4 8
Km
Kalk Bay
Harbour
Land
20km Buffer
Marine Protected Areas
4 2 0 4 8
Km
Kalk Bay
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km
Kalk Bay
Harbour
Land
20km Buffer
Shark Cage Diving
4 2 0 4 8
Km
Kalk Bay
Harbour
Land
20km Buffer
Exposed Area
Sheltered Area
East Swell Limit (130deg)
West Swell Limit (290deg)
4 2 0 4 8
Km
Kalk Bay
20
30
30
20
60
30
30
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km



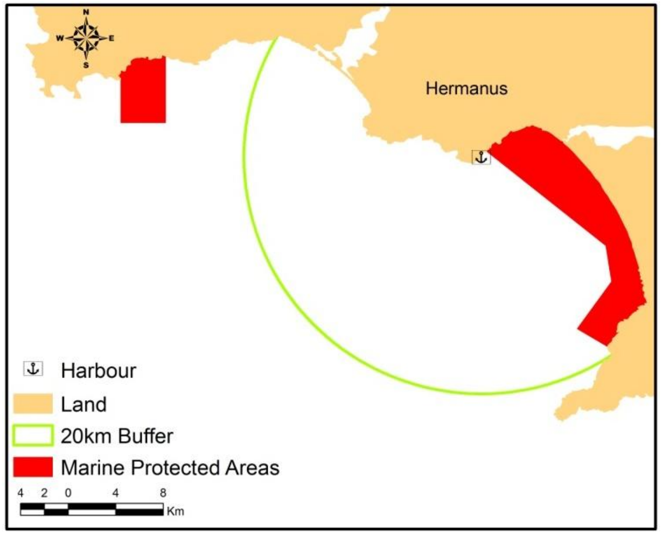


No potential inshore ADZ, no zones, identified potential offshore finfish ADZ shown in Figure 20

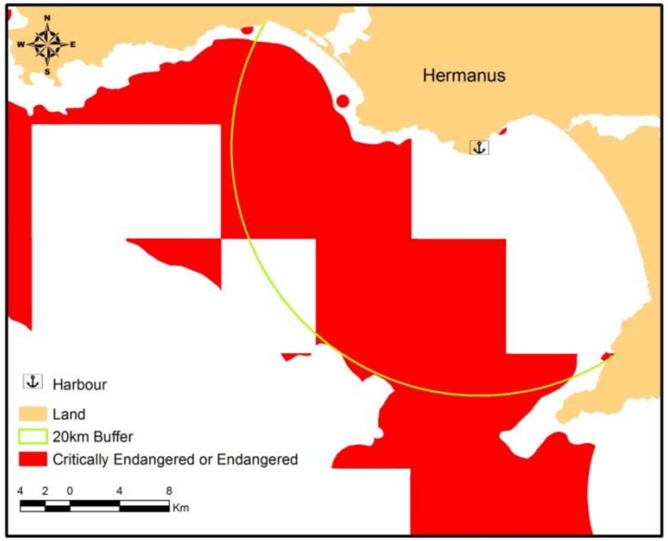
Hermanus



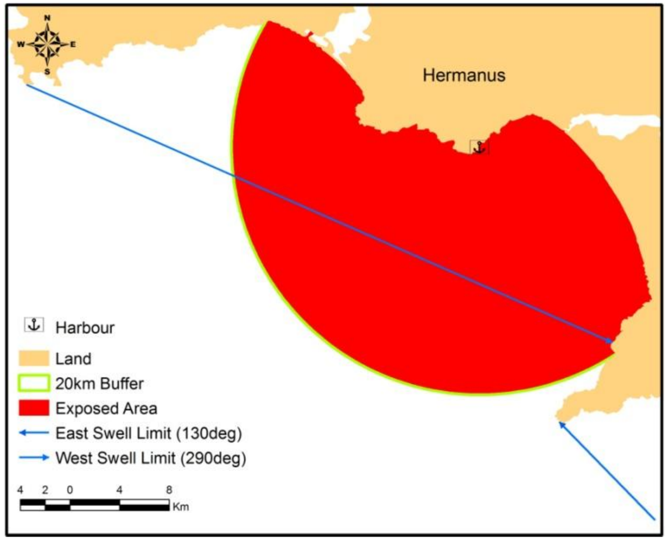
N
W
E
S
Hermanus
Harbour
Land
20km Buffer
Upwelling Cells
4 2 0 4 8
Km



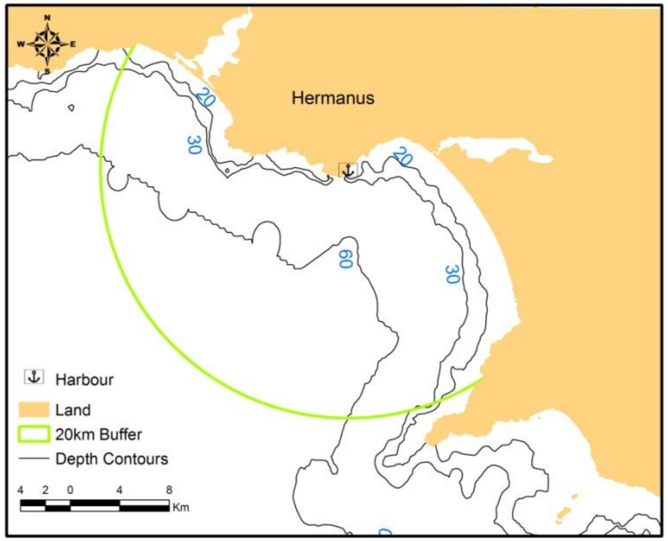
N
W
E
S
Hermanus
Harbour
Land
20km Buffer
Marine Protected Areas
4 2 0 4 8
Km



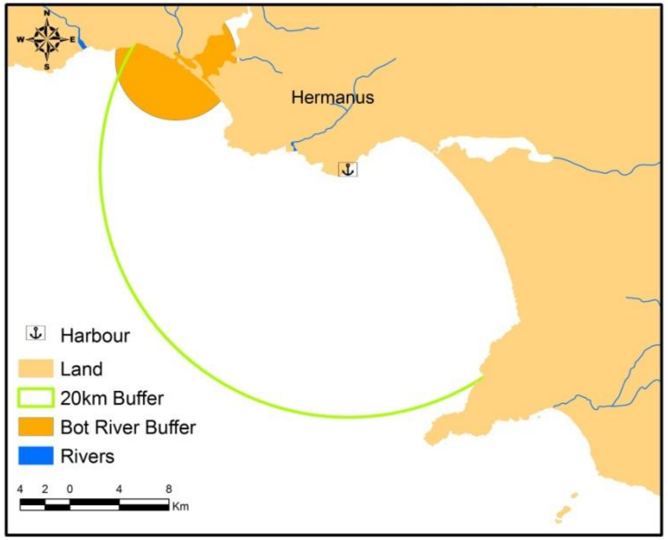
N
W
E
S
Hermanus
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km



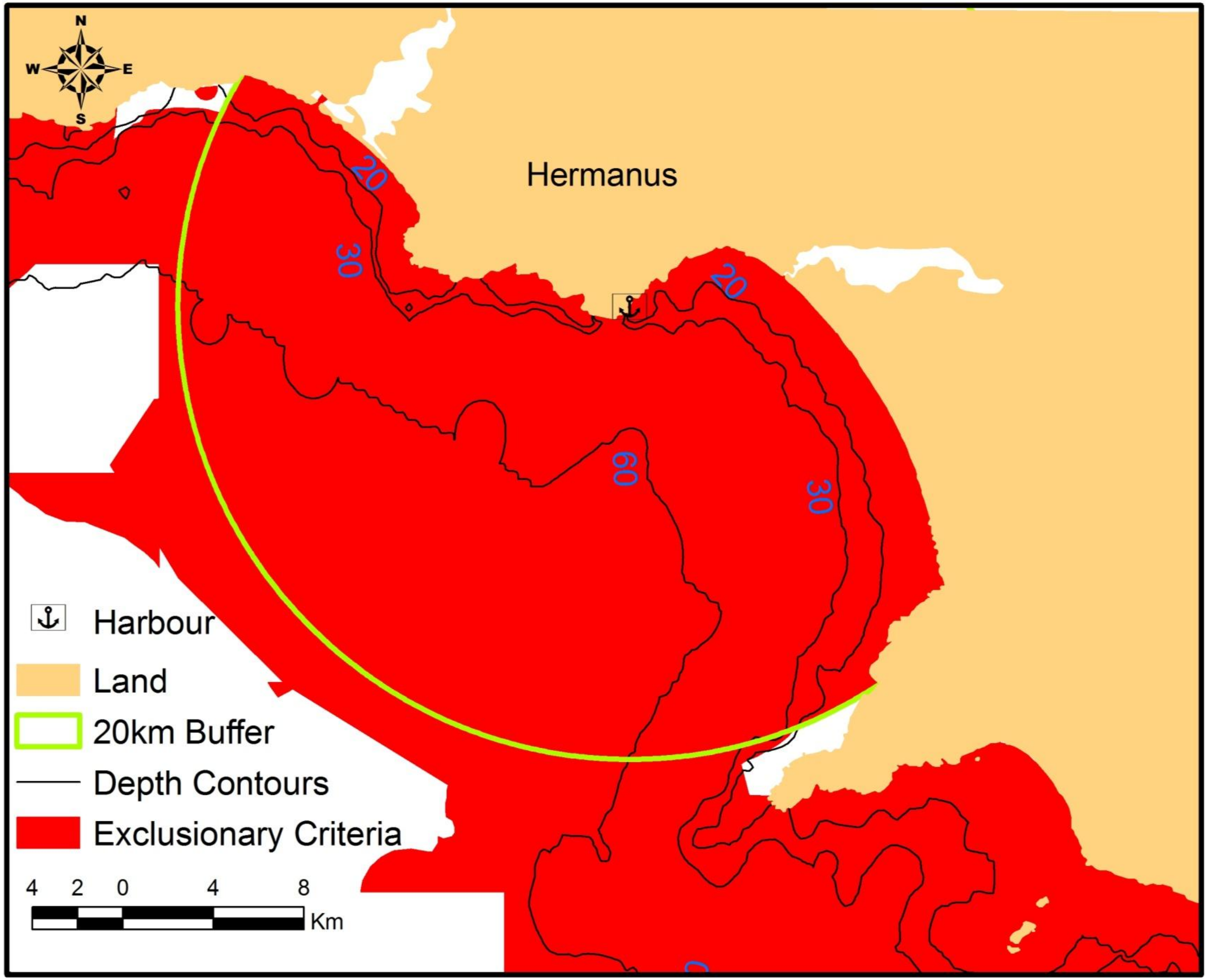
N
W
E
S
Hermanus
Harbour
Land
20km Buffer
Exposed Area
East Swell Limit (130deg)
West Swell Limit (290deg)
4 2 0 4 8
Km



N
W
E
S
Hermanus
20
30
20
60
30
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km

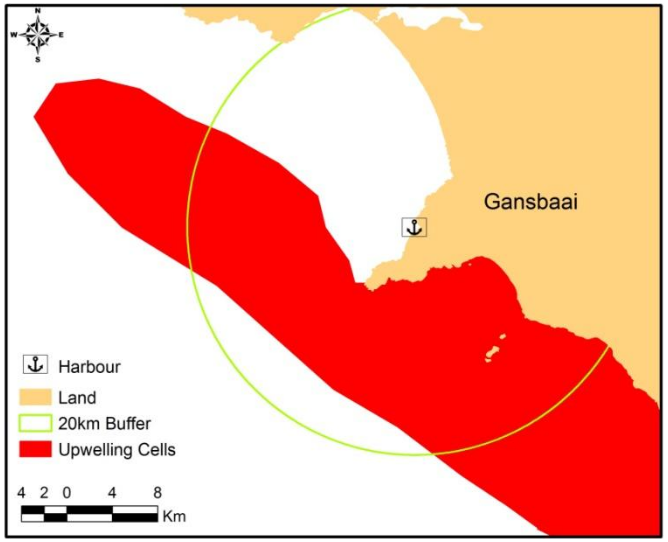


N
W
E
S
Hermanus
Harbour
Land
20km Buffer
Bot River Buffer
Rivers
4 2 0 4 8
Km

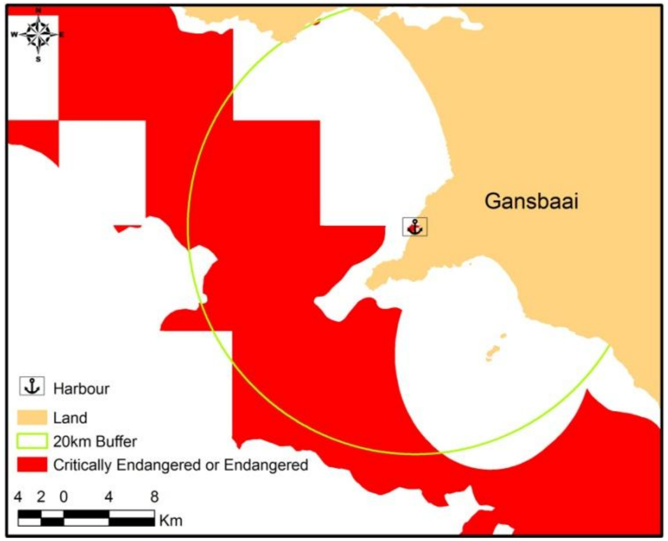


No potential Inshore ADZ- No zone, identified potential offshore finfish ADZ shown in Figure 21.

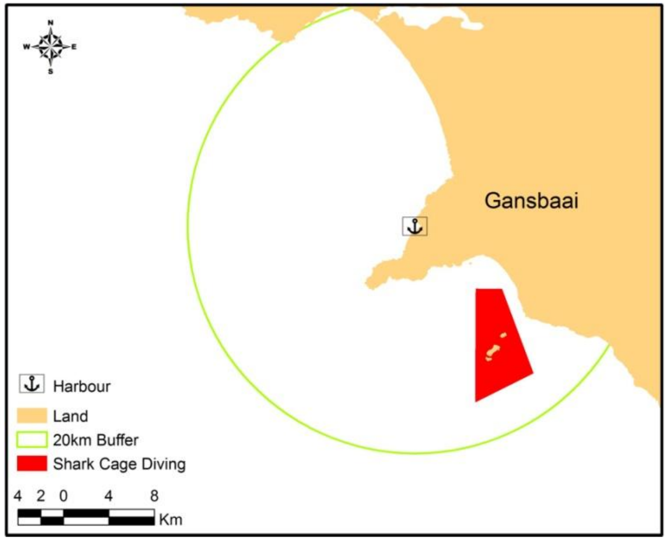
Gansbaai



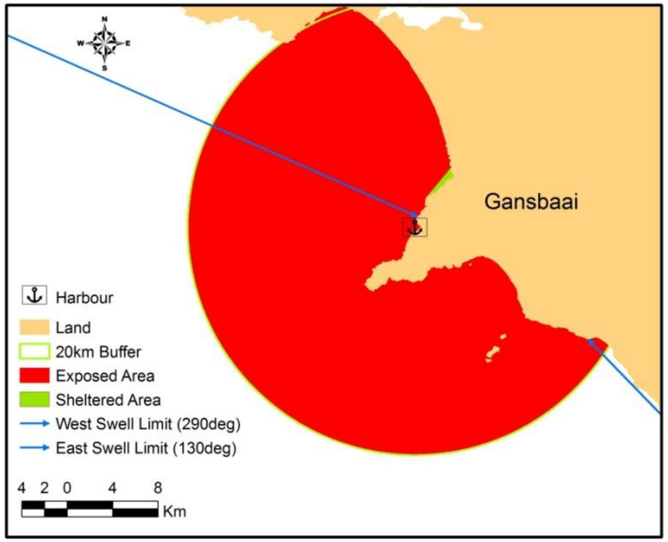
Gansbaai
Harbour
Land
20km Buffer
Upwelling Cells
4 2 0 4 8
Km



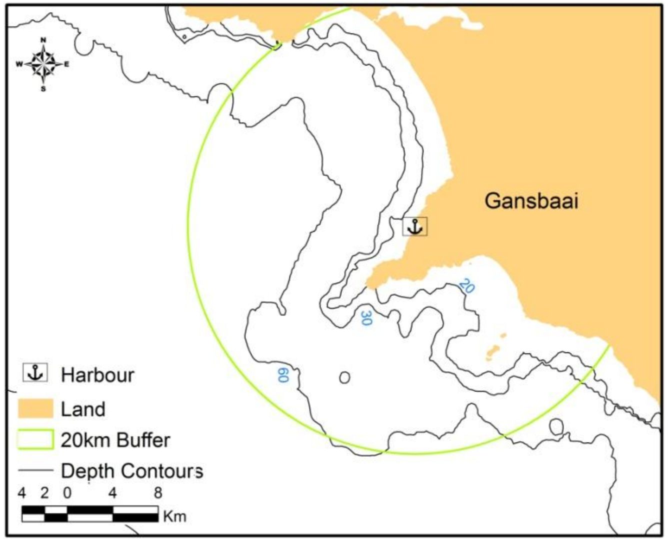
Gansbaai
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km



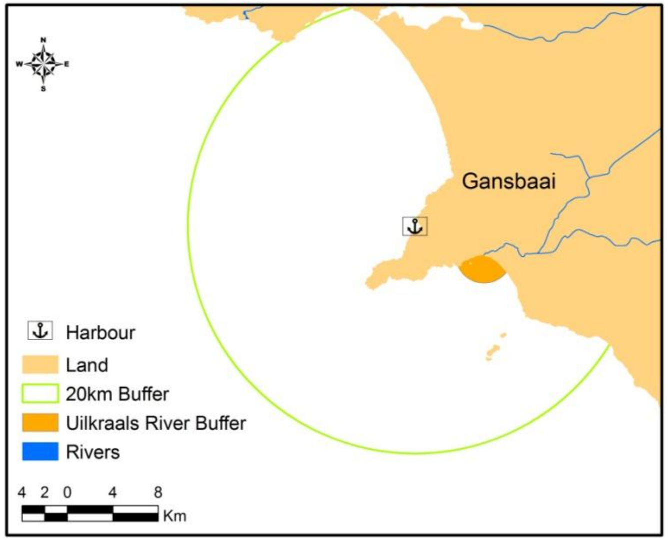
Gansbaai
Harbour
Land
20km Buffer
Shark Cage Diving
4 2 0 4 8
Km



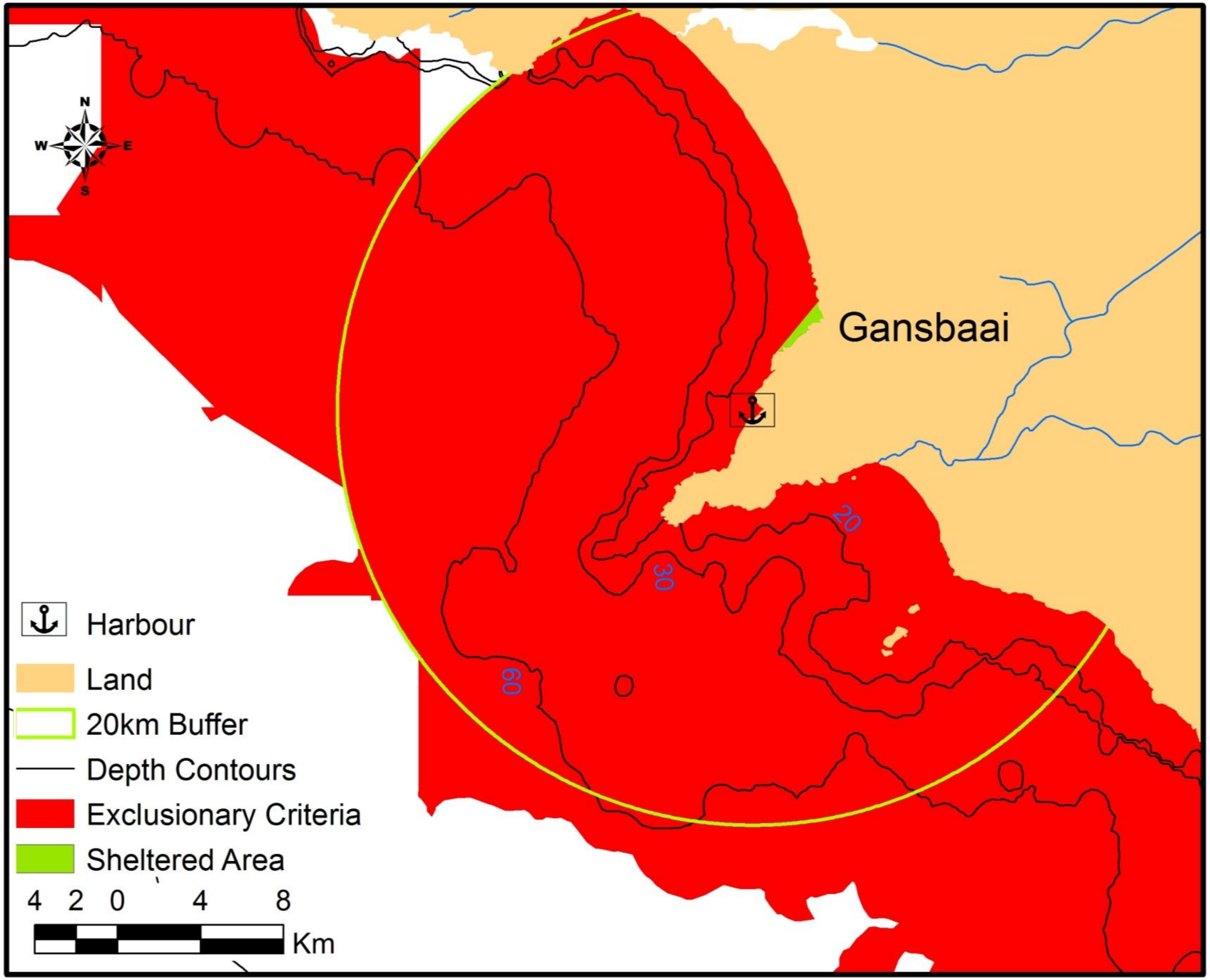
Gansbaai
Harbour
Land
20km Buffer
Exposed Area
Sheltered Area
West Swell Limit (290deg)
East Swell Limit (130deg)
4 2 0 4 8
Km



Gansbaai
20
30
60
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km

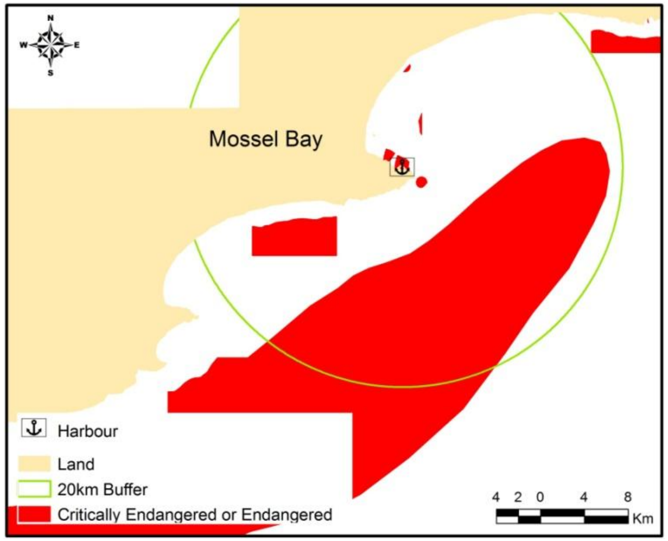


Gansbaai
Harbour
Land
20km Buffer
Uilkraals River Buffer
Rivers
4 2 0 4 8
Km

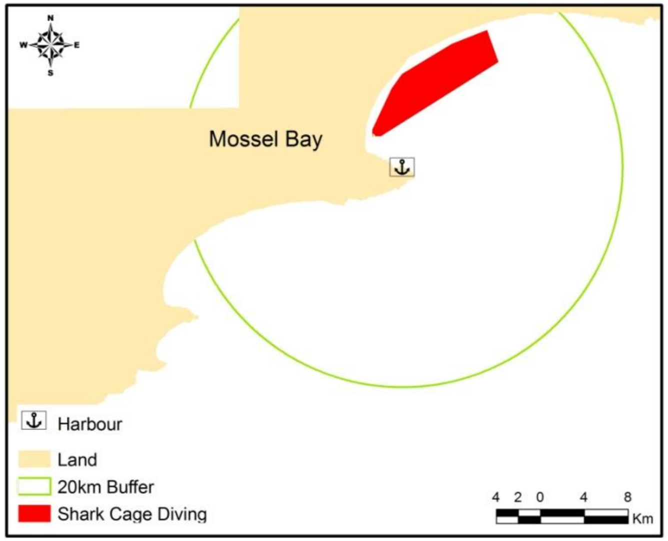


No potential inshore ADZ, identified potential offshore finfish ADZ shown in Figure 22

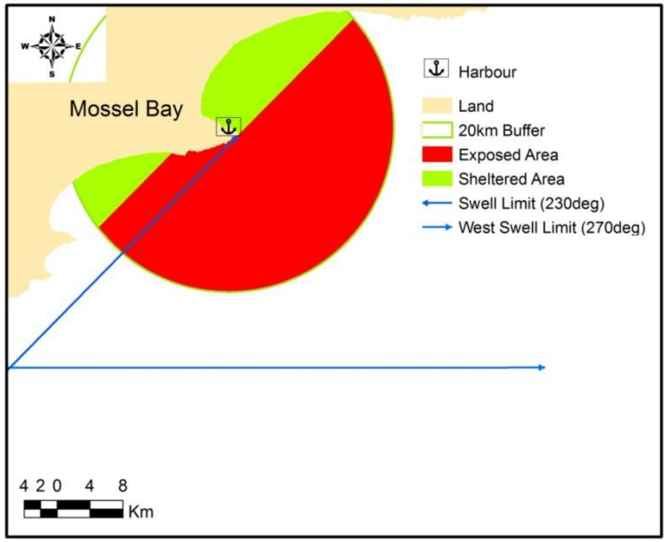
Mossel Bay



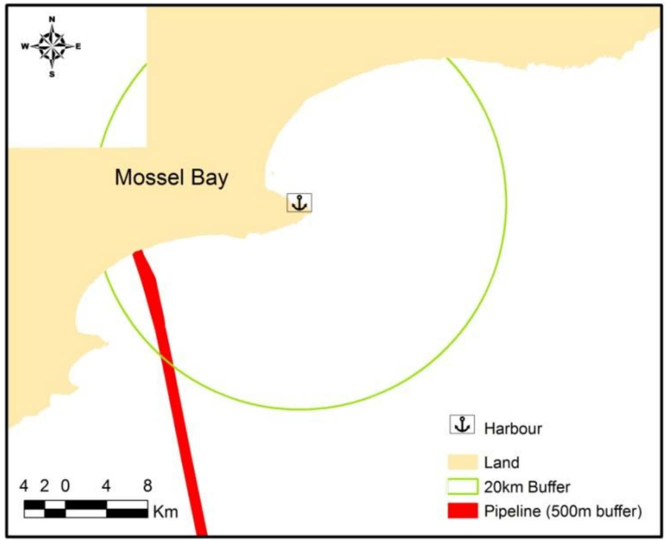
Mossel Bay
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km



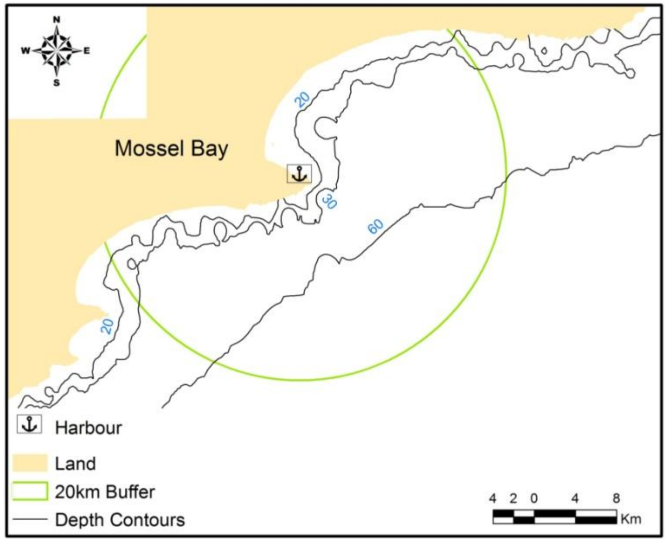
Mossel Bay
Harbour
Land
20km Buffer
Shark Cage Diving
4 2 0 4 8
Km



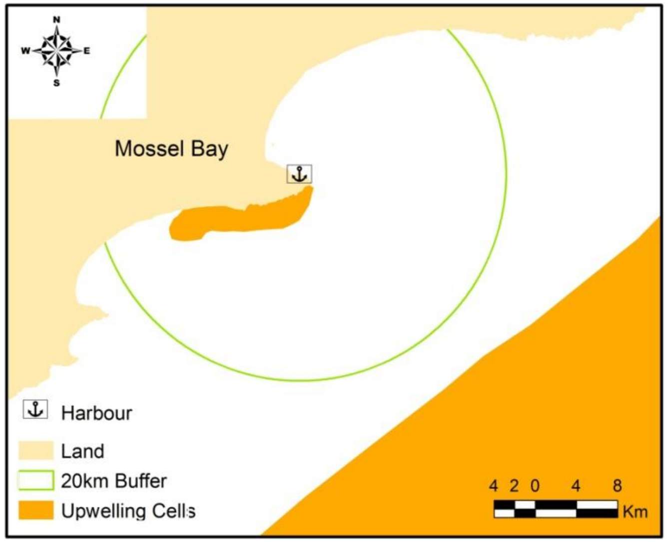
Mossel Bay
Harbour
Land
20km Buffer
Exposed Area
Sheltered Area
Swell Limit (230deg)
West Swell Limit (270deg)
4 2 0 4 8
Km



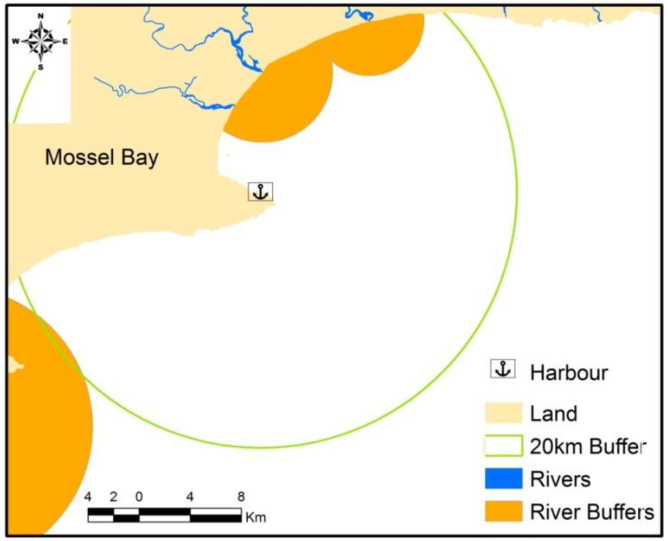
Mossel Bay
Harbour
Land
20km Buffer
Pipeline (500m buffer)
4 2 0 4 8
Km



Mossel Bay
20
30
60
20
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km

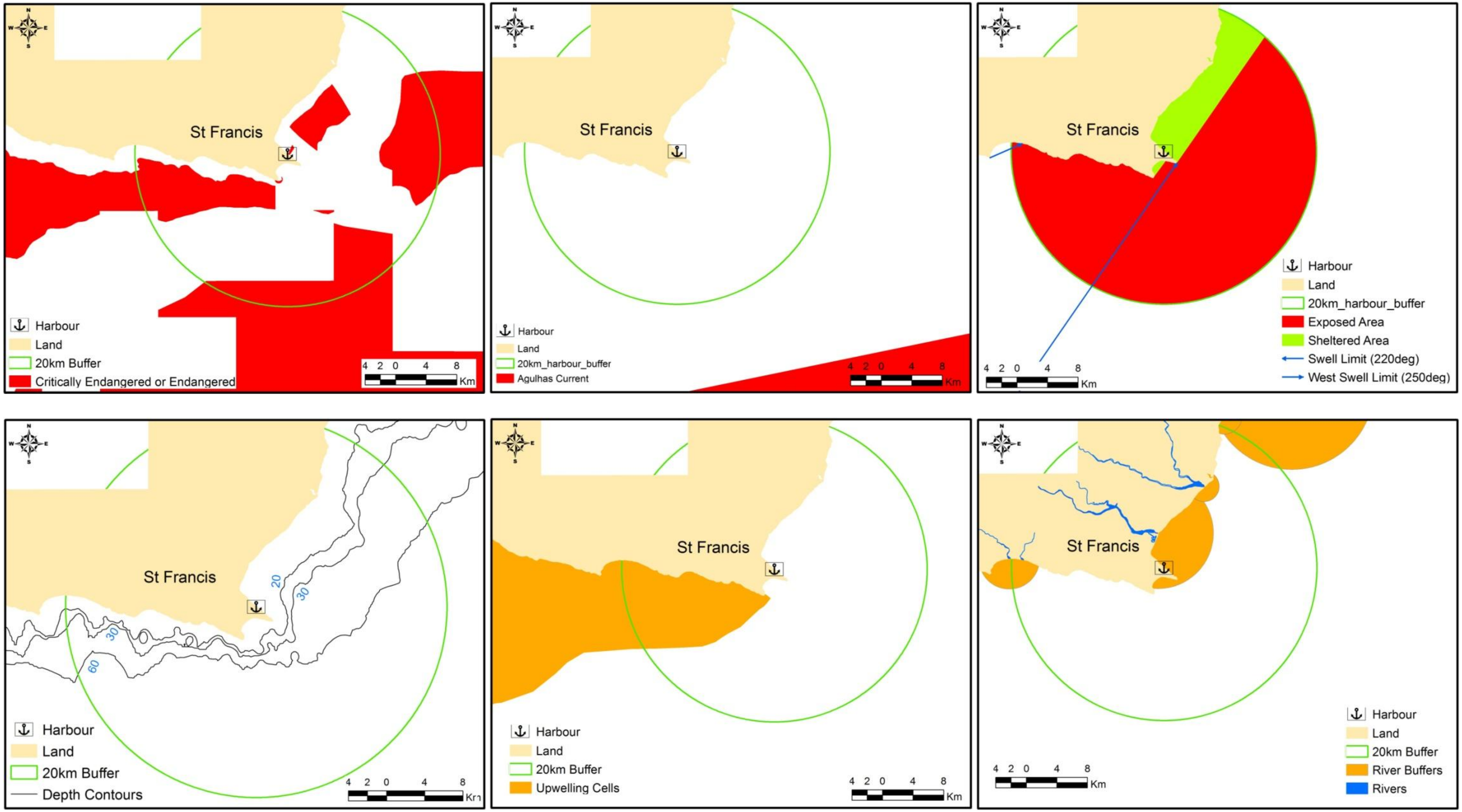


Mossel Bay
Harbour
Land
20km Buffer
Upwelling Cells
4 2 0 4 8
Km



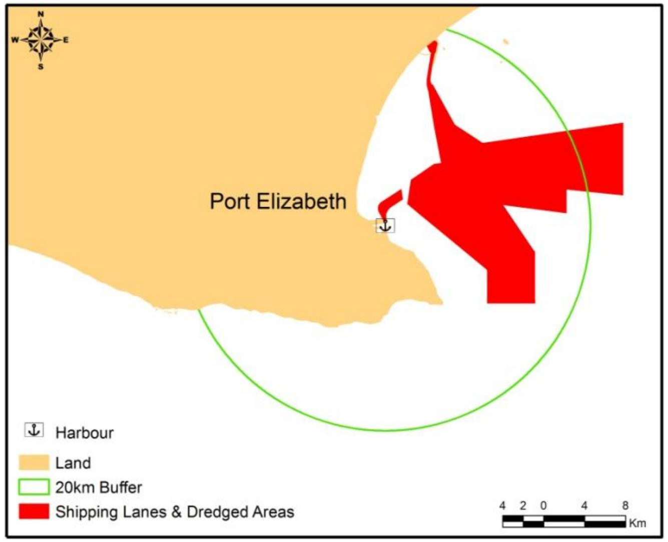
Potential inshore and offshore finfish ADZ shown in Figure 16 & Figure 24 respectively.

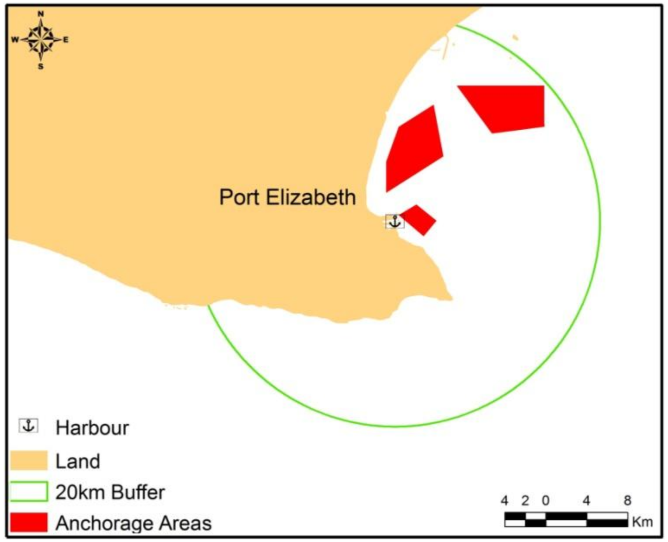
St. Francis

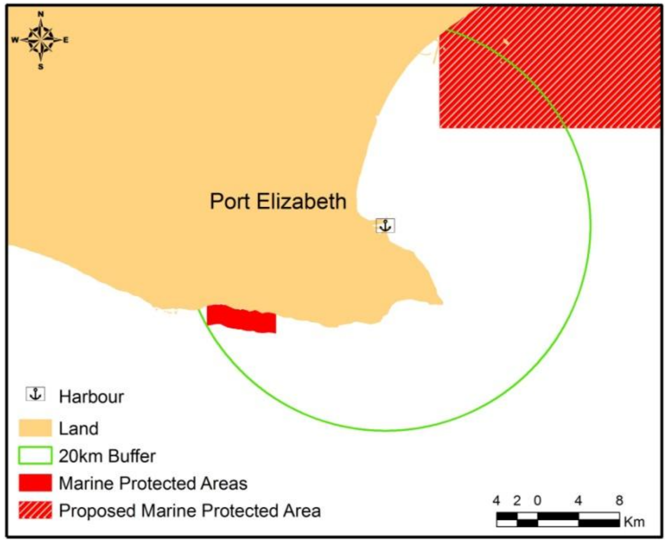


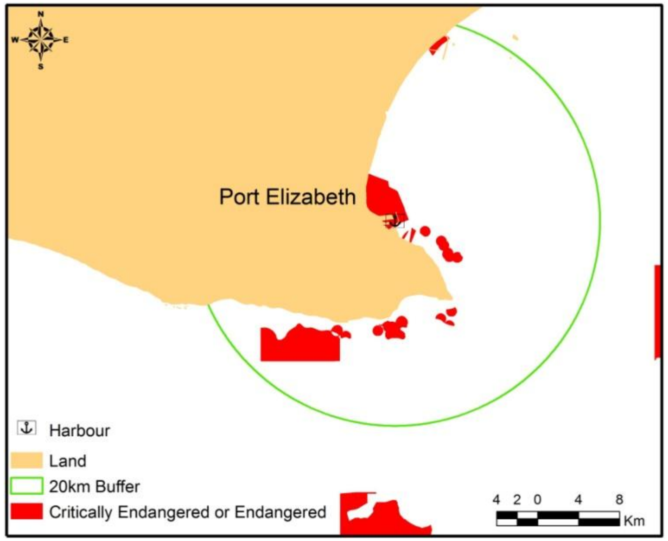
Potential inshore and offshore finfish ADZ shown in Figure 16 & Figure 24

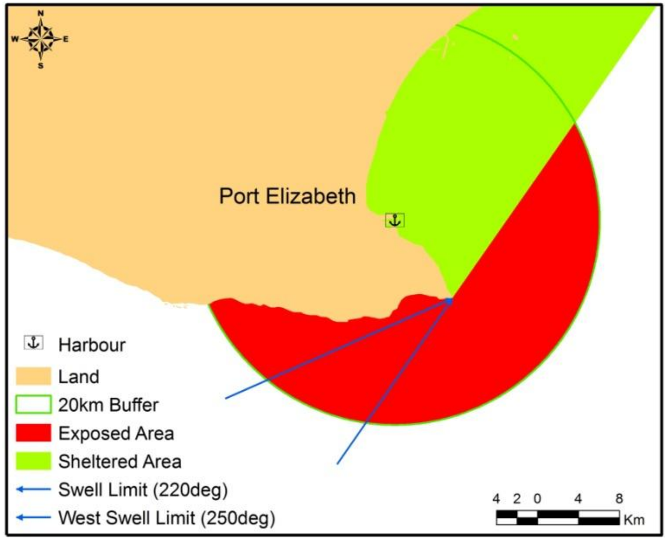
Port Elizabeth

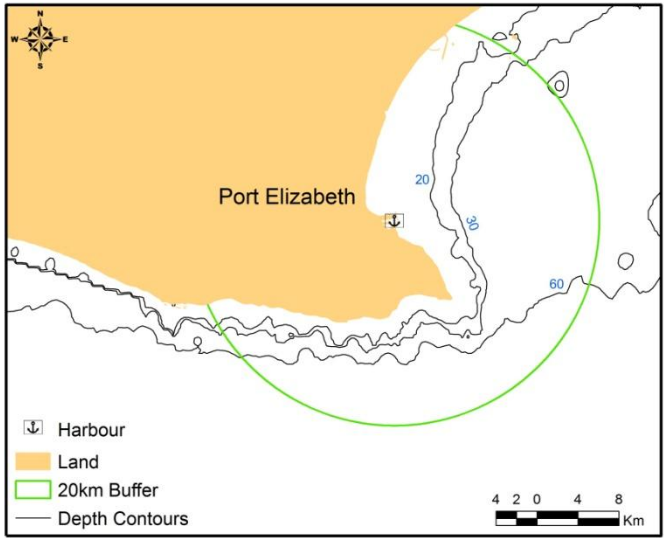




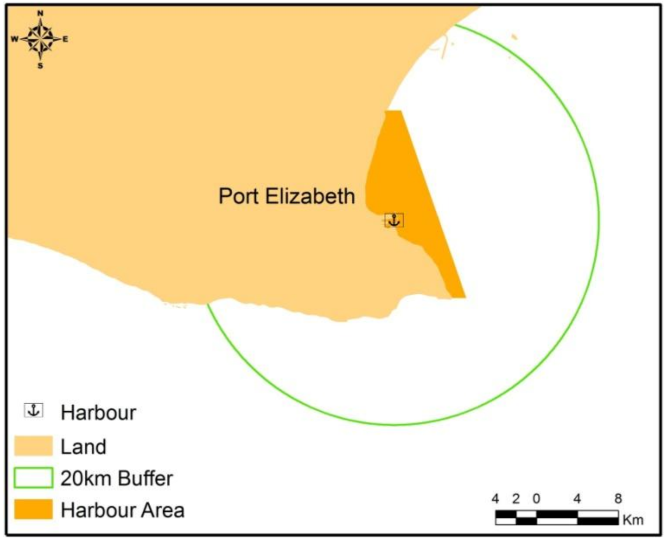


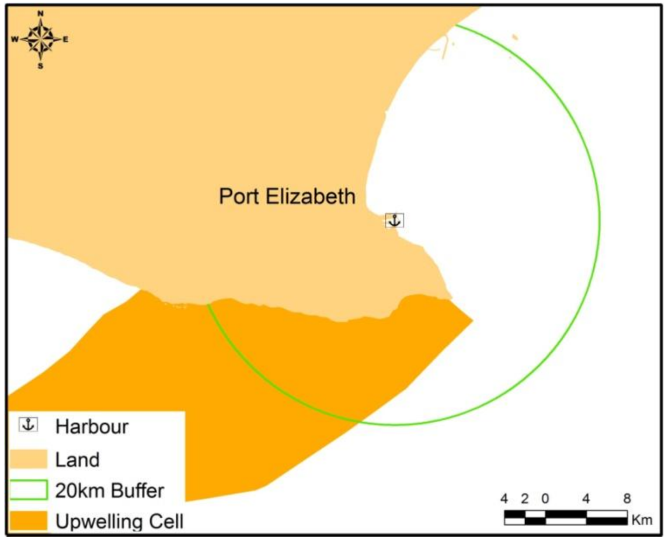


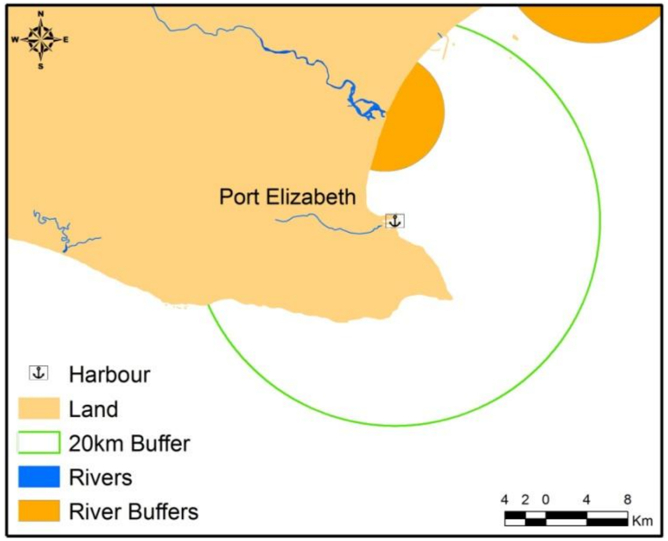




Port Elizabeth contd.

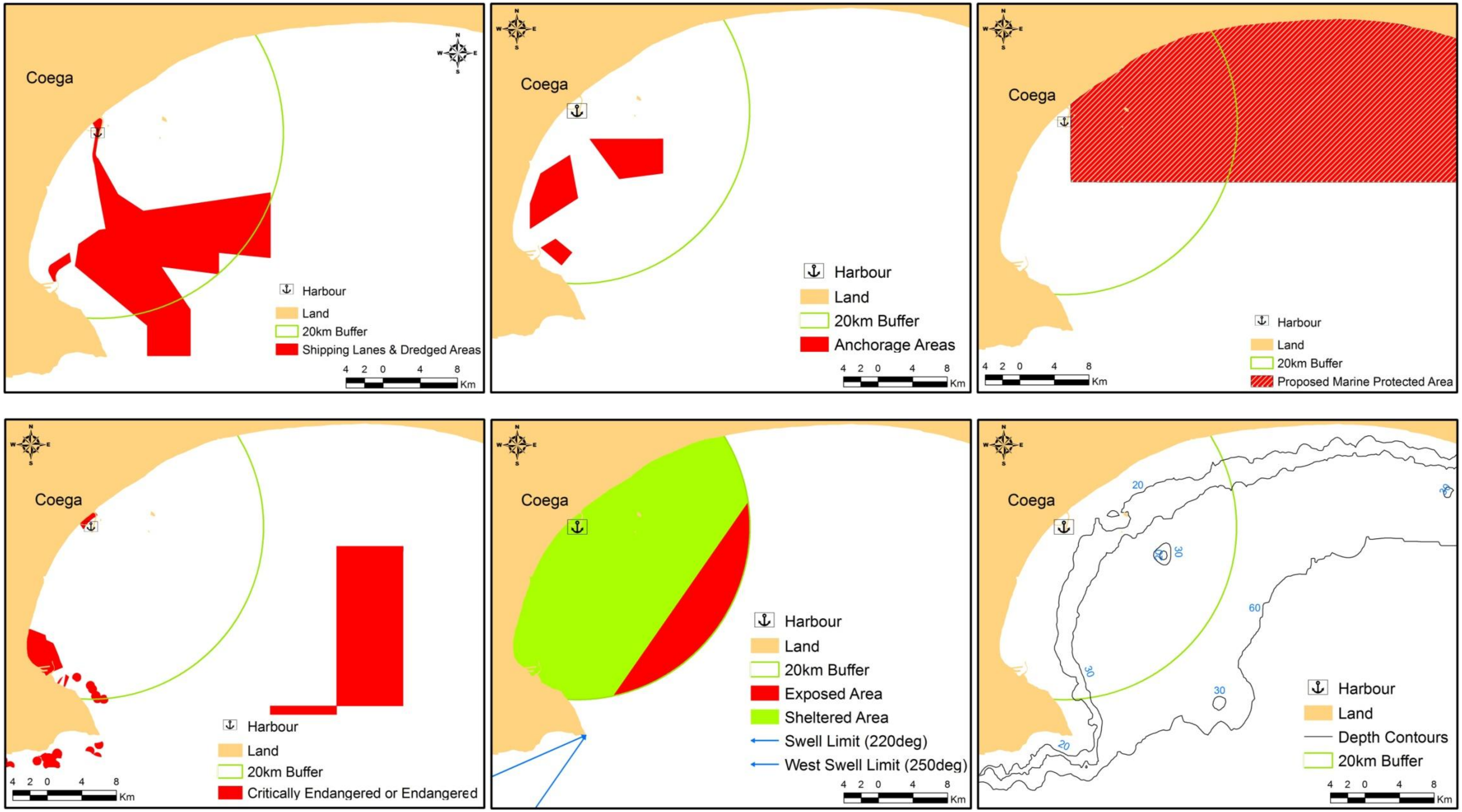






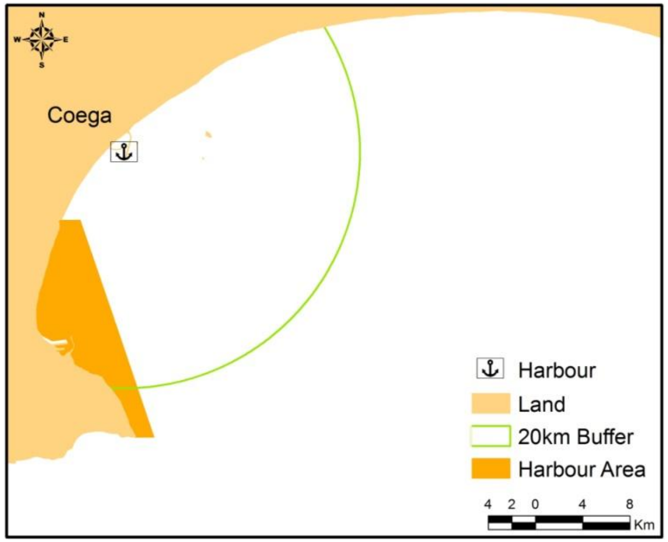
Potential inshore and offshore finfish ADZ shown in Figure 17 & Figure 25

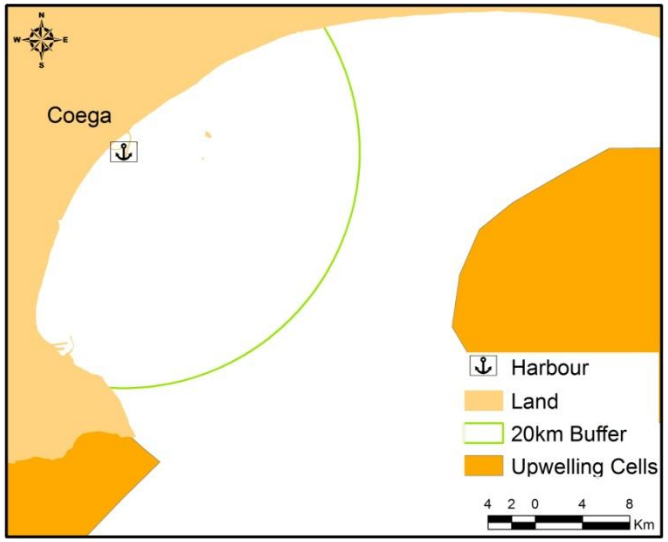
Coega

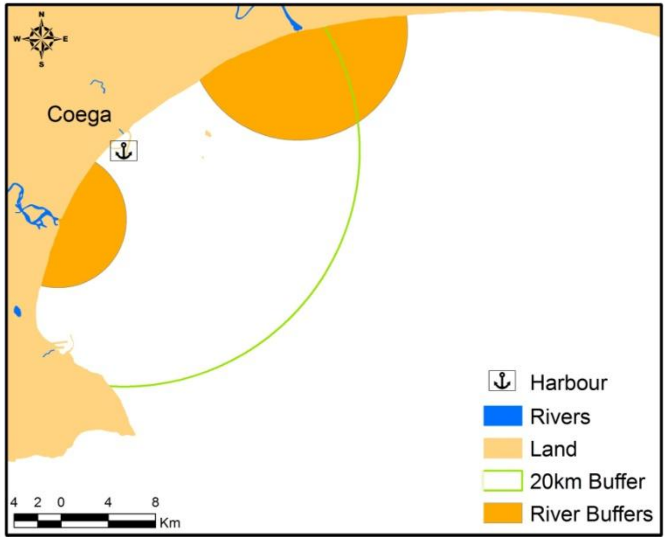


Coega
Harbour
Land
20km Buffer
Shipping Lanes & Dredged Areas
Anchorage Areas
Proposed Marine Protected Area
Critically Endangered or Endangered
Exposed Area
Sheltered Area
Swell Limit (220deg)
West Swell Limit (250deg)
Depth Contours
20
30
60
4 2 0 4 8
Km

Coega contd.

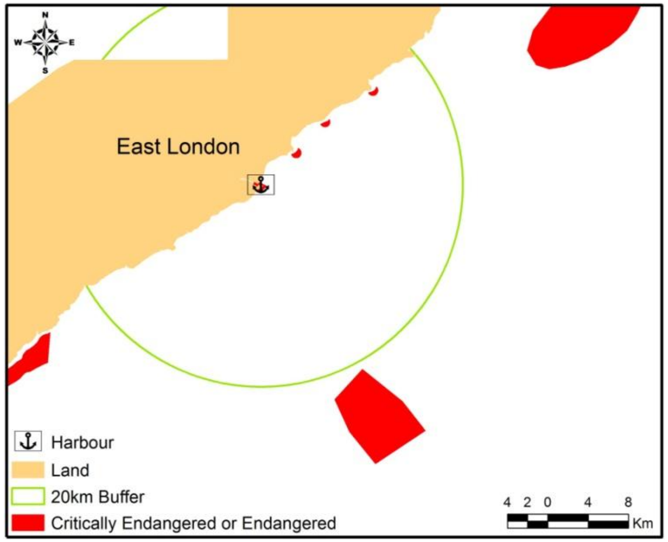




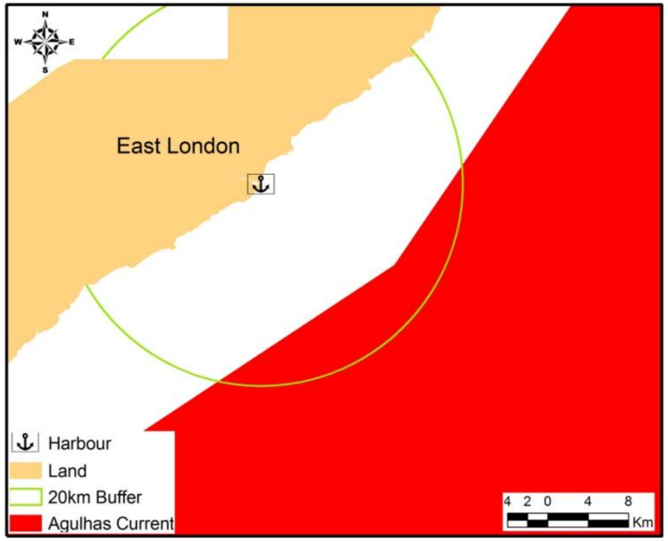


Potential inshore and offshore finfish ADZ shown in Figure 17 & Figure 26

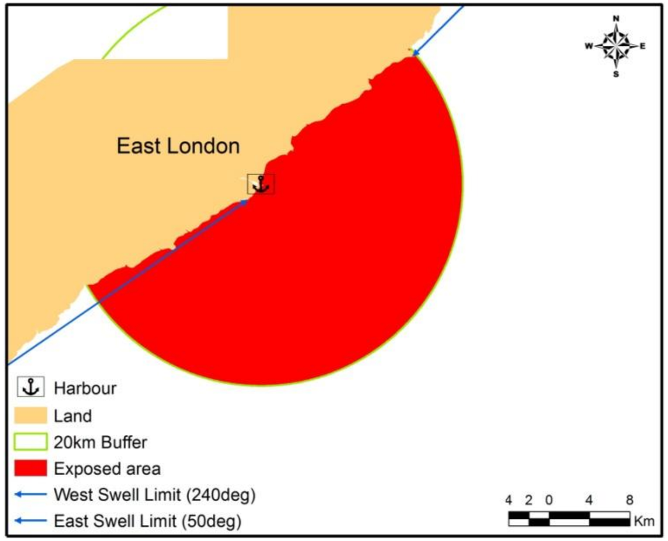
East London



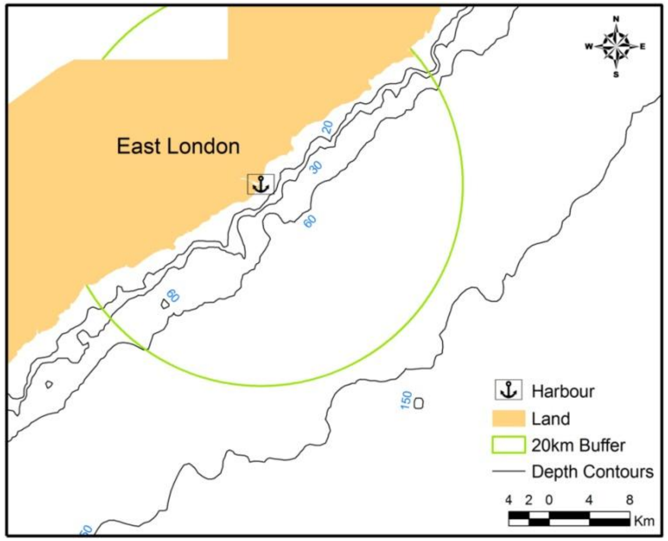
N
W
E
S
East London
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km



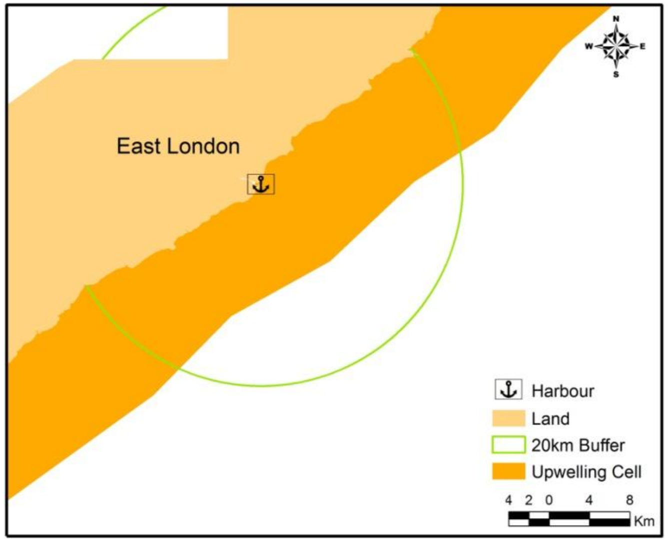
N
W
E
S
East London
Harbour
Land
20km Buffer
Agulhas Current
4 2 0 4 8
Km



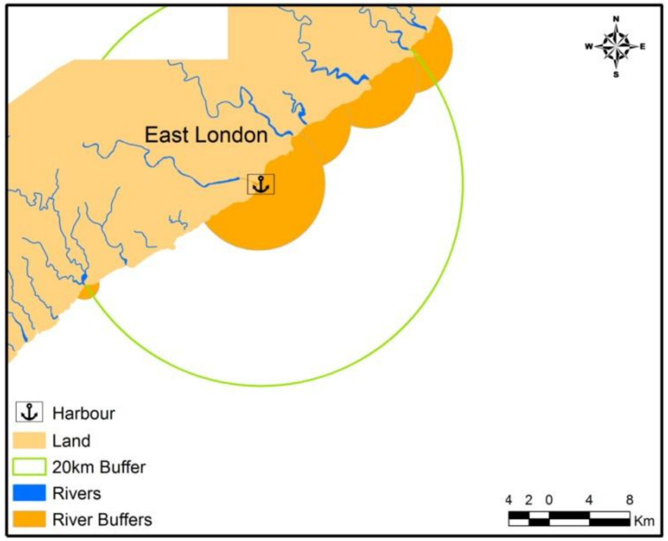
N
W
E
S
East London
Harbour
Land
20km Buffer
Exposed area
West Swell Limit (240deg)
East Swell Limit (50deg)
4 2 0 4 8
Km



N
W
E
S
East London
20
30
60
80
150
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km

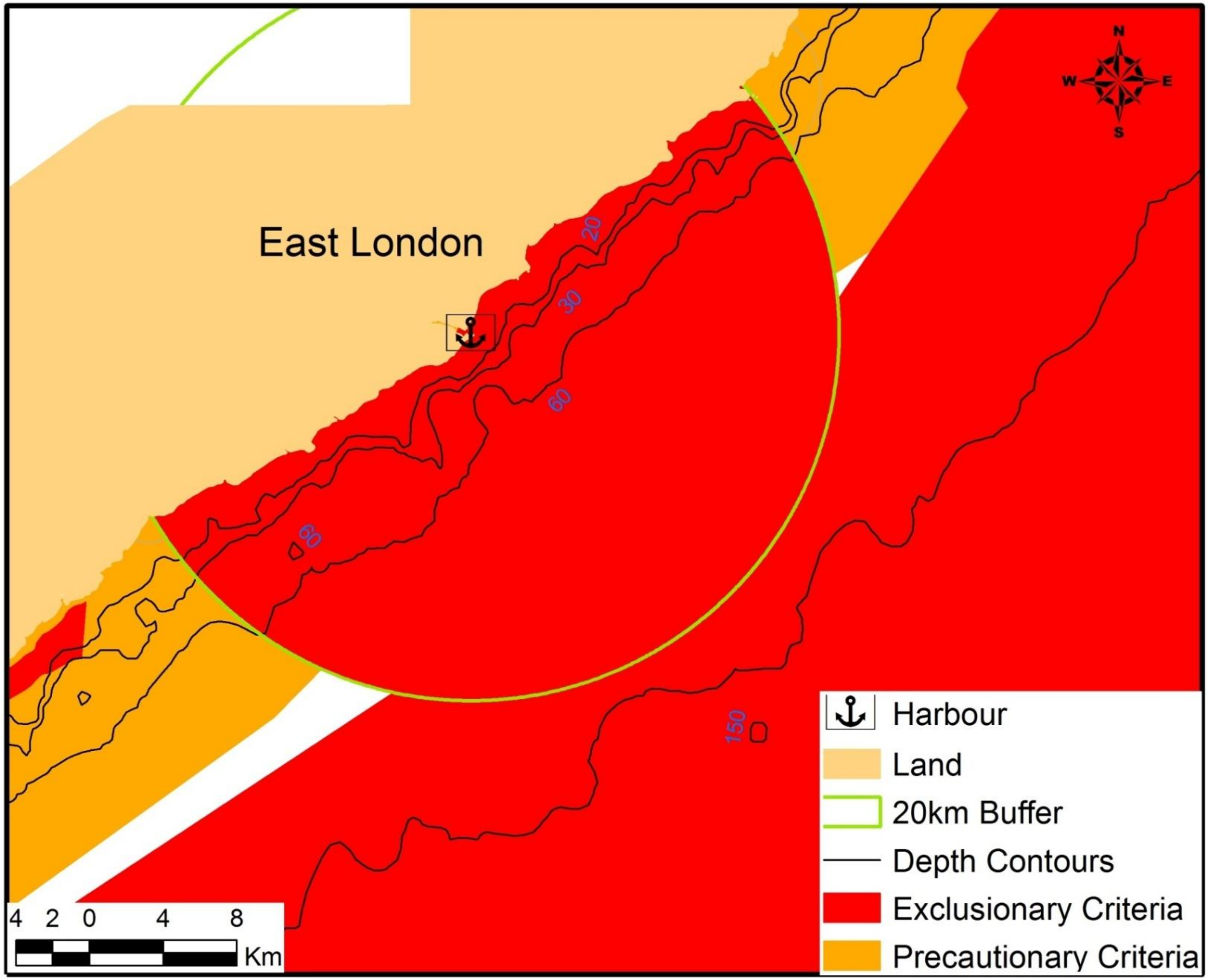


N
W
E
S
East London
Harbour
Land
20km Buffer
Upwelling Cell
4 2 0 4 8
Km



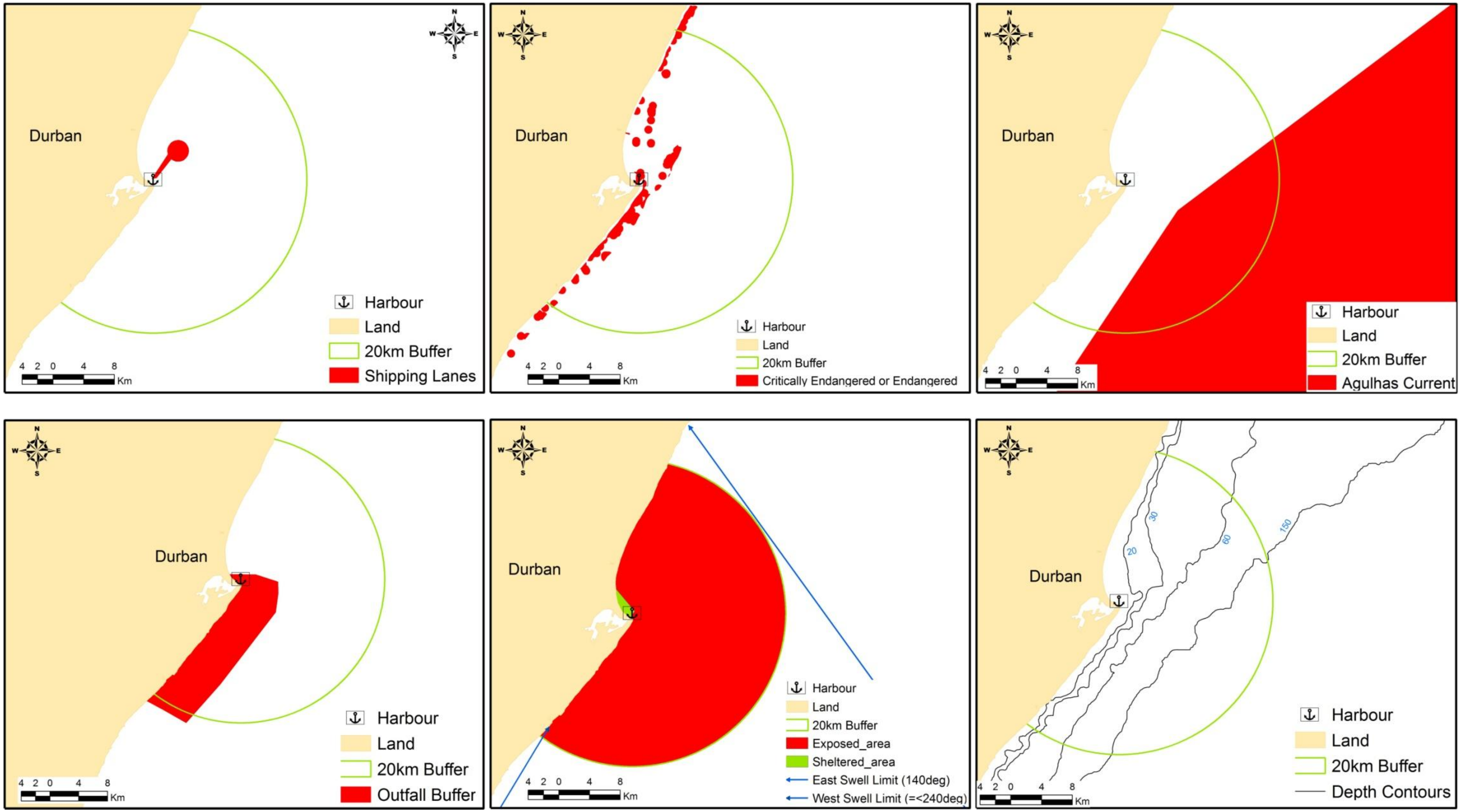
N
W
E
S
East London
Harbour
Land
20km Buffer
Rivers
River Buffers
4 2 0 4 8
Km

East London contd.



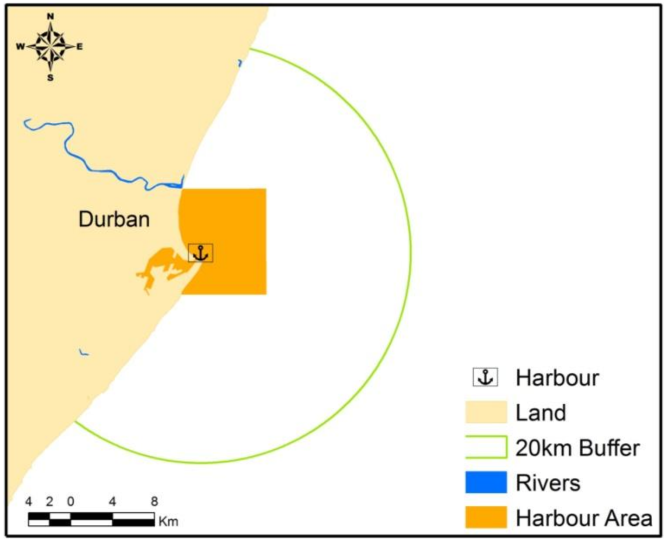
No potential inshore finfish ADZ, potential offshore zone shown in Figure 27

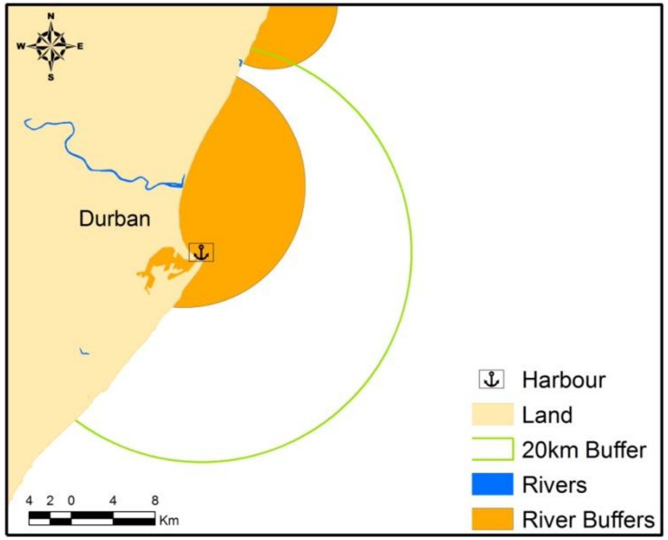
Durban

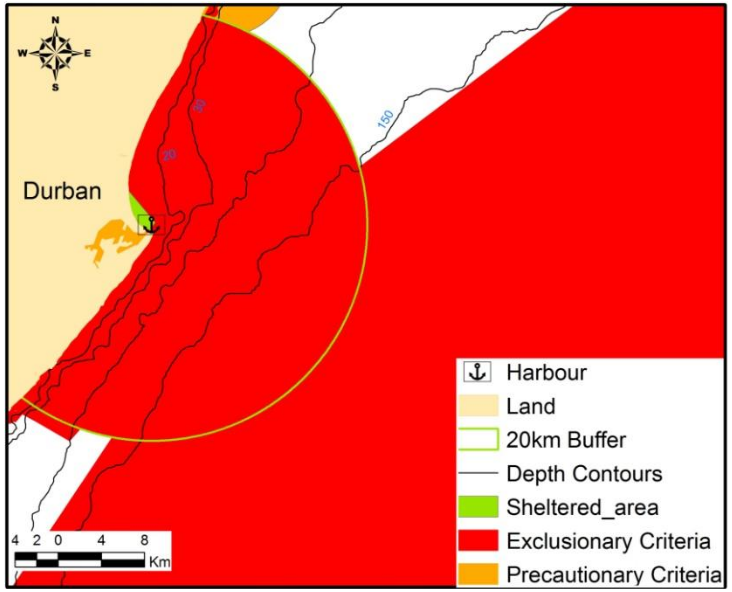


Durban
Harbour
Land
20km Buffer
Shipping Lanes
4 2 0 4 8
Km
Durban
Harbour
Land
20km Buffer
Critically Endangered or Endangered
4 2 0 4 8
Km
Durban
Harbour
Land
20km Buffer
Agulhas Current
4 2 0 4 8
Km
Durban
Harbour
Land
20km Buffer
Outfall Buffer
4 2 0 4 8
Km
Durban
Harbour
Land
20km Buffer
Exposed_area
Sheltered_area
East Swell Limit (140deg)
West Swell Limit (=<240deg)
4 2 0 4 8
Km
Durban
30
20
60
150
Harbour
Land
20km Buffer
Depth Contours
4 2 0 4 8
Km

Durban contd.

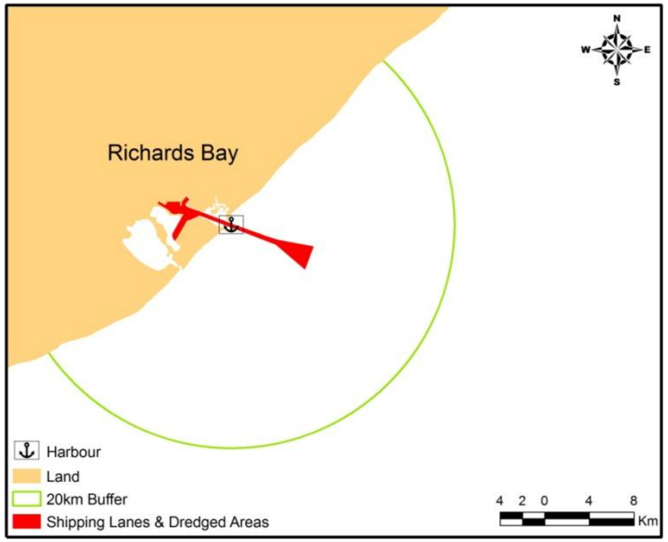


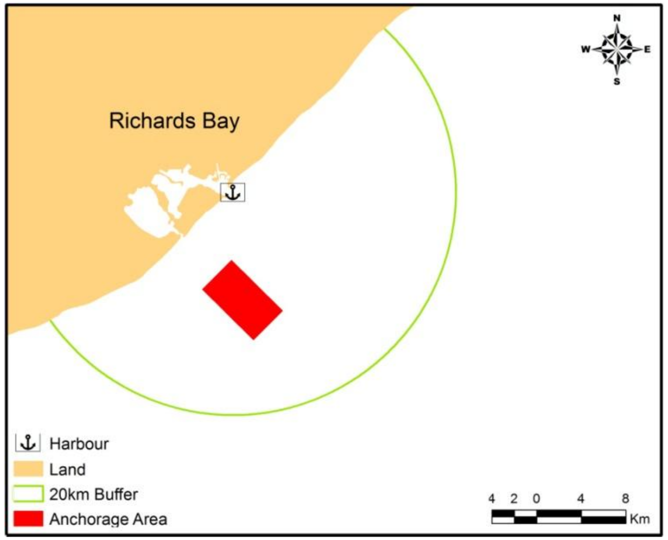


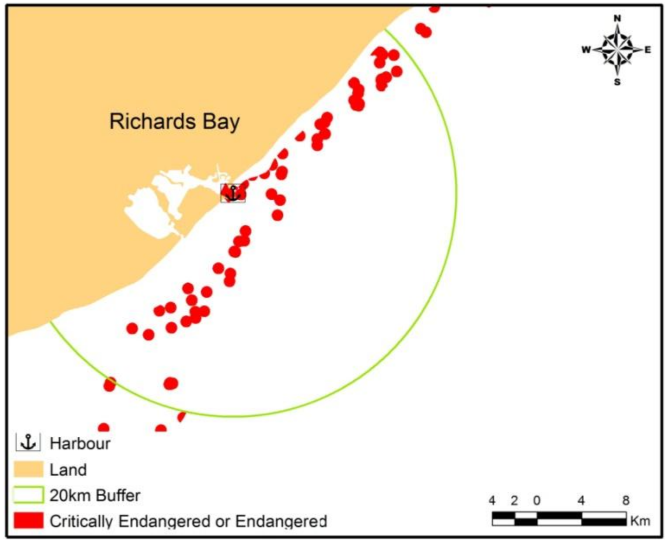


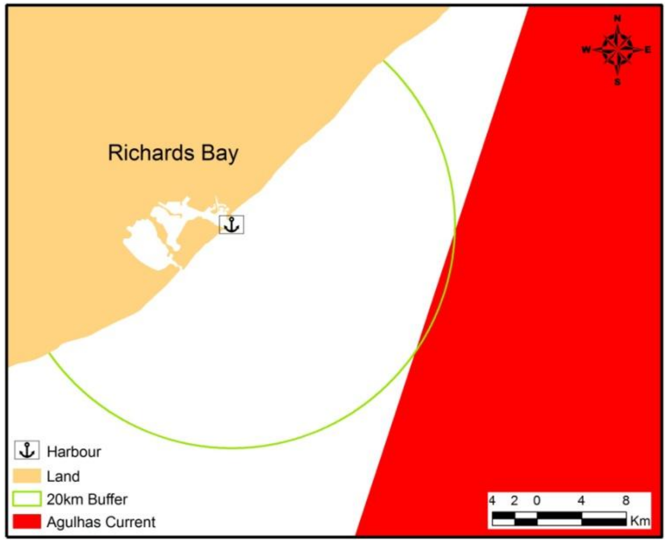
No potential inshore finfish ADZ, potential offshore zone shown in Figure 28

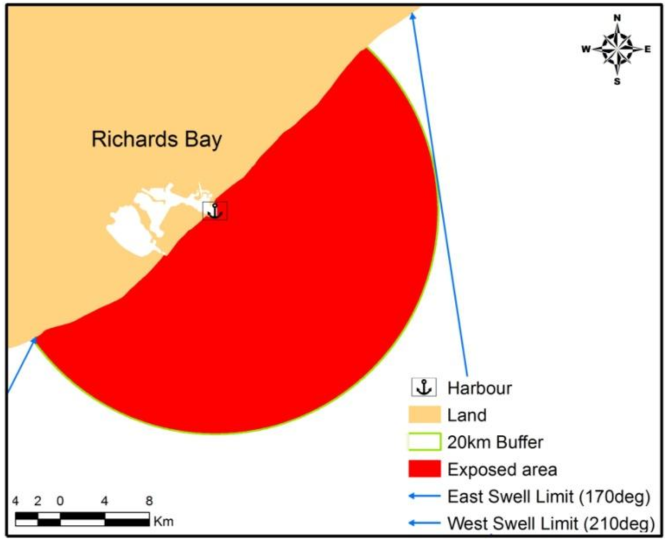
Richards Bay

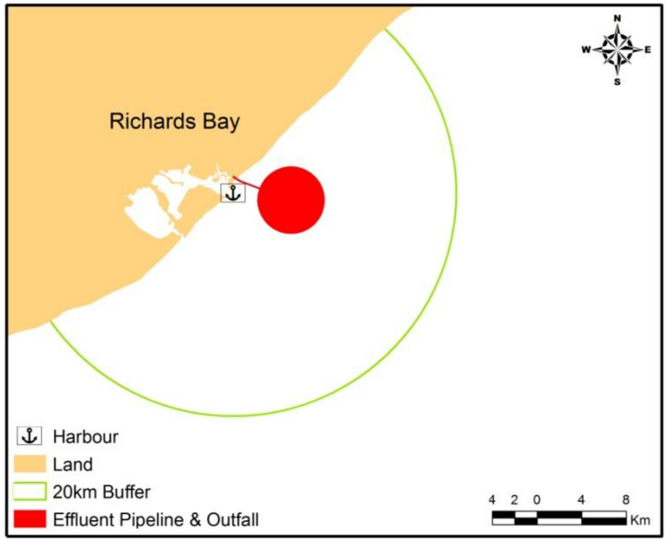


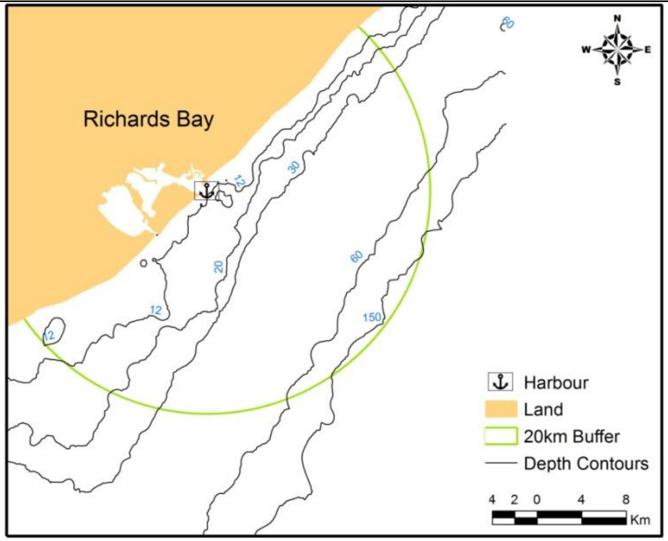


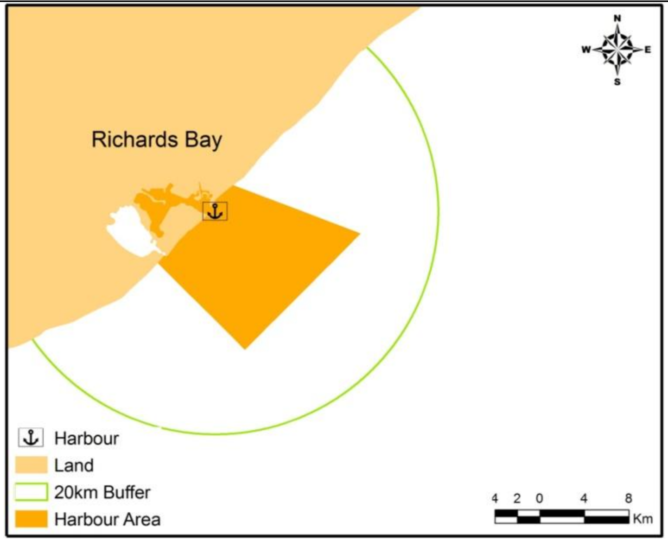


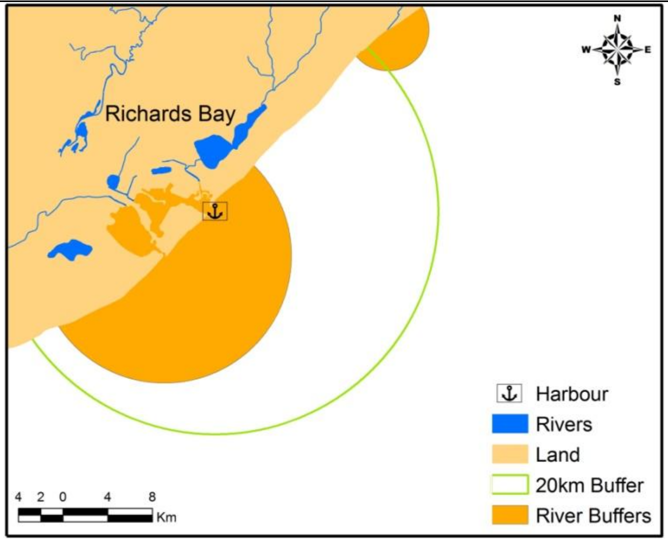


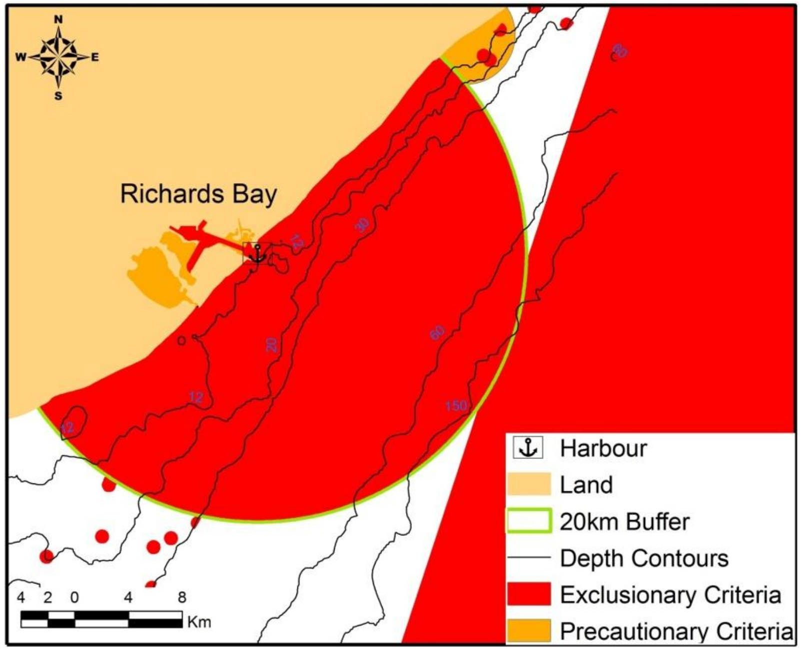












No potential inshore finfish ADZ, potential offshore zone shown in Figure 29.

APPENDIX 6: IDENTIFIED POTENTIAL OFFSHORE ADZS

Saldanha 3

Saldanha 3: 14 200 ha in extent, 14-20 km from port. Note that this area overlaps with a recently identified focus area for offshore biodiversity protection (Sink et al. 2010). It includes hard ground and reef habitat and overlaps with important feeding areas for threatened seabirds.

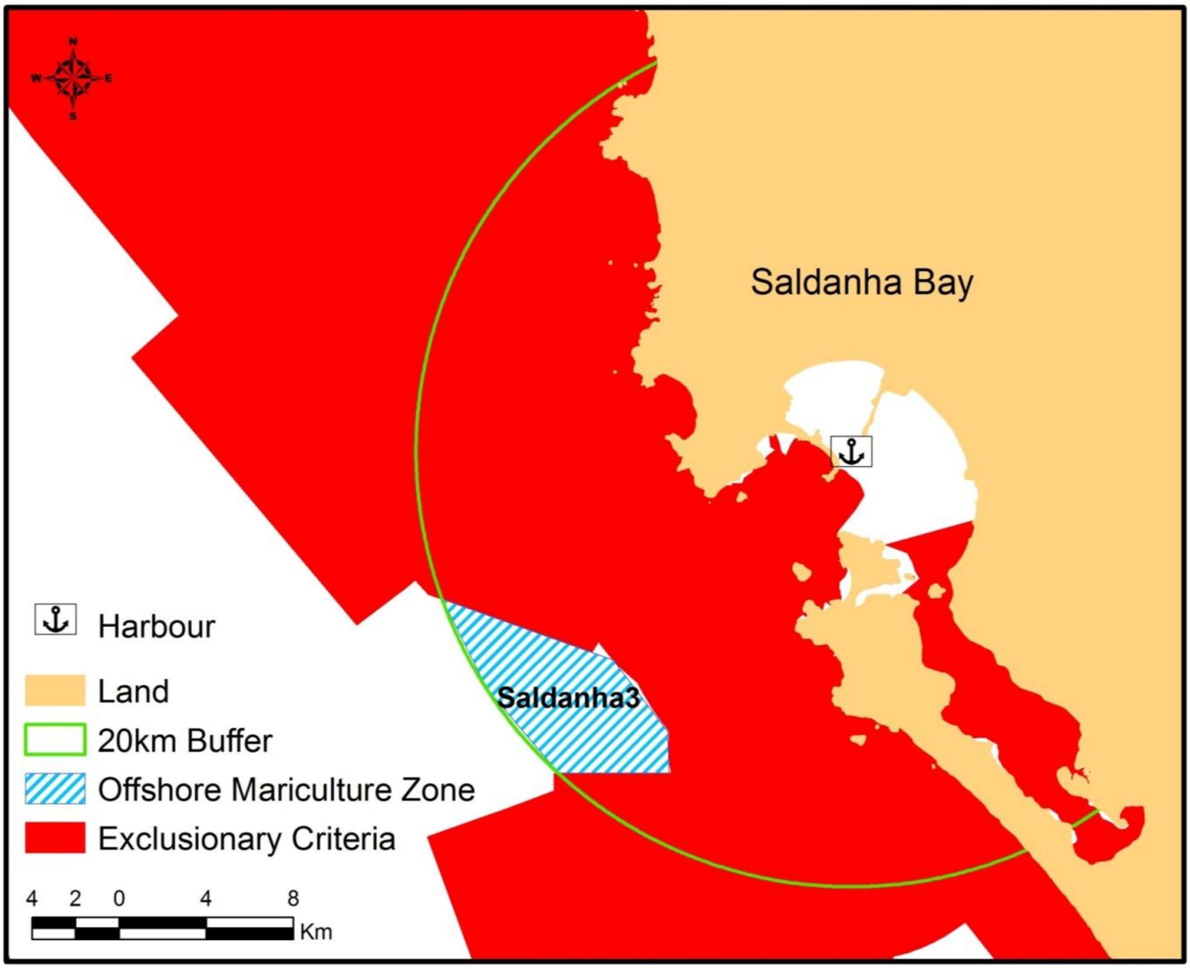


Figure 18. Areas that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of Saldanha Bay.

Simonstown

Simonstown1: 11 817 ha, starts 11km from Simons town harbour.

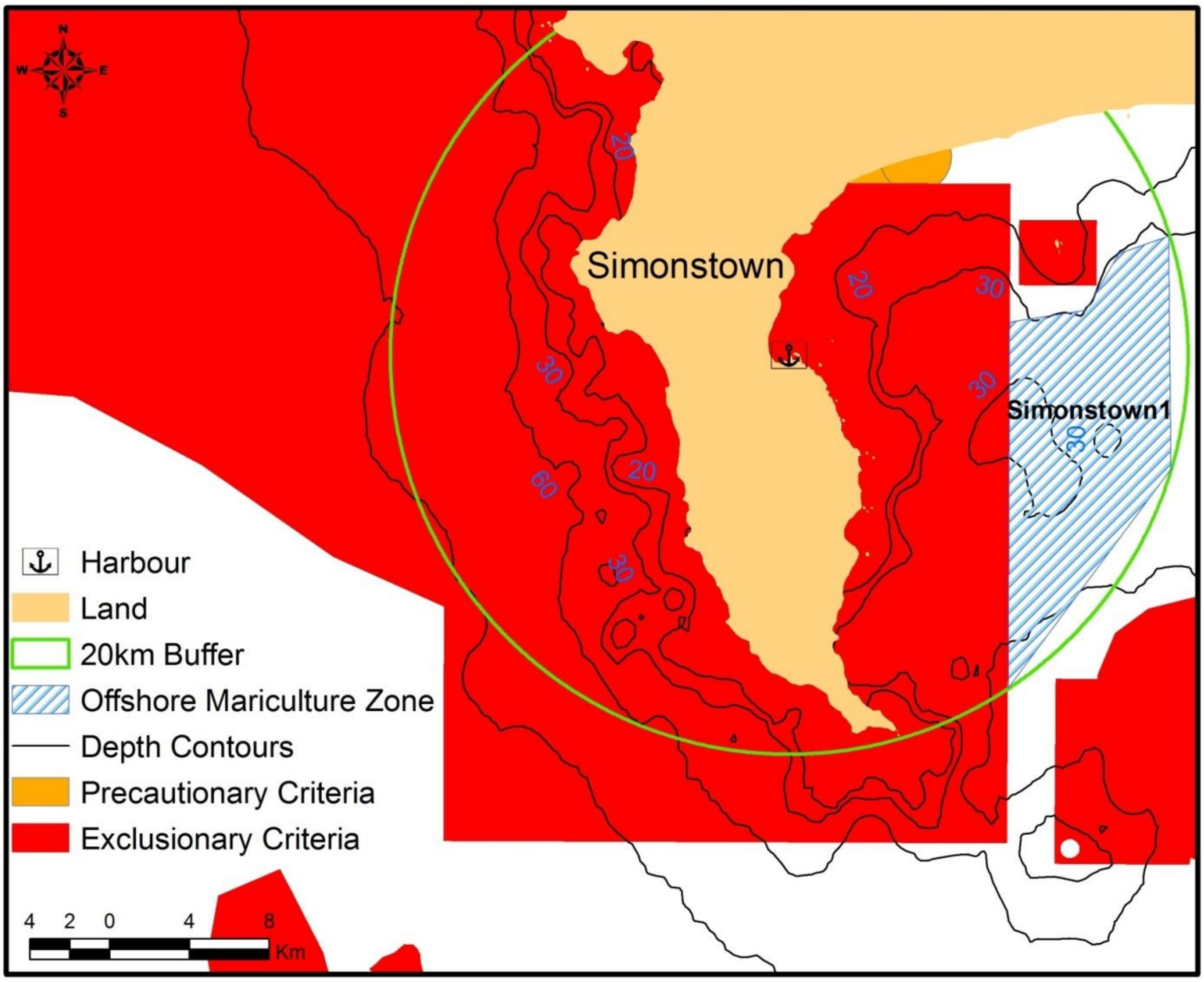


Figure 19. Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20 km radius of Simonstown harbour.

Kalk Bay

Kalk Bay 1: 9 551 ha, starts 11km from Kalk Bay harbour (overlaps with Simonstown potential offshore ADZ).

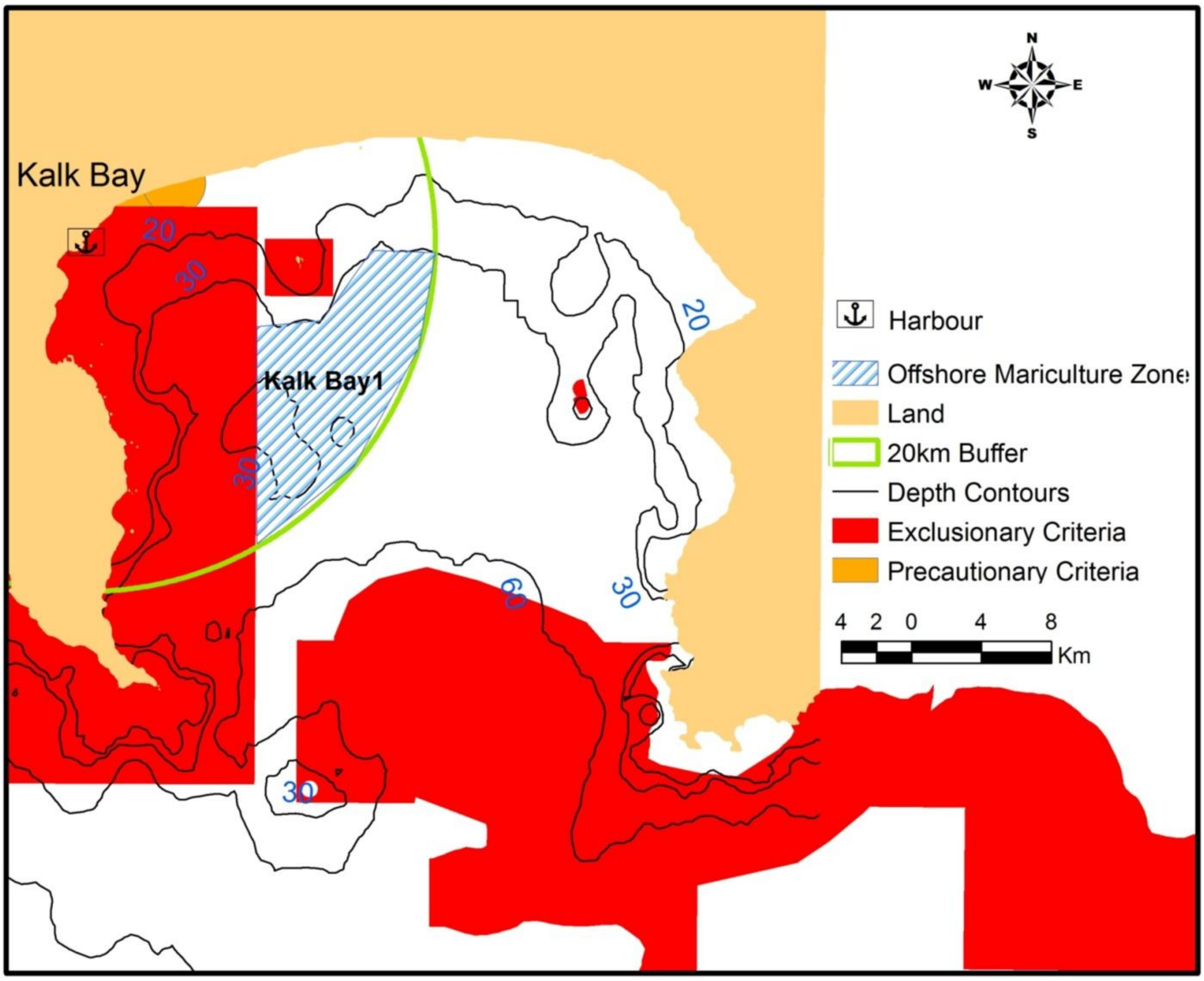


Figure 20. Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of Kalk Bay.

Hermanus

Hermanus 1: 13 447ha, starts 1.2km from Hermanus harbour.

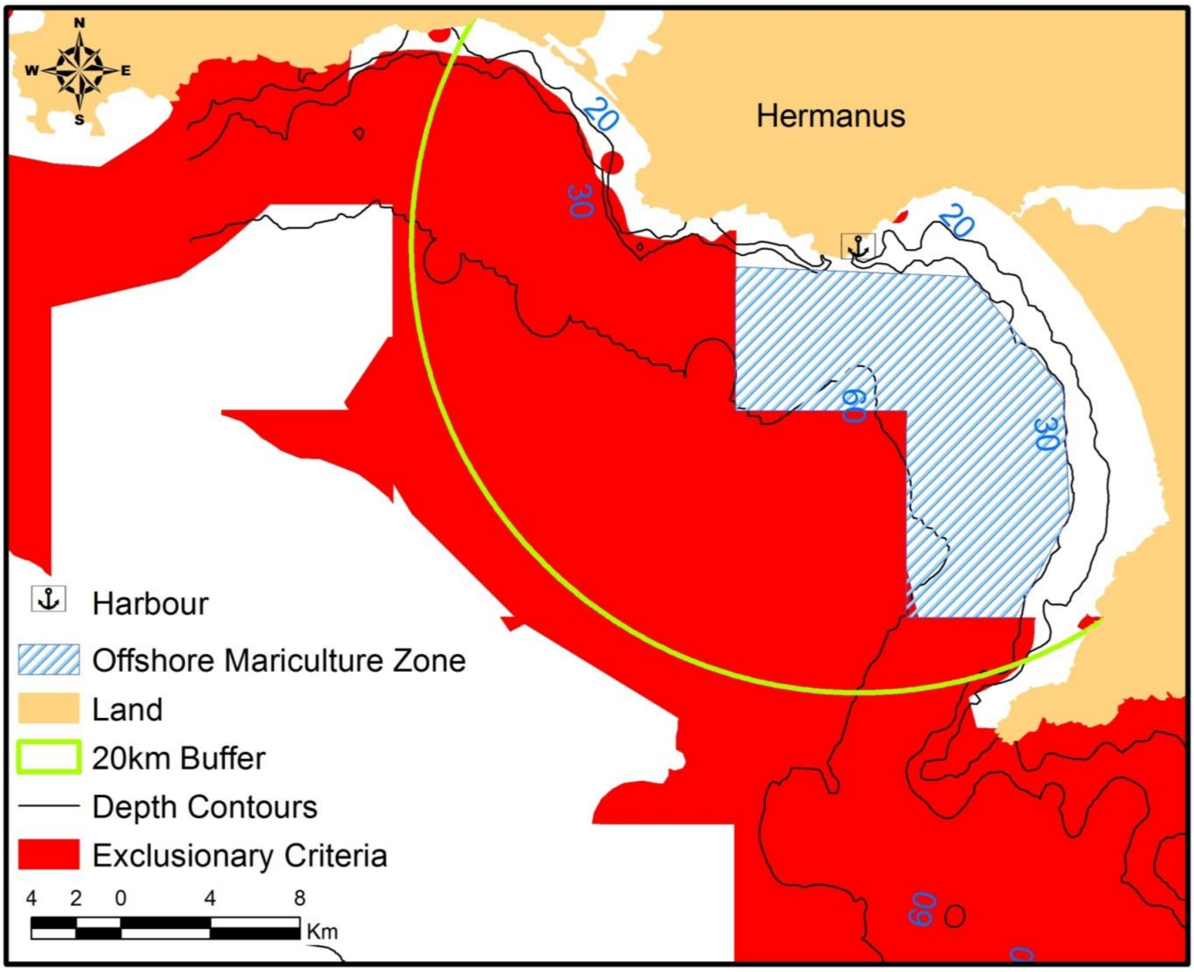


Figure 21. Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of Hermanus harbour.

Gansbaai

Gansbaai 1: 12 736 ha, starts 3.4 km from Gansbaai harbour.

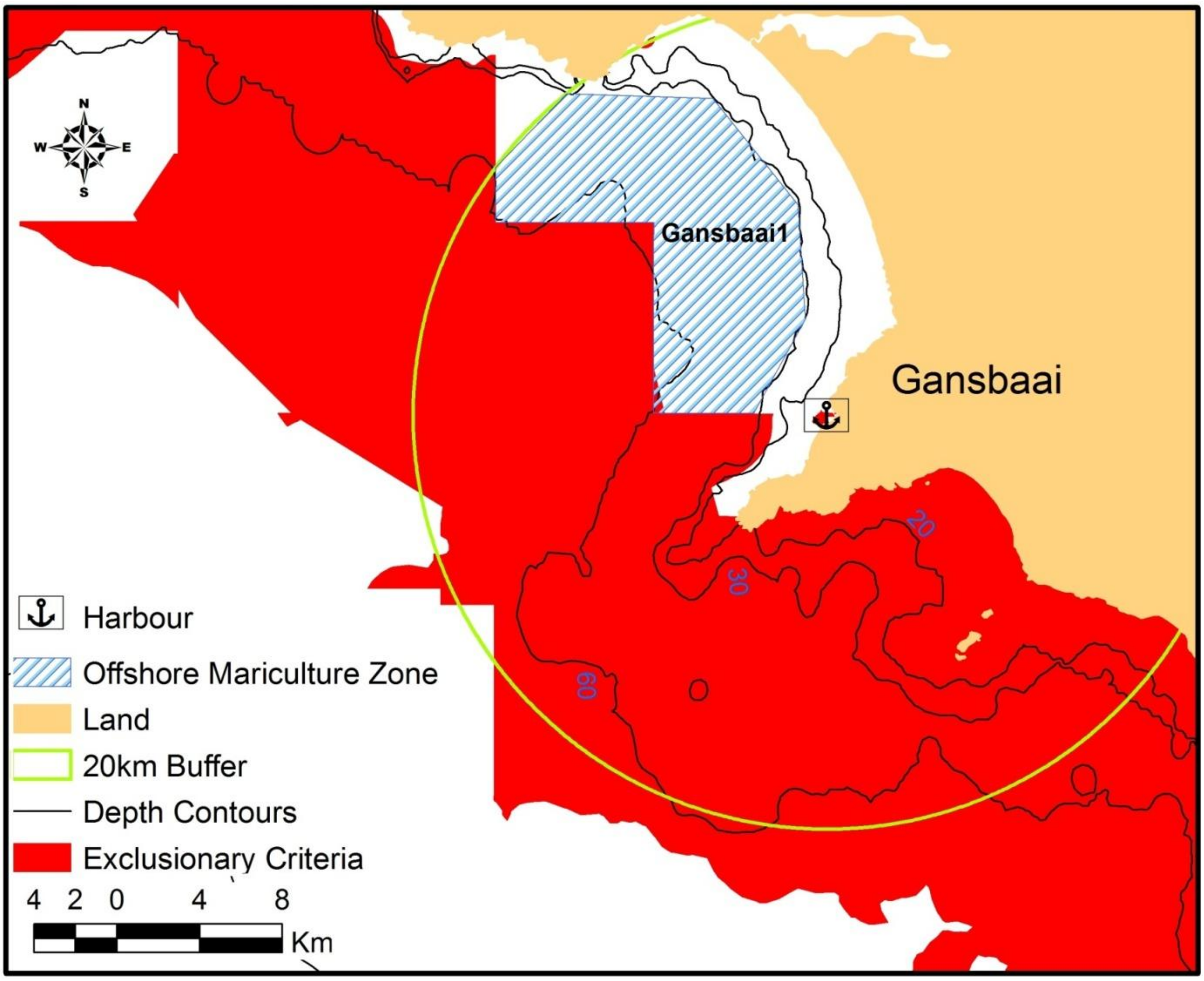


Figure 22. Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of Gansbaai harbour.

Mossel Bay

Mossel Bay 4: 38 228 ha, starts 4km from Mossel Bay harbour.

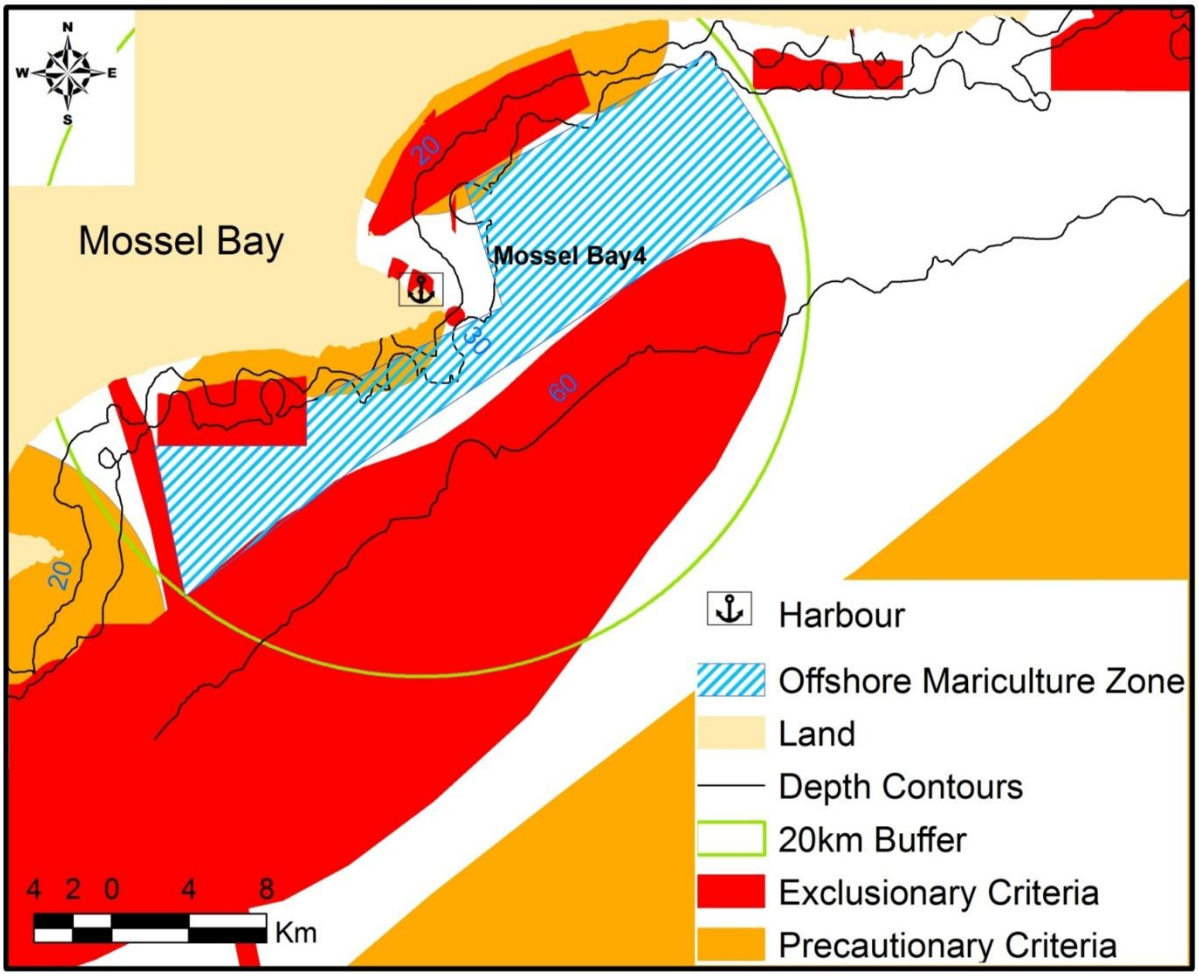


Figure 23. Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of Mossel Bay harbour.

St Francis

St Francis 3: 38 228 ha, starts 4km from Port St Francis.

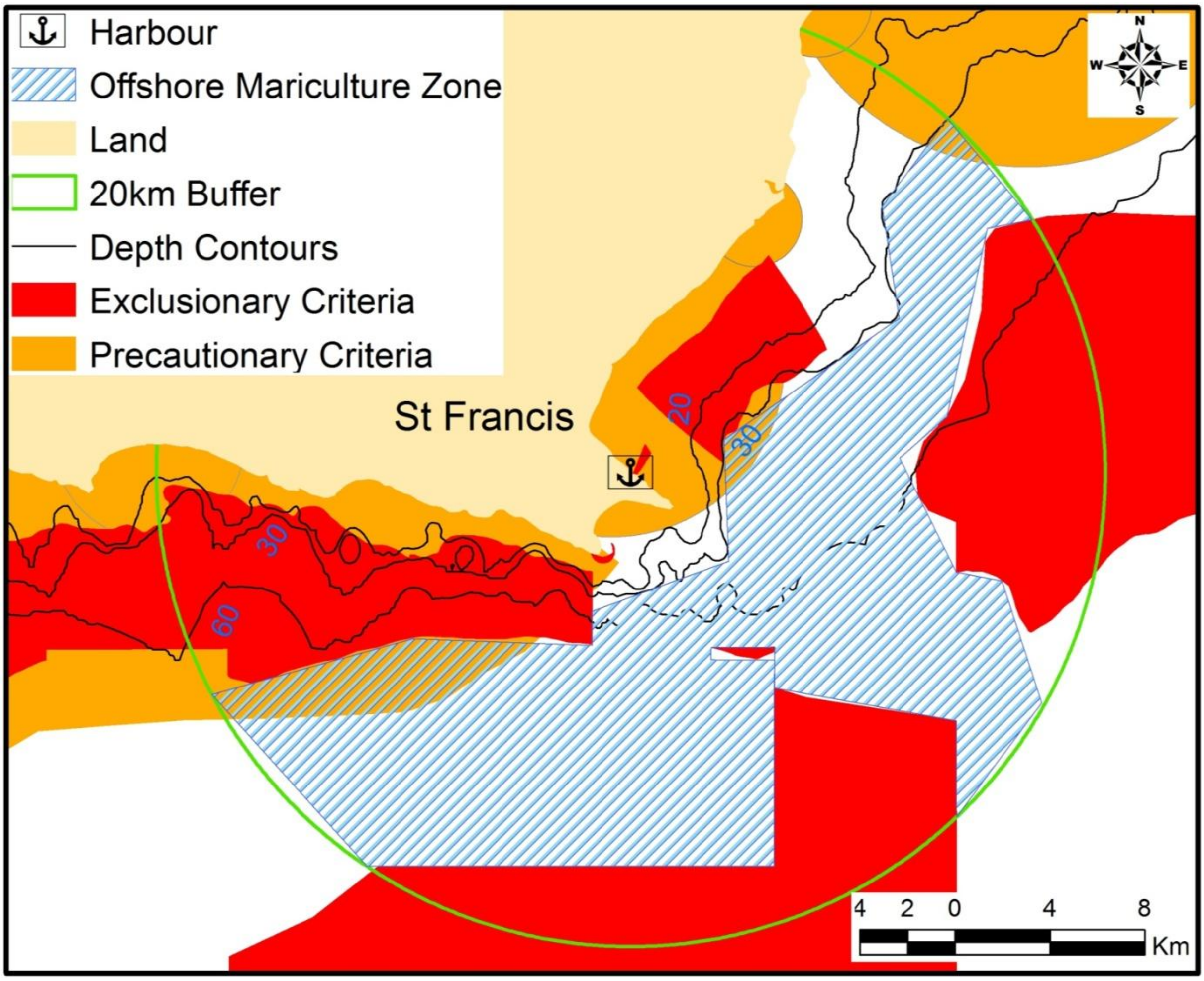


Figure 24. **Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of Port St Francis.**

Port Elizabeth

Port Elizabeth 4: 25 257 ha, starts 4 km from PE harbour entrance.

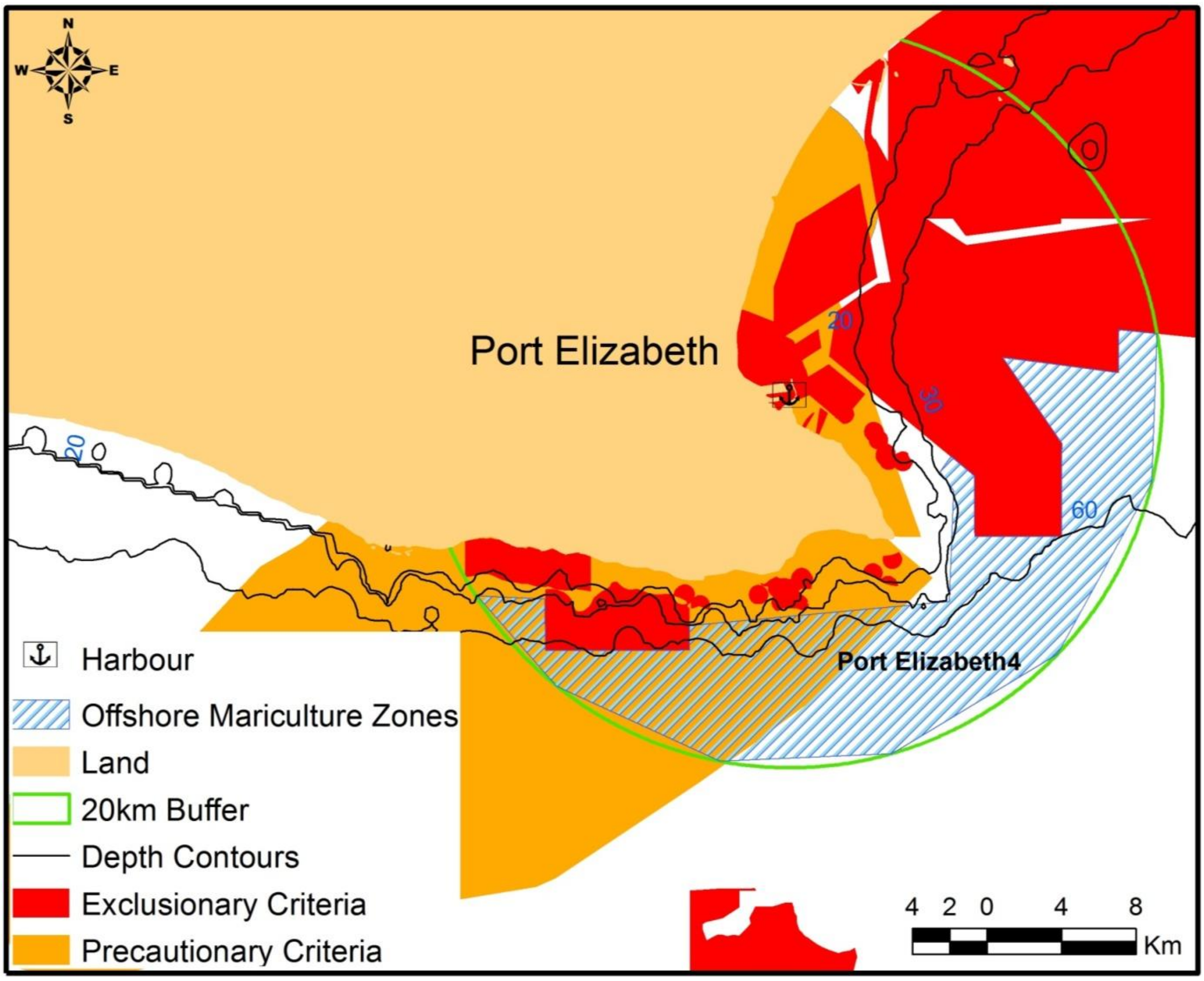


Figure 25. Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of Port Elizabeth.

Coega

Coega 4: 929 ha, 16 km from the Coega Port entrance.

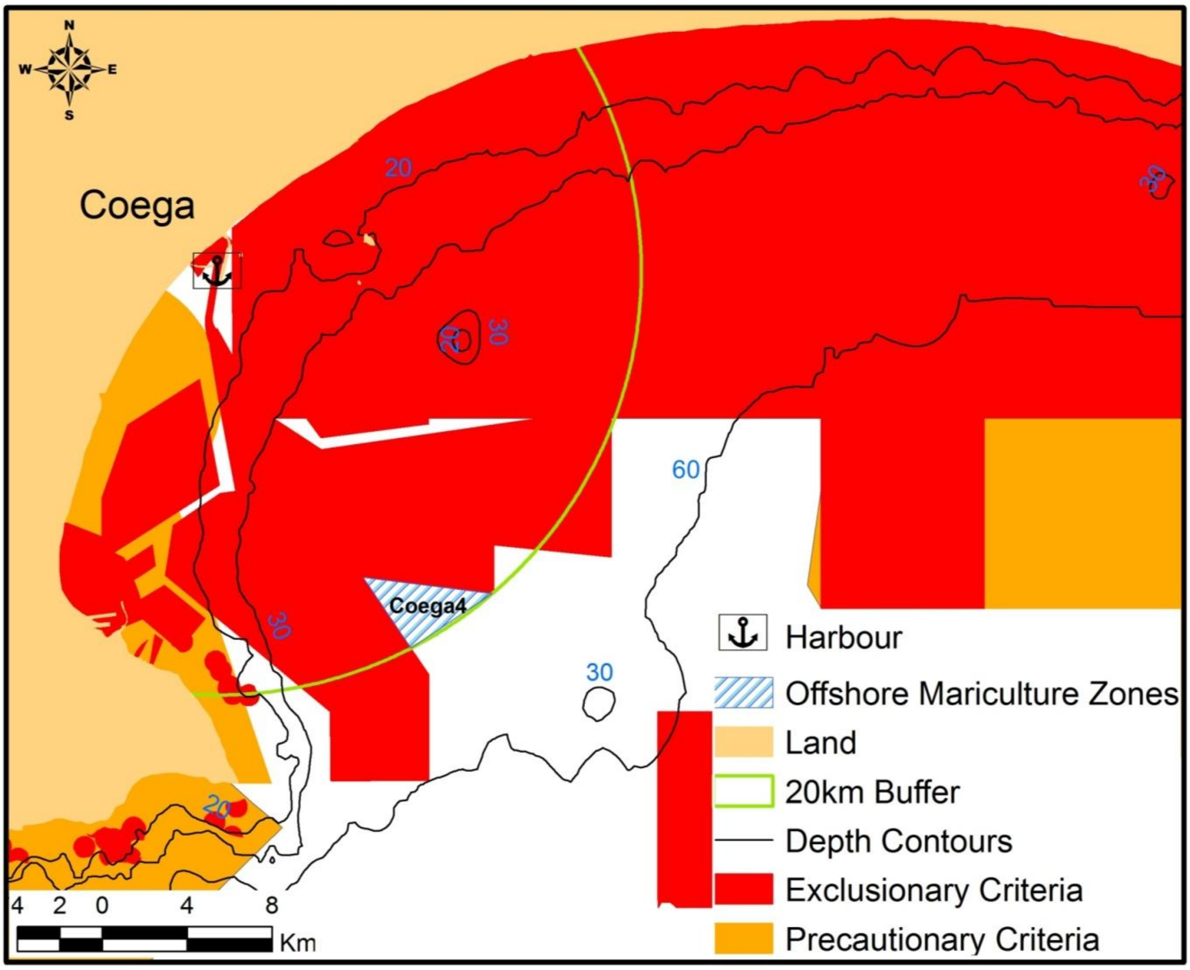


Figure 26. **Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of Coega Port.**

East London

East London 1: 41 613 ha, 1.6 km from East London harbour.

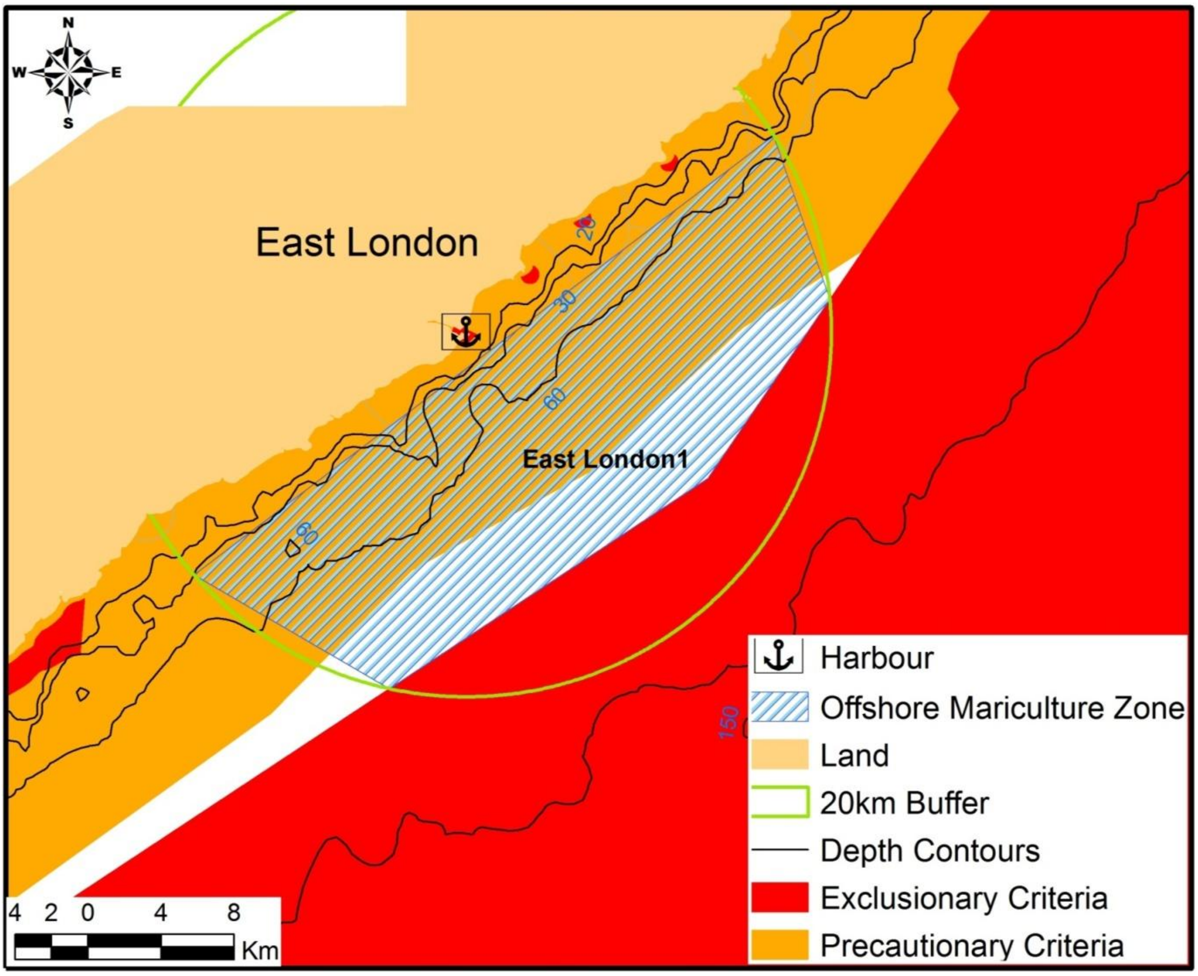


Figure 27 Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of East London.

Durban

Durban1: 19 210 ha, starts 4.5 km from Durban harbour.

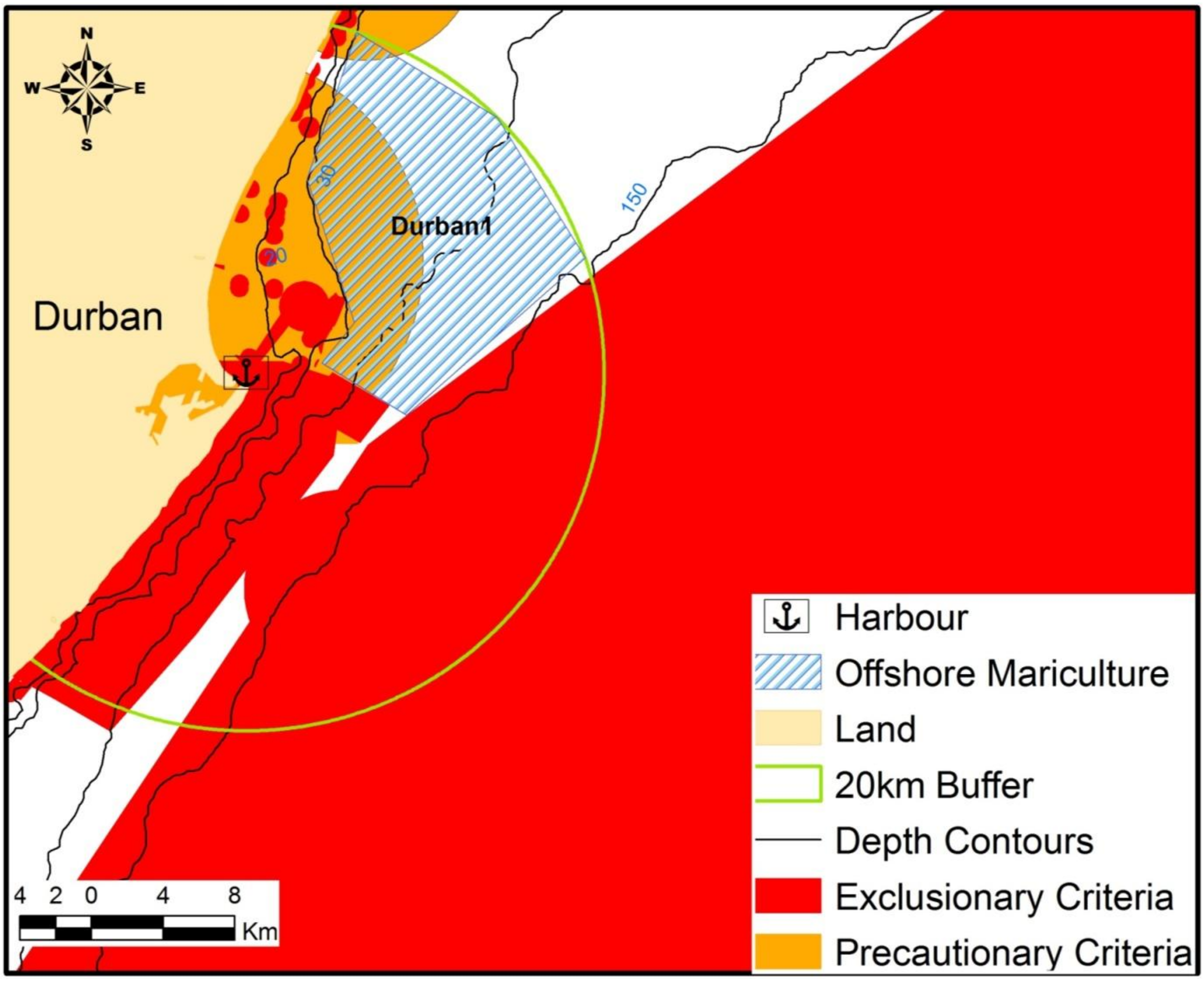


Figure 28. **Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of the Port of Durban**

Richards Bay

Richards Bay 1: 25 741 ha, starts 7.8 km from Richards Bay Port.

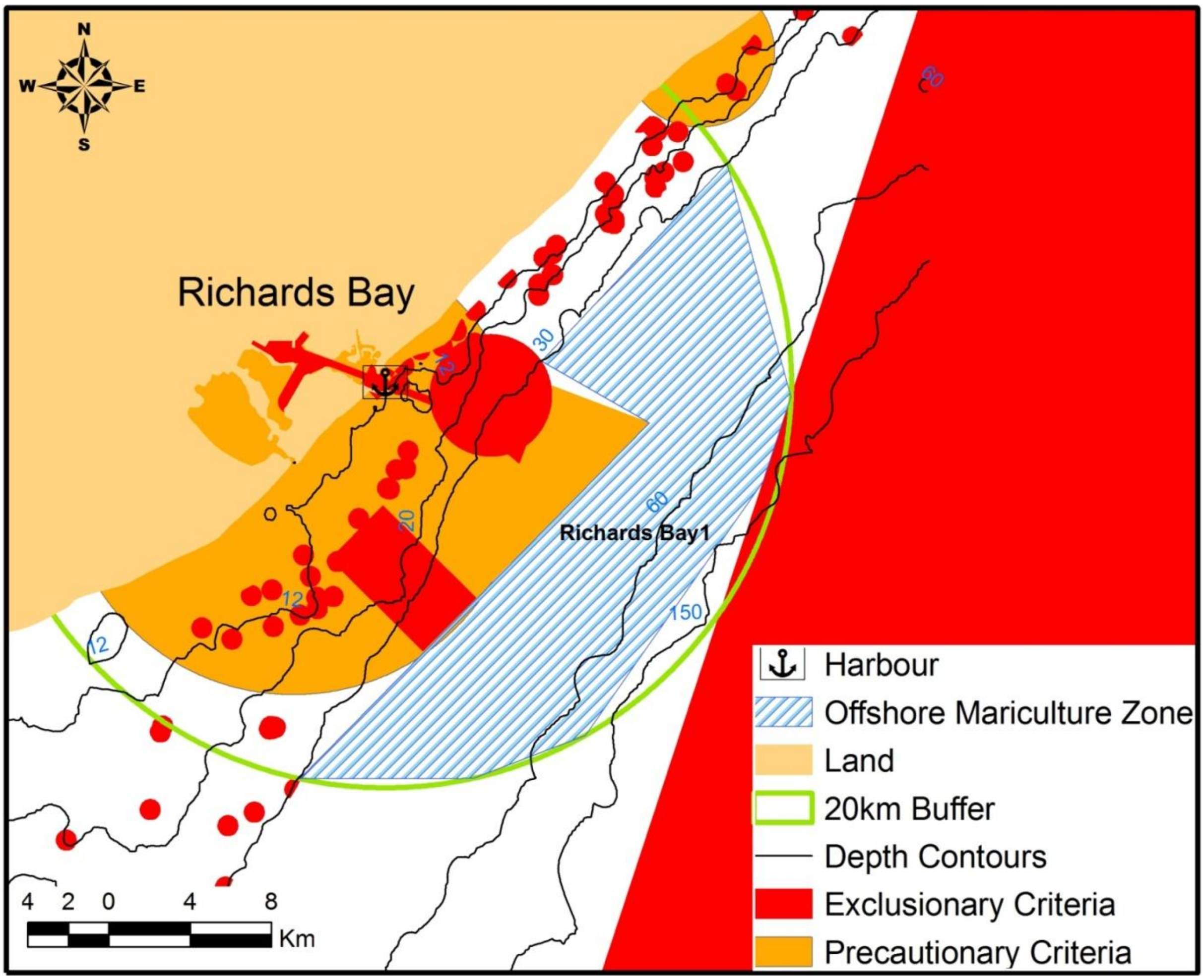


Figure 29 **Area that met the site selection criteria for potential finfish aquaculture development zone using offshore cage technology within a 20km radius of the Port of Richards Bay.**