South African Kelp Farming Project
(Phase 2 - Project number: 300708-201)

Funded through UK aid by the UK government.

Project Quarterly Report

	Quarter 1 (Apr – Jun 2023)
	Quarter 2 (Jul – Sept 2023)
√	**Quarter 3 (Oct – Dec 2023)**
	Quarter 4 (Jan - March 2024)

Compiled by: Dr Lizeth Botes

On behalf of:

Bivalve Shellfish Farmers Association of South Africa (BSASA)

Declaration of the Project Manager

I hereby declare as Project Manager (on behalf of BSASA) and as per FCDO Accountable Grant Arrangement with BSASA that (please encircle):

1. All FCDO funding has, to the best of my knowledge, been used on the project's deliverables and assets as outlined in the Grant Arrangement

(YES)/NO (If no, please provide explanation)

2. All assets bought with FCDO funding to date are, to the best of my knowledge, being recorded and can confirm that I have verified the assets, that they are in good working condition and being used for the purposes of the project.

(YES)/NO (If no, please provide explanation)

3. All progress of project deliverables are satisfactory and still within the FCDO Grant Arrangement time frames & budget, and that I have timeously reported on delays due to unforeseen circumstances.

(YES)/NO (If no, please provide explanation)

5. To the best of my knowledge, am not aware of suspicions or complaints of any incidences of sexual exploitation, abuse and sexual harassment (SEAH).

(Confirm)/Unable to confirm (If unable to confirm, please provide explanation)

31/01/2024

Project Manager

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Glossary of Terms

ADZ	Aquaculture Development Zone
AMC	Aquaculture Management Committee
BOM	Blue Ocean Mussels
BSASA	Bivalve Shellfish Farmers Association of South Africa
CTD data	Conductivity, Temperature and Depth data
DFFE	Department of Forestry, Fisheries and Environment
DSI	Department of Science and Innovation
EA	Environmental Authorisation
EMPr	Environmental Monitoring Programme
FCDO	Foreign, Commonwealth & Development Office
GeO_2	Germanium dioxide
MREx	**M**ussel **R**aft **c**loser to the **m**outh (going forward referred to as **MR2-cm**)
MRSh	**M**ussel **R**aft **f**urther away from the **m**outh (going forward referred to as **MR1-fm**)
LLEx	**L**ong-**l**ine **c**loser to the **m**outh (going forward referred to as **LL2-cm**)
LLSh	**L**ong-**l**ine **f**urther away from the **m**outh (going forward referred to as **LL1-fm**)
POC	Paternoster Oyster Company
PM	Project Manager
RAs	Research Assistants
RED	Research and Evidence Directorate within the FCDO
SA	South Africa
SABS	South African Bureau of Standards
SOP	Standard Operating Procedures
TOR	Terms of Reference
UCT	University of Cape Town
UK	United Kingdom

1. Introduction

The Government of the United Kingdom (UK) of Great Britain and Northern Ireland acting through the Research and Evidence Directorate (RED) at the Foreign, Commonwealth & Development Office (FCDO), deliver science and technology partnerships to maximise the UK's development impact internationally.

In 2021-2022 the FCDO commissioned the non-profit Bivalve Shellfish Farmers Association of South Africa (BSASA), in collaboration with the Department of Forestry, Fisheries and Environment (DFFE), to conduct a short three-month pre-feasibility study (Phase 1) to assess the potential for the commercial cultivation of African kelp along South Africa's West Coast. The final output report concluded/recommended that a Phase 2 Feasibility Study be conducted.

In 2022-2023, the FCDO commissioned BSASA to proceed to Phase 2 of the project with the Accountable Grant Agreement signed at the end of July 2022. Phase 2 only gained momentum toward the end of 2022 when two Research Assistants (RAs) and a Project Manager (PM) were appointed in late Nov 2022 as part of the implementation team. The Saldanha Bay Aquaculture Development Zone (ADZ) was identified as the study area for grow-out trials to be conducted in/on already existing industry infrastructure & structures. Phase 2 is planned to be conducted over a 30-month period and will focus on the following activities:

- Refining kelp hatchery/nursery technologies
- Testing and refining kelp grow-out technologies in Saldanha Bay
- Conducting food safety analyses to inform future food safety standards and certification
- Monitoring environmental parameters and assessing environmental benefits/risks as decision support for the DFFE's Environmental Management Programme (EMPr)
- Conduct stakeholder engagements to disseminate information and gain insights into the Kelp Value Chain and associated employment opportunities
- Investigate the financial feasibility of kelp farming in South Africa (SA)

The overall goal of the project is to disseminate information and research results available to a broad stakeholder base, including the existing kelp industry and new potential entrants in order to build a sustainable Kelp Aquaculture Industry in SA.

1.1 Phase 2: Year 1 (2022-2023):

While the project only gained momentum around November 2022, efforts to successfully establish the project by the FCDO's financial year end in March 2023 were ongoing. Progress during those months were captured in the 2022- 2023 Project Year-end Report.

1.2 Phase 2: Year 2 (2023-2024) Quarter 1 (Apr-Jun 2023):

Much of the 1st quarter (Q1) was spent on repositioning the project to accommodate a grow-out site change and accounting for assets, a change in the Project Implementation team, drafting and updating a Project Plan, considering the request from the RAs to use the data generated from their respective components toward MSc degrees and, implementing tasks that were planned for Q1 (progress of which were captured in the Phase 2: Yr2-Q1 report)

1.3 Phase 2: Year 2 (2023-2024) Quarter 2 (Jul-Sep 2023):

Similar to Q1, quarter two (Q2) focused on strengthening the project by furthering progress at the new grow-out site at Blue Ocean Mussels (BOM), setting up an industry-based hatchery at Paternoster Oyster Company (POC), restoring the kelp hatchery based at DFFE Sea Point Research Aquarium and implementing the tasks that were planned for Q2 (progress of which were captured in the Phase 2: Yr2-Q2 report).

1.4 Phase 2: Year 2 (2023-2024) Quarter 3 (Oct-Dec 2023):

With the project sites and project team now established (see Figure 1), the focus for quarter 3 (Q3) shifted toward:

- Refining kelp hatchery/nursery technologies
- Testing and refining kelp grow-out technologies in Saldanha Bay
- Conducting food safety and nutritional analyses to inform future food safety standards and certification
- Continuing to monitor the environmental parameters in Saldanha Bay
- Gaining insights into the Kelp Value Chain Analysis, Market Assessment and roadmap for the development of a kelp farming industry

1.5 Project team & Project Delivery Chain Map:

The project team's roles and responsibilities are briefly outlined below:

<u>The Project Sponsor/Funder representatives:</u>
Ms Leanne Jones (Team Leader, Southern Africa Research and Innovation Hub [SARIH], FCDO).
Ms Kristin Klose (FCDO Technical Advisor - Science, Technology and Innovation)
Mr Jaco Louw (FCDO Global Science Lead: Programmes and Finance)

<u>The Implementation team:</u>
Industry:
Mr V Pienaar (Chairperson of BSASA as lead implementation and host organisation, Imbaza Mussels)
Mr M Tarrant (BSASA Secretary & Boland Financial Services)

BSASA member representatives and project participants:
Mr S Visser (COO of Blue Ocean Mussels [BOM])
Mr T Maswanganye (Assistant Farm Manager at BOM)
Mr J Louw/M Smith (Manager at Paternoster Oyster Company [POC])
Ms I Meyer (Hatchery Manager at POC)

BSASA appointed:
Dr L Botes (Project Manager)
Ms F Hill (Research Assistant)
Ms N Xulu (Research Assistant)
Scientific Advisor: Emeritus Prof JJ Bolton (Associated with University of Cape Town [UCT])

<u>Government:</u>
Department of Forestry, Fisheries and Environment (DFFE) Representatives:
Ms A Bernatzeder (Director of Aquaculture Research – strategic support)
Dr B Macey (Specialist Scientist: Aquaculture Research – scientific input)
Mr John Foord (Food safety officer)
Dr Mark Rothman (Specialist Scientist: Fisheries Research – seaweed research)
Andre du Randt (Scientific Technician: Aquaculture Research – environmental monitoring)
Ms Koena Seanego (Candidate Scientist for Environmental Interactions)

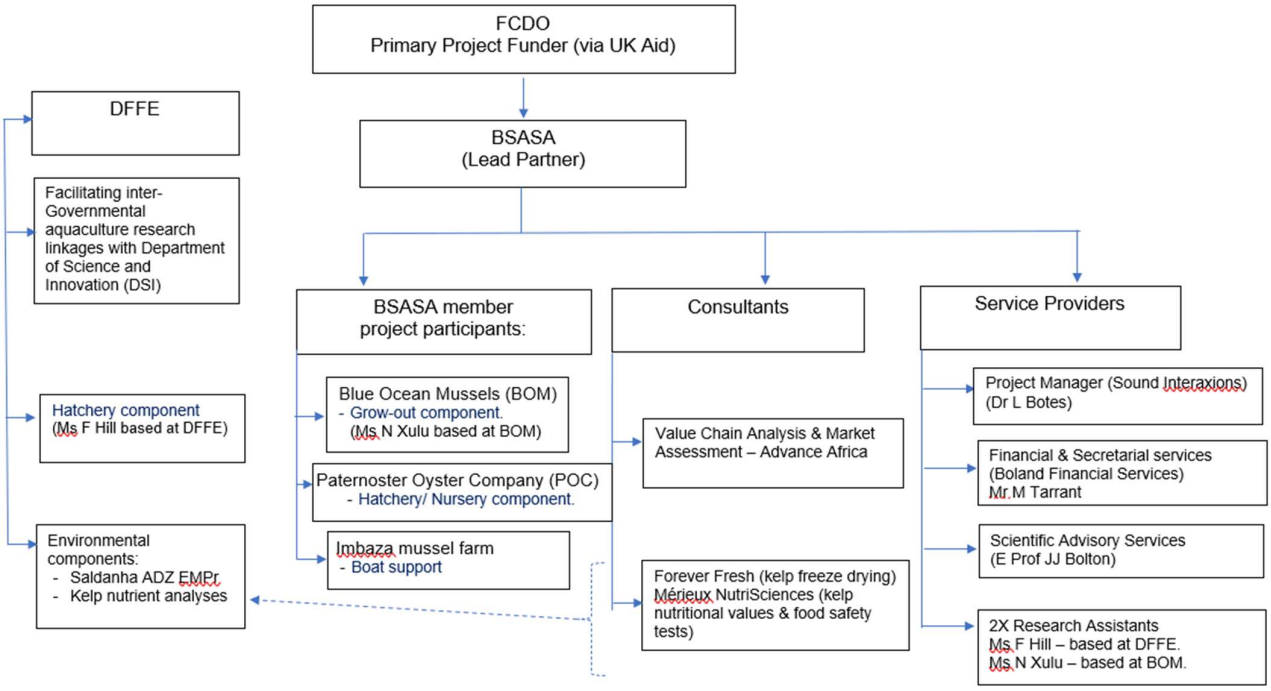


Figure 1. Diagrammatic summary of the Project Delivery Chain Map.

2. Summary of milestones achieved to date

The milestones achieved during Q1-Q3 are outlined below:

~ Two of the three target species (namely *Laminaria pallida* and *Macrocytis pyrifera*) were grown from hatchery spools (PVC spools wrapped with hatchery twine on which the kelp sporophytes grow) and out-planted on mussel rafts. Hatchery spools with *Ecklonia maxima* sporophytes are due for out-planting in the upcoming months.

~ In addition, *M. pyrifera* was also grown from wild collected holdfast fragments and out-planted on mussel rafts and long-lines.

~ Of the two farmed species, *M. pyrifera* was the only species with enough yield to be harvested and sent for the food safety and nutritional analyses as well as for microbial tests. *L. pallida* will be analysed once big enough to be harvested.

~ Environmental parameters were collected to provide a better understanding of site-specific environmental trends.

~ The Value Chain Analysis, Market Assessment and roadmap for the development of a kelp farming industry was successfully completed and due to be presented (together with the progress on the Hatchery and Grow-out components) at the upcoming workshop.

The last quarter (Q4) will be utilised to prepare the farming structures for the upcoming out-planting season during which all 3 target species will again be out-planted to improve on and compare with data captured during 2023-2024.

3. Progress on project objectives & deliverables

The sections below summarise the different project components and provide an overview of progress to date. The monthly progress reports, attached as Annexures, provide more detail.

3.1 Hatchery technologies of targeted species:

- **Kelp hatchery facility based at the DFFE Sea Point Research Aquarium:**
  As mentioned in the Q2 report, while Ms F Hill was waiting for the temperature-control rooms at the kelp hatchery based at the DFFE to be fixed after the winter storms, she had received the new project microscope and started photographing the developmental stages of the 3 target species seeded on spools that were being maintained in the two project incubators located in the Microbiology laboratory at Sea Point (see figure 2). The details of Ms Hill's activities during Q3 can be found in her monthly reports, attached as Annexure A.

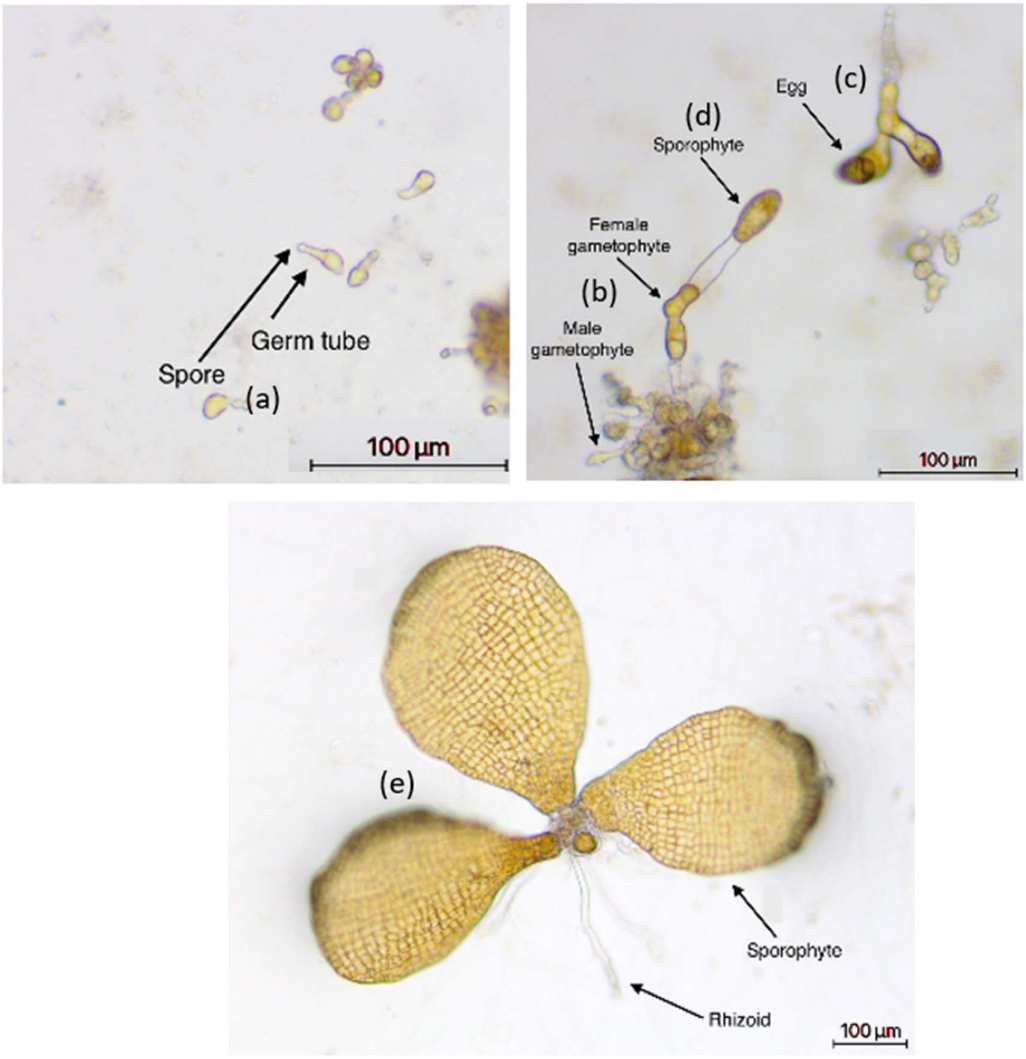


Figure 2. Kelp developmental stages during the first four weeks of development: (a) spore with germination tube, when contents are pushed through the germination tube to form the gametophyte (known as the dumbbell stage) (b) gametophyte (male & female) (c) female gametophyte with egg to be fertilised by sperm in order to form the (d) sporophyte which will grow into (e) a bigger sporophyte until big enough to be out-planted (Photo credits: F Hill)

All the hatchery spools of the 3 target species which Ms F Hill had set-up during this quarter, had to be discontinued. Some spools were discontinued due to a contaminant that both she and Ms I Meyer had experienced in Oct'23. Others were discontinued due to the generator which did not kick in during loadshedding and soon thereafter, the air conditioning unit in the Microbiology laboratory (were the incubators are kept) stopped working. The incubators are not able to hold their respective temperatures without the air conditioner working to keep the laboratory cool and is therefore switched off until the air-conditioning is fixed.

As a result, Ms Hill has not been able to start the hatchery optimisation experiments in the incubators as planned. Robust results of these experiments are crucial, as it will inform the optimum hatchery conditions for future kelp hatcheries. Ms Hill seeded another batch of project spools with spore material of all 3 target species at the end of Nov/beginning of Dec'23 which are now being maintained in the temperature-control rooms in the DFFE kelp hatchery which was subsequently repaired, and we are hopeful that the spools will survive for out-planting in Mar'24.

- **Kelp Hatchery/Nursery Facility based at Paternoster Oyster Company (POC)**

  As mentioned in the Q2 report, the POC kelp hatchery/nursery facility was set-up during Aug'23, with the 1st batch of spools seeded with spore material of all 3 target species from both Kommetjie and Jacobsbaai by the end of Aug'23. The objective was to compare growth rates of the 3 target species collected from Kommetjie and Jacobsbaai. Note, these spools were grown in PES growth media and were NOT treated with an Iodine solution (before sporulation) and Germanium Dioxide (after sporulation).

  By day 6 (see Oct 2023 Monthly report), there was evidence of gametophyte development of all 3 species and by day 12 sporophytes of all 3 species were present. Unfortunately, from day 12 onwards the spools were progressively overgrown with a green *Ulva* sp. (known by aquarium hobbyists as green hair algae). The *E. maxima* and *L. pallida* spools were thus discontinued whereas, out of interest, the *M. pyrifera* spools were maintained until mid-Oct'23. At this point, the sporophytes reached 7mm in length (a month and a half after the batch was started) while the sporophytes at the DFFE Sea Point hatchery were still mere spots on the spools. All spools were then discontinued as it was taken over by contaminants.

  By the end of Oct'23, new batches of spools of all 3 target spp. were started but with the following amendments; kelps were grown in F_2 growth media (instead of PES growth media), frond material was sterilized with a Iodine solution (before sporulation) and Germanium Dioxide was added to the tanks to prevent diatom contamination. By day 14 (see Nov'23 monthly report), sporophytes from all 3 species collected from both Jacobsbaai and Kommetjie had almost the exact same measurements (i.e. ~120µm), this pattern continued up to day 21 (except for *Laminaria* that got a Cyanobacteria contamination and subsequently discarded). From day 21, *Macrocystis* started growing slightly faster than *Ecklonia* in both the Jacobsbaai population and the Kommetjie population. After 2 months, the *Macrocystis* sporophytes reached between 0.5-1cm whereas the *Ecklonia* sporophytes were ~0.5cm. (see Dec'23 monthly report). Furthermore, at this stage, there did not appear to be much difference between the growth rates of the two species from the two collection sites (Kommetjie vs. Jacobsbaai). This will be monitored in the upcoming months in order to verify this pattern.

  Although the sporophytes of the Aug'23 batch that were grown with PES (without Iodine and Germanium dioxide) were bigger than those of the Oct'23 batch that are currently grown in F_2 (with the Iodine and Germanium dioxide) after 28 days, the contamination in the Oct'23 batch were significantly less. Thus, the use of the Iodine solution (before sporulation) and the addition of Germanium Dioxide (after sporulation) seems to be essential to keep contamination at bay. We hope to out-plant these spools in

Jan'24 to see if any of the three target species will survive a summer out-plant. For more details, please find Ms I Meyers monthly reports attached as Annexure B.

The two common contaminants at both kelp hatchery sites were Cyanobacteria and green algae with occasional diatom contamination (which may perhaps be due to tissue-boring diatoms that colonizes kelp blades). Contamination issues in the hatcheries must be resolved, as these contaminants compete with the sporophytes in the hatchery and may well carry over to grow-out which could potentially have negative effects.

3.2 Grow-out trials & Monitoring of environmental parameters:

- **Blue Ocean Mussels' (BOM) grow-out facility.**

At the BOM grow-out study site, kelps are out-planted on ladder structures onto mussel rafts and long-lines at two positions, one closer to the mouth (marked in red, see figure 3) and the other further away from the mouth (marked in blue, see figure 3). The ladder structures are 2m wide and a little over 6m long/deep with ladder rungs at 2m, 4m, and 6m depth.

Figure 3. Blue Ocean Mussels (BOM) study site in Saldanha Bay (SB)

While Ms Xulu's reports (attached as Annexure C) present more detailed descriptions of the data collected during this quarter, only the main points of interest are highlighted here.

(a) Progress on monitoring of the kelp growth:

The *M. pyrifera* sporophytes (on avg. 1mm in length) out-planted from the DFFE's hatchery spools in May'23 as well as the *M. pyrifera* grown from wild holdfast fragments (mostly >30cm in length) and out-planted at the end Aug'23 and beginning Sep'23, all reached lengths of between 2-3m by Oct'23.

However, the spools with *M. pyrifera* sporophytes that were affected during the winter floods which affected the electronics of the temperature-control rooms at the DFFE Sea Point Aquarium hatchery during Jun/Jul'23, and out-planted in mid-Jul'23 and beginning of Aug'23, grew much slower and all were < 80cm by Oct'23. Although this was disappointing, there is value in these results in that it provides insight to a potential kelp industry that should something like this occur in a hatchery, it perhaps is not worth out-planting such spools as it could negatively impact yields.

During the cooler months the sporophytes (grown from hatchery spools and wild holdfast fragments) at 2m depth grew best (with blades across all depths looking healthy) but as water temperatures started

increasing (and nutrients decreasing) during Oct'23 and Nov'23, specimens at 4m started to grow better (with many blades across all depths showing signs of biofouling in particular with the crustose bryozoan *Membranipora* spp.) while during Dec'23, specimens at 6m depth still increased in length and those at 2m and 4m slowly deteriorated and withered away (with all blades significantly fouled).

It is likely that the *L. pallida* sporophytes that were out-planted from the spools rescued during the DFFE hatchery challenges during Jun-Jul'23 storms, and out-planted in Jul-Aug'23, were also negatively affected. Unfortunately, we did not have a batch that was out-planted before the hatchery challenges started for comparison and hence cannot be sure as this species (as well as *E. maxima*) are naturally much slower growing species (M Rothman pers. comm.) than *M. pyrifera*. Regardless, although the specimens of this species have to date not surpassed 50cm in length, early indications are that during the cooler months and up to Oct'23, they performed better at 2m depth and from Nov'23 to Dec'23 the sporophytes at 4m and particularly at 6m started growing better than those at 2m depth with some reaching nearly 50cm in length at 6m depth in Dec'23. As in the case with *M. pyrifera*, by the end of Dec'23 the blades were covered by fouling and blades tips were withering away. When compared to results of M Rothman's MSc thesis in 2015 (where *L. pallida* and *E. maxima* were grown from hatchery sporophytes of 1cm in length at Oudekraal beach which is directly connected to the open ocean in an upwelling region at the Oudekraal Nature Reserve), the maximum total length of some of the *L. pallida* specimens grown on the mussel raft closer to the mouth only reached 48cm after 5 months with blades deteriorating due to biofouling and siltation, whereas those grown in Oudekraal were ~60cm after 4 months with blades intact and appearing very healthy.

The difference in the growth of the kelps on the two different structures (rafts vs long-lines) and the two experimental sites (closer vs further away from the mouth) must also be taken into account. By Nov'23, the *M. pyrifera* (grown from holdfast fragments and out-planted at the end of Aug'23) on the mussel rafts closer to the mouth, seemed to have out-performed those grown on the mussel rafts further away from the mouth at all three depths. But by Dec'23, many broke off at both rafts and those that were left deteriorated with only the specimens at 6m depth on the raft further away from the mouth still showing positive blade growth.
Contrary to the mussel rafts, the *Macrocystis s*porophytes (grown from wild holdfast fragments and out-planted in the beginning half of Sept'23) on the long-line further away from the mouth out-performed those grown on the long-line closer to the mouth during Oct'23 (especially at 4 and 6m depth). However, by Dec'23, many sporophytes on both long-lines also broke off with only the kelps at 6m on the long-line further away from the mouth still doing well. It is worth noting that on the long-line furthest away from the mouth, the sporophytes at 6m depth performed the best during Oct'23, Nov'23 and Dec'23 where those at 4m on the long-line closer to the mouth performed best during Oct'23, Nov'23 and Dec'23. But again, by the end of Dec '23, the sporophytes were covered in fouling with the blade quality less desirable (see figure 5, 6 and 7).

Furthermore, when comparing the percentage loss of the *M. pyrifera* (grown from holdfast fragments) between the structures, the biggest loss of kelps was on the mussel rafts, likely due to the kelp being grown adjacent to the mussel ropes on the rafts. With the increase in winds from a southerly direction (i.e. S, SE, SW) and wind speeds intensifying in the afternoons during the summer months and thus likely causing rougher waters, it was surprising to see how the percentage loss of kelps increased from Nov'23 to Dec'23 likely due to the longer kelps being damaged by the mussels on the mussel ropes. It would have

been interesting to see how the kelps would have fared on the mussel rafts if no mussels were grown on ropes adjacent to the kelps.

The data collected to date suggest that October seems to mark a definite turning point in the bay where winds from a southerly direction start to increase and as a result some degree of upwelling starts to take place, triggering biofouling which intensifies toward December to such a degree that the blade quality of both *Laminaria* and *Macrocystis* starts to seriously degrade. While the relative growth rate of the kelps did decrease due to a decrease in nutrient availability toward October, the actual blade length still increased over this time.

In the Q2 report we had expressed hope that the kelps at 6m depth that would be exposed to nutrient-rich upwelled water could possibly be maintained throughout summer. Although the sporophytes of both kelp species at 2m declined in growth and quality, and those at 4m and 6m depth generally seemed to have performed better, the fact that biofouling and siltation severely impacted the blade quality from October onward does cast significant doubt on the possibility of growing kelps in the bay past the October mark. To determine if year-round kelp farming will be possible, a location more directly connected to the open ocean (to better enable exposure to cold nutrient-rich water during summer and where there is less fouling) may perhaps be a better option. Alternatively, production of kelp may be limited to seasonal production within Saldanha bay from April to October.

(b) Progress on monitoring of environmental parameters:

During July – Sep 2023, water temperature across the three depths (2, 4 and 6m) increased gradually to approximately (~) 16°C with a narrow range of fluctuation between the three depths. However, although there was a gradual increase in water temperatures from the end of Sep'23 to the end of Nov'23 when it reached ~20°C, periodic upwelling events during this time regularly caused water temperatures to drop to as low as 12.5°C. From the end of Nov'23 to the end of Dec'23, water temperatures decreased from ~20°C to ~16.5°C (with the 6m temperatures dropping as low as 11.5°C). Unfortunately, concentrations of all the nutrients (nitrate, nitrite, ammonium, phosphate and silicates) gradually dropped from Jul'23 to surprisingly low levels in Oct'23 (despite the periodic upwelling events) which together with the increasing water temperatures during Oct/Nov'23 and increasing biofouling from Oct'23 onwards, may not be the most ideal scenario for growing kelps beyond October (Note: nutrient concentrations for Nov/Dec'23 were not available from UCT at the time of writing this report).

From Jul-Dec'23, there seem to have been a few low dissolved oxygen events during the first half Nov'23 and then again during the first half of Dec'23, which may have been as a result of phytoplankton blooms. These low dissolved oxygen events may also negatively impact the kelps.

(c) Harvesting of *M. pyrifera* blades for testing (see also section 2.4):

A carefully selected 10kg batch of healthy *M. pyrifera* blades were harvested (see figure 4 and 5) in collaboration with Dr B Macey and Emeritus Prof John Bolton on 17 Nov'23. Although *L. pallida* was also growing on the farming structures, there was not enough biomass that could be harvested for testing.

Although some biofouling (especially bryozoans) had already started to settle on the kelps, blades were carefully cleaned before freeze-drying and then sent for food safety and nutritional analyses as well as for microbial tests.

Figure 4: *M. pyrifera* blades being carefully selected at the BOM grow-out site (Photo credit: Mila Geldenhuys)

Most of *M. pyrifera* stipes with blades were left intact in order for growth measurements to continue throughout summer, and to see if new uprights and blades will form after harvesting. To date, the biofouling and siltation have made it near impossible to make decent observations in this regard. It should be emphasised that when the *M. pyrifera* holdfast fragments were initially out-planted, growth of the holdfasts as well as new uprights and blades were observed within 1 month, so theoretically new growth should have been visible by Dec'23. It is possible that the kelps may not be able to regenerate in the warm water containing less nutrients and an overwhelming amount of biofouling.

Figure 5. *M. pyrifera* blades (10kg) collected from BOM after being cleaned and weighed. (Photo credit: Mila Geldenhuys).

(d) Skills transfer to the Imbaza workers assisting in project activities:

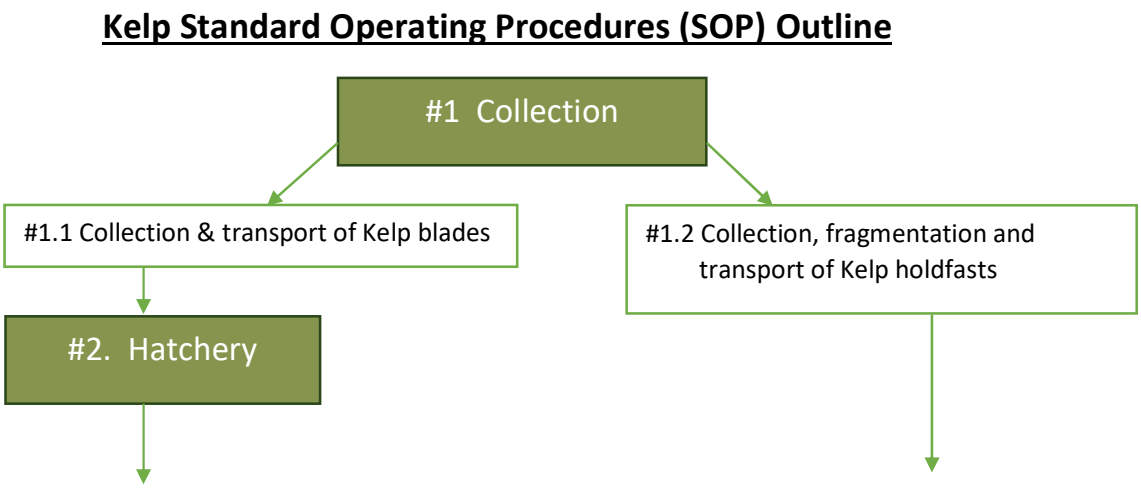
Aside from the boat support that the Imbaza Mussel farm is providing to the project, various staff members have assisted Ms N Xulu with her tasks learning how to measure and record the growth of the kelps, taking water samples with the Niskin bottle as well as other general cleaning and maintenance tasks at sea. Throughout the season, they have also had the opportunity to see the progress of the kelps from the moment it was out-planted, to blades being selected and harvested for food safety tests, to the moment when biofouling started overtaking the structures during Dec'23 and degrading the quality of the kelps (see figure 6)

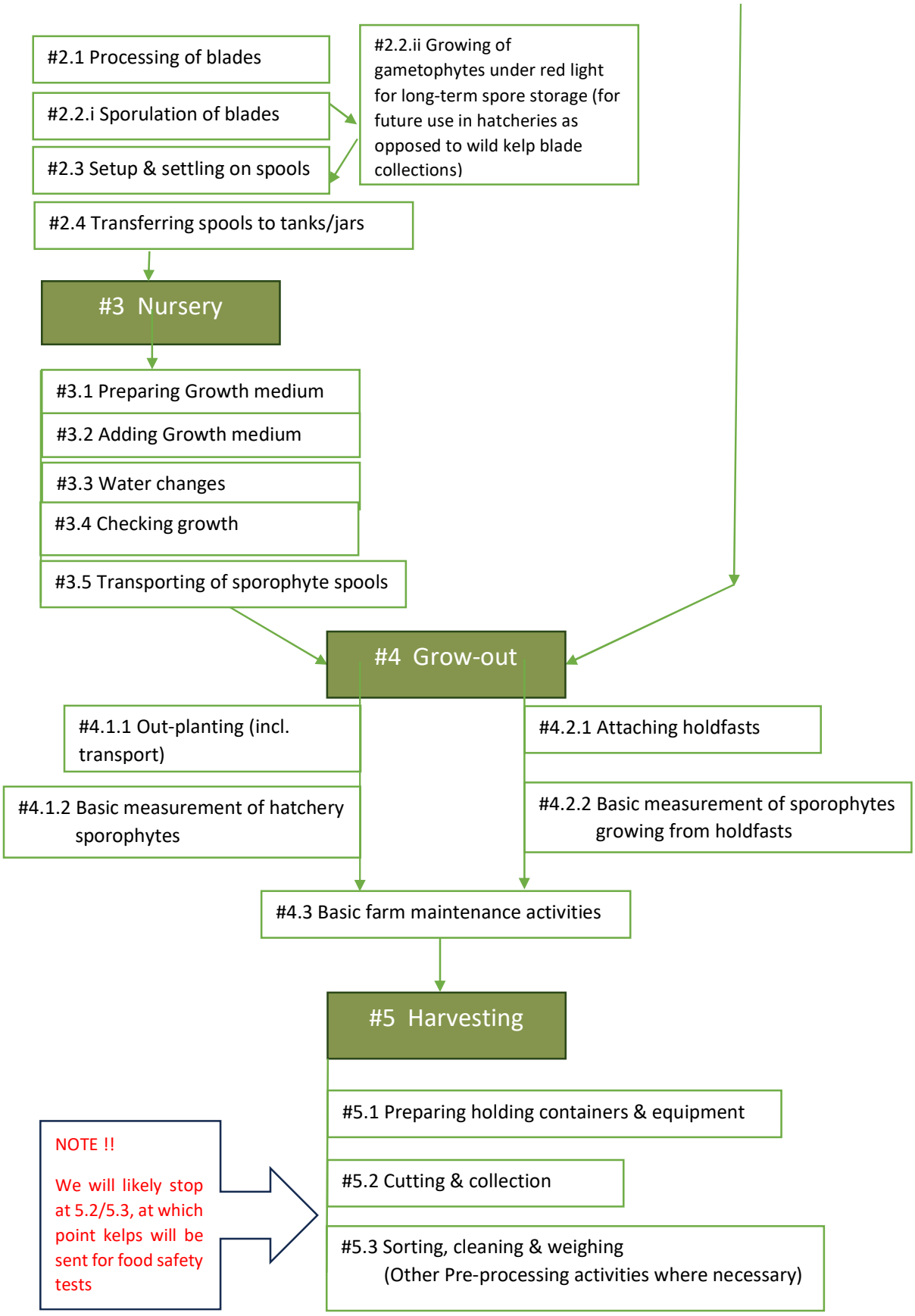
Figure 6. Imbaza Mussels' skipper (Mr Jacobus P. Adams - Cobi) assisting with monitoring of kelps (Photo credit: L Botes)

3.3 Updating of Project Plan (containing Research protocols & SOPs):

The purpose of this document is to summarise the overarching project plan and associated research protocols. It is a living document that is continuously being updated to reflect the research developments, with particular reference to the Standard Operating Procedures (SOPs). As the Research Assistants (RAs) trial the protocols under the guidance of the project team, the SOPs will be updated to eventually be released with the rest of the deliverables of this project in the hope of establishing a sustainable kelp farming industry in South Africa.

The draft diagram below outlines the SOPs which will likely be relevant to the industry. Draft copies of SOP 2.1-2.4 and 4.2.1 will be attached to the Q4 report as Annexure D. The rest of the SOPs will be added as the project progresses and thus will remain open for inputs/comments until the point that it will be signed off when the project draws to a close at the end of March 2025.




#2.1 Processing of blades
#2.2.i Sporulation of blades
#2.3 Setup & settling on spools
#2.2.ii Growing of gametophytes under red light for long-term spore storage (for future use in hatcheries as opposed to wild kelp blade collections)
#2.4 Transferring spools to tanks/jars
#3 Nursery
#3.1 Preparing Growth medium
#3.2 Adding Growth medium
#3.3 Water changes
#3.4 Checking growth
#3.5 Transporting of sporophyte spools
#4 Grow-out
#4.1.1 Out-planting (incl. transport)
#4.1.2 Basic measurement of hatchery sporophytes
#4.2.1 Attaching holdfasts
#4.2.2 Basic measurement of sporophytes growing from holdfasts
#4.3 Basic farm maintenance activities
#5 Harvesting
#5.1 Preparing holding containers & equipment
#5.2 Cutting & collection
#5.3 Sorting, cleaning & weighing
(Other Pre-processing activities where necessary)
NOTE !!
We will likely stop at 5.2/5.3, at which point kelps will be sent for food safety tests

3.4 Food safety testing and nutritional analyses of kelp:

The aim of the investigation is to study the nutritional value and potential food safety risks of wild kelp vs farmed kelp. The data will eventually be used toward the drafting of food safety standards for the kelp industry and serve as a comprehensive overview of the potential for kelp use in human and animal nutrition.
Initial data from the three wild candidate species collected in the Kommetjie region (as part of Phase 1) showed that all three kelp species have a high mineral content. The essential minerals were within the range recorded for other seaweed species, with the exception of Fe, Mn, and Zn, which were notably higher. Furthermore, all heavy metals fell within the range of values reported for other brown seaweed species, except for *M. pyrifera* that showed the highest Al, Pb, and Cd contents of the three kelp species collected from the same geographical area.

For Phase 2 of the project, fronds/blades of two species of wild kelp (*E. maxima* and *L. pallida*) were collected from three sites in Saldanha Bay and freeze-dried by Forever Fresh (Somerset West, Western Cape) and subsequently sent to Mérieux NutriSciences laboratories in Cape Town for food safety analysis. Since *M. pyrifera* does not occur naturally in Saldanha Bay it was not included for testing. A full report on the food safety analysis of the two kelps was attached to the Q1 report as Annexure E.

Fronds from *M. pyrifera* that was grown at BOM, were collected on 17 Nov 2023 from the mussel rafts and long-lines. Dr. B Macey and Emeritus Prof. JJ Bolton are also involved with OceanGrown Aquaculture's (previously WCOG) *M. pyrifera* farming project, and also collected fronds from *M. pyrifera* on the same day.

Similar to the wild kelps collected earlier in the year, the material was sent to Forever Fresh for freeze drying after which it was sent to Mérieux NutriSciences laboratories in Cape Town for food safety and nutritional analyses as well as microbial testing. While we are still awaiting feedback from the food safety and nutritional analyses, the results from the microbiological tests were released showing that the kelps harvested at BOM tested negative for the presence of *E. coli*, *Salmonella* and *Vibrio* species. Once all the results are in, it will be made available as part of the quarter 4 (Q4) report.
As mentioned in the previous report, Dr B Macey assisted with the drafting of a project proposal to the South African Bureau of Standards (SABS) to request the development of standards for seaweed for human consumption. The proposal was submitted on the 12th of June 2023, and following minor amendments has been submitted (on 3 Aug 2023) to the technical committee to start the process of developing the standard.

3.5 Value Chain Analysis, Market Assessment & Roadmap to develop a kelp farming industry:

The Kelp Value Chain Analysis, Market Assessment and Roadmap to develop a kelp farming industry (commissioned by this project and compiled by Advance Africa), commenced at the beginning of Sept 2023 and was completed by the end of Nov 2023. The full report attached here as Annexure F, maps and establishes the current market value for kelp in South Africa and identifies key gaps and inefficiencies within the value chain. The Kelp Value Chain Roadmap describes practical components that should be implemented to unlock opportunities for parties interested in kelp farming in South Africa. It is premised on the successful development of kelp farming technologies investigated within this project. If the technologies provide reliable and commercially useful proof-of-concept, then the five roadmap strategies can be implemented. These include a Developmental/Regulatory Strategy, an R&D Strategy, a Product-Market Strategy, a Commercialisation Strategy and a Community Participation Strategy.

The data presented in this report along with the identified value chain inefficiencies, market opportunities and roadmap, establishes a baseline that should be understood before embarking on or investing in kelp farming. Failing to grasp these insights put kelp farming investors at risk of pursuing a production-driven venture instead of one driven by market demand.

3.6 DFFE Environmental Management Programme (EMPr) update:

The desktop study to investigate the Environmental Impacts and Risks/Benefits associated with Kelp Farming (commissioned by this project and compiled by Ecosense) was sent to the Saldanha Bay ADZs Aquaculture Management Committee (AMC) for inputs after which the go-ahead was given for the DFFE to proceed with a Part 1 amendment (minor) in order to include Kelp into the Environmental Authorisation.

Currently, DFFE is busy with the application process for a Part 1 amendment. More information on this will be provided as information becomes available.

3.7 Financial feasibility study for kelp farming in South Africa:

This component has not yet been addressed. Discussions around this need to take place to ensure a common understanding of what this component needs to achieve to circumvent expectations that might lead to an undesirable outcomes.

4. Challenges & Recommendations

4.1. Challenges experienced in each project component with accompanying recommendations

4.1.1 Hatchery technologies of targeted species:

- **Hatchery facility at DFFE Sea Point facility**

  The on-going challenges at the DFFE Research Aquarium has resulted in Ms F Hill not being able to provide Ms N Xulu with healthy spools that are ready for out-planting this year. She has been in a perpetuating stop-start cycle due to the continuous crashing of her spools as a result of either contamination and/or maintenance issues and more recently the air conditioner not working in the laboratory. The incubators are not able to hold their respective temperatures without the air conditioner working to keep the laboratory cool and thus currently switched off. Ms Hill is therefore unable to conduct the hatchery optimisation experiments until she is able to use the incubators again. Subsequently all her hatchery optimisation experimental work that she has planned to do in the incubators are now on hold until the air conditioner is fixed. She has re-started a set of project spools at the end of Nov'23/beginning Dec'23 which is currently maintained in the temperature-control rooms. With a year into the project and only a year left, this has placed significant pressure on the project to achieve its contractual deliverables and we are now looking to the kelp hatchery at POC to further the progress of the project.

- **Hatchery facility at POC**

The batches of kelp spools which were started in Oct and Nov 2023 are still doing well, but Ms I Meyer is finding it more and more difficult to keep up with her own duties as POC Oyster Hatchery Manager as well as maintaining the kelp spools, especially considering that this time of year is the busiest in terms of oyster hatchery duties. With the kelp tanks having to be cleaned and water changes that must be done weekly while spending hours photographing the kelps each week, she is desperately in need of assistance. For this reason, we have not been able to add a batch of spools in December nor will we be able add any additional spools in the coming months without the necessary assistance to help attend to the project spools.

Recommendation applicable to both hatchery facilities:
It is recommended that Ms F Hill temporarily relocate (from mid-Feb to June 2024) to POC with the two incubators. She will then be able to do the hatchery optimisation experiments in the incubators and looking after the project spools at POC to provide the project with the best chance of making use of the upcoming out-planting season. Practically this means that MS Hill will spend Monday-Tuesday at Sea Point to check-in on her batch of spools that is currently at Sea Point while spending the rest of the week at POC until her hatchery optimisation experiments in the incubators are completed. This will resolve Ms Meyer's need for assistance and Ms Hill's need again for a stable hatchery in which she can conduct her hatchery optimisation experimental work. After Jun'23, Ms Hill wishes to commence with her investigation into the red-light set-up in the incubators at Sea Point.
Crucial to note is, if we miss this upcoming opportunity to out-plant healthy kelp spools of all three species (especially *L. pallida* which according to literature seems to grow better during summer and early autumn), the project will not be in a position to obtain reliable data on the hatchery side nor on the grow-out side resulting in BSASