# Blue Entrepreneurship Scoping Study

## Unlocking business solutions that benefit People, the Ocean & Climate

LEAD AUTHORS
Floor Overbeeke
Leigh Shepherd
Stéphanie Canac
Alexis Grosskopf

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## Executive Summary

The urgency of the climate crisis and the ongoing work of economic development in Kenya has contributed to the emergence of the Blue Economy as a critical arena for making substantive impact, both for the environment and for local prosperity. IUCN continues to engage in the discussion and aims to develop a pilot model to serve the greater WIO (Western Indian Ocean) region. This report is the first step in identifying and targeting priority interventions and solutions that can support local marine-based communities, as suggested interventions help spearhead the work of trialing key concepts along Kenya's coastline.

This scoping study utilizes a combination of primary research (stakeholder interviews, focus group discussions, and field research) and secondary research (literature review) to prioritize value chains and recommendations. The study highlights seaweed farming, sea cucumber farming, and finfish farming as key opportunities. This executive summary overviews strengths and weaknesses of each value chain along with recommendations to drive sector transformation and reach optimal impact. Alongside the strategic levers for each value chain are opportunities for the sector, Kenya's current competitive position, and the potential for an inclusive market system. Additional detail and specific suggestions are developed in further detail in Chapter 7: Recommendations.

## Seaweed Farming

Kenya can maximize potential in the seaweed industry through a dramatic increase in production and scale, as unlocking the potential for communities to produce at capacity can lead to sector-wide transformation. At present, Kenya is not competitive in the regional seaweed market, and success hinges on both attracting new farmers and utilizing productive space at full capacity. By offering substantive volume, Kenya can draw the attention of additional exporters, developing pricing competition that can benefit smallholders.

The research identified three strategic levers to catalyze transformation in the seaweed sector:

*Table 1: Seaweed Farming Strategic Levers*

| | Opportunity | Competitiveness | Inclusivity |
|---|---|---|---|
| **A** Increase **production** to reach current export capacity | • Develop business case for seaweed farmers to produce at maximum capacity<br>• Sensitize communities and expand production base to include additional farming locales<br>• Improve efficiency with covered drying facility to reduce labor and time required<br>• Mobilize technical assistance for ongoing farmer support and new farmer upstart | • Tanzania (specifically Zanzibar) is Kenya's biggest regional competitor, producing over 103,000 tonnes of seaweed in 2019<br>• With similar ecosystems and with an extra 100km of available coastline, Kenya has the capacity to develop its seaweed production volumes and be competitive in the WIO region | • As over 90% of current Kenyan seaweed farming is done by women, expansion opportunities stand to include even more female farmers in the sector<br>• Furthermore, opportunity exists to encourage household participation for value-add tasks (like carrying heavy loads and transportation) |
| **B** Draw **new exporter** entrants to the sector | • Develop business case for seaweed exporters to enter the Kenyan market<br>• Sensitize communities and expand production base to include additional farming locales<br>• Mobilize technical assistance for new farmer upstart | • An uptick in post-pandemic global price will unlock better margins for exporters coming into Kenya<br>• As the Kenyan national and coastal governments are prioritizing seaweed as a sector, enabling environments for foreign investment are expected to be favorable | • Expanding competition among seaweed purchasers is expected to elevate farmgate price, enabling more Kenyan farmers to join |
| **C** Scale farming of **higher-value species** with **new** production **methods** | • Incorporating additional high-value species stands to earn farmers 3x the current value with the same yields<br>• Offshore farming is less prone to negative effects of rising ocean temperatures | • Mastering deeper-ocean seaweed cultivation (which has historically been challenging for both Kenya and neighbor Zanzibar), has the potential to unlock access to a much larger seaweed market, as the "Eucheuma spp." (which includes Cottonii) category represents 29% of global production | • Female seaweed farmers are highly motivated to start cultivating this species (despite male dominance), pending investment needed to kickstart the offshore farm<br>• Female inclusion requires sea-safety training and boat-operator training, or these services could be provided by men in the community |

The current seaweed industry in Kenya faces many addressable challenges. Limited production, which thereby limits income potential and market diversity, is caused by intensive labor conditions, a falling global price, historical dependence on external (donor or private sector) funding, and current perceptions among farmers, as they see an unattractive value proposition. COVID-19 has impacted the global price for seaweed, as an influx of farmers from once-tourism-dependent countries have fallen back on farming, increasing current global supply. However, as the global market dynamics are anticipated to return to normal post-pandemic, Kenya has an opportunity to increase production and be prepared to capitalize on an expected favorable market price.

Kenya benefits from an extensive coastline with ecosystems conducive to growing seaweed, current farmers operating below potential, and new untouched communities, all pointing to the production potential within the country. Additionally, with low barriers to entry, seaweed farming presents inclusive participation opportunities for vulnerable groups (women, youth, and people with disabilities).

Seaweed farms offer alternative incomes among communities who would otherwise stress wild marine stocks through overfishing, and they also create habitats that foster natural biodiversity, so investment in seaweed farming can improve the overall quality, resilience, and productive potential of coastal ecosystems.

## Sea Cucumber Farming

Current sea cucumber production in Kenya is limited to the dangerous practice of wild-capture. Due to decades of overfishing, sea cucumber wild stocks are dwindling, harming the overall biodiversity of coastal ecosystems and forcing fishers into increasingly-risky diving practices. With a high price point, growing global demand, and an existing link to the export market, spearheading inclusive sea cucumber farming models in Kenya will revolutionize the sector.

Neighboring countries in the WIO region have spent years trialing and refining the smallholder-outgrower model, and Kenya's success in the industry hinges on a three-step intensive investment: 1) establish sustainable models for short-term wild-capture of fingerlings, 2) pilot inclusive farming and generate proof-of-concept for both community-government and farmer engagement, and 3) draw private sector investment for hatchery systems that will enable long-term scale and sustainability.

The research identified three strategic levers to catalyze transformation in the sea cucumber sector:

*Table 2: Sea Cucumber Farming Strategic Levers*

| | Opportunity | Competitiveness | Inclusivity |
|---|---|---|---|
| **A**<br>**Pilot** inclusive **farming model** to generate proof-of-concept | • Develop business case for sea cucumber farmers and local government, and by so doing, develop business case for hatchery investment<br>• Sensitize communities and pilot production model<br>• Mobilize technical assistance for new farmer upstart | • Kenya's coast already proves conducive to sea cucumber growth (as evidenced by historically-documented wild stocks)<br>• As a top producer in the WIO region, Madagascar represents the strongest competition in the sea cucumber market; however, with growing global demand and an unlimited export potential, it seems there is room for unencumbered growth without negative competitive impacts | • In other countries, sea cucumber production represents an inclusive opportunity (60-80% of farmers are female)<br>• Seaweed farmers often make the best sea cucumber farmers, as they already spend their time in the ocean, know the tides and the currents, are used to working with commercial partners, and are already aware of the value of these animals |
| **B**<br>Invest in **scaleable hatchery** model for sea cucumber juveniles | • Sensitize private sector investors and pilot hatchery model<br>• Mobilize technical assistance for hatchery upstart | • With ongoing government support of regional multi-species hatchery facilities, the enabling environment for foreign investment is expected to be favorable<br>• Based on existing global research, Kenya can pilot ready-made models, drastically reducing time-to-market for sea cucumber juveniles | • While the hatchery model itself is not inherently inclusive, it enables inclusive farming opportunities<br>• While low-scale, introduction of a new facility would warrant local job-creation ranging from technical (marine hatchery experts) to inclusive / accessible (administration and cleaning) |
| **C**<br>Develop **processing and aggregation** services at the farmer level | • Invest in processing equipment and facilities, along with farmer training, to ensure quality is met to maintain favorable pricing<br>• Shorten the supply chain and retain more value at the smallholder level | • Increasing proportion of value-add services at the farmer level would put smallholders in competition with local traders and possibly regional exporters<br>• Leveraging the farming model will drastically increase production, giving farmers a healthy volume of final product with which to negotiate, as compared to wild-catch sea cucumber fisheries | • Processing activities at the export facility are already done by women, proving the potential for an inclusive model (for women and youth) at the community level<br>• However, as the financial control of high-value jobs or products tends to be dominated by men, it is critical that value-add activities do not add to women's workload without providing appropriate benefit |

The biggest threat to a successful sea cucumber industry in Kenya is the impossibility of production without an operational hatchery for sea cucumber juveniles. Hatchery setup has proven challenging in the region, but Kenya can lean on global models and learn from failed attempts. Using the ongoing research and investment in a coastal multi-species marine hatchery as a business case, Kenya has the opportunity to develop proof-of-concept for private sector investors, yielding a more sustainable hatchery option for the long-term growth of the industry. However, as an emerging value chain, sea cucumber farming is faced with minimal regulatory guidelines, underdeveloped governance, and yet-unproven negotiations around sea-use access. Furthermore, as high-value items, dried sea cucumber offers strong economic potential for smallholders, but this same benefit also makes the industry vulnerable to theft. Low barriers to entry make sea cucumber farming an attractive option for women and youth, and the low levels of capital investment needed for processing tasks presents an opportunity for smallholders to capture more of the value within the chain.

Farming sea cucumber can offer lucrative alternatives to overfishing, giving coastal ecosystems an opportunity to regenerate, while increasing the presence of species that support environmental health. Further, current government support for this priority crop creates a favorable enabling environment.

## Finfish Farming

Fishing plays a vital role for coastal communities, both in terms of food security and in terms of income generation. Kenya and the rest of the world suffer as global fish stocks disappear through overfishing. Investing in finfish farming using cage structures in marine sites has the potential to disrupt the current Kenyan value chain for local coastal consumption of fish by increasing and controlling production, avoiding restrictive market relationships, and reducing pressure on local environments. Local demand fish remains strong, and Kenya has an opportunity to develop sustainable production methods through marine-based finish cage farming. Investment in fingerling access (through hatcheries) and responsibly-sourced feed are critical to long-term success in the sector, both financially and environmentally.

The research identified three strategic levers to catalyze transformation in the finfish farming sector:

*Table 3: Finfish Cage Farming Strategic Levers*

| | Opportunity | Competitiveness | Inclusivity |
|---|---|---|---|
| **A** **Pilot and scale farming model** for proof- of- concept | • Develop business case for farmer-owners, and by so doing, develop business case for hatchery investment<br>• Sensitize communities and pilot production model<br>• Mobilize technical assistance for new farmer upstart | • Artisanal fishers reliant on wild-capture methods are the main competition among fish destined for local coastal markets<br>• While farming comes with the burden of facility investment and ongoing costs for inputs and operation, the advantages include: guaranteed production, control over harvest, and ability to operate in poor-weather seasons when prices are higher | • The deep-sea nature of the cage structure can be prohibitive for female inclusion, as can the capital requirement for investing in the group model<br>• Interventions should identify drivers of female participation (±25%) among Lake Victoria group-ownership models |
| **B** Invest in **scaleable hatchery** model for finfish fingerlings | • Sensitize private sector investors and pilot hatchery model<br>• Mobilize technical assistance for hatchery upstart | • With ongoing government support of regional multi-species hatchery facilities, the enabling environment for investment is expected to be favorable<br>• Hatcheries have the opportunity to lean on extensive research and development already done by KMFRI, drastically reducing time-to-market for local species fingerlings | • While the hatchery model itself is not inherently inclusive, it enables inclusive farming opportunities<br>• While low-scale, introduction of a new facility would warrant local job-creation ranging from technical (marine hatchery experts) to inclusive / accessible (administration and cleaning) |
| **C** **Engage partners** to develop supportive **enabling environment** | • Engage with invested market actors who have authority to develop the enabling environment<br>• Encourage policies and regulation that support responsible rearing and harvesting of fish (incl. feed, seed)<br>• Support research and development, and deployment, of critical technologies and investments<br>• Support integration of a Market Systems Development (MSD/M4P) approach | • Current investment in KMFRI trials of marine-based cage farming display government interest, and stakeholder interviews indicate a willingness to partner to reach scale<br>• Designing policy and regulation for a new industry can set the stage for sustainable practices and inclusive markets from the onset | • Opportunity exists to bring the enabling environment conversation to a variety of different stakeholders, each with their own expertise and inclusivity agenda<br>• Involvement of carefully-selected partners can ensure that special attention is paid to inclusivity (women, youth, people with disabilities) for any regulations or policy implementation |

The finfish farming industry faces many challenges. A lack of technical knowledge and relatively high startup costs, especially without viable financial products to support community-level investment, can bar smallholders from entering the sector. Even more, the high-risk nature of mariculture, in that stocks are vulnerable to theft and escape, make the potential investment even more precarious. Long-term success in the sector also necessitates consistent and sustainable access to fingerlings and feed, but as the farming efforts are only just emerging, there are no viable hatchery facilities and no resource management systems around wild-capture of feed. Furthermore, the deeper-water nature of finfish farming structures, paired with the asset-burden of capital investment, leads to a lower potential for inclusivity among women in the community. However, the market for cage-farming aquaculture systems is already developed and operational along Kenya's Lake Victoria. Transferring and adapting existing successes (and inclusivity measures) into the marine environment can decrease the upstart burden and unlock untold opportunities to utilize coastal ocean waters.

Fortunately, the Kenyan government, through KMFRI (Kenya Marine and Fisheries Research Institute) is proving the business case in active testing, priming the space to pilot a scalable model among the private-sector. Once constructed and regulated, the low running costs bring community-level operations within reach of smallholders. The industry benefits from strong local coastal demand for fish consumption (through a growing population and increasing dependence on fish imports).

Finally, investing in finfish farming has the potential to disrupt the current value chain by increasing and controlling production and harvests, allowing farmers to avoid restrictive market relationships and drawing more of the value toward the smallholder. Once scaled, sector innovations like cage farming can offer nature-based solutions that combat the impacts of destructive fishing practices and reduce pressure on local environments.

What follows are detailed assessments and recommendations for each value chain that outline critical steps for success in the sectors, along with overall suggestions for boosting coastal economies and supporting pilots for farmer programs. Important to note is the ever-present threat of climate change, as each of the selected value chains will be affected by rising sea temperatures and more turbulent waters. These efforts are expected to contribute to a holistic approach for ensuring sustainable, meaningful impact, both for Kenyan ecosystems and for local-area alternative livelihoods.

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| | |
|---|---|
| CAGR | compound annual growth rate |
| CWiFE | Coastal Women in Fisheries Entrepreneurship |
| EEZ | Exclusive Economic Zone |
| EIA | Environmental Impact Assessment |
| FAO | Food and Agriculture Organization of the United Nations |
| GDP | gross domestic product |
| IMTA | integrated multi-trophic aquaculture |
| IUCN | International Union for Conservation of Nature |
| IUU | Illegal, Unregulated and Unreported |
| JKP | Jumuiya ya Kaunti za Pwani |
| KEMFSED | Kenya Marine Fisheries and Socio-Economic Development |
| KES | Kenyan shilling |
| KMFRI | Kenya Marine and Fisheries Research Institute |
| KWS | Kenya Wildlife Service |
| LMMA | locally managed marine area |
| MCS | Monitoring, Control and Surveillance |
| MEL | monitoring, evaluation, and learning |
| MPA | marine protected area |
| MSD (M4P) | Market Systems Development (Making Markets Work for the Poor) |
| NbS | Nature-based Solutions |
| NDC | Nationally Determined Contribution |
| NEMA | National Environment Management Authority |
| NGO | non-governmental organization |
| R&D | research and development |
| SACCOS | Savings and Credit Cooperative Societies |
| SEAFDEC /AQD | Southeast Asian Fisheries Development Center Aquaculture Dept |
| UN SDGs | United Nations Sustainable Development Goals |
| US$ | United States dollar |
| WIO | Western Indian Ocean |
| WWF | Worldwide Fund for Nature |

# 1. INTRODUCTION

## 1.1. Background

The International Union for Conservation of Nature (IUCN), dedicated to actions that "conserve nature and accelerate the transition to sustainable development," seeks to further engage in the Blue Entrepreneurship space, build on existing successes across East Africa, and scale creative solutions, using Kenya as the pilot location. By participating in the Kenyan Blue Economy (definition and details further outlined in Chapter 2) with a focus on coastal regions, IUCN hopes to positively impact communities whose livelihoods depend on the ocean and marine-based incomes, while also promoting sustainable, regenerative value propositions that actively protect and enhance the ocean environment.

Fortunately, Kenyan president Uhuru Kenyatta has marked the Blue Economy as an integral driver for reaching Kenya's 'Vision 2030,' Kenya's "long-term development blueprint for the country." As the nation and its priorities reflect the importance of sustainably capitalizing on the economic potential along Kenya's coast and waterways, IUCN can expect to seamlessly offer support to government strategies by finding ways to promote and grow markets in the Blue Entrepreneurship space. Furthermore, Kenya sits among the 14 countries on the High Level Panel for a Sustainable Ocean Economy (Ocean Panel), an initiative which further highlights Kenya's enthusiasm for identifying innovative solutions that will protect the ocean and develop ocean-based economic opportunities. Not only does Kenya's participation in the groundbreaking Ocean Panel reinforce the degree to which the national government is primed to engage in this space, but the Ocean Panel itself serves as a resource for cutting-edge technologies and captivating ideas, and it acts as a global support for sustainable Blue Economy ventures.

Looking at the potential support for entrepreneurship, Kenya shows immense promise around innovation and new ventures, as evidenced by the World Economic Forum flagging Kenya as an "emerging global start-up hotspot." Kenya is actively prioritizing startup ventures through its Enterprise Kenya program, the government's "national accelerator to catalyse innovations and provide entrepreneurs with needed support in their innovation journey." Additionally, the amount of funding toward startups and the number of investments shows a continued increase from previous years, with Kenya benefitting from US$564 million in investment funding in 2019, ranked second across the African continent behind Nigeria only. While still battling some of the challenges common to lower middle-income economies, Kenya showcases that its startup environment is conducive and can be expected to grow ocean ventures.

The potential to drive impact among coastal communities grows year-on-year, as a combination of factors highlights Blue Entrepreneurship as a key driver. For example, global demand for ocean-based and ocean-adjacent products and services continues to grow, due to a rising global population who need inexpensive protein sources, , an increasing middle-class interested in travel, and a growing proportion of world tourism being dedicated to "emerging markets." Kenya benefits from both of these sectors, with 0.8% of national gross domestic product (GDP) dedicated to fisheries and aquatic proteins (with only 2%13 currently coming from the ocean) and with 8.2% of total GDP coming from travel and tourism (of which, 20-25% of total tourist spending has historically been coastal in nature). Mindful of the ongoing health and economic consequences of the COVID-19 pandemic on Kenya and its coastline, there is a need to explore opportunities in the Blue Economy and other sectors to maximize positive impact on both coastal communities and ocean ecosystems. As such, interventions are expected to adhere to the IUCN Global Standard for Nature-based Solutions (NbS) that ensure environmental impacts are conscious of any potential unintended consequences.

## 1.2. Objectives of the Study

The objective of this scoping study for the Blue Economy in Kenya is to provide a roadmap of strategies, activities, and investments that have the potential to benefit people, the ocean, and the climate. This research outlines a strategy and plan that enhances the competitiveness of each sector by identifying specific initiatives to strengthen and improve the functioning of the market ecosystem.

The recommendations will not only identify ways to catalyze investment but also underscore strategies to catalyze inclusive impact in the sectors, particularly in regards to the scaling of initiatives that positively impact the climate and ocean biodiversity.

It is also particularly important that the strategy builds on existing donor and government

initiatives and harnesses ways to both enhance and scale what is
already working as well as recommend improved coordination among market actors where there is an opportunity.

The sub-objectives of the research are orientated around the following elements:

- Establish market fundamentals: Gain clear understanding of how the sector currently operates, the opportunities and gaps in terms of competitiveness, the opportunities and challenges in regards to inclusive supply chains (particularly how value flows upstream and downstream), and develop a clear map of current donor initiatives and government policies supporting the sector.
- Prioritize opportunities: Develop a long-list of potential interventions to support the sector, assess their potential for additionality in terms of i) climate impact ii) ocean biodiversity impact iii) employment opportunities created, and iv) feasibility, and identify those 2-3 value chains and/or strategies that seem to offer the greatest potential.
- Deliver overall vision and strategies for transformation: Bring the analytical components together into a broader sector vision. Detail the strategies required, how they would work, how they will close the competitiveness gap, how they will deliver climate and conservation impact, how they drive greater inclusivity, how they will leverage existing programs and policies. Quantify the investment and impact benefits. Illuminate strategic pillars to achieve these visions and outline a roadmap over the next four years.

## 1.3. Research Questions and Methodology

Ultimately, the research aims to answer:

- Which three value chains present the optimal opportunity and most immediate potential for Kenya to positively impact coastal communities in terms of livelihoods and environmental progress (both conservation and regeneration)?

By addressing this question using a combination of intensive literature review, desk research, and semi-structured interviews, the research will reveal the influential factors enabling or blocking potential for positive impact. Once the broad framework is in place, more specific value-chain-related questions can be explored and expounded. From there, the research hopes to address sub-questions like:

- What are the market constraints and opportunities in the selected value chains?
- Which specific dynamics should be accounted for when planning future interventions?

## 1.4. Limitations of the Research

This research intends to utilize available resources to understand the current landscape for enterprises in coastal Kenya.

We have limited the scoping efforts to ocean-based opportunities or value chains that have a direct connection to the coastline, thereby excluding on-land drivers of ocean health like plastics pollution and waste management. Additionally, we excluded in-depth analyses of enablers, like government policy or large-scale infrastructure. These parameters help us target impacts around coastal communities, enterprises, and households.

While there is a pressing need to find scalable opportunities that can benefit the Western Indian Ocean (WIO) region, the scope of this research is limited to the Kenyan context, with a specific focus on coastal geographies. Due to time constraints, local-area primary research was conducted exclusively in Kwale County locations, but we can reasonably expect some transferability across geographical areas when assessing the enablers and blockers.
Secondary research is limited by widely-acknowledged over- and under-reporting of global fisheries data, complicating the exercise of pinpointing and reporting exact figures. We recognize the constraints to available data, and we proceed with the understanding that all assessments and recommendations are based on an incomplete global picture. Additionally, primary data collection was limited by time, resources, and availability or unwillingness of third-parties to grant interviews.

## 1.5. Structure of the Research

The research team included pan-African development professionals from TechnoServe, an international non-governmental organization (NGO) with vast experience working in Kenya and other developing countries to promote livelihoods and reduce poverty. To round out the study, the research team consulted an advisory committee consisting of IUCN staff and external experts with distinct competencies to contribute including: East African smallholder development, livelihoods and market systems facilitation, poverty reduction, impact venture catalyzation, ocean sectors, marine biology, venture incubation, and disruptive innovation.

The research was structured into 3 main segments:

- Prioritization of value chains
- Value chain assessments
- Identification of opportunities and recommendations for potential impacts that address gaps

Research supporting the prioritization of value chains occurred January - February 2021. The research team conducted desk research and stakeholder interviews (see Appendix 1 for more detail) to assess the current Kenyan landscape and identify key value chains with timely potential for impact. (This step is further outlined in Chapter 3.)

The research team also collected data for the value chain assessments from January - March 2021. This included desk research, stakeholder interviews, and primary, local-market-actor interviews to map the core functions across the 3 priority value chains. (This step is further outlined in Chapters 4-6.)

To develop opportunities and recommendations, the research team leaned heavily on primary and secondary value chain research and utilized stakeholder insights to identify gaps and challenges, pinpointing opportunities for innovative solutions. The research concluded March 2021. (Additional outputs from this step are further outlined in Chapter 7.)

# 2. ECONOMY

## 2.1. The Blue Economy Concept

The following research relies on a combination of established working understandings of the Blue Economy, particularly those which integrate 'sustainability' as a core component. While some sources consider all economic activities that operate within the backdrop of the ocean, this report sets expectations of responsible engagement with value chains that promote regeneration and/or conservation impacts for the ocean and seas. For example, in line with what the World Bank describes as the "sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health," the Commonwealth of Nations depicts the Blue Economy as "an emerging concept which encourages better stewardship of our ocean or 'blue' resources." This research will not attempt to define the "Blue Economy," per se.

However, embedded in the purposes of this investigation is an underlying expectation that interventions or recommendations will promote the livelihoods of coastal communities (including vulnerable populations) and engage in enterprising activities that promote both active (conservation) and proactive (regeneration) benefits toward the ocean and the species therein. For the purposes of this study, we interpret 'Blue Entrepreneurship' as components within the Blue Economy space that involve individual (or household) business opportunities. Additionally, coastal communities are among the most affected by climate change impacts and ocean overexploitation, as their direct livelihoods are dependent on ocean resources, making the focus on coastal Blue Entrepreneurship all the more urgent.

By responsibly engaging in the Blue Economy sector, Kenya also showcases the initiative's support of and contributions toward the United Nations Sustainable Development Goals (UN SDGs). Regenerative, sustainable ocean-facing ventures contribute directly toward SDG 14: Life Below Water, and these initiatives also have the potential to support SDG 13: Climate Action. By applying a gender-aware lens during data collection, data analysis, and innovation ideation phases, the study is positioned to produce outcomes that also address gender equity among coastal communities (SDG 5). In addition, the follow-on effects from increased local investment in critical ecosystems is expected to support SDG 12: Sustainable Consumption and Production, while with improved, more-stable incomes enable enterprising households and communities to tackle poverty (SDG 1), food insecurity (SDG 2), health (SDG 3), and education (SDG 4). According to insights from the OECD Roundtable held in March 2019, it is estimated that we will only achieve the SDGs by 2094 if we continue to operate with a business-as-usual approach. This staggering outlook compels us to urgently take proactive measures and address systemic issues surrounding poverty, health, and the environment.

## 2.2. The Importance of the Blue Economy to Kenya

### 2.2.1. People

According to the 2019 national census, the 6 coastal counties in Kenya, including Kilifi, Kwale, Lamu, Mombasa, Taita-Taveta, and Tana River, collectively represent just over 9% of Kenya's total population. While the country population has increased by around 23% in the past 10 years, the population along the coast has increased by around 30%. Comprehensive research and sustainable interventions that prioritize the Blue Economy stand to serve a growing proportion of Kenya's people.

It also seems that county governments are adopting and promoting Blue Economy interventions as of late, as they recognize the importance of the sector on their local populations. For example, Lamu County government reports the fisheries industry as affecting 70% of county incomes, underscoring the need for attention in this space. Interestingly, when reviewing Kenya's documented 2016 County Prioritised Value Chains across the 6 coastal counties, only Tana River claimed 'fish' as an industry of interest. Despite being hailed as a priority from the national government, on-land agriculture and livestock has historically been perceived at the highest importance. However, in more recent years, it is clear from individual county development plans for 2018 - 2022 actions that fisheries are a focus. Even more, plans reinforce county appreciation for the ocean, and they emphasize interest in developing the sector in a sustainable way. Despite movement toward ocean-based support, it is clear that Kenyan coastal counties have yet to capitalize on the boundless potential of their access to this Blue natural resource.

Furthermore, Kenya's coastline is home to both intensely crowded areas (Mombasa's population density is 67x the national average) and notably rural areas (Tana River's population density is 1/10 the national average). With an array of settings, economic makeups, and community needs, it becomes critical to focus on enterprise solutions that speak to the diverse local contexts and area issues. Not only will this research aim to parse out how different communities experience Blue Entrepreneurship growth, that is, understanding the needs of both the producing and consuming parties, but we will also consider the various ways communities are able to leverage natural resources sustainably, given local resource management constraints. Additionally, the Blue Economy is growing unevenly across regions and sectors, with supporting infrastructure following a similar pattern. Therefore, problems in an urban coastal region will not be the same as the problems in a rural one, underscoring the need for thoughtful analysis and flexible solutions.

### 2.2.2. Planet

Ocean waters cover around "71% of the Earth's surface." These waters operate as a life-support system of our planet, and ocean health is critical in the quest for a sustainable future. The ocean generates 50% of Earth's oxygen, absorbs 25% of all carbon dioxide (CO2) emissions, and captures a staggering 90% of the excess heat generated by these emissions. The ocean is also the primary source of protein for half of the population in the least developed countries. Our collective carelessness with this integral resource threatens ocean health with a variety of potential catastrophes, so regenerating and protecting our Blue spaces is paramount to the Earth's condition and our survival.

Our ocean is facing increasingly tougher challenges, like pollution, overexploitation, and climate change, that creates both rising sea temperatures and increased ocean acidity. According to a WWF report, plastic pollution kills "100,000 sea mammals and 1 million sea birds" every year. In parallel, World Bank data indicates that around "almost 90 percent of global marine fish stocks are now fully exploited or overfished." This changing ecosystem and destruction of biodiversity in the ocean leads to follow-on effects that are not sustainable; the loss of our ocean will become a loss of us.

Fortunately, the Blue Economy is increasingly at the top of Africa's political agenda and is seen to be a "major contributor to the continental transformation, sustainable economic progress, and social development." Similarly, the Kenyan government repeatedly reinforces its public commitment to a healthier planet through global panels, forums, and initiatives. In December 2020, along with the co-member countries of the Ocean Panel, Kenya boldly "committed to sustainably manage 100% of the ocean area under national jurisdiction by 2025." Additionally, Kenya hosted the first Sustainable Blue Economy Conference in 2018, bringing global stakeholders together to a platform centered around "creating economic growth that is inclusive & sustainable." Meanwhile, as co-host of the UN Ocean Conference (postponed due to COVID-19 restrictions), we can likely expect more commitments from Kenya, and even perhaps more investments beforehand, as Kenya showcases its leadership in the sector.

### 2.2.3. Profit

According to recent research, if the ocean was an economy (specifically, thinking of the total "value of key ocean assets"), it would be the world's 7th largest, worth $24 trillion. , From that immense global resource, the "ocean asset base" of the WIO region values around an estimated $334 billion. Measuring economic output in a manner similar to measuring a country's GDP, the WIO produces nearly $21 billion annually, comprised from sectors like coastal tourism ($10.4 billion), carbon sequestration ($2.9 billion), and 'direct outputs' like fisheries and aquaculture ($1.9 billion).47 With Kenya's 536 kilometers of coastline, it benefits from a range of ocean-based industries like fishing and seafood capture, coastal and marine tourism, and shipping. Kenya, which was cited as one of the fastest-growing economies in Sub-Saharan Africa, showcases potential for economic growth across the country's coasts across a variety of sectors. The Blue Economy currently contributes just under 180 billion KES per year (2.5% of the national GDP), and at full potential, the Blue Economy stands to bring in 500 billion KES per year.

However, Kenya fell victim to the economic constriction of Q2 2020, taking a particular hit in the tourism sector, as the COVID-19 pandemic struck. Global supply chain disruptions along with changes to daily operating life (like a government-mandated curfew) have impacted the Kenyan local and national economies in ways not yet fully captured. Even so, this research and subsequent recommended interventions are informed with an awareness of the economic impacts, both globally and domestically, of the COVID-19 crisis, especially as more focus is being brought to the profit potential of the ocean and coastal ecosystems.

For ocean-dependent industries to offer long-range profitability for Kenya and its people, the ocean must be clean, full, and healthy. Exploitation and resource-consumption might offer alluring short-term benefits, but building sustainable solutions can offer both growth potential for the Kenyan economy and a regenerative focus that will maintain the resource for generations. The development of the Blue Economy, a sustainable ocean economy, is an immensely important first step toward creating sustainable development pathways that enable powerful social and economic impacts.

## 3.1. BLUE ECONOMY SECTORS

### 3.1.1. Climate Impact

The devastating results of climate change not only threaten the health of our planet and the ocean, but they put Blue Economy development at risk. This makes it vital to develop a resilient Blue Economy that can adapt to these threats.

Climate change increases the frequency and intensity of natural disasters. When occurring offshore, these natural disasters are a threat to marine industries such as the cruise industry (tourism), shipping (trade), and oil and gas (energy). If happening inshore, they dramatically increase coastal erosion and biodiversity loss, through destruction of natural habitats. Natural disasters that happen on land transport pollution to the ocean.

Another climate change impact is acidification of the ocean. This change leads to widespread collapse of coral systems, which are home to at least 25% of all species in the ocean. Moreover, ocean acidification threatens the health of zooplankton; if these die alongside the 25% of all biodiversity sustained by reefs, the whole ocean food chain is at risk of collapse. Such a dramatic impact on the marine food chain would directly impact the 2.4 billion people living less than 100km from the coast , and who rely on the ocean for business and food security.

Furthermore, ocean stratification due to climate change means that the oxygen-rich upper layer of the ocean heats up faster than the nutrient-rich bottom layer. This leads to less natural stirring of the two layers, and in the long run, can create a precarious environment in which the majority of species will struggle to find both food and oxygen. Additionally, the rise of sea levels, due to increasing global temperatures and glacial ice melting, impacts photo-dependent marine species (like corals and seaweed) whose positions under water will soon be too deep for the sun's rays to reach.

The global community is only recently realizing the intense negative impacts of climate change on the ocean, with more new information constantly made available. We are beginning to understand the threat to marine life and to the coastal communities who depend on these changing ecosystems. This reinforces the urgent need to develop innovative solutions that support communities as they integrate into their income-building activities the critical conservation and regeneration efforts needed to abate the disastrous effects of climate change.

### 3.1.2. Percent GDP of Kenyan Economy

In 2019, the Kenya National Bureau of Statistics published a report tallying Gross County Product from 2013 - 2017, which reports that coastal counties contributed ±9% to Kenya's overall GDP. However, according to Jumuiya ya Kaunti za Pwani (JKP), Kenya's Economic Development Organization for coastal counties, the total Blue Economy in Kenya currently contributes only ±1% (that is, about 44 billion KES) to national-level GDP. Although a relatively small portion of the overall country economics, the Blue Economy plays a major role among coastal communities who depend on the ocean for food security and income.

Across the Kenyan coastline, innovative ventures are emerging that blend community livelihoods targets with conservation and regenerative aims. These Blue Economy strategies are proving that environmental protection and profit can, in fact, go hand-in-hand. For example, Mikoko Pamoja (which means "Mangroves Together" in Swahili) operates as "a business case for carbon credit in Gazi - Kwale County, Kenya" and builds a community-level income-generation system that simultaneously incentivises ecosystem preservation. Additionally, JKP's Jumuiya Innovation Lab targets youth in the 6 coastal counties, aiming to equip them and facilitate linkages and entrepreneurship across a wide variety of industries.

This research aims to further contribute to the growing body of evidence that supports the Blue Economy as not only necessary for ocean health and long-term viability, but also as profitable enough to enrich and sustain livelihoods for coastal communities.

### 3.1.3. Forecasts / Expectations

With the expanding global population and with ever-decreasing barriers to globalization, we are seeing increased demand for transportation, shipping, food, medicine, and entertainment from the ocean. While more and more global consumers are making purchasing decisions that account for supply chains and their environmental impacts, this grassroots interest is not enough to maintain and preserve the Blue natural capital resource for the long run. Instead, the Ocean Panel and other organizations are calling upon countries to plan for and execute strategies that address the increasing economic and resource pressure being placed upon the ocean.

Citing Kenya's National Spatial Planning (NSP) 2015-2045, Jumuiya ya Kaunti za Pwani (JKP) highlights how the Kenyan national strategy is developing expectations and accordingly positioning the Blue Economy for growth in coming years.

### 3.1.4. Policy Environment

At the national-policy level, the "Climate Change Act, 2016  is the key legislation guiding Kenya's climate change response." As part of the effort to fulfill that Act, Kenya's Ministry Of Environment And Forestry released the National Climate Change Action Plan (NCCAP) 2018 - 2022. This Action Plan supports "the achievement of [Kenya's] Nationally Determined Contribution under the Paris Agreement," which identifies "water and the Blue Economy" as one of the targeted areas for intervention.59 Certainly as Kenya works toward its devolution status, legislative challenges and delays can be expected as each county becomes responsible for its own interpretations, enactments, and enforcements of national-level initiatives and goals.  Even so, efforts that support environmental conservation and regeneration are primed to be supported at high levels by Kenya's policy structures.

Activities and initiatives within the Kenyan Blue Economy space are subject to, among others, the following relevant national and local government goals and policies:

- Kenya Vision 20303 and the Big Four Agenda
- Fisheries Management and Development  Act, 2016
- Wildlife Conservation and Management Act, 2013
- Environmental Management And Co-ordination Act, 2012
- Integrated Coastal Zone Management Policy, 2014
- Maritime Zones Act, 2012
- County Integrated Development Plans (2018-2022)

While there are no new policies directly related to the Blue Economy, on-the-ground work is already underway in the Kenyan landscape, as the national government showcases its interest in rehabilitation of vital coastal ecosystems. For example, Kenya has established its "mangrove ecosystem management plan for the 2017-2027 period"  along with "a management and conservation strategy for coral reefs and seagrass ecosystems."  Additionally, the government has committed to establishing a network of Marine Protected Areas that will cover 30% of its Exclusive Economic Zone (EEZ) by 2030, Opportunity exists to join the momentum across Kenya as it rebuilds its coastal ecosystems and supports the regeneration of the ocean that connects us.

### 3.1.5. Government Priority / Expenditure

The Kenyan government has deemed the Blue Economy and various ocean-based sectors as priority areas for focus and sustainable growth. The President established the Blue Economy Implementation Committee, tasked with "co-coordinating and overseeing the implementation of the prioritized programmes"  to achieve the country's Blue growth goals.

Domestically, the government has elevated fisheries and fisheries management as a target sector, engaging in multiple projects that reinforce national support for the myriad actors along the value chain. In an effort to build capacity for sustainable livelihoods in the fisheries sector, in early 2020, "the government collaborated with the World Bank to launch the $100 million Marine Fisheries and Socio-Economic Development Project (KEMFSED)."  Additionally, the KE€OFISH program, worth just over $1 million and bringing together partners from Kenyan coastal county governments, WWF Kenya, and the EU, targets regional financing, fisheries management, and post-harvest challenges. Meanwhile, the Kenya Marine and Fisheries Research Institute (KMFRI) invested time and resources to develop the first National Status of Fisheries Book  to document, outline, and plan the future of the fisheries sector, as a part of the broader Kenyan Blue Economy.

### 3.1.6. Challenges

Kenya's engagement with the Blue Economy, particularly at the small-scale Blue Entrepreneurship level, faces challenges such as limited production inputs (due to limited technology, equipment, and skilled workers) and dependence on a small number of mariculture buyers (due to constrained market access), both of which have the potential to be addressed with local-area-appropriate solutions and technologies. Poor infrastructure and inconsistent policy regulation and enforcement also add to the challenges of the local-level entrepreneur.

Moreover, the COVID-19 pandemic has highlighted the risk of an over-reliance on tourism. De-risking coastal communities through diversification, while simultaneously stimulating Blue Economy growth and prosperity, depends on collective effort that regenerates and conserves the Blue natural capital upon which all these coastal industries depend. This research underscores the need for interventions that link livelihoods and economic benefits with long-term ocean health.

A final important challenge to the Blue Economy is lack of specific technical know-how around ocean-related economies. Kenyan coastal communities, while armed with a wealth of indigenous and historical knowledge, lack technical ocean understandings and are disadvantaged from a lack of access to advanced technologies. At the high-level, the translation of research into development and implemented practices is minimal, as evidenced by a noticeable lack of marine economic ventures, despite years of marine research in the country. Kenyan coastal success depends on reliable biodiversity and human ocean-activity data, ocean floor and coral mapping, and economic data related to Blue outputs. At the local-level, communities are under-educated about simple, actionable conservation and restoration practices and how critical these practices are to both their livelihoods as well as to the long-term health of their local ecosystems.

## 3.2. Value Chain Overview per Sector

This scoping study is built upon a 3-part structure, the first of which includes an exercise that prioritizes selected value chains for deeper investigation and more thorough understanding. To arrive at a final Short List of 3 prioritized value chains, the selection exercise was divided into the following steps:

- Create an exhaustive list of possible value chains to investigate
- Pare down to a Long List of targeted value chains with high potential
- Decide upon a Short List of value chains to explore (further detailed in Section 3.4)

The goal for the initial list was to brainstorm and consider ±60 maritime ventures, and for this segment, the research team took the following action steps:

- Establish a framework for brainstorming potential maritime initiatives
- Expose potential for enterprises, leaning on desk research and ocean-based expertise within IUCN, the advisory committee, and the research team

The investigation began by exploring possible ventures along the Blue Economy spectrum. A report published through the European Commission identifies key maritime functions and sub-functions, and the research team adopted this framework to initiate value chain brainstorming activities. The structure divided the first-round work into the following six functions:

- Maritime transport and shipbuilding
- Food, nutrition, health and ecosystem services
- Energy and raw materials
- Leisure, working and living
- Coastal protection
- Maritime monitoring and surveillance

More detail on functions and sub-functions can be found in Appendix 2.

While creating a truly comprehensive set of ocean-based value chains represents an impossible task, the research team instead utilized the selected framework to investigate and expose various backdrops within the Blue Economy, making the list as complete and representative as possible. Simply put, the initial research phase attempted to identify a multi-sector assortment of 'ways to make money' across the coast. Important to note are some primary exclusion criteria for the initial exhaustive list of Blue Economy options. Based on the scoping study framing and the intended impacts for results and recommendations, we did not include ventures that were:

- Non-income-generating (e.g.: volunteer or unpaid conservation efforts);
- Inland-based (e.g.: on-land pollution-reduction schemes); and/or
- Enablers (e.g.: government policy)

From there, we set out to pare down to the final Long List of 8-12 ventures, so the research team needed to:

- Develop selection criteria for the first assessment (further detailed in Section 3.3) that could quickly and efficiently reduce the exhaustive list across a variety of cross-cutting measures
- Use stakeholder interviews and secondary research to evaluate each option on the exhaustive list against the first-assessment selection criteria
- Promote the ventures with the strongest potential to the Long List

Finally, the research team developed the Short List, aiming for 2-3 high-priority value chains for the deep-dive investigation. To arrive at the final Short List, we took the following actions:

- Develop a set of selection criteria for the second assessment (further detailed in Section 3.3), introducing additional metrics that could point to economic and community potential within the value chains
- Conduct secondary research and stakeholder interviews to assess the Long List against the second-assessment selection criteria
- Host a Focus Group session with a variety of industry experts to generate an engaging discussion around the Long List status and the potential of an initial suggested Short List
- Work closely with IUCN for final approval of the Short List

Ultimately, the research team identified 66 value chains for the Blue Economy in Kenya, 11 options for the Long List, and ended with 3 Blue Economy value chains for the Short List.

### 3.3. Selection Criteria

As part of the 'prioritizing value chains' step in the study process, the research team developed an efficient, comprehensive set of selection criteria. These criteria pinpoint value chains that exist in the overlap between ventures positioned to meet the livelihoods and environmental goals of the overall project and value chain areas primed to benefit from long-term support and current national and regional momentum.

The first-assessment selection criteria focused on the following metrics:

- **Community- Enterprise Potential:** Can you start or promote an inclusive enterprise (scaled thru community) with this value chain?
- **Regenerative Potential:** What is the potential for the local environment to be restored and conserved? What is the potential to avoid future degradation of ecosystems?
- **Nature Conservation & Climate Change Potential:** To what degree will the value chain activities conserve animals or plants in the ecosystems? To what degree will activities mitigate effects or help communities adapt to climate change impacts?
- **Upstart Time:** How long until profit potential?
- **Kenya Government Priority:** Did the Kenyan government list the activity in the Vision 2030,3 in the Nationally Determined Contribution (NDC), or in the Blue Economy Implementation Committee working documents?
- **High-Level Panel Priority:** Did the Ocean Panel list the activity in the Transformations for a Sustainable Ocean Economy?

Important to note, the research team evaluated value chains against the first-assessment metrics under the assumption that activities and ventures would be done 'sustainably' if selected, investigated, and implemented. Essentially, we assumed they represented the 'best possible' versions of the value chains. We also did not apply any additional, explicit weighting to these criteria; however, based on rating scales used, Kenya Government Priority and High-Level Panel Priority criteria carry ½ or ⅓of the weight of other metrics, respectively.

Figure 1 shows the selection of 66 value chains in the initial exhaustive list, presented by function, as ranked against the first-assessment selection criteria. The four-color visual rating scale ranges from Red = low suitability to Dark Green = high suitability.

*Figure 1: Exhaustive value chain list against first-assessment selection criteria*

| | | | First Cut Selection Criteria | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Function[1]** | **Sub-function[1]** | **Value Chain Options** | **Community - Enterprise Potential** | **Regenerative Potential** | **Nature Conserv'n & Climate Change Potential** | **Upstart Time** | **Kenya Gov't Priority** | **High-Level Panel Priority** |
| **Maritime transport and shipbuilding** | *1.1 Deepsea shipping* | 1 Cargo shipping | | | | | | |
| | *1.2 Shortsea shipping (incl. RoRo)* | 2 Mombasa Port Services / Logistics | | | | | | |
| | *1.3 Passenger ferry services* | 3 Ferry operation | | | | | | |
| | *1.4 Inland waterway transport.* | 4 Local transport operation | | | | | | |
| | | 5 LMMA transport | | | | | | |
| **Food, nutrition, health and eco-system services** | *2.1 Catching fish for human consumption* | *—farming—* | | | | | | |
| | *2.2 Catching fish for animal feeding* | 6 Seaweed | | | | | | |
| | *2.3 Growing aquatic products* | 7 Offshore Oyster | | | | | | |
| | *2.4 High value use of marine resources (health, cosmetics, etc.)* | 8 Offshore Mollusk - Clams | | | | | | |
| | *2.5 Agriculture on saline soils* | 9 Offshore Mollusk - Scallops | | | | | | |
| | | 10 Offshore Mollusk - Mussels | | | | | | |
| | | 11 Offshore Shellfish - Shrimp | | | | | | |
| | | 12 Offshore Shellfish - Crab | | | | | | |
| | | 13 Offshore Shellfish - Crayfish | | | | | | |
| | | 14 Finfish | | | | | | |
| | | 15 Sea Cucumber | | | | | | |
| | | 16 SandWorm | | | | | | |
| | | 17 Agriculture on Saline Soil | | | | | | |
| | | *—wild-catch—* | | | | | | |
| | | 18 Large-scale fishing (finfish) | | | | | | |
| | | 19 Artisanal fishing (finfish) | | | | | | |
| | | 20 Sea Salt production | | | | | | |
| | | 21 Fish Hatchery - on shore | | | | | | |
| | | 22 Fish Quality (Evaluation) Service | | | | | | |
| | | 23 Fish Processing | | | | | | |
| **Energy and raw materials** | *3.1 Oil, gas and methane hydrates* | 24 Oil & gas | | | | | | |
| | *3.2 Offshore wind energy* | 25 Wind turbines | | | | | | |
| | *3.3 Ocean renewable energy resources (wave, thermal, etc.)* | 26 Ocean renewable energy | | | | | | |
| | *3.4 Carbon capture and storage* | 27 Ocean Thermal Tech | | | | | | |
| | *3.5 Aggregates mining (sand, gravel, etc.)* | 28 Sand production | | | | | | |
| | *3.6 Marine mineral resources* | 29 Gravel production | | | | | | |
| | *3.7 Securing fresh water supply (desalination)* | 30 Desalination Systems | | | | | | |
| | | 31 Alternative Construction Materials | | | | | | |
| **Leisure, working and living** | *4.1 Coastline tourism* | *—tourism—* | | | | | | |
| | *4.2 Yachting and marinas* | 32 Tourism promotion (ocean-specific) | | | | | | |
| | *4.3 Cruise including port cities* | 33 Transportation (water) | | | | | | |
| | *4.4 Working* | 34 Accommodation (local stay, cultural stay) | | | | | | |
| | *4.5 Living* | 35 Bars & Restaurants | | | | | | |
| | | 36 Fast Food (ocean-based) | | | | | | |
| | | 37 Kiosks (ocean-based) | | | | | | |
| | | 38 Handicraft Suppliers | | | | | | |
| | | 39 Handicraft Workshop / Shop | | | | | | |
| | | 40 Crafts-workers | | | | | | |
| | | 41 Marine Protected Area - Creation / Mgmt | | | | | | |
| | | 42 Above-water Watersports | | | | | | |
| | | 43 Under-water Watersports (Diving) | | | | | | |
| | | 44 Tourist Guides + snorkeling + MPA | | | | | | |
| | | *—living & working—* | | | | | | |
| | | 45 Fishing Nets | | | | | | |
| | | 46 Electric powered boats | | | | | | |
| | | 47 Fishing Bait | | | | | | |
| | | 48 Fishing Boats | | | | | | |
| | | 49 Fishing Boat finance | | | | | | |
| | | 50 Fishing Boat insurance / protections | | | | | | |
| | | 51 Seafood Transportation Service | | | | | | |
| | | 52 Seafood Storage Service | | | | | | |
| | | 53 Business / Conference travel | | | | | | |
| **Coastal protection** | *5.1 Protection against flooding and erosion* | *—planting—* | | | | | | |
| | *5.2 Preventing salt water intrusion and water quality protection* | 54 Mangrove Planting - Carbon Credit (KE) | | | | | | |
| | *5.3 Protection of habitats* | 55 on-land Trees (protecting mangrove) | | | | | | |
| | | 56 Seagrass (meadow) | | | | | | |
| | | 57 Salt Marshes | | | | | | |
| | | 58 Coral | | | | | | |
| | | *—rehabilitation—* | | | | | | |
| | | 59 Mangrove Restoration - Carbon Credit (KE) | | | | | | |
| | | 60 Seagrass (meadow) | | | | | | |
| | | 61 Salt Marshes | | | | | | |
| | | 62 Coral | | | | | | |
| | | 63 Mangrove honey | | | | | | |
| **Maritime monitoring and surveillance** | *6.1 Traceability and security of goods supply chains* | 64 Neighborhood watch service | | | | | | |
| | *6.2 Prevent and protect against illegal movement of people and goods* | 65 Drone Rangers service | | | | | | |
| | *6.3 Environmental monitoring* | 66 Ocean quality monitoring service | | | | | | |

Through the ranking exercise, 11 value chains emerged as being ‘most suitable’ based on data collected for the first selection. Table 4 outlines the 11 value chains promoted to the Long List, with a summary of the rationale behind their selection.

*Table 4: Long List Rationale*

| Long List | Rationale |
|---|---|
| Seaweed farming | • High potential for community enterprise<br>• Strong potential for positive environmental impact<br>• Government support |
| Offshore Oyster farming | • High potential for community enterprise<br>• Moderate potential for positive environmental impact |
| Finfish cage farming | • Current KE government focus on fisheries<br>• Moderate potential for positive environmental impact<br>• However, deep-sea landscape offers lower potential for community enterprise |
| Sea Cucumber farming | • Current KE government focus<br>• High potential for community enterprise<br>• Moderate potential for positive environmental impact |
| Artisanal fishing (finfish) wild catch | • Current KE government focus on fisheries<br>• Moderate potential for positive environmental impact (assuming activities are done 'sustainably', e.g.: controlled quotas for resource management)<br>• High potential for community enterprise with very low adoption barrier, as most coastal communities already depend on the sector |
| Accommodation (local stay, cultural stay) | • Current KE government focus on cultural tourism<br>• High potential for community enterprise<br>• Moderate potential for positive environmental impact (assuming activities are done 'sustainably', e.g.: waste- and energy-efficient) |
| Marine Protected Area - Creation / Mgmt | • Current KE government focus<br>• Strong potential for positive environmental impact<br>• Low potential for community enterprise<br>• However, potential for innovative solutions to bring more value to local communities |
| Tourist Guides + snorkeling + MPA | • Solid on all measures<br>• Quick to upstart |
| Planting On-land Trees (protecting | • Solid on all measures |

| | |
|---|---|
| mangroves) | • Strong potential for positive environmental impact<br>• Slow to upstart |
| Mangrove Restoration - Carbon Credit (KE) | • Current KE government focus<br>• Strong potential for positive environmental impact<br>• Low potential for community enterprise<br>• However, potential for innovative solutions to bring more value to local communities |
| Mangrove honey | • Strong community enterprise potential<br>• Strong potential for positive environmental impact (both from mangrove-protection and as an alternative source of income, which allows for fishing closures that support repopulation) |

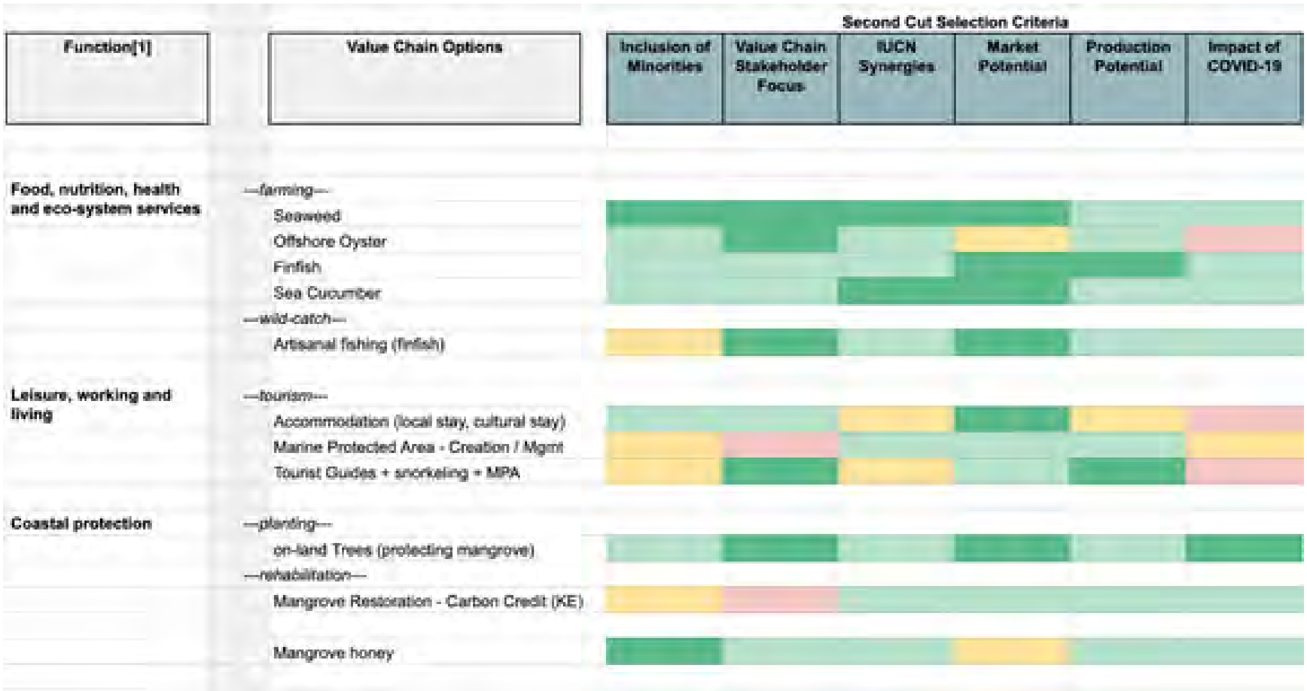
At the next stage of the exercise, the second-assessment selection criteria focused on the following metrics:

- Community Priorities
- Inclusion of minorities: What is the potential for an inclusive community venture, one that is accessible to women, youth, and people with disabilities?
- Value Chain Stakeholder Focus: How close to the household level are benefits expected to disperse and how accessible is that involvement?
- Synergies with Existing Initiatives: What existing expertise or involvement could IUCN transfer onto this context? To what degree does IUCN strategic direction mark this value chain as a priority?
- Private Sector Interest
- Market Potential: What are demand dynamics, either domestically or internationally?
- Production Potential: To what degree are Kenyan coastal areas positioned to grow production / output?
- Impact of COVID-19: To what degree has the value chain been negatively affected by the COVID-19 pandemic?

The second-assessment selection evaluation embedded the assumption that activities highly negatively affected by the COVID-19 pandemic would be de-prioritized until some stability and regularity return to the industries. All criteria are equally weighted.

Figure 2 shows the 11 value chains in the Long List, presented by function, as ranked against the second-assessment selection criteria. The four-color visual rating scale ranges from Red = low suitability to Dark Green = high suitability.

Figure 2: Long List against second-assessment selection criteria




The research team then engaged in the Focus Group activity, with the aim of generating discussion around the Long List and the emerging Short List. At that time, the front-running value chains were:

- Seaweed farming
- Finfish cage farming
- Sea Cucumber farming
- Planting On-land Trees (to prevent mangrove deforestation)

The virtual Focus Group event was held on 18 February 2021. Besides the research team and IUCN representation, there were six attendees from across Kenya, bringing expertise in various subjects and representing various stakeholders, including: Coastal Women in Fisheries Entrepreneurship (CWiFE), Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Wildlife Service (KWS), and Jumuiya ya Kaunti za Pwani (JKP).

Several key takeaways emerged from the Focus Group, notably:

- Social and economic impacts of the COVID-19 pandemic affected the local fisheries industry primarily through a government-mandated curfew ordinance which affected traditional fishing and fish-processing working hours, with the majority of the economic disruption occurring for women
- Seaweed is an important focus of government-led or government-backed organizations
- Sea cucumber and octopus present strong potential across coastal fisheries and mariculture projects, and these value chains were targeted as priority for Kenya among the Blue Economy Implementation Committee

Additionally, since financing and innovation are already in place to achieve scale for on-land timber production, other value chains seemed to have more need, and therefore more potential, for additional support and investment. This assessment fits with the research aims, namely the end results of scalable, innovative recommendations for the sector. With this updated knowledge, alongside the secondary research, first-hand accounts from stakeholder interviews, and insights from the expert panel, the research team finalized the prioritization of value chains exercise.

Important to note is that this step represents a prioritization, not an elimination. The research is not deeming non-prioritized value chains as 'bad' ideas, per se. We are not discouraging actors from investing in the deprioritized options, but based on the factors considered, the research team arrived at the final Short List of 3 value chains for immediate focus and more comprehensive deep-dive research.

### 3.4. Top 3 Value Chain Outcomes

After a detailed, multi-step analysis, the Top 3 Value Chain outcomes that emerged as 'highest priority' are:

- Seaweed farming
- Sea Cucumber farming
- Finfish cage farming

Table 5 highlights the three value chains selected for the final Short List, with a summary of the second-assessment rationale behind their selection. These factors operate in addition to the rationale listed in Table 4.

*Table 5: Short List Rationale*

| Short List | Rationale |
|---|---|
| Seaweed farming | ● High potential for minority inclusion<br>● Strong market potential<br>● Strong IUCN synergies and focus |
| Sea Cucumber farming | ● Marked as a KE government priority<br>● Strong market potential<br>● Potential for innovative solutions,(e.g.: symbiotic farming in combination with seaweed) |
| Finfish cage farming | ● Strong market potential<br>● Moderate potential for minority inclusion<br>● Potential to innovate within the sector |

The remainder of this report engages in a detailed dissection of each of the Short List value chains individually, representing the value chain analysis stage of the research (further detail in Chapters 4 - 6). Based on the Kenya-specific data collected, the research team will present findings and recommendations for the 3 selected value chains and the Blue economy sector as a whole (further detail in Chapter 7).

# 4. VALUE CHAIN ANALYSIS: SEAWEED FARMING

## 4.1. Market Dynamics

Across our planet, there are some 72,500 known species of seaweed (or macroalgae), around 220 of which have commercial value. Only a handful of these species are "intensively cultivated,"65 but the majority of global seaweed production, 97.1% according to FAO reports, is farmed rather than collected from the wild.

Many seaweed varieties are used, both raw and processed, for food and human consumption. By 2017, seaweed was listed as "the fastest-growing component of global food production." Processed seaweed extracts (like alginate, agar and carrageenan) are used as binders, gels, and emulsifiers in food and food products. Further still, seaweed and seaweed outputs are used in animal feed, cosmetics, pharmaceuticals, biofuels, and more.83,

Beyond its application for commercial products, seaweed holds immense value for ocean ecosystems and the planet. Seaweed forests offer natural benefits like sequestering excess carbon, providing diverse animal and plant habitats, contributing to the ocean food chain, and mitigating coastal erosion from wave forces.83 Therefore, responsible participation in the value chain recognizes and alleviates the potential negative impacts of unsustainable exploitation.

The global seaweed market shows overall strong growth in recent years. Total production, including both collected and farmed, went from "0.6 million tonnes in 2000 to 32.4 million tonnes in 2018."83 Important to note is that while the overall production of aquatic algae (of which, seaweed is the primary output) is increasing, it is increasing at a decreasing rate.83 While FAO-collected data shows that the majority of seaweed production (over 99%) occurs in Asian countries, the report is clear in saying that total values are underrepresented, therefore leading to potentially inaccurate country-assigned proportions, as it does not have data from several major global producers.83 The value of the global commercials seaweed market varies due to over- and under-reporting of data more so than because of actual output variations. FAO reports value total aquatic algae (dominated by seaweed) production in 2020 at US$ 13.3 billion. While other sources report a much lower total, claiming the industry was worth only US$ 5.9 billion in 2019, and they cite expected growth at a CAGR of 9.1% from 2020 to 2027. Collecting precise seaweed figures understanding trends accurately is a challenge, due to under- and over-reporting of fisheries data. Any subsequent analyses or calculations utilize values from FAO reports.

The worldwide market is dominated by two key varieties: Japanese kelp (Laminaria japonica) and Eucheuma seaweeds (multiple species of Eucheuma), which account for 35% and 29% of production, respectively. Euchema denticulatum (Spinosum), the single species currently being farmed and exported from Kenya, makes up only 0.6% of the global market, and global production was on the decline from 2015 to 2018.

While many other industries faltered during the COVID-19 pandemic, the seaweed industry has actually seen a production boom, as many communities that have historically relied on tourism have returned to seaweed farming to supplement lost incomes. The result of an influx of supply has led to a dramatic drop in price at a global scale. Some anecdotes from Bali indicate that farmers are making only half of the pre-pandemic value, and this ominous trend adds to the vulnerability of the smallholder farmers who depend on seaweed as an important source of income.

## 4.2. Production Base

The global commercial landscape for seaweed production includes a variety of mechanisms, ranging from small-scale operations (like wild-harvest and near-shore cultivation) to large-scale commercial ventures (like off-shore -or "at sea"- cultivation) to innovative designs (like integrated multi-trophic aquaculture (IMTA) systems).

In Kenya, production of exportable seaweed is exclusively farmed, as the sole exporter, C-WEED Corporation, does not purchase wild-harvested products. To maintain quality and a transparent purchasing chain, the Kenya Country Representative buys exclusively from its own registered farmers.

Reports confirm that Kenya's seaweed production potential is bolstered by its "lengthy coastline endowed with a wide variety of habitats for seaweed communities" as well as its many (over 380) naturally-occurring species, some of which are unique to Kenyan coastal areas. However, current production is limited to Kwale County, where previous seaweed farming program pilots existed and then went dormant. A scout from C-WEED, a global exporting company operating in Zanzibar, Tanzania for over 30 years, happened upon villages where farmers had successfully stored seaweed for up to three to four years, ready for purchase and export. By early 2018, C-WEED had registered in Kenya, and the once-quiet seaweed industry began to restart along the southern coast. At present, Kenya's seaweed farms are centered around eight seaweed centers, located in Gazi, Nyumba Sita, Tumbe, Funzi Island, Mwambao, Mkwiro, Jimbo, and Kibuyuni, all in Kwale County. Expansion to farming locales in the north (Malindi and Kilifi) is pending.

Seaweed farms are situated in intertidal zones, ideally in geographies that are not heavily affected by freshwater inflows during rainy seasons. Farmer groups petition local Beach Management Units (BMUs) for sea-use access for production, and the designated area is then sub-divided into 1,500m2 plots, each one assigned to a different farmer. Each plot is sectioned into smaller blocks that the farmer can use to set up a rotating system that ideally allows for continuous planting and continuous harvesting. Each farmer area can hold 300 ropes, but field reports indicate that the space is often under-utilized. The average farmer is currently producing 300 - 500kg per production cycle (that is, every six weeks), whereas the production potential is more like 1 tonne of dried seaweed in the same timeframe. However, the Kenya Country Representative for C-WEED is assured of the potential for success in Kenya's seaweed farms, as the growing conditions in Kwale County mirror those in Zanzibar, where farmers are producing at maximum.

Required production inputs include ropes upon which seaweed grows, tie-tie for securing seaweed to the ropes, and pegs (either wooden or metal) to anchor the ropes in the intertidal waters. Farmers also use mallets for initial construction (securing the pegs), and safety boots while doing on-farm work. Farmers are responsible for replacing pegs, costing 5-10 KES each, roughly one time each year. Because most inputs have been provided through NGOs, local government, or the exporter, pegs are the only asset most seaweed farmers have had to buy. Additionally, as seaweed is propagated by retying smaller harvested bunches back onto the ropes and allowing them to re-grow, there is no 'seedling' cost past the first season. Farmers are currently only growing the Eucheuma denticulatum species. This variety is farmed for carrageenan, used as a gelling and stabilizing agent in the "production of pharmaceutical, cleaning and personal care products like lotions and toothpaste, as well as in edible food such as burgers and various types of desserts."

Farming cycles align with tidal cycles, and farmers work during the spring tide that comes every two weeks. During this period (5-7 days) where the low tides are lowest and the high tides are highest, farmers ideally spend the first three days harvesting and drying seaweed, with the remaining four days dedicated to re-seeding the ropes and securing them back into position. After two to four spring tides of growth (approximately 6 weeks), the seaweed should be ready. Farmers must take care to harvest quickly enough, else over-grown seaweed that pushes too hard against the tie-tie becomes severed and floats away. During working weeks, farmers average roughly three to four hours per day, when tides are low enough to access farm plots. On site, farmers monitor their crops and do the tiring work of carrying heavy loads to drying stations, often without help.

Production cycles are also depending on seasonal weather patterns. Conditions are good and yields are generally high from March through early May, during the inter-monsoon season. From June to July/August, coastal areas in Kenya are subject to the SouthEast Monsoon. This season brings extreme wind and rough sea conditions that not only cause seaweed to break away from ropes but also bring invasive filamentous green algae that destroy crops. Production increases again during August/September to November when conditions are relatively cool. From December to February, seaweed plants are unable to survive the hot temperatures of summer waters, so farmers plant 'survival seedlings' in deep-water storage zones where cooler and more regulated water temperatures will keep the seedlings safe until it is time to replant.

To date, there are around 1,500 registered seaweed farmers in Kwale County; however, only about 500-600 are active and have substantial production. While some youth participate, farmers are generally between 40 and 55 years old, and over 90% of farmers are women.

Kenyan seaweed faces a number of production-specific challenges. Unsurprisingly, environmental factors, like unfavorable weather patterns and warming sea temperatures, make farming in certain seasons impossible and come with higher risk of infestation or disease. Farmers also complain of a lack of assets, such as boots, mallets, and boats/rafts, that would support farming activities. Although, some stakeholders argue that the frustration around inputs is a natural result of dependence on a revolving door of NGO and donor-funded projects. With the arrival of each new program, and the accompanying flurry of funding and startup support, local farmers are further disincentivized to see seaweed farming as a business and invest in necessary assets and equipment themselves. Between the expectation of support and the current perception of low prices for difficult labor, motivation among farmers can be a challenge to production.

## 4.3. Broader Value Chain Mapping

As the seaweed value chain in Kenya is export-only and dominated by a single exporter, the broader dynamics are relatively simple. Seaweed is grown and dried by coastal farmers, and then seaweed is collected, transported, and exported by the C-WEED Corporation.

Farmers operate in eight geographies across Kwale County and are visited by the C-WEED Country Representative on a bi-weekly basis to receive technical support and advice. After farming for six-week cycles, farmers are responsible for the singular processing step: drying the seaweed, an activity that requires frequent turning and takes between three and six days in the coastal Kenyan heat.

Farmers then take the seaweed to be stored in their homes. Seaweed of acceptable quality has been dried sufficiently with acceptable moisture content (meaning it is not overdried and therefore brittle), has not been in contact with freshwater, and is free from impurities like insects and sand. When harvest volumes are sufficient, the Representative organizes a day for weighing, recording, and purchasing from individual farmers.

Farmers are paid 25 KES/kg for dried seaweed, yielding average revenues of 7,500 - 12,500 KES (approximately US$ 70 - 115) every six weeks during productive seasons. However, if producing at potential, farmers stand to earn 25,000 KES (approximately US$ 230) for six weeks of effort. At the mid- to- high end of the average, and only at the farm part-time (±50 hours/month),90 seaweed farmers are still earning on-par with the Kenyan minimum wage  for rural general labor. Farmers might be paid once or twice a year, and the infrequency is due to low production and the time it takes the community to meet a minimum village volume that justifies exporter collection and transportation costs. After receiving payments, farmers often contribute to their village-level seaweed-farming SACCOS (Savings and Credit Cooperative Societies) that serves as a local financial instrument.

Purchases are made in bulk, ranging anywhere from 2 - 23 tonnes in a given collection. The exporting company takes on the operating costs of transportation and labor, and collections are taken to the main center in Kibuyuni, where dried seaweed is baled. The commercial-grade baling machine packs seaweed from farmer sacks into 100kg bales. These bales are then transported to Mombasa, where they are loaded into shipping containers, holding 20 tonnes of dried seaweed each (200 bales for each 120ft container). While the parent company ships seaweed across the globe based on client demand, the Kenya operation has exclusively shipped its seaweed product to a manufacturer in France. C-WEED has managed to export 80 tonnes per year in both 2020 and 2021, falling dramatically short of the company's current export potential of around 300 tonnes per year. The global price for seaweed dropped by US$ 100 per metric ton in 2020, and again by US$ 120 per metric ton in early 2021.90 This means the exporter is now earning only 74 KES/kg on the global market, as opposed to the pre-pandemic price of 92 KES/kg.

Using estimates of operating costs, it is likely that farmers retain 30-45% of the profit proportion in the value chain, while the exporter retains 55-70%. With decreasing global prices, the export business is caught between the challenges of low production volumes and shrinking margins. Increasing both yield (which is sometimes an issue of farmer motivation) and number of farms would help justify continued spending on operational costs.

While not yet developed, the sector has the potential to incorporate additional market actors for value-add and support activities. For example, intensive labor and carrying of heavy loads might be outsourced to local income-generating youth groups. With sufficient production, transportation services might also be a sustainable business model for local entrepreneurs.

Kenya has yet to be competitive in the WIO seaweed trade, limited by scale and productivity challenges. With target expansion efforts and thoughtful farmer support, Kenya's coastal farmers have the potential to outstrip production in Zanzibar, which currently stands at over 100,000 tonnes annually.83

### Enabling Environment

The sector is also marked by the presence of NGOs who have historically offered farmer training programs and distributed inputs. The local government, specifically the BMUs, are involved from a sea-use access and monitoring perspective. At the county-level, the government currently supports the seaweed value chain through sensitization among communities to encourage the uptake of seaweed farming.

Positively, four of the six coastal county governments explicitly included development of the seaweed sector in their county integrated planning documents for 2018 - 2022.30, , , , , Some counties are in early stages of investment (like feasibility studies) while others are farther along (like infrastructure development). Kwale County is among those investing in infrastructure, including construction of a seaweed storage facility in Kibuyuni and construction of a storage and drying facility in Gazi. The county government continues to identify areas of need and is currently partnering with the EU-funded Go Blue project to construct a drying facility in Mkwiro, while also exploring the possibility of establishing a processing plant for value-added products. The exporter engages with both the Department of Fisheries and Trade at the county level and the Blue Economy office (through the office of the President of Kenya) at the national level, all while subject to national government regulations for plant transport and export. Finally, the seaweed value chain is influenced by government research facilities responsible for completing suitability mapping and updated environmental impact assessments.

## 4.4. Key Challenges and Threats

Several prominent challenges face the seaweed industry in Kenya today. First is one of scale. At present, only a small number of farmers are producing seaweed, limiting the attractiveness of investment by private sector players and exporters. Farmer issues, like difficult, exposed working conditions and the poor value proposition of intensive effort for minimum payout, all discourage new farmers from entering the market. Fewer farmers thereby limits Kenya's overall potential to scale the industry. Furthermore, seaweed farming, as a relatively new venture, still struggles with dependence on government and donor support, and only a few farmers in Kwale County have managed to create a fully-autonomous business. Scaling seaweed output in Kenya, especially as global prices are currently falling, requires either easing the production burden or capturing more of the market value at the smallholder level, driving farming adoption in the category and bringing critical attention to Kenya as a viable market player. Additional scaling challenges have been reported from some coastal communities who are unwilling to set up seaweed farming in their areas. Some local leaders fear that developing farming ventures will disrupt the status quo and are wary of the increased empowerment that comes with female farmers generating their own incomes.

Over the past decade, several seaweed farming pilots have been launched across Kenya's coastline. As such, the local BMUs have developed protocols for sea-use access and leasing to farmer groups. Even though the governance work has begun, gaps for comprehensive management remain. Currently, seaweed farmers complain of conflict with local fishers, who take advantage of increased fish populations in the newfound habitats but destroy seaweed lines and crops in the process. The lack of complete zoning and protections, that is gazetting the sea-access rights, threatens the security and scalability of the seaweed farming sector.

Another threat to seaweed farming longevity is unstable access to a changing global market. First and foremost, there is no domestic market for farmed seaweed, apart from small value-added products that have yet to prove large enough to absorb significant levels of production. Therefore, the industry is dependent on global exports. At present, the entire sector rests on the export capacity of a single, solitary buyer; without enough volume to attract additional export players, farmers and their livelihoods are dependent on the success and intervention of this sole market actor. Highlighting the risk of dependence are reports from stakeholders of infrequent exports. The Country Representative from C-WEED Corporation confirmed the delay in shipments was due to deflated global demand related to an oversupply in the global market and a downward price trend.

Moreover, financial impacts of the COVID-19 crisis also threaten the success of the sector, as production from other tourism-dependent countries has increased, dropping global prices. Granted, any worldwide event that dramatically reduces the price for farmers will exacerbate already-thin margins and a waning value proposition. The influx of supply due to COVID-19 happens to be the current culprit. Incomes from seaweed are already relatively low due to the commoditized nature of the product, and Kenya will struggle to entice farmers and generate required sector scale if prices drop further.

Finally, as with all mariculture initiatives, climate change impacts pose a threat to long-term Kenyan seaweed production. The intertidal areas where seaweed is grown are at greater risk of rising temperatures, and changes in weather patterns that generate rougher seas negatively impact farming infrastructure. Similarly, the farmers themselves face challenges related to overexposure to UV rays without proper protection.

## 4.5. Key Strengths and Opportunities

Leaning on lessons from Kwale County seaweed pilots and learnings from seaweed farming projects in Zanzibar, Tanzania, it is clear that Kenya boasts coastal ecosystems that are conducive to growing seaweed. As farming gains more traction, the extensive Kenyan coastline offers untold expansion potential for smallholder farming.

Encouragingly, seaweed farming has low farmer barriers to entry in that the input costs are relatively low, the farm plots are accessible to all, and best practices are relatively easy to master. Additionally, seaweed production does not require clearing of land or use of freshwater. These 'avoided production costs' also make farming relatively environmentally-friendly, albeit farmer practices and community conflict are the main drivers of unintended negative environmental consequences (like destruction of seagrass meadows).

In Kenya, seaweed farming appeals to women. Beyond the low cost, there is no requirement for land ownership, and the near-shore area is safer (as compared to deep-water ventures like fishing). At this stage in value chain development, profit margins are also limited, so seaweed is not yet appealing as a crop for male involvement. Further involvement in the sector must responsibly consider the societal and family dynamics at play in Kenyan coastal communities, as the role of women as primary seaweed farmers develops. Innovations and interventions must be cognisant of potential harm (emotionally, financially, or otherwise) to women by outlining an expectation of intensive work with minimal benefit.

Reports from the field suggest that the sector also benefits from momentum driven by local enthusiasm and word-of-mouth promotion. Farmer-focused efforts will be more effective and have stronger staying-power if they can reduce the effort spent on mobilization and idea-pitching by capitalizing on the organic energy and supporting communities on projects they select.

Furthermore, as a product, dried seaweed can be stored for long periods of time (potentially up to four or five years) which means that, if stored securely, farmers can retain post-harvest value without worries of spoilage.

Another strength of the seaweed industry in Kenya is its status as a high-priority area for government support. Its position as a key sector for the Blue Economy agenda in Kenya is encouraging for market players who want to be assured of high-level attention and cooperation, in funding, research, and policy, for pushing seaweed success. County governments are also taking the lead on seaweed. In Kwale County,93 for example, the county government already allocates funds to the sector, and the Fisheries Director reports on plans to expand the value-chain by ensuring a ready-market for the current production. Additionally, because pilots are already underway in key areas, local government Beach Management Units (BMUs) have already outlined governance structures for sea-use access of community-based seaweed farms. Replicating the model and adapting for local context across other geographies will be much simpler than developing all the regulations from scratch.

Seaweed farming is attractive to farmers, as the barriers to entry are relatively low (like low-tech farming mechanics and minimal input cost). As seaweed can be produced year-round and does not require full-time attention, coastal households benefit from an alternative livelihood option that offers supplemental, rather than replacement, income and constant cash flow. As the plots utilize near-shore intertidal zones, seaweed farming can be taken up by a full range of community members, including women and youth, making it a welcome economic option to help coastal areas recover from COVID-19 declines. Diversification and access are two critical components for building household economic resilience, and seaweed farming serves to both reduce the community's dependence on fishing as an income source as well as reduce the strain on the local ecosystems from overfishing.

# 5. VALUE CHAIN ANALYSIS: SEA CUCUMBER FARMING

## 5.1. Market Dynamics

Sea cucumbers are marine animals, specifically echinoderms, the same phylum as starfish, sea urchins, sand dollars. These animals live on the ocean floor and benefit marine ecosystems by acting as deposit feeders, , which means they consume "organic matter and microalgae ... excreting 'clean' sand."102 By acting as cleaners for their habitats, sea cucumbers have been found to improve ocean water by regulating pH,102 mitigating ocean acidification, and reducing algal blooms which deplete oxygen.103 Additionally, data suggests that subtropical seagrass beds and coral reefs benefit from the presence of these creatures.103 According to The Economist, "because of the part sea cucumbers play in cleaning up the seabed, it's believed that they help maintain stocks of other marine life."

Of the over 1,250 species of sea cucumber found in the ocean, only about 70 species have commercial value.103, ,107 On land, sea cucumbers are dried and sold, then reconstituted and consumed as a delicacy, primarily in Asia and the Middle East. Demand for edible sea cucumbers continues to grow on the global market, with a boom among China's middle class in the 1980s spearheading the trend. Additionally, chemicals found in the skin can be used in both traditional and modern medicine, so the market is also responding to a growing interest among pharmaceutical firms.107 These converging interests compound demand and have led to dramatic overfishing of sea cucumber globally.

Sources say that upwards of 70% of global fisheries for sea cucumber are fully or over-exploited or depleted,102,104 with "no natural populations remaining" in China.102 This dramatic rise in demand and price have led to what Mongabay terms a "marine gold rush."104 As of 1996, only 35 countries engaged in the sea cucumber export business, but by 2011, that number had more than doubled to 83.107, Furthermore, between 2011 to 2016, the global average market price for sea cucumbers rose nearly 17%.107

This extreme demand generates damaging results. Fisheries around the world are seeing drops in wild availability. For example, in Yucatan, Mexico it took only 2 years (2012 to 2014) for wild sea cucumber harvests to drop 95% (from 260 tons to only 14 tons).107 Business Insider reports that, as of 2019, from the "70 or more species of exploited sea cucumbers, seven are now classified as endangered... all through exploitation."107 These results do critical damage to local ecosystems as well as to the communities whose livelihoods depend on fisheries for survival. The decline in available resources is linked to a combination of foreign demand, ineffective governance structures, and daily economic pressure among poor coastal communities. Over-reliance on small scale fisheries is common, and 66% of sea cucumber fisheries are small-scale.106 Exploitation of any piece of these fragile ecosystems puts the environment and the livelihoods of hundreds of millions of people at stake.

As much of the sea cucumber trade worldwide exists through informal channels supported by poaching, global production statistics are hardly comprehensive. The market is fraught with illegal hunting and, either through negligence or intentional subversion, underreported import and export figures. , For example, a 2020 study from Traffic shows that between 2012 and 2019, Hong Kong reported receiving sea cucumber imports from 33 African countries, whereas only 6 of those countries reported exporting to Hong Kong during the same timeframe.111 While figures vary between the Hong Kong Bureau of Statistics and UN Comtrade reports, records reveal that between 2012 and 2019 "African countries exported approximately 4 million killogrammes of dried sea cucumbers [to Hong Kong], accounting for 13% of the total dried sea cucumbers imported by Hong Kong."111 However, those import numbers from Africa have been declining over recent years, from over 650,000 kilograms recorded in 2012 to just over 350,000 kilograms of imports claimed in 2019. Adding to the complication is that much of the available data references export figures and does not account for a country's own production, domestic consumption, or import-to-export practices. Using rough estimates, we can calculate that between 4.3 and 4.6 million kilograms (between 4,300 and 4,600 tonnes) of sea cucumber imports flowed into Asia in 2019. Some sources estimate global 2019 sea cucumber revenues at US$1.053 billion, with expected growth (CAGR) 5.28% during 2020-2025, while other sources estimate the value of sea cucumber production in China alone to be upwards of US$4.4 billion.

While sea cucumber prices vary by type and size, reports reveal the Holothuria scabra species, also called the sandfish and currently the species promoted through the Blue Ventures sea cucumber farming projects in Madagascar, can claim retail prices between US$370 /kg111 and US$850 /kg.107 According to data from the Hong Kong Bureau of Statistics, however, import value of sea cucumbers is much lower, with exports from East African countries of Mozambique, Seychelles, Madagascar, and Tanzania garnering trade value of US$21, US$17, US$15, and US$10 /kg, respectively.111

With increased attention on the sector, a variety of global stakeholders, from Madagascar to Panama, and from the private sector, to government, to universities, are investing in research around sea cucumber wild stocks as well as sea cucumber rearing and farming. This attention has yet to translate into sufficient government monitoring and intervention, however. For example, even as of 2020, Madagascar, who had been among the top African exporters of sea cucumber to Asia,111 still had "no quota system and no accurate stock assessments"104 upon which to base government regulation or national resource management plans. Sea cucumber trade and production is a high-value industry. Therefore, this issue that necessitates increased regulatory oversight and financial resources dedicated to security and anti-corruption measures is the same issue that points to a lucrative global market with potential to capitalize on unmet demand while simultaneously creating models that offer sustainable production and even regenerate ocean ecosystems.

## 5.2. Production Base

Global production of sea cucumber consists of a mixture of wild-catch and aquaculture farming facilities, with the prevalence of each production type dictated by availability of wild stocks, access to hatchery and rearing technology, and prevalence and enforceability of local governance requirements.

In many countries that see an overlap of hospitable ecosystems and minimal (or no) domestic consumption, sea cucumber wild catch is the predominant means of production. Due to the high value, and because sea cucumbers are slow-moving, 'catching' is really more like 'collecting,' adding to the problem of global sea cucumber stocks that are dramatically overfished. Because of the extreme discrepancy between supply and global demand, many fishers who wild-catch sea cucumbers are engaging in increasingly dangerous109 (and sometimes illegal)104 diving behaviors. Fishers are put at great risk due to outdated equipment, poor-quality or nonexistent protective gear, limited training,104 nighttime dives in the dark, and the nosebleeds, headaches,102 and decompression sickness107 that come with the need to explore ever-deeper waters.

In Kenya, the sea cucumber market is based exclusively from wild-catch production. Coastal fishers (effectively all men) dive to collect the creatures during the "northeast monsoon season when the sea is calm and water is clear." They fish in subtidal zones and use snorkeling equipment to venture into ever-deeper waters, as near-shore high-value populations have been decimated through unregulated trade. Some reports111 reference a 2003 Kenyan ban on using SCUBA equipment, as a response to overfishing; however, these same sources indicate compliance was lacking. Kenya is at risk from the combination of outdated, under-enforced regulations and mis-aligned incentives that drive the industry toward more clandestine channels. With increased fishing pressure from limited stocks and high market prices, the sea cucumber sector is at a standstill unless market actors can unlock mariculture farming options with investment in a hatchery for sea cucumber fingerling distribution.

Discussions with a sea cucumber exporter and Kwale County sea cucumber trader confirm that the market is home to four primary species: golden sandfish (Holothuria scabra), white teat fish (Holothuria fuscogilva), black teat fish (Holothuria nobilis), and curryfish (Stichopus herrmanni). Of these, market actors prefer trading sandfish, as this a high-value species and thus fetches a high export price. It is also a more stable product than the curryfish, for example, which is quite delicate and prone to post-harvest loss if not handled properly. Among other varieties, the sandfish has a relatively high demand and there is some current availability within Kenyan coastal areas.

High season for the sea cucumber market is roughly September/October to April, when catch is high and quality is high, yielding strong profits. Then, from May to August, fishers can still manage a relatively high catch, but quality is reduced, due to smaller sizes. Additional challenges of the rainy season include lower production base, as many fishers avoid the practice when seas are rough, and post-harvest losses due to excess rain that make drying processes slower or less effective. Export prices from Kenya are highest from November to February, coinciding with holidays like Christmas and Lunar New Year.

Kenya competes on the global market with Asian countries, like Fiji in particular, and with other African countries, like Madagascar and Seychelles. When vying for a position in the global export market, Kenya faces production challenges like climate change, insufficient supply, and declining stocks. According to the Fisheries Directors of Kwale County, wild sea cucumber stocks have been on the decline for decades, forcing several operators to close their sea cucumber businesses.93 Sea cucumber aquaculture is an option for Kenyan production that could solve some of the problems with availability, while also building back the ecosystems in ways that protect and regenerate other animal populations.

Several examples of sea cucumber aquaculture projects exist in the WIO region, some more successful than others. A Zanzibar, Tanzania sea cucumber project, supported by FAO and Korea International Cooperation Agency, faces the aftermath of a livelihoods program cut short. Despite technical research and training through FAO and Blue Ventures, the hatchery has shut down due to an inability to master sea cucumber juvenile feeding techniques115 and a lack of funding, stopping the program in its tracks.

However, leaning on decades of trial, adaptation, and learning, Blue Ventures102,106 offers an example of a community-farming setup in Madagascar and points to the potential successes that can be found for both ecosystems and local community livelihoods. In Madagascar, Blue Ventures sea cucumber farmers are earning on-par with the country's agricultural minimum wage, just from doing sea cucumber farming part-time (roughly 20 hours/month).115 These farmers also produce high-value seaweed, adding to their incomes. Additionally, the farming practices are yielding a 60% return on juveniles to harvest, which is double the return at a standard industrial farm. By 2015, the 100+ active farmers in 2 villages in southwest Madagascar had produced and sold nearly 24,000 market-sized sea cucumbers, with a total value of more than US$ 18,000. This model also encourages community engagement and supports local leaders as they establish and enforce sustainable governance practices that protect farmers and mitigate conflict. Additionally, locals in Madagascar are seeing ecosystem improvements, like more biodiversity and faster-growing seaweed, due to the increased presence of sandfish.

The sea cucumber mariculture model is a non-extractive model, in that the community is not running a Blue natural capital deficit by taking from the sea. It is also a flexible model, in that some programs operate in partnership with a private-sector hatchery, encouraging farmers to buy sea cucumber juveniles (fingerlings) as inputs, at one time costing US$0.16 per juvenile.126 The farming can also be done as an outgrower-style model, where juveniles are given for free, but farmers are obligated to sell back to the private sector partner (who also coordinates processing and export) at a reduced rate. Profits have been reported around US$1.15 per sea cucumber reared.126 By 2019, farmers in Madagascar working with Blue Ventures had seen some of their largest harvests to date, yielding profits of around US$4,800 across the group of nearly 80 farmers. Sources say that it takes farmers around five years115 to master the economics and run a sustainable business that allows them to pay operating costs and make a profit without dependence on donor funding or NGO support. Additionally, because farming activities occur in intertidal (near-shore) areas, technical training and livelihoods benefits can be accessed by vulnerable populations like women and youth. Farmers are seeing substantially higher incomes105,109 relative to other activities, and the example set by this model shows the livelihoods potential for other coastal communities.

Fortunately, the sandfish (Holothuria scabra) piloted and reared in Madagascar is the same high-value species already in Kenyan export market systems. Presuming access to fingerlings, startup costs to the farmer are low, as inputs are minimal and feed costs are non-existent. Sea cucumbers are what DeWeerdt refers to as "a kind of double alchemy: non-fed aquaculture species grown on the wastes of other non-fed aquaculture species." Mariculture systems that utilize the sandfish outgrower model require planning and consideration around production requirements like:

- Sea-use access and governance structures, including community involvement around farming regulations and sea cucumber pen management
- Inputs like netting and stakes for the enclosures, brushes or brooms for cleaning the nets, and rubber boots and buckets for monitoring and collecting
- Viable seed procurement, through an operational hatchery
- Upstart time, as juveniles can anywhere from 6-7120 to 9-12106 months to grow into a harvestable (400g+) size
- Technical know-how, like enclosure construction, rearing best practices, disease monitoring, and stocking maximums
- Security of sea cucumber stocks, as they are vulnerable predators and theft
- Harvest timings, which occur twice per month (during full moon or new moon) at times in the tide cycle when farmers can access sufficiently-shallow waters at night (as sea cucumbers often bury themselves under the silt during the daytime)126

As no hatchery currently exists that could supply necessary juveniles, coastal areas could utilize SouthEast Asian Fisheries Development Center (SEAFDEC) models for community-based hatcheries, , which have been shown to require relatively low construction costs (US$ 30,000) and reasonable annual operating costs (an additional US$ 30,000 - 40,000) while producing a quarter- to a half-million transplantable juveniles per year.

Production models that utilize sustainable mariculture methods and environmentally-responsible practices have the potential to engage smallholders and increase supply of a high-value product while aligning incentives that protect and build back local ecosystems.

## 5.3. Broader Value Chain Mapping

As sea cucumber farming currently does not exist in Kenya, the present Kenyan production chain is a simple one, involving roughly three parties: the fisher, the trader,121 and the exporter.120 All sea cucumbers are wild-caught in the ocean. Because of the relative dangers of deeper waters, the task is primarily performed by men; in fact, in Kwale county, sea cucumber fishers are 100% male.93 Production (or 'collecting') requires minimal inputs including gear (like a snorkelling mask and fins), equipment (like buckets or nets for gathering collected creatures), and transportation (like access to a boat for reaching deeper seas). Sea cucumber quality is primarily determined by size, and A and B quality levels garner prices between 250-600 KES/kg. Final profits at the fisher-level represent between 1-5% of the final market value. Traders travel to the landing sites, paying the transportation costs to buy the day's catch fresh and direct from fishers; however, due to overfishing, there is sometimes no catch to buy.

From there, the trader executes the first level of post-harvest processing to ensure proper preservation for transportation. Traders are responsible for grading, gutting, boiling, salting, and sometimes drying, depending on exporter demand. The traders then travel to exporters, sometimes paying transport costs and sometimes being reimbursed by the exporter, to sell their semi-processed sea cucumbers. For the same A or B quality sea cucumbers, traders can earn revenue of 1,200 - 2,000 KES/kg. After paying for any assets needed (like a boiling pot), inputs (like salt), and operational costs (like transportation), traders claim between 5-10% of the sea cucumber's final market value. Due to the lack of government regulation, traders complain about exploitation by exporters.

The final stage occurs when the exporter buys the semi-processed animals, finishes the processing steps, and exports fully-processed sea cucumbers to Asia. Processing takes upwards of 2-3 weeks and includes steps like boiling, soaking, peeling (removing the outer calcium layer), salting, boiling again, and sun-drying (for up to 2 weeks until very hard). The full process can transform a fat, wet sea cucumber that started at 450g into a hard, dried item of only 15g.126 Many exporters are based in Mombasa, while some prefer keeping operations in smaller fishing villages, like Shimoni, where supply is easily accessed and labor is less expensive. One exporter interviewed chooses to travel to Hong Kong from Mombasa, carrying the shipment himself. This work, of course, requires a special export license, as well as four additional certifications. For high-quality sea cucumbers, the exporter is able to collect prices of 15,000 - 18,500 KES/kg from Asian customers, retaining an astounding 85-90% of the final value of the product. At present, the sea cucumber export market in Kenya is limited, as exporters are facing increased financial pressure, and some have recently shut down operations.93

Throughout the whole of Kenya, no sea cucumber aquaculture presently exists,93 and introducing sea cucumber farming will disrupt the current value chain. Opportunity exists to harness a lucrative industry, incorporate innovative ideas (that are inclusive of vulnerable populations) to boost supply, and generate substantial value for local-fisher livelihoods.

### Enabling Environment

As an emerging value chain, the sea cucumber industry is widely unregulated across Kenya. This means that wild populations are not monitored or measured, no catch quotas exist, and sea cucumber businesses are subject to general sector regulations, rather than measures informed specifically for the product. The Kwale County Fisheries Director confirmed that, in the county, regulations around sea cucumber catch are nonexistent. However, the county is currently undergoing efforts to revive aquaculture practices that stalled during the Economic Stimulus Program. As the county government prioritizes its constituant's demands, efforts currently focus on freshwater aquaculture near dams. Positively, Kilifi County government set targets for 2018 - 202295 that include conducting feasibility studies, with sea cucumber named specifically as a priority. Market actors can expect the enabling environment and government regulation of sea cucumber on the coast to be a work-in-progress for the foreseeable future.

## 5.4. Key Challenges and Threats

The most pressing bottleneck for a robust, sustainable sea cucumber aquaculture value chain in Kenya is the issue of instituting and maintaining viable hatcheries. At present, not a single hatchery exists, and the sector has no chance of survival or scale without operational hatcheries relatively close to farming grounds, as fingerlings are too delicate to transport far distances (that is, no further than 100km).115,120 As seen with the Zanzibar effort, the hatchery challenge represents a combination of issues including funding (even with an active hatchery, similar projects require a minimum of five years115 of external program funding to achieve self-sufficient systems), technical expertise (facility mechanics, feeding systems, and biological requirements for breeding and rearing), and governance (ensuring management of the facility is sustainable after program interventions).

Furthermore, industry actors must prepare for additional challenges within the emerging sea cucumber value chain. First, the lack of current government regulation in the sector means farmers are at risk from both ecological and financial factors. Lack of regulation around stock monitoring, quotas, and ecosystem protections has the potential to jeopardize efforts to improve natural habitats and increase smallholder access to Blue natural capital. Moreover, the lack of regulations around pricing or exporter policy leaves the economic agency of smallholders at risk from potential monopolistic behavior throughout the value chain, as has been a challenge to sea cucumber farming efforts in both Madagascar115 and Tanzania. Additionally, the process to engage local community governments to solidify protected and gazetted sea-use access for smallholders can take many years.61

Finally, all marine-based extraction value chains in Kenya will face short-term challenges of farming safety, that is, farmer exposure to the sun's damaging UV rays and environmental dangers that come with a lack of swimming skill and safety equipment. In the medium-to-long-term, climate change issues, like warming water temperatures and rougher seas, pose a risk to all Kenyan mariculture initiatives.

If Kenya can solve the hatchery issue and find funding for sufficient support during farmer scale-up, we can expect to build an industry that is competitive with Madagascar in the WIO region. In the mid-to-long term, a healthier supply of stocks would help draw new entrants into the export side of the market, reducing the risks of monopolistic behaviors and spreading more control and wealth downstream.,

## 5.5. Key Strengths and Opportunities

Despite the challenges and risks, there is great potential for the sea cucumber value chain in Kenya. Beyond the growing global demand and attractive prices, there is "unlimited" export opportunity in Kenya 93,120 and hardly any price volatility.120 Simply put, the market is there to be filled. Knowing that local stocks exist (as in the wild-catch market) are assurance that the Kenyan coastline boasts appropriate growing conditions for farming sea cucumber.

As the sea cucumber industry sits as a Kenyan government priority, efforts in the space will benefit from this directed attention, enthusiasm, and funding. Importantly, the national government, with financial support from the World Bank,123 is currently investing in the research and development of a hatchery pilot in Shimoni, Kwale County. This multi-species facility, while currently undergoing construction, is several years away from being fully operational. It is probable the facility will eventually be able to provide sea-cucumber fingerlings for farmer pilot programs, but of even greater value will be its ability to expose the proof of concept for a viable hatchery business. By highlighting the business case, this facility can help unlock critical private sector interest and investment in the value chain. Moreover, while an under-regulated industry holds inherent risk (as outlined in Section 5.4), organizations like IUCN have the unprecedented opportunity to become an irreplaceable partner for robust regulation-setting that drives forward an eco-conscious agenda (including ecosystem protections, stock population monitoring, and environmental measurement requirements) as well as local-area best-practices (like advocating for local community involvement in governance setup and the protection and inclusion of vulnerable populations). In the meantime, while policies are being developed, there exists a window of opportunity to trial thoughtful, responsible short-term breeding solutions that pull juveniles from the ocean in a sustainable way. This type of pilot integrates into government regulatory conversations while also breaking ground on farmer pilot programs in parallel to hatchery development.

Among the strengths of the sea cucumber industry are benefits to farmers, such as low barriers to entry (achievable technology, low upstart costs, and part-time farming hours), relative safety (as compared to current wild-capture diving practices), and constant cash flow (when farms are operational and invest in monthly seeding practices, they can benefit from monthly harvests, too). The close-to-shore nature, and the opportunities for value-addition services are conducive to including vulnerable populations like women and youth. Especially in the aftermath of the national economic decline in 2020 due to COVID-19 crisis, market actors can develop a value chain in Kenya that engages the full household to build pandemic-era livelihoods that support coastal families.

Acknowledging the benefit these creatures have to coastal ecosystems, a critical environmental opportunity exists. Farmers could develop partnerships or arrangements with local government entities with resources and incentive to buy-back stocks throughout the process. These sea cucumbers could then be used to reseed into the wild, bolstering biodiversity, enhancing LMMA and MPA ecosystems, and bringing compounded benefits as they make underwater habitats even better than before.

Finally, as sea cucumber farming is expected to take only around 20115 hours per month from the smallholder, building into the sea cucumber value chain has the opportunity to offer critical alternative livelihoods options to coastal households that are supplemental to, rather than exclusive of, existing activities. By diversifying income streams, households can reduce their dependence on fishing, building resilience for both ecosystems that suffer from over-exploitation as well as resilience for coastal families.

# 6. VALUE CHAIN ANALYSIS: FINFISH CAGE FARMING

## 6.1. Market Dynamics

According to a Sustainable Seafood Overview report, "approximately 3 billion people in the world rely on wild-caught and farmed seafood as a primary source of protein." FAO estimates the average global citizen consumes 20.5kg per year, as of 2018.83 With an increasing global population, aquatic animals emerge as a critical category for food security and daily protein. In fact, the growth rate for human consumption of fish not only outpaces growth rates for other animal proteins, but it has been increasing at "a rate almost twice that of annual world population growth."83 Not only are there more of us, we are eating much more fish. These growth trends are markedly more pronounced in developing countries.

When FAO outlines global fisheries and aquaculture production, the totals for 'fish' include shelled molluscs, finfish, crustaceans, and other aquatic animals, but exclude "aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants."83 Global production of fish reached 179 million tonnes in 2018, and 69% of the world's total comes from Asia, of which China accounts for more than half. Africa trails behind the Americas and Europe, contributing only around 7% to global totals.83 Most fish is consumed locally, as exports account for only 38% of worldwide production, but even so, the global fish export industry has a reported annual value of over US$ 164 billion.83

Global production comes from a relatively even split between wild-capture (96.4 million tonnes, representing 54%) and farmed aquaculture (82.1 million tonnes, representing 46%). However, according to reports, "the value of farmed fish was higher, around US$ 250 billion compared with [US]$ 151 billion for wild-caught fish."128 On an upward trend, it is estimated that aquaculture production will "increase by one-third by 2030 … and will supply the majority of aquatic protein in people's diets by 2050."128

While wild-catch production is predominantly marine-based (88%), only 38% of farmed fish comes from the ocean. Shelled molluscs are the primary product from marine-based aquaculture, with finfish representing around 24%. On the whole, then, marine-based finfish farming accounts for less than 9% of global aquaculture production and just over 4% of global fish production overall.

The aquaculture industry is underdeveloped across the African region, and the continent contributed less than 3% to the global aquaculture total in 2018, with sub-Saharan Africa contributing less than 0.5%.83 The continent is heavily dependent on wild-catch, and according to FAO, "aquaculture accounted for 17.9 percent of total fish production in Africa,"83 as compared to the worldwide proportion of 46%.

Sources agree that wild stocks of fish are dwindling. It is estimated that anywhere from 70% up to 85%138 and 90% of the world's fisheries are overfished and overexploited. What's more, reports show that "many fisheries throughout the world throw away more fish than they keep."138 Accidentally catching non-targeted species, or by-catch, results in millions of tonnes of wasted fish across the globe. The long-term capture fishing industry is unsustainable, as the overall volume, along with wasteful practices that do damage to both inland and marine habitats, leave ecosystems decimated and destroy essential biodiversity.

Further compounding the problem is Africa's growing population and the ever-increasing challenge of food security. In 2019, the prevalence of undernourishment in Eastern Africa reached just over 27%. That figure is expected to grow to nearly 34% by 2030. The World Bank reports Kenya's 2019 population growth rate of 2.3% fell just behind the 2.7% seen across all sub-Saharan Africa. Kenya imports fish to mitigate the annual deficit of 800,000 tonnes, and in sub-Saharan Africa and globally, Kenya's per capita consumption of fish (less than 4kg per year) is among the lowest. The challenge on the horizon is one of feeding Kenya's increasing population as surrounding countries compete to support their own populations that are growing even faster. The pressure on supply is likely to make fish imports more scarce and more expensive for Kenya in coming years. Reports show that "fish catches have been declining in Africa in recent years by a million tons a year," making it clear that Africa's overreliance on wild-capture fishing poses a threat for not only the health and nutrition of the population, but to the ecosystems upon which coastal communities rely.

Mirroring worldwide reports, the COVID-19 pandemic has taken a toll on Kenya and the WIO region. With the global tourism industry at a standstill, there is no surprise that coastal communities in Kenya are feeling the financial impacts of the shutdown. Also, the increasing difficulty of accessing medical care along with new government-mandated public health protocols add additional pressure on poor households. Many are forced into subsistence fishing to feed their families, and the increased fishing activity strains the productive potential of ecosystems. Additionally, the government-mandated evening curfew has impacted the Kenyan coastal fishing industry in a number of ways. First, from the production side, without the option for night-fishing in deeper waters, local fishers end up taking advantage of more near-shore habitats, even if they are protected areas like community-based LMMAs.148 Lower fish stocks make fishing an ever-more-challenging task, with excess effort spent to reap less reward. Not only does this negatively impact household income and food security, but local ecosystems are suffering, causing a negative biodiversity ripple effect as regenerative potential dwindles. Stories from Vanga in Kwale County tell of the challenges within coastal fish trades caused by the pandemic; Blue Ventures quotes one of their Kenyan contacts as saying:

"They have cut and taken the buoys we put to mark our LMMA area. It is now a prime fishing area and there is not much we can do. The number of people fishing at the reefs here has increased but the fish trade has fallen very low. Previously here in Vanga, up to six fish trucks would come everyday to collect fish for the Mombasa and Nairobi market. But recently, only one truck has been able to ferry fish to Mombasa, and that was for the local market."148

On the positive side, local coastal demand for fish in Kenya remains strong, and pandemic-restricted trade comes with both an increase in "catches [that] are sold locally" and a welcome decrease in local price.148

## 6.2. Production Base

The market dynamics for the Kenyan fisheries sector are complex, and it is not the aim of this report to detail the entire production base. For example, Kenya produces aquatic animals through both wild-capture and aquaculture (farmed) methods. These activities occur both inland and in marine environments. Furthermore, Kenya produces an array of animal types, including finfish, mussels, octopi, crabs, oysters, and more. Some products are for the export market, some are for high-value domestic consumption (involving transport across the country), and some are for local coastal consumption. In line with the objectives of the study, and with priority value chain outputs in mind, this report focuses specifically on: marine-based, finfish aquaculture for the local coastal market. As such, the production base analysis for this value chain details avenues that address demand for finfish in the local (coastal Kenyan) market.

In 2019, overall fish production (wild-capture fishing and farming combined) in Kenya was just over 146,500 tonnes,50 with nearly 25,700 tonnes (around 17%) coming from the coast. While aquaculture represents almost 15% of freshwater production, coastal production is dominated by wild-capture fishing. Not even 1,000 tonnes of fish were produced in 2019 through marine farming; this figure represents only around 3.5% marine output and only about 0.6% of Kenya's total fish production. Large-scale wild-capture is done by the 17 industrial-level fishing vessels that can venture into deep waters beyond the reef, generally bringing back fish bound for export markets. However, fish consumption at the local level is driven by some 80,000 small-scale artisanal fishers, utilizing some 17,000 artisanal fishing vessels.50 Along the coast, it is men who do the dangerous work of artisanal fishing.

Kenya's fish stocks are becoming more and more depleted, putting pressure on the traditional artisanal fishing ecosystems that support local fish consumption. Anecdotal reports indicate that it is not uncommon for a local fishing boat in the coastal county of Kwale to go out to sea and return empty. Challenges to artisanal fishing include depleted fish stocks, worsening sea conditions for small vessels, and increasing need for local landing sites to which fishers can bring their catch.

In spite of being introduced into Kenya for decades, mariculture has failed to take root due to insufficient investment and inadequate technical expertise. Previous attempts at coastal aquaculture have not yielded positive, sustaining results. However, the sector has received a boost under the KEMFSED project (Kenya Marine Fisheries and Socio-Economic Development Project), which promises to build a national mariculture resource and training center. In response, Kenya Marine and Fisheries Research Institute (KMFRI) is currently piloting marine-based cage farming as a potential solution to the fish supply deficit along the coast. Two of the pilot cages are housed in Kilifi County, and a third is positioned in Kwale county, with plans to establish another cage in the same Kwale site. The research is proving that cage farming can work, and the government is preparing to move into the community development phase. To date, research from previous fish farming pilots indicate that farming (specifically milkfish) has been "practiced at subsistence level, and extensively, contributing more to the food security of the communities, rather than to economic gains." As mariculture represents only 213 - 5%152 of all farmed aquatic animal production (marine and freshwater combined), Kenya has yet to fully exploit the marine farming sector.152

### Cage Model

At present, finfish pilots are being tested with milkfish and rabbitfish species. KMFRI is also currently pursuing ongoing testing and research around marine-rearing of other species like tilapia, potentially positioning finfish mariculture as an alternative to frozen imports.

Finfish production using current cage-culture technology follows four main steps.

First, site selection must be performed. The cage structure will float in the deeper waters before the reef, but past the shallow intertidal zone. The site should have unrestricted underwater currents to keep the environment properly oxygenated and to keep fish healthy. However, ocean areas that come into contact with land-based rainwater runoff are not ideal, as the incoming fresh water reduces necessary salinity and causes dangerous stratification of the water temperature.

Next, stakeholders build the physical structure. There are several construction models being tested, but the preferred method in Kwale County consists of a floating wooden structure that is anchored to the ocean floor. A sample layout would include compartments made of netting that descends 2-3m into the ocean waters. Including two separate compartments enables farmers to separate smaller fish from larger fish. Construction can take around 2 weeks and requires tools and inputs like culture nets, wood, floaters, concrete sinkers, ropes, nails, bolts, and a canoe.

Third, farmers secure fingerlings from the wild. At present, local fishers are paid 10KES for each fingerling (a juvenile fish weighing approximately 1g). For fingerling collection, fishers require assets like snorkeling gear and buckets. The two-compartment Kwale County model currently holds 10,000 fingerlings in one compartment and 6,000 in the other, at a stocking density of 200 and 150 fish/m3, respectively. Farmers are responsible for the fingerling input cost. In this case, one cycle of fingerling inputs costs 160,000KES (just under US$ 1,500). As more cage systems are deployed across the coast and more fingerlings are required, the need for sustainable sources of seed (fingerlings) becomes of the utmost importance. Future endeavors might utilize government-led hatchery facilities or integrate a specific hatchery area within the cage chamber to ensure scaled operations are not detrimental to wild populations.

As a final step, fingerlings are placed inside the compartments and allowed to grow. Growing cycles take 5-6 months, meaning a structure could support 32,000 fish in a year. Wild seaweed is collected and used as food, although experts are researching if a business case exists for buying supplemental food to encourage nutrition and growth. In either case, responsible scaling of the marine-cage-farm sector requires sustainable, non-disruptive feed solutions (whether collected or purchased). During the growth stage, facility staff feed and monitor fish stocks for size and health, routinely check the netting system and anchors, do necessary repairs, and ensure security is in place 24 hours/day to protect the harvest. The facility usually sees two people working full-time, one technical manager for daytime shifts, and a security guard at all hours. Beyond staff salaries, farmers are responsible for collecting required tools for daily operations like snorkels, brushes, and a record book.

Fish are ready to be harvested when they reach 300-400g, and the facility prepares for harvest by purchasing buckets and a weighing scale. At harvest, farmers are obligated to pay a tax to the BMU of 2KES/kg of fish sold. Even with the most conservative profit and loss estimates, a cage farm operating at full capacity under this model stands to make a profit in the first cycle that would pay for the construction costs. During a normal cycle, if the collective profit is spread across a farmer group of 10 people, monthly payments per group member already exceed the minimum wage for Kenyan rural labor.

Cage farming is appealing to fishers because the system eliminates the exercise of searching for fish schools, and the harvest timing can be controlled. At present, local fishers have a limited window in which to sell their daily catch, otherwise the fish spoil and the effort is wasted. Marine-based fish farming disrupts the current value chain as farmers can produce an exact purchase volume, fresh and of high quality, on demand. Assuming 10 farmers were to produce together at full capacity using the Kwale County piloted farming method, rough estimates show that the production and harvest capacity per cycle would be more than double the average volume of wild-capture during the same cycle period. Reports from aquaculture cage farming on Lake Victoria also indicate that a fully-stocked cage farm with good management can produce more fish per cycle than what artisanal fishers are seeing with dwindling stocks. Furthermore, farming and harvesting can occur year round, which is particularly helpful during rainy seasons when the weather makes deep-water fishing dangerous and unproductive. During the months when traditional catch is low, prices increase, so fish farmers stand to take advantage of seasonal pricing.

Finfish farming comes with drawbacks, of course. The initial upstart cost requires an investment and cash flow that is prohibitive for an individual farmer. Securing a group loan, encouraging private sector-investment for an outgrower-style model, or identifying less-expensive local building options might make construction more accessible to the fishing community. While farmers benefit from always knowing where their fish are, so does everyone else; fish farming stocks are at great risk of theft. Even if accidental, any small issue with the underwater netting means the entire harvest can be lost. Finally, the fish farming setup is most likely to be adopted by men in the community who have sea safety and marine survival skills. Women do not traditionally know how to swim, which poses a threat to the potential inclusivity of the project.

### 6.3. Broader Value Chain Mapping

According to Kenya Fisheries Service, fisheries contribute around 0.5% annually to Kenyan GDP. The country is home to around 80,000 fishers and 60,000 fish farmers. There are around 50,000 fish traders in Kenya, with 300,000 people employed upstream. The sector also supports the 2 million people indirectly employed,50 effectively touching the lives of over 5% of Kenya's total population.

This complex value chain,93,155 with its multitude of actors, service providers, and value-addition remains fairly consistent between artisanal finfish wild-capture and finfish farming for the local market. Production differs (as detailed in Section 6.2), but the basic premise remains the same: the first-stage market actor collects finfish from the water. Fish from the wild and from aquaculture installations both enter into the market through the local landing site. Traders converge at the landing site to purchase the day's catch, as their power within the value chain precludes fishers from selling directly to the market. An important difference to note is the trader relationship with artisanal fishers. Often, traders are the owners of the boats and equipment, and they enter into exclusive purchasing agreements, generally at market price, with fishers in exchange for leasing the vessel. Farmers who operate without in-kind support from a trader would disrupt this element of the value chain as they would be free to sell to anyone at the landing site.

The end market can take many forms. Working backwards, consumption occurs, generally, in one of three locations: at home, in the market, or in a restaurant. Customers who purchase fish to take home to cook usually purchase from a market vendor. Locals who consume freshly-prepared fish in the market purchase a plate from someone like a 'mama karanga,' a woman who processes (by frying) fish on-site for immediate consumption. These simple businesses are often relatively informal and occur in the open-air. This business model was among those negatively affected by the COVID-19 government curfews, as legal operating hours were drastically slashed.

At the landing site, a fisher might sell to a trader or directly to a mama karanga, but a mama karanga can also purchase her fish from other stakeholders en-route to market. Vendors and restaurateurs might also purchase their fresh supplies from the fish brokers, who are intermediaries between the traders and the market-level actors. As such, the value chain for local coastal fish consumption can follow several routes, including multi-stakeholder chains (like a fisher - trader - broker - market - consumer path), simple chains (like a fisher - vendor - consumer path), and all paths in-between. Common species sold for local-market preparation are rabbitfish and milkfish, and they generally are sold whole and unprocessed through the trader- and broker-levels.

Most of the local-level market action happens in daily cycles, as challenging infrastructure and a lack of cold storage limit the potential to retain freshness for extended periods. Tana River government records indicate that, in 2015, up to 20% of fish harvests were lost to poor post-harvest processing.31 The limited freshness window also means that market action is restricted to local geographies, as transportation even to cites like Mombasa require heavy investment in equipment and cooling-enabled vehicles. Some local governments have provided coolboxes for use throughout the value chain, to help mitigate the challenges of keeping fish catches fresh in the coastal Kenyan heat.

As prices vary market-to-market and across seasons, dissecting the exact amount of value retained by each actor becomes an impossible task. However, one example recorded among fishers, traders, and brokers in Kwale County shows that, after buying from the fishers for an average price of 200 KES/kg, traders sold to brokers at a price of 300 KES/kg. The broker then sold the fish at 350 KES/kg. Fish species for the local market all garner the same price per kg.

General fisheries challenges, as noted by the Kenya Fisheries Service, include issues of production capacity (by only accessing a small portion of Kenya's Exclusive Economic Zone (EEZ)), supply (overfishing and dwindling stocks), production costs, processing losses (due to a lack of cold store, weighing stations, and aggregation facilities)31 and governance (insufficient Monitoring, Control, and Surveillance (MCS) along with increases in Illegal, Unregulated, and Unreported (IUU) fishing).50 Tana River government documents reveal additional challenges across the fish value chain like "lack of landing sites, poor prices for fish, disorganization among fish value chain actors, and inadequate investment."31 However, field reports reveal that tackling these issues can lead to dramatic change for local fishing communities. As a result of interventions in Tana River, production increased, fish prices increased by 50%, post-harvest losses were cut in half, and BMU membership increased by almost 25%, compounding positive effects by increasing the resource base with which to support the local fishing industry.31,

## Enabling Environment

At the local level, persons involved with marine finfish farming must secure sea-use access by going through the BMU, the local agency tasked with overseeing ocean use practices within their jurisdiction. The local government is involved as the project identifies a suitable area for setup and as community members are sensitized and invited to join. Fortunately, the governmental rules and regulations surrounding the fish trade are well established, and any new finfish farming ventures would make use of the protections established from inland aquaculture ventures.

For a fish farming venture, local communities must be engaged to procure local building materials, laborers for construction of the cage facilities, and farmers to run day-to-day operations. In some cases, the local government might offer financial support for construction. Beyond monetary contributions, local government institutions are also expected to provide or support training and technical services for mariculture activities. Presently, local governments like Kwale County are actively supporting the local-market artisanal fishing value chain by providing coolboxes for fishers to take on boats as well as supplying water coolers and freezers to landing sites.

Coastal county governments have earmarked support for mariculture in their County Integrated Development Plans, ranging from establishing marine fisheries96 and hatcheries,30,97,99 to specifically promoting cage fish farming.97 Government is also involved from a policy level, including the production of an Environmental Impact Assessment (EIA) to get authorization from the National Environment Management Authority (NEMA). At the national level, the government has prioritized the operationalization of fish quality control laboratories.50 This national-level support underscores the way the government is currently supporting initiatives that "improve management of priority fisheries and mariculture and increase access to complimentary livelihood activities in coastal communities."50 These efforts are targeted at governance measures that can ensure "long-term sustainability of fish stocks."50

## 6.4. Key Challenges and Threats

For finfish farming to offer a viable alternative to wild-capture fishing, it must address the key challenges that threaten potential success.

First, construction and initial setup are costly investments. Community mobilization, private sector or government intervention, or access to appropriate financial instruments is crucial. Unfortunately, the Kwale County Fisheries Director maintains there are no suitable loan products currently available.93 The farming facility itself also proves to be a risky investment when all of the valuable stock is vulnerable; theft or damage to the facility can mean the difference between a full farm and a completely empty farm. Additionally, the upstart time (at least 7-9 months before the first harvest) can be discouraging for cash-poor farmers who are investing time, energy, and resources while waiting for a payout. Additionally, as fish farming incurs additional costs (like fingerlings, feed, and security), farmers must believe in the value proposition that appears to increase costs without a noticeable market-price benefit. At the local-market, a farmed fish is the same as a caught one. Proof-of-concept must be established for mobilization and community engagement to take hold. Even with community participation, a history of failed development projects proves that collective management and group-ownership consistently pose a challenge that impedes long-term success.

From an inputs perspective, the current value chain does not have sufficient or consistent access to fingerlings, as hatchery facilities are currently underway. While trials have proven successful using wild-catch fingerlings in the short-term, access is unpredictable and dependent on wild spawning seasons.93 Operating the farm at full capacity is also a challenge, as fish farming relies "on wild caught seed, leading to the inability to stock ... at appropriate stocking densities."154 Ongoing success for the sector and ongoing protection and regeneration of the local environment depend on finding a sustainable hatchery solution.

Additionally, farmers must be equipped with the technical knowledge of caring for fish, whereas their current practices require only knowledge of where to find and how to collect wild fish. Success hinges on an in-depth understanding of setup and rearing best practices.

Furthermore, the fish market is currently monopolized by traders who generally block fishers from accessing the market directly. While fish farming has the potential to bypass some of the exclusive-sale agreements, creating new market avenues and systems is no easy task. Farmers should also be prepared for resistance from traders who currently dominate.

Environmental conditions also pose a long-term threat through climate change issues as water temperatures rise and seas become rougher and more dangerous. Fish farming also poses a safety threat, from both sun safety and water safety perspectives. Working on a fish farm structure in deeper water requires adequate swimming ability, appropriate safety equipment, as well as sufficient protection from the sun. Because women traditionally do not have deep-water training, the sector faces a challenge in making the practice as inclusive as previous pond-based coastal fish farming projects. Certain financial requirements, like capital for investment or land ownership, might further alienate potential female fish farmers. For Lake Victoria as of 2017, "only 16 percent of fishing cages [were] owned by women," with additional financial exclusion burdens from working to earn income that is controlled by husbands.

Fish farming ventures in coastal Kenya also depend on a system of governance and regulation that is properly planned and properly enforced. At present, the lack of strong resource management plans poses a threat to the viability of fingerling and seaweed-feed activities.

Finally, for a fish farming to truly be a success, their implementation must have a positive impact on the environment. However, the "weak regulatory environment ... around common resources" can lead to "environmental degradation." Assessments from Lake Victoria show that a dramatic increase in scale (170% increase in the number of cages between 2016 and 2018) has contributed to negative ecological outcomes. Proper site selection, spacing, and waste management systems are critical for the environmental sustainability of a cage system, especially at scale. Additionally, addressing issues around fish bio-wastes could not only drive value and investment in the sector but could also reduce environmental harm caused by the value chain. At the coast, Kenya has an opportunity to build and enforce regulatory systems before fish farming booms.

## 6.5. Key Strengths and Opportunities

The finfish farming value chain benefits from the strong local demand and the established coastal market for fish. Declining wild stocks make a strong business case for mariculture production.

Positively, the Kenyan landscape boasts strong government enthusiasm for fisheries. Local governments are actively supporting the local-market fish value chain in general, as evidenced through provision of supplies. In the context of finfish farming, KMFRI is managing the launch of an experimental hatchery in Shimoni, Kwale County. Forward momentum underscores the urgency with which Kenya is seeking innovative solutions within the fish sector. Additionally, by piloting a government-managed hatchery to prove the business case, the industry has the opportunity to draw to the space private sector permanent market actors who can continue investing after government or donor funding ends.

While certainly more expensive than wild catch in terms of inputs, the costs to operate a finfish farming facility are relatively low. Supplies and inputs are available locally, and the payout for investment is strong. Moreover, because the harvest can be planned, farmers are not as dependent on, or controlled by, trader prices. Farmers, as opposed to fishers, are not pressured to offload stocks before they spoil. This leverage increases the opportunity to develop a farmer-friendly market system, like scheduling harvests and linking directly with buyers or transporters. An increase in competition can prove useful for local farmers and fishers alike.

At the macro-level, Kenya will struggle to meet the protein needs of a growing population. Increasing wild catch sustainably requires a commercial or government investment in fishing equipment and vessels and better resource management (like the use and enforcement of quotas, more coast guards, and more landing site inspections). On the other hand, fish farming offers high rates of productivity, greater oversight around sustainability of practices, and guaranteed supply, even during traditionally low-catch seasons.

Finally, from a livelihoods perspective, investing in fish farming reduces the volatility and risk of depending on unpredictable, unsafe daily trips to the sea. Fish farming is safer, more stable, and closer to home. For systems that use continual (week-by-week) seeding, farmers can enjoy a continual cash flow, even in seasons that are traditionally unfit for wild-capture. Planning harvests can reduce waste in the finfish value chain, making farmers into good stewards of their Blue natural capital resources. By reducing the amount of fishing in Kenya's coastal waters, finfish aquaculture enables wild populations to regenerate. Farmers also have the opportunity to reinvest some of their developed stock into LMMA or MPA zones to help repopulate struggling species, increase biodiversity, and build better marine ecosystems.

# 7. RECOMMENDATIONS

## 7.1. Way Forward for Kenya

First and foremost, developing a clear strategy is paramount to ensure success for efforts in the Kenyan Blue Economy. A comprehensive understanding of how Blue Entrepreneurship advances the national agenda will act as a roadmap that outlines plans for when other players join the sector. The opportunity exists to build rapport and support the Blue Agenda by engaging with the government on current initiatives, like the Jumuiya ya Kaunti za Pwani (JKP) Jumuiya Innovation Labs,55 for example. Furthermore, strategic planning must acknowledge and balance the overarching considerations that will impact potential systemic changes for coastal communities; addressing community and gender dynamics, critically analysing incentive structures, developing good habits for ecosystem management, and investing in extensive measurement and knowledge-sharing is essential for all interventions. Finally, the strategy for any venture includes a thoughtful value proposition for participating in ecosystem conservation and rehabilitation. For any undertaking, it is critical to clearly demonstrate a link between investing in the ecosystem and household-level benefits like higher yields, better returns, or more income. Wealth from natural habitats can only be derived from healthy habitats.

This report outlines recommendations for the three selected value chains: seaweed farming, sea cucumber farming, and finfish farming. The following highlights recommendations for individual value chains as well as for the farmer program pilots, the suggestions for which are largely cross-cutting with some customization based on specific factors and value chain needs.

### Seaweed Farming

The following recommendations promote success within the seaweed farming value chain.

Critical for Kenya's competitiveness as a global seaweed exporter is a growth strategy aimed at maximizing scale. At present, Kenya is not a significant player in the WIO region's seaweed market, and investing in inclusive mechanisms that attract new farmers and encourage timely planting and harvesting, thereby drawing new exporter attention, is key to success.

### Proposed Strategic Levers

The research revealed three critical levers to support this vision for the sector:

A. Increase production to reach current export capacity
B. Draw new exporter entrants to the sector
C. Scale farming of higher-value species with new production methods

### A. Increase production to reach current export capacity

The current market chain relies on a solitary buyer and exporter of seaweed, who has recently (within the past 3 years) started building operations in Kenya. The exporter's stated current capacity is 300 tonnes per year, but present exports are only reaching 80 tonnes per year.90 There is a ready-market to absorb another ±4x current farm-level production.

At the most basic level, seaweed production hinges on planting as many ropes as possible during the spring-tide, waiting for those seedlings to develop, and harvesting at the appropriate maturity level, some 6 weeks later. Simply put, increasing farm-level production is a function of devoting time and effort to the tasks. Unfortunately, with dropping global prices, the value proposition for farmers is too low to encourage a diversion away from other daily activities and into maximum seaweed effort.

Even so, the current farmer base of 600 active seaweed farmers in Kilifi County would only need to produce 0.5 tonnes per year at each farm to reach current export capacity. This volume is well within reason, as evaluations from Zanzibar seaweed farms show "the average production per farmer would have been about 100 kg per month."173 Even closer to home, some Kilifi County farmers interviewed report they were able to achieve 1, 2, and even up to 3 tonnes per year per farm.

Increasing production to achieve current export capacity requires no new investment in farm setup or farmer-base expansion; instead, scale hinges on developing a value proposition that encourages farmers to do timely planting and harvesting. However, investing in covered drying facilities close to the farm areas would support production in a number of ways. First, farmers are constrained by the time and labor required to carry heavy loads for drying. Second, providing a covered space for drying saves labor time, as seaweed that comes into contact with rainwater must be re-processed (that is, taken back to the ocean to be submerged and revitalized in the salt water and then transported and dried again). Covered drying facilities in close proximity can improve efficiency by decreasing production time, as well as reduce post-harvest losses, or more specifically, post-harvest loss of farmer time and labor.

**Opportunity:**

- Develop business case for seaweed farmers to produce at maximum capacity
- Sensitize communities and expand production base to include additional farming locales
- Improve efficiency with covered drying facility to reduce labor and time required
- Mobilize technical assistance for ongoing farmer support and new farmer upstart

**Competitive Position:**

- Tanzania (specifically Zanzibar) is Kenya's biggest regional competitor, producing over 103,000 tonnes of seaweed in 201983
- With similar ecosystems and with an extra 100km of available coastline, Kenya has the capacity to develop its seaweed production volumes and be competitive in the WIO region

**Inclusivity:**

- As over 90% of current Kenyan seaweed farming is done by women, expansion opportunities stand to include even more female farmers in the sector
- Furthermore, opportunity exists to encourage household participation for value-add tasks (like carrying heavy loads and transportation)

**B. Draw new exporter entrants to the sector**

High production volume is the best way to flag Kenya as a viable market and encourage new exporter entrants. The influx of new market actors is expected to drive competition and provide farmers with more choice, stronger agency, and higher prices. Kenya has the opportunity to develop production volumes that draw new exporters to the sector. Presuming three is the optimal number of permanent exports, and using C-WEED's export capacity as an indicator, Kenya must increase current production over 11-fold.

Expanding the farmer network, potentially using outgrower models, is the most realistic source of this extra volume. For the exporter, asset investment (like an aggregation/storage facility and a commercial-grade baler) is required, in addition to operating costs (like transportation and labor). However, from the perspective of investing in new-farm setup, it is estimated that a seaweed plot operating at even moderate productive capacity (300kg for 6 weeks) could earn enough revenue to pay for initial farm upstart after only one cycle. This value proposition can encourage additional exporter entrants to support farm setup and expansion efforts.

**Opportunity:**

- Develop business case for seaweed exporters to enter the Kenyan market
- Sensitize communities and expand production base to include additional farming locales
- Mobilize technical assistance for new farmer upstart

**Competitive Position:**

- An uptick in post-pandemic global price will unlock better margins for incoming exporters coming into Kenya
- As the Kenyan national and coastal governments are prioritizing seaweed as a sector, enabling environments for foreign investment are expected to be favorable

**Inclusivity:**

- Expanding competition among seaweed purchasers is expected to elevate farmgate price, enabling more Kenyan farmers to join

**C. Scale farming of higher-value species with new production methods**

The Spinosum (Eucheuma denticulatum) seaweed currently being exported from Kenya is a durable species but with low prices. The Cottonii (Kappaphycus alverezii) species yields a value 3x that of Spinosum, but because of its sensitivity to weather shocks (in particular, higher ocean temperatures and resulting ice-ice disease), Cottonii is much less suitable for near-shore cultivation. Successful farming of this species occurs on lines attached to anchors further offshore, where temperatures are more stable. Investment in alternative farming methods will not only unlock potential for farmers to diversify species grown, but the expansion to deeper waters can increase productive farming areas for currently-farmed species as well. While these systems demand higher upfront investments (like cement anchors and canoes for transport to farms), farmers stand to benefit from less-labor intensive farming methods and dramatically higher profits.

**Opportunity:**

- Incorporating additional high-value species stands to earn farmers 3x the current value with the same yields
- Offshore farming is less prone to negative effects of rising ocean temperatures

**Competitive Position:**

- Mastering deeper-ocean seaweed cultivation (which has historically been challenging for both Kenya and neighbor Zanzibar), has the potential to unlock access to a much larger seaweed market, as the "Eucheuma spp." (which includes Cottonii) category represents 29%83 of global production

**Inclusivity:**

- Even though the offshore Cottonii farms are currently mostly cultivated by men, all female seaweed farmers interviewed (including the female president of a seaweed growing association) are highly motivated to start cultivating this species, pending investment needed to kickstart the offshore farm
- Female inclusion requires sea-safety training and boat-operator training, or these services could be provided by men in the community

*Table 6: Seaweed Farming Recommendations*

| Constraint Category | Activity Category | Description | Market Actors to Engage | Time Horizon* |
|---|---|---|---|---|
| Supply Side | New entrant catalyzation | Implement community sensitization to uptake seaweed farming | New seaweed farmers<br>Village leadership | ST |
| | | Expand farmer training (see below Farmer Program Pilot) | New seaweed farmers | ST |
| | Farmer technical/ commercial capacity | Connect new farmers with current 'star farmer' mentors | New seaweed farmers<br>Seaweed farmers | ST |
| | | Integrate climate-resilience solutions into existing training | Seaweed farmers<br>Research institutions | MT |
| | | Implement training for farming models for higher-value varieties already in Kenya (cottonii) | Seaweed farmers<br>Research institutions<br>Regional exporters | LT |
| | Access to capital and assets | Connect farmers to permanent market actors who can fund asset provision and infrastructure development (farming equipment, drying stations) | Seaweed farmers<br>Regional exporters<br>Local businesses<br>Local government | ST |
| | | Engage financial institutions to develop products that align with farmer needs, then connect farmers (savings, loans) | Seaweed farmers<br>Financial institutions | ST |
| Demand Side | Farmer access to markets | After production increases sufficiently, connect farmers to additional exporters | Seaweed farmers<br>Regional exporters | MT |
| | Market development | Explore feasibility and market potential of alternative uses for seaweed (human consumption,[165] animal feed,[166] fertilizer, packaging) and value-add products (soap, cosmetics) | Local businesses<br>National businesses<br>Regional exporters | MT |

| | | | | |
|---|---|---|---|---|
| | | Pilot value-addition / service-provision programs (drying, packing, storage, transport) | Seaweed farmers<br>Youth groups<br>Village leadership | MT |
| Enabling Environment | Policy | Support regulation to reduce farmer-fisher conflict | Seaweed farmers<br>Local fishers<br>Local government | ST |
| | | Support regulation to secure sea-use access rights | Seaweed farmers<br>Local government | MT |
| | | Support environmental regulation (monitoring, quotas, resource mgmt) | Seaweed farmers<br>Local government | LT |
| | R&D efforts & coordination | Fund research for feasibility of integrated farming systems | Regional businesses<br>Research institutions | MT |
| | | Fund research for alternative farming methods[167,168] | Local government<br>Research institutions | MT |
| | | Fund research for farming models for higher-value varieties already in Kenya (cottonii) | Research institutions<br>Regional exporters | MT |
| | | Fund research for feasibility of more-resilient, higher-value seaweed species to introduce | Research institutions | LT |
| | | Fund research for feasibility of domestic processing | Regional exporters<br>National businesses<br>Research institutions | LT |
| | Community engagement | Continue engaging diversified groups in farming seaweed (include women, youth, men) | Seaweed farmers<br>Village leadership<br>Local government | ST |
| | | Sensitize households for joint engagement: female income generation & male value-add | Local households<br>Village leadership<br>Local government | ST |
| | | Fund research for evaluating yields of various farming model options (individual, community groups) | Seaweed farmers<br>Research institutions | MT |

*Note: ST = short term (0-1 years); MT = medium term (2-3 years); LT = long term (4+ years)

## Sea Cucumber Farming

The country's current sea cucumber value chain relies on dangerous wild-capture of dwindling stocks. Spearheading inclusive sea cucumber farming models in Kenya will be groundbreaking for the sector. While other countries in the WIO region have already proven the business case for this high-value export product, Kenya's success in the sector hinges on a tiered plan for intensive investment.

## Proposed Strategic Levers

The research revealed three critical levers to support this vision for the sector:

A. Pilot inclusive farming model to generate proof-of-concept for both local-government and farmer engagement
B. Invest in scaleable hatchery model for sea cucumber juveniles
C. Develop processing and aggregation services at the farmer level to draw more of the market value to the smallholder

**A. Pilot inclusive farming model to generate proof-of-concept for both local-government and farmer engagement**

As a first step in developing the sea cucumber farming value chain, potential market actors must be convinced of the value and the potential success. Therefore, the entry point of the sector is piloting a sea cucumber farming model that works. Upstart investment to the pilot is minimal, including only enclosure supplies and security staff payments. As no hatchery system exists in Kenya, a critical component to the farming pilot is the establishment of a sustainable model for short-term wild-capture of fingerlings. Left with no alternative, the pilot must rely on the ocean for seed resources, but this behavior must be thoughtful, sustainable, and with only a short-term view in mind. The goal of the pilot is not to exploit the limited wild sea cucumber stocks, but instead, the goal is to prove the business case that will spur private investment in hatchery systems.

**Opportunity:**

- Develop business case for sea cucumber farmers and local government, and by so doing, develop business case for hatchery investment
- Sensitize communities and pilot production model
- Mobilize technical assistance for new farmer upstart

**Competitive Position:**

- Kenya's coast already proves conducive to sea cucumber growth (as evidenced by historically-documented wild stocks)
- As a top producer in the WIO region, Madagascar represents the strongest competition in the sea cucumber market; however, with growing global demand and an unlimited export potential, it seems there is room for unencumbered growth without negative competitive impacts

**Inclusivity:**

- In other countries, sea cucumber production represents an inclusive opportunity (60-80% of farmers are female)
- Seaweed farmers often make the best sea cucumber farmers, as they already spend their time in the ocean, know the tides and the currents, are used to working with commercial partners, and are already aware of the value of these animals

**B. Invest in scaleable hatchery model for sea cucumber juveniles**

Access to fingerlings (that is, access to a close, operational hatchery) is essential for long-term success of a sea cucumber farming industry. Wild-capture fingerling collection is not sustainable in the long-run, so investment in inputs production will unlock sector transformation. Using the SEAFDEC132 model as an example, one community-based hatchery, at an investment cost of US$ 30,000 has the potential to generate 300,000 to 500,000 juveniles per year. Factoring in survival rates of sea cucumbers in enclosures, it can be estimated that a fully-functioning community farm (with access to a fully-functioning hatchery) could raise 100,000 to 150,000 exportable sea cucumbers in that year. At maximum production, and even at the conservative end of current farmgate prices for fresh sea cucumbers in Kenya, the facility could pay for itself within the first year of operation. Realistically, a community or a private investor could expect to recoup facility costs by Year 2 or 3 of the project. For every operating year after that, 2 cycles of revenues from sea cucumber sales would cover operating costs of the facility, and the remaining revenues (3 cycles) going toward enclosure upkeep, security, and farmer profit.

As fingerlings cannot be transported more than 100km to be transplanted, a minimum of 3 hatcheries are needed to cover Kenya's entire coastline.

**Opportunity:**

- Sensitize private sector investors and pilot hatchery model
- Mobilize technical assistance for hatchery upstart

**Competitive Position:**

- With ongoing government support of regional multi-species hatchery facilities, the enabling environment for foreign investment is expected to be favorable
- Based on the wealth of research and piloting done globally on sea cucumber hatchery specifications, Kenya can learn from these interventions and pilot ready-made models (of course with context-specific adjustments), drastically reducing time-to-market for sea cucumber juveniles

**Inclusivity:**

- While the hatchery model itself is not inherently inclusive, it enables inclusive farming opportunities
- While low-scale, introduction of a new facility would warrant local job-creation ranging from technical (marine hatchery experts) to inclusive / accessible (administration and cleaning)

### C. Develop processing and aggregation services at the farmer level to draw more of the market value to the smallholder

The current sea cucumber value chain skews dramatically in favor of the exporter, who retains the vast majority of the value. In unbalanced market systems like this one, there is great opportunity to develop value-addition services along the chain that bring more of the wealth to the smallholder. Fortunately, sea cucumber processing does not require capital-intensive investment, and the technical process is within reach, based on the capacity of local communities. Sea cucumber trader reports in Kilifi County show a staggering 3-5x boost in price when selling "more processed" sea cucumbers as opposed to "semi-processed" ones. Investment in technical training and necessary inputs would ensure that community-level processing meets export standards and garners maximum value. Communities would also require aggregation service centers with exceptional security, as the high-value items are prone to theft.

Reasonable goals within a five-year plan for the sector could include proving the production model, paired with processing and aggregation services that immediately capture more value for the smallholder. Longer-term opportunities exist, after reaching appropriate scale, as offering export-ready products opens the door for direct market links between farmers and end consumers.

**Opportunity:**

- Invest in processing equipment and facilities, along with farmer training, to ensure quality is met to maintain favorable pricing
- Shorten the supply chain and retain more value at the smallholder level

**Competitive Position:**

- Increasing proportion of value-add services at the farmer level would put smallholders in competition with local traders and possibly regional exporters
- Leveraging the farming model will drastically increase production, giving farmers a healthy volume of final product with which to negotiate, as compared to wild-catch sea cucumber fisheries

**Inclusivity:**

- Processing activities at the export facility are already done by women, proving the potential for an inclusive model (for women and youth) at the community level
- However, as the financial control of high-value jobs or products tends to be dominated by men, caution must be taken to ensure that value-add activities do not add to women's workload without providing appropriate benefit

Table 7: Sea Cucumber Farming Recommendations

| Constraint Category | Activity Category | Description | Market Actors to Engage | Time Horizon |
|---|---|---|---|---|
| Supply Side | New entrant catalyzation | Implement community sensitization to uptake sea cucumber farming | New sea cucumber farmers<br>Village leadership | ST |
| | | Implement local government sensitization to allocate enclosure space | Local government | ST |
| | | Pilot farmer training program<br>(see below Farmer Program Pilot) | New sea cucumber farmers | ST |
| | | Engage permanent market actors to invest in private sector hatchery[169] | Regional businesses | LT |
| | | Fund and deploy replicable community-based hatchery[130,131] | County Government<br>Regional businesses<br>Research institutions | LT |
| | Farmer technical/ commercial capacity | Fund research for sustainable community wild-capture seed model | Sea cucumber farmers<br>Regional businesses<br>Research institutions | ST |
| | | Implement 'best practices' training for optimal yields | Sea cucumber farmers<br>Exporters<br>Local Extension Officer | ST |
| | | Integrate climate-resilience solutions into existing training | Sea cucumber farmers<br>Research institutions | MT |
| | Access to capital and assets | Connect farmers to permanent market actors who can fund asset provision, enclosure development, and hatchery facilities | Sea cucumber farmers<br>Regional exporters<br>Local government | ST |
| | | Engage financial institutions to develop products that align with farmer needs, then connect farmers<br>(savings, loans) | Sea cucumber farmers<br>Financial institutions | ST |
| Demand Side | Farmer access to markets | Implement community-level aggregation models | Sea cucumber farmers<br>Sea cucumber traders | ST |
| | | Implement processing training to boost value-add service | Sea cucumber farmers | MT |
| | Market development | Explore feasibility and demand potential of additional markets beyond Asia | Regional exporters<br>National businesses | LT |
| Enabling Environment | Policy | Support regulation to secure sea-use access rights | Sea cucumber farmers<br>Local government | MT |
| | | Support environmental regulation<br>(monitoring, quotas, resource mgmt) | Sea cucumber farmers<br>Local government | LT |

| | | | | |
|---|---|---|---|---|
| | R&D efforts & coordination | Fund research for environmental impact assessment of farming | Research institutions<br>Local government | ST |
| | | Fund research for feasibility of integrated farming systems | Regional businesses<br>Research institutions | MT |
| | | Fund research for feasibility of higher-value species to introduce | Research institutions | LT |
| | Community engagement | Mobilize diversified groups in farming sea cucumber (include women, youth, men) | Seaweed farmers<br>Village leadership<br>Local government | ST |
| | | Sensitize households for joint engagement: female income generation & male value-add | Local households<br>Village leadership<br>Local government | ST |

*Note: ST = short term (0-1 years); MT = medium term (2-3 years); LT = long term (4+ years)

**Finfish Cage Farming**

Fishing has historically been a main source of income and protein for coastal communities. The mass depletion of wild stocks is not only detrimental to the local biodiversity and ecosystem chains but also the average artisanal fisher on Kenya's coast struggles to catch enough.

As marine-based finfish farming gains traction across the Kenyan coastline, the following recommendations represent the forefront of sector innovation and offer nature-based solutions that combat the impacts of destructive fishing practices. Demand for local fish consumption is strong, so driving competitiveness and sustainability in this industry requires mobilizing communities and capital to uptake this new venture and generating proof of concept for private-sector hatchery investment. Long term sustainability requires investment in fingerling access (through hatcheries) and responsibly-sourced feed. Investing in finfish farming using cage structures in marine sites has the potential to disrupt the current value chain by increasing and controlling production, avoiding restrictive market relationships, and reducing pressure on local environments.

**Proposed Strategic Levers**

The research revealed three critical levers to support this vision for the sector:

A. Pilot and scale inclusive community-owned farming model to generate proof-of-concept for farmer-owner engagement
B. Invest in scaleable hatchery model for sufficient and sustainable access finfish fingerlings
C. Engage with partners (like government, NGOs, research institutions) to build an enabling environment that supports and protects the finfish cage farming industry as it comes to maturation

**A. Pilot and scale inclusive community-owned farming model to generate proof-of-concept for farmer-owner engagement**

The marine-based cage-farming industry is emerging, with KMFRI pilots proving the concept and refining the technical expectations for success. However, it is the investment from private-sector entrants taking up the idea that will drive this value chain to scale. Potential systems include examples of Lake Victoria aquaculture models, whereby groups of farmer-owners pool resources (or access group credit) to invest in construction, stocking, and human resource costs. While keeping small roles (like feeding, records support, or post-harvest processing), the group-ownership model necessitates payment for a site manager, a technical expert charged with rearing the fish to market size, as well as security to keep the stock safe. By designating the responsibility to paid employees, the business model eliminates the 'tragedy of the commons' effect of group ownership without designated accountability.

While government pilot facilities have garnered input costs upward of 600,000 KES for construction, it is estimated that locally-sourced and locally-negotiated construction could be much less expensive. Even with relatively conservative estimates, a cage farm operating at half capacity could repay construction costs after 3 cycles; in a best-case scenario, the facility would be paid off in the first cycle of production.

Some Lake Victoria cage models have achieved production levels nearly triple that found in the KMFRI pilots. As finfish mariculture develops, leveraging best practices from inland systems is likely to increase productivity of cage systems in the ocean.

The Kenyan coast is home to nearly 200 landing sites, the entry points for all marine catches, including mariculture production. Even in a future scenario with 5 cages for each landing site operating at full capacity, fish production would only abate little more than 1% of the annual Kenyan fish deficit. Production potential is then limited by scale (sustainably increasing the number of cages stationed in the ocean), access to inputs (fingerlings from a hatchery), and down-stream market constraints (like cold chain and transportation, as the local coastal market is not expected to absorb large-scale increases in production).

**Opportunity:**

- Develop business case for farmer-owners, and by so doing, develop business case for hatchery investment
- Sensitize communities and pilot production model
- Mobilize technical assistance for new farmer upstart

**Competitive Position:**

- Artisanal fishers reliant on wild-capture methods are the main competition among fish destined for local coastal markets
- While farming comes with the burden of facility investment and ongoing costs for inputs and operation, the advantages include: guaranteed production, control over harvest, and ability to operate in poor-weather seasons when prices are higher

**Inclusivity:**

- The deep-sea nature of the cage structure can be prohibitive for female inclusion, as can the capital requirement for investing in the group model
- Interventions should identify drivers of female participation (±25%) among Lake Victoria group-ownership models

**B. Invest in scaleable hatchery model for sufficient and sustainable access finfish fingerlings**

Current cage systems rely on wild-caught fingerlings as seed for production. From both ecological and supply perspectives, this inputs-system is unsustainable. Critical for long-term success of finfish mariculture is sufficient access to fingerlings. Proving the production model's capacity for scale is the first step to unlocking interest and private-sector investment in hatchery operations. From there, technical expertise and upstart capital are required. In Kwale County, KMFRI is investing in a multi-species hatchery facility to act as a pilot, reducing the burden and proving the hatchery model for sector uptake.

**Opportunity:**

- Sensitize private sector investors and pilot hatchery model
- Mobilize technical assistance for hatchery upstart

**Competitive Position:**

- With ongoing government support of regional multi-species hatchery facilities, the enabling environment for investment is expected to be favorable
- Hatcheries have the opportunity to lean on extensive research and development already done by KMFRI, drastically reducing time-to-market for local species fingerlings

**Inclusivity:**

- While the hatchery model itself is not inherently inclusive, it enables inclusive farming opportunities
- While low-scale, introduction of a new facility would warrant local job-creation ranging from technical (marine hatchery experts) to inclusive / accessible (administration and cleaning)

**C. Engage with partners (like government, NGOs, research institutions) to build an enabling environment that supports and protects the finfish cage farming industry as it comes to maturation**

The marine fishing industry is already well-established across coastal Kenya; local communities have depended on wild-capture fishing as a source of food security for hundreds of years. While certainly with some costs and risks, these fishing practices, and the associated market structures, are relatively low-cost and deeply entrenched. Marine-based cage farming faces a significant challenge of being competitive in an established market with established norms, especially as there is no price differential at market for farmed fish over wild-caught fish.

However, there simply are not enough fish left in the wild, and artisanal fishing cannot continue as-is. Without a shift toward innovative practices, local coastal fishing will suffer as supply dwindles, competition from imports increases, and actual fishing activities become more dangerous. New practices that increase sustainable production (like cage farming) are needed, as the strain on the environment (from depleted wild stocks and from unstable ecosystems causing a loss of biodiversity) puts the entire underwater food chain at risk. The Kenyan coast has an opportunity to develop broad-reaching incentives, support structures, and new technologies that align with both economic and environmental goals: more availability of sustainability-sourced fish for local consumption.

**Opportunity:**

- Engage with invested market actors who have authority to develop the enabling environment
- Encourage policies and regulation that support responsible rearing and harvesting of fish, including fingerlings and feed systems
- Support research and development of critical technologies and investments (like hatchery specifications and sustainable, highly-nutritious sources of feed), and support market actors as they make new technologies broadly available to finfish cage farmers
- Support integration of a Market Systems Development (MSD/M4P) approach, which would work on understanding and intervening in the market system to address the underlying causes of market dysfunction, all aimed at reducing poverty and creating large-scale, lasting benefits for coastal communities

**Competitive Position:**

- Current investment in KMFRI trials of marine-based cage farming display government interest, and stakeholder interviews indicate a willingness to partner (as the government is not a commercial entity) to reach scale
- Designing policy and regulation for a new industry can set the stage for sustainable practices and inclusive markets from the onset

**Inclusivity:**

- Opportunity exists to bring the enabling environment conversation to a variety of different stakeholders, each with their own expertise and inclusivity agenda
- Involvement of carefully-selected partners can ensure that special attention is paid to inclusivity (women, youth, people with disabilities) for any regulations or policy implementation

*Table 8: Finfish Cage Farming Recommendations*

| Constraint Category | Activity Category | Description | Market Actors to Engage | Time Horizon* |
|---|---|---|---|---|
| Supply Side | New entrant catalyzation | Implement community sensitization to uptake fish farming | New fish farmers<br>Village leadership | ST |
| | | Pilot farmer training program<br>(see below Farmer Program Pilot) | New fish farmers | ST |
| | Farmer technical/ commercial capacity | Implement 'best practices' training for optimal yields | Fish farmers<br>Buyers<br>Local Extension Officer | ST |
| | | Fund research for sustainable community wild-capture seed model | Sea cucumber farmers<br>Regional businesses<br>Research institutions | ST |
| | | Integrate climate-resilience solutions into existing training | Fish farmers<br>Research institutions | MT |
| | Access to capital and assets | Connect farmers to permanent market actors who can fund asset provision and infrastructure development for fish farming outgrower model | Local businesses<br>Local government | ST |
| | | Engage financial institutions to develop products that align with farmer needs, then connect farmers<br>(savings, loans) | Fish farmers<br>Financial institutions | ST |
| | | Connect farmers to government hatchery | Fish farmers<br>County Government | LT |
| | | Engage permanent market actors to invest in private sector hatchery | Regional businesses | LT |

| | | | | |
|---|---|---|---|---|
| Demand Side | Farmer access to markets | Connect farmers to direct market consumers (restaurants, hotels) | Fish farmers<br>Local businesses | ST |
| Demand Side | Farmer access to markets | Implement harvest-planning and negotiation training | Fish farmers<br>Buyers | ST |
| Demand Side | Farmer access to markets | Connect farmers to transportation / cold storage providers | Fish farmers<br>Local transporters<br>Service providers | ST |
| Demand Side | Farmer access to markets | Develop sustainably-sourced marketing for high end buyers (restaurants, hotels) | Fish farmers<br>Local businesses | ST |
| Demand Side | Farmer access to markets | Implement community-level aggregation models | Fish farmers<br>Fish traders | ST |
| Demand Side | Farmer access to markets | Implement processing training to boost value-add service | Fish farmers | MT |
| Demand Side | Market development | Pilot value-addition / service-provision programs (storage, transport) | Fish farmers<br>Youth groups<br>Village leadership | MT |
| Demand Side | Market development | Fund research for feasibility and market potential of value-add products (preserved, processed fish) | Local businesses<br>National businesses | MT |
| Demand Side | Market development | Fund research for feasibility and market potential of alternative income sources (community restaurant,[170] post-dining eco-tours) | Local businesses<br>National businesses<br>Tourism board | MT |
| Demand Side | Market development | Fund research for feasibility and market potential of repurposing fish waste (meal powder,[93] fish leather[171]) | Local businesses<br>National businesses<br>Research institutions | MT |
| Enabling Environment | Policy | Identify and connect carefully-selected partners to develop enabling environment | Local government<br>NGOs<br>Research institutions | MT |
| Enabling Environment | Policy | Support regulation to secure sea-use access rights | Fish farmers<br>Local government | MT |
| Enabling Environment | Policy | Support environmental regulation (monitoring, quotas, resource mgmt) | Fish farmers<br>Local government | LT |
| Enabling Environment | R&D efforts & coordination | Fund research for environmental impact assessment of farming | Research institutions<br>Local government | ST |
| Enabling Environment | R&D efforts & coordination | Explore feasibility of inexpensive locally-available construction alternatives | Local construction<br>Local businesses<br>Research institutions | ST |

| | | | | |
|---|---|---|---|---|
| | | Fund research for feasibility of more-resilient, higher-value fish species | Research institutions | MT |
| | | Fund research for feasibility of alternative feeding systems that optimize nutrition/growth | Research institutions | MT |
| | | Fund research for feasibility of integrated farming systems | Regional businesses<br>Research institutions | LT |
| | Community engagement | Train women and youth in swimming and deep sea safety | New fish farmers<br>Village leadership<br>Local government | ST |
| | | Mobilize diversified groups in farming sea cucumber (include women, youth, men) | Seaweed farmers<br>Village leadership<br>Local government | ST |
| | | Sensitize households for joint engagement: female income generation & male value-add | Local households<br>Village leadership<br>Local government | ST |

*Note: ST = short term (0-1 years); MT = medium term (2-3 years); LT = long term (4+ years)

**Farmer Program Pilot**

Successful engagement with each of the selected value chains hinges on expansion of the farmer base through support, mobilization, government coordination, and technical instruction emerges as a critical component to scaling the impact.

To begin, each of the value chains is primed to leverage other regional learnings and examples, customizing and deploying thoughtful versions on the Kenyan coast. As transplanting a model from outside the context (internationally or even within the Kenya landscape) holds inherent risk, sector participants can be prepared for the inevitable learning curve by ensuring programs have excellent monitoring and feedback mechanisms to make necessary adjustments along the way. Important examples for pilot program inspiration include:

**Seaweed:**

- Kwale County programs, learning from KMFRI, Pact Kenya
- Regional programs, learning seaweed farming initiatives in Zanzibar, Tanzania ,
- Sea Cucumber:
- Regional programs, learning from Blue Ventures in Madagascar ,106
- Finfish Farming:
- Kwale County programs, learning from KMFRI finfish mariculture pilot
- Kenya domestic programs, learning from freshwater finfish aquaculture157

All farmer pilot programs come with risks and challenges. It is wise to be prepared for upstart issues (like long upstart time and high upstart costs, particularly for the sea cucumber and finfish farming ventures), as well as mobilization issues (like farmer motivation) and entrepreneurship issues (like farmer professionalization and business mindset).106, Farmer pilot programs also face implementation challenges, particularly around comprehensive technical expertise (like mariculture best practices, growing conditions, site selection, and training) as well as inputs supply and knowledge (like seed, particularly for the sea cucumber and finfish farming ventures).

From a governance standpoint, present challenges include access (like sea-use rights), regulation (like over- or under-regulation by the national and county governments), community involvement (like local governance challenges), and security (both for high-value items like sea cucumber and finfish and for easily-damaged farm plots like seaweed). Unpredictable market dynamics threaten any farmer pilot program, and each of the selected value chains faces unique challenges. For example, the seaweed value chain is at risk for a potential price drop due to the influx of supply, generated as many tourism-based economies have focused on farming during the COVID-19 pandemic. ,89

Sea cucumber is a high-value item, so market dynamics are affected by poaching and side-selling. Meanwhile, the domestic finfish markets in Kenya are dominated by traders, so the livelihoods impacts for fishing and fish-farming households is constrained. Finally, climate change poses an ongoing risk to all selected value chains, as rising sea levels, ocean warming, and acidification will continue to alter coastal ecosystems, threatening the long-term stability of investment.

To combat these and other challenges, TechnoServe leans on its extensive experience working with a variety of farmers, stakeholders, and value chain market actors. As such, we recommend the following guidance for embarking on farmer pilot programs:

**Begin with sector and community engagement:** Initiate farmer pilot program efforts by building relationships and engaging key stakeholders (like government, community, and private-sector sector partners) to build rapport and gain trust, support, and contextual understanding. Successful interventions will build on existing momentum and enthusiasm as they plan interventions, timing, and support structures that optimize outcomes. In particular, engage government initiatives (like seaweed infrastructure and storage facility construction, sea cucumber research and hatchery planning, and finfish research, hatchery facilities, and infrastructure), both supporting and integrating these efforts for long-term sector-wide success.

**Do thorough Kenya coastline mapping to ensure proper site selection:** When identifying priority geographies across the Kenya coastline for farmer pilot programs, explore:

**Space and access factors:** Investigate any existing Locally Managed Marine Areas (LMMAs) or Marine Protected Areas (MPAs), and assess any potential to leverage these zones and their sea-use access rights. Identify existing governance structures and gaps. Determine if the area is accessible by foot during the spring-tide (particularly important for seaweed and sea cucumber farming).

**Social factors:** Prioritize communities that are primed to engage in alternative livelihoods activities. For example, mobilization potential increases if communities are already equipped with mindset and skills of performing non-traditional farming exercises (like collecting octopus). Additionally, build on momentum that exists if communities already demonstrate ecosystem management practices (for example, protection zones or timed fishing closures). Furthermore, selected value chains (like seaweed and sea cucumber) that are expected to target and engage female beneficiaries are more likely to succeed in geographies that are enthusiastic about household-level or collective farming and/or areas that demonstrate support for entrepreneurial and financially-independent women. Finally, a farmer pilot program for fish farming is likely to have better social motivation in areas where wild-catch success is dwindling or limited, as these areas are more likely to accept the required investment of energy and money in order to develop innovative solutions to local fishing challenges.

**Ecosystem factors:** Identify priority geographies whose ecosystems are conducive to program requirements. The mapping phase also includes an investigation of predominant weather patterns and key environmental issues, enabling smart investment in weather-resistant construction. Ecosystem requirements are specific for each of the selected value chains and include the following:

**Seaweed:** Villages in Kwale county that are already showing success with seaweed farming indicate that seaweed crops grow best in intertidal zones that are protected from high-energy wave activity and boast relatively regulated water temperatures. Areas with seagrass meadows are often conducive to seaweed farming.

**Sea Cucumber:** 106,115 Successful sea cucumber farming sites in Madagascar meet the following specifications: 1) ±60% coverage by seagrass 2) 15+ centimeters of fine sediment 3) high salinity (no freshwater input) 4) constant water coverage, even during low tide 5) relatively regulated water temperatures 6) protection from high-energy waves and natural predators. Note: capitalizing on ideal ecosystem overlaps, Blue Ventures scaling programs have successfully paired sea cucumber farming pens (closer to shore) side-by-side with seaweed farms (farther out to sea).

**Finfish Farming:-** 155 Current and future cage farming efforts in Kenya are most likely to succeed in ecosystems with relatively regulated water temperatures, protection from rough waves, sufficient current and waterflow to wash the chambers, and suitable ocean depth (±5m during low tide, ±13m during high tide).

**Solidify finance and planning to secure inputs during the program setup phase:** Ensuring sufficient funding for program setup is critical, as long-term community-level sustainability depends on proof of concept and noteworthy revenues. Programs that benefit from ample startup investment enable success and stability for ongoing business activities that are not dependent on ongoing intervention.

**Secure comprehensive technical expertise:** Engage top-quality technicians and industry experts with sufficient local context when choosing innovations and designing curricula. Identify actors who have exhaustive knowledge of construction, farming activities, and growing requirements (like bio-health, animal or plant monitoring, environmental callouts, and technical risk reduction). Then, engage stakeholders who can most effectively convey this knowledge and train local communities in best practices. For example, the Kenyan government has proven experience training farmers in seaweed (with the help of local and international NGOs) and finfish farming practices. Meanwhile, Blue Ventures has prepared a transferable toolkit of resources174 for interested parties, and the organization has even availed itself to run comprehensive trainings that outlined sea cucumber deployment in Zanzibar, Tanzania.

**Facilitate proper governance:** Critical to the success of any farmer pilot program is a robust governance structure. At the local level, it is wise to engage communities with setting up and maintaining governance structures, making locally-informed resource management a collective and responsive effort. Resource management strategies might include no-take zones or no-take periods, and community involvement will address potential conflicts with sea-use and marine resources (particularly important for conflicts between seaweed farms and destructive fishing boats). Other programs have found success by entrenching environmental regulations and ecosystem management support into farmer lease agreements,106 for example, including a mandatory collective fund from farmers to pay back into the LMMA / MPA where they are operating. Additional benefits can be found in supporting government and local entities as policies and regulations (like monitoring, population and stock measurement, and market restrictions) are being crafted for emerging sectors.

**Select beneficiaries:** While carefully sensitizing communities and thoughtfully selecting beneficiaries for the farmer pilot programs, sector actors can lean on TechnoServe's 3-pronged approach for female engagement. Ensuring selection is inclusive and representative of all local people and people groups enables buy-in and long-term project success. Some models recommend clan or tribal mapping, then selection quotas are distributed among local leaders for assessment and final decisions.115

**Consider ecosystem impacts:** According to IUCN objectives, a farmer pilot program will not be successful if it does not improve the natural environment. Therefore, any project upstart must carefully assess and monitor proposed interventions and their potential impacts within the selected ecosystems. For example, an increase in the presence of seaweed from farming initiatives might disrupt the amount of UV light that reaches the ocean floor. Additionally, farming practices have potential to disrupt naturally-occuring seagrass meadows, and loose seaweed can negatively impact coral health. Structures like finfish cages are bound to affect the environments in which they are placed, so it behooves sector actors to examine ecosystem impacts (like UV light and current flow) along with protection measures that might be required. Of course, some ecosystem impacts will, by design, be positive. For instance, providing an undisturbed habitat through seaweed farming has been shown to increase fish populations. This effect in itself must be monitored as changes in animal populations might impact or motivate different community behaviors; all opportunities and incentives must be carefully monitored and addressed.

Similarly, providing farmed solutions as alternatives to sea cucumber and finfish wild catch give the ecosystems an opportunity to rest and regenerate. However, as species repopulate, these habitats will likely see increased fishing and dangerous diving activities. Communities might consider regenerative options (like introducing a 'throwback' percentage, where a portion of each harvest is given to the wild for environmental rehabilitation).

Work with **permanent market actors:** Engaging key market stakeholders (like traders, processors, and exporters) enables early-stage buy-in and support that can not only maintain energy in the value chain beyond donor funding windows but also distribute benefits across communities. Specifically, current seaweed farming assets (like ropes and boots) are donor-sponsored, and farmers have yet to understand useful life and associated costs. Without market engagement of suppliers and distributors, the projects cannot be assured of farmer financial stability and sustainable livelihoods benefits. Additionally, engaging an array of permanent market actors in the finfish value chain can develop a value proposition that redistributes agency and control away from traders and back to smallholders.

Develop **comprehensive monitoring and measurement systems** during the trial periods, and make data-driven adjustments: Driving sustainable growth for the Blue Entrepreneurship sector requires diligent measurement and mindful adaptation, and it is advantageous to set up innovative, thoughtful models that can be scaled. Not only will monitoring and responsiveness streamline farmer-level tasks for efficiency and cost-effectiveness, but careful data collection and systems tracking will embolden communities to track and preserve their blue natural capital resources. Market actors have a responsibility to design and implement programs carefully, so as to instill good environmental habits across the country and across the region.

Support farmers with **household financial training** and **access to financial products** that will help keep their newfound income safe and secure while feeding into discussed, planned family investments and well-being.

## 7.2. Further Recommendations

Kenya is in a unique position to drive true innovation across the Blue Economy. By addressing Blue Entrepreneurship with innovation and ground-breaking problem-solving, Kenyan coastal communities will benefit from more cost-effective designs, systems that produce maximum output, and contributions to global learnings. In addition to scaling up existing enterprises and making them more inclusive, it is imperative to generate and incubate new industry ideas and pair them with teams that have industry expertise at various stages of concept and launch along with access to appropriate investment vehicles.

**Integrated Multi-Trophic Aquaculture (IMTA)**

An intriguing concept, and one such innovation, might be research into and deployment of marine-based integrated multi-trophic aquaculture (IMTA) systems. These systems involve farming carefully-selected, mutually-beneficial plants and animals in close proximity in order to "take advantage of synergistic interactions among species" and use a diverse poly-culture approach to restore and conserve coastal ecosystems. With careful site-selection and technical understanding of species interactions, market actors can pioneer models that promote coastal livelihoods and benefit marine ecosystems through harmonious layers of nature-based solutions.

**Entrepreneurship Training**

In parallel to value-chain-specific initiatives, supporting other local activities alongside the identified ventures is critical. Opportunity exists to enhance communities and all Blue Entrepreneurship efforts by providing cross-cutting general business training for coastal industries. Providing financial literacy, savings and investment, governance, and management training not only boosts the efficiency of the Blue Economy as a whole, but it helps protect communities and programs from specific risks across seaweed, sea cucumber, and finfish farming value chains.

Similarly, this type of support benefits coastal communities as they adapt and re-emerge from COVID-19 tourism shutdowns. Spearheading a mindful approach that focuses on environmental and livelihoods resilience will influence Kenya's tourism sector strategy in a way that builds the industry back better than it was before.

**IUCN Global Standard for Nature-based Solutions**

To supplement monitoring, evaluation, and learning (MEL) efforts associated with all pilot interventions, all initiatives, actions, and measurements should utilize the IUCN Global Standard for Nature-based Solutions16 before, during, and after execution. The Standard enlists eight criteria to provide "clear parameters for defining NbS and a common framework to help benchmark progress." Ensuring all efforts align with a recognized standard of care will avoid unintentional harm to ecosystems while also building systems that have potential for meaningful impact at scale.

## 7.3. Conclusions

This scoping study explored an array of functions and sub-functions with the Blue Economy in Kenya and identified three key value chains for priority engagement: seaweed farming, sea cucumber farming, and finfish farming. This report details dynamics of each value chain and mechanisms for engaging at the community livelihood level, bridging the gap and promoting Kenya's Blue Entrepreneurship sector. Included recommendations provide a strategic outline to develop the Blue Economy across Kenya and the Western Indian Ocean region by mobilizing investments that promote entrepreneurship, foregrounding strategies to scale positive environmental impacts and enhance ocean biodiversity, and building on existing momentum that benefits people, the ocean, and the climate.

# APPENDIX

## Appendix 1: Stakeholder Interviews

The research team conducted stakeholder interviews with the following industry experts, representing local communities, government agencies, NGOs, and others. Their insights and contributions are integral to the success of this research. Participants include:

*Table 9: List of Interviewees*

| Interviewee | Role | * |
|---|---|---|
| **Kenya Government** | | |
| Gilbert Atuga | Research Scientist, Oceanography and Hydrography[179]<br>Kenya Marine and Fisheries Research Institute (KMFRI) | SI |
| Martin Kiogora | Fisheries Director - Kwale County | SI |
| Dr. David Mirera | Assistant Director in charge of Mariculture Research and Development[180]<br>Kenya Marine and Fisheries Research Institute (KMFRI) | SI |
| Ali Mwanzei | Deputy Director Field Operations[181]<br>National Environment Management Authority (NEMA) | SI |
| Stephen Mwangi | Marine Scientist, Oceanography and Hydrography[182]<br>Kenya Marine and Fisheries Research Institute (KMFRI) | FG |
| Emmanuel Nzai<br><br>Dr. Flaura Kidere | CEO[183]<br>Jumuiya ya Kaunti za Pwani (JKP) Secretariat<br><br>Coordinator, Sustainability & Enterprise Development Expert<br>Jumuiya Innovation Labs | SI, FG<br><br>SI, FG |
| Dr. Betty Nyonje[184] | Member Technical Committee<br>High Level Panel for a Sustainable Ocean Economy<br>Executive Office of the President<br><br>Member of Blue Economy Secretariat<br>Executive Office of the President | SI |
| Judith Nyunja | Senior Research Scientist<br>Kenya Wildlife Service (KWS) | FG |
| Dan Odiwuor | Acting Principal Laboratory Technologist, finfish cage culture<br>Kenya Marine and Fisheries Research Institute (KMFRI) | SI |
| Francis Okalo | Programme Manager, Coastal and Ocean Resilience[185]<br>International Union for Conservation of Nature (IUCN)<br><br>formerly:<br>Research Associate, Seaweed Mariculture and Sustainable Aquaculture[186]<br>Kenya Marine and Fisheries Research Institute (KMFRI) | SI, FG |
| Dr. Melckzedeck Osore[187] | Research Scientist, Coastal and Marine Ecology and Taxonomy<br>Kenya Marine and Fisheries Research Institute (KMFRI)<br><br>Regional Research Coordinator<br>Western Indian Ocean Marine Science Association (WIOMSA) | FG |
| Dr. Jacqueline Uku | Research Coordinator[188]<br>Kenya Marine and Fisheries Research Institute (KMFRI)<br><br>President[189]<br>Western Indian Ocean Marine Science Association (WIOMSA) | SI |

| | | |
|---|---|---|
| **Non-Governmental Organizations (NGOs) & Non-Profit** | | |
| Des Bowden<br>John Dominic | CEO<br>Head of Policy<br>Oceans Alive Trust[190] | SI |
| Gurveena Ghataure | Marine Programme Manager, Kenya[191]<br>Fauna & Flora International (FFI) | SI |
| George Maina | Fisheries Strategies Manager, Africa Region<br>The Nature Conservancy (TNC) | SI |
| Tanguy Nicholas | Programme Manager (Marine), Africa<br>Fauna & Flora International (FFI) | SI |
| David Obura | Founding Director[192]<br>Coastal Oceans Research and Development – Indian Ocean (CORDIO) East Africa | SI |
| Hery Lova Razafimamonjiraibe | Livelihoods National Technical Advisor<br>Blue Ventures Madagascar | SI |
| **Institutions & Associations** | | |
| Evans Adiang | Trainer, Aquaculture & Fisheries<br>Ramogi Institute Of Advanced Technology (RIAT) | SI |
| Mercy Mghanga | Executive Director[193]<br>Coastal Women in Fisheries Entrepreneurship Association (CWiFE) | FG |
| Jason Rubens | Senior Fisheries Specialist[194]<br>The World Bank | SI |
| Dr. Arthur Tuda | Executive Secretary[195]<br>Western Indian Ocean Marine Science Association (WIOMSA) | SI |
| **Additional Stakeholders: Consultancy, Business Owner, International Contacts** | | |
| (Anonymous) | Exporter: sea cucumber (Shimoni) | SI |
| Jon P. Altamirano, Ph.D. | Associate Scientist, Aquaculture Department<br>Southeast Asian Fisheries Development Center (SEAFDEC) | SI |
| Jonathen Arul | Co-Founder & Director[196]<br>Indian Ocean Aquaculture Ltd | SI |
| Ali P. Athumani | Dealer: sea cucumber (Shimoni) | SI |
| Kerry Nasidai<br><br>Sharon Macharia | Project Leader<br>Open Capital Advisors[197]<br><br>Senior Analyst<br>Open Capital Advisors[198] | SI<br><br>SI |
| Victor Opondo | Country Representative, Kenya<br>C-WEED Corporation, LTD | SI |
| **Farmer Interviews: Field Research** | | |
| Kibuyuni seaweed farmers | Intentionally Anonymous<br>3 male; 2 female | SI |
| Nyumba Sita seaweed farmers | Intentionally Anonymous - focus group<br>4 male; 11 female | SI |

*Note:
- SI denotes Stakeholder Interview;
- FG denotes participation in the 18 Jan strategic Focus Group

# APPENDIX

## Appendix 2: Maritime functions and sub-functions

The following table was used as the framework or initial brainstorming of value chains and can be found in Figure 1. Overview of functions and maritime economic activities can be found on pp. 33-34 of the Blue Growth Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts - Final Report

*Figure 3: Blue Growth maritime functions and sub-functions*

**Table 2.1 Overview of functions and maritime economic activities**

| Function | Maritime economic activities | Short description |
|---|---|---|
| 1. Maritime transport and shipbuilding | 1.1 Deep sea shipping | International (freight) transport by sea with large vessels that often sail fixed routes (containers, major bulks) or tramp shipping. |
| | 1.2 Short-sea shipping (incl. RoRo) | National and international freight transport within Europe and to/from neighbouring countries with medium sized ships. The same segments are found as under deep sea shipping. |
| | 1.3 Passenger ferry services | Transporting passengers on fixed sea routes, national and international. Mainly intra-European. Sometimes this is combined with RoRo transport. |
| | 1.4 Inland waterway transport. | Freight transport on inland waterways in Europe, consisting of both fixed link services and tramp services. |
| 2. Food, nutrition, health and eco-system services | 2.1 Catching fish for human consumption | Extracting wild natural resources (i.e. fish, crustaceans, molluscs, algae, etc.) for human consumption. The final product is either raw or processed fish. |
| | 2.2 Catching fish for animal feeding | Extracting wild natural resources (essentially fish) for animal consumption. The final product is mainly fishmeal and fish oil, which can be used by agriculture and aquaculture. |
| | 2.3 Marine aquatic products | Farming of aquatic organisms, mainly for human consumption (mainly fish and molluscs) |
| | 2.4 Blue biotechnology | Using wild and farmed aquatic living resources as precursors of bio-molecules used for high value products (health, cosmetics, etc.). It is about unravelling the potential of the biodiversity of a specific earth compartment for the benefit of the rest of the economy. |
| | 2.5 Agriculture on saline soils | Development of agriculture on saline soils, through improving existing crops or adapting salt tolerant plants. |

| Function | Maritime economic activities | Short description |
|---|---|---|
| 3. Energy and raw materials | 3.1 Oil and gas | Extraction of liquid fossil fuels from offshore sources |
| | 3.2 Offshore wind | Construction of wind parks in marine waters, and exploitation of wind energy by generating electricity offshore |
| | 3.3 Ocean renewable energy | Offshore development and exploitation of a variety of renewable energy sources excluding wind, including wave energy, tidal energy, Ocean Thermal Energy Conversion, Blue energy (osmosis) and biomass. |
| | 3.4 Carbon capture and storage | Caption of CO2 at large emitters and ship these to empty offshore fields and other favourable geological formations for long term storage as a means to contribute to sustainability targets. |
| | 3.5 Aggregates mining (sand, gravel, etc.) | Extraction of marine aggregates (sands and gravels) from the seabed. |
| | 3.6 Marine minerals mining | Deep sea mining of raw materials other than aggregates., including critical materials which have a risk of supply shortage |
| | 3.7 Securing fresh water supply (desalination) | Desalination of sea water for fresh water usage (agriculture irrigation, consumer & commercial use) |
| 4. Leisure, working and living | 4.1 Coastal tourism | Shore based sea related tourist and recreational activities. |
| | 4.2 Yachting and marinas | Construction and servicing of seaworthy leisure boats and the required supporting infrastructure including marina ports. |
| | 4.3 Cruise tourism | Tourism based on people travelling by cruise ship, having the ship itself as their home base of holidays and making visits to places passed during the trip. |
| | 4.4 Working | Employment and economic activities taking place in coastal regions. |
| | 4.5 Living | Residential functions and associated services in coastal regions. |
| 5. Coastal protection | 5.1 Protection against flooding and erosion | Monitoring, maintaining and improving the protection of coastal regions against flooding and erosion. |
| | 5.2 Preventing salt water intrusion | Measures associated with coastal protection works aiming at the prevention of salt water intrusion as a measure to protect fresh water functions in coastal regions. |
| | 5.3 Protection of habitats | Measures associated with coastal protection works aiming at protecting natural habitats. |
| 6. Maritime monitoring and surveillance | 6.1 Traceability and security of goods supply chains | Equipment and services used for security purposes in the field of maritime transportation. |
| | 6.2 Prevent and protect against illegal movement of people and goods | Monitoring and surveillance of the EU coastal borders using a variety of services, technologies and dedicated equipment. |
| | 6.3 Environmental monitoring | Marine environmental monitoring is not a clear-cut function. It may cover water quality, temperature, pollution, fisheries etc. |

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Rue Mauverney 28
1196 Gland
Switzerland

+41 22 9990000
+41 22 9990002 (Fax)
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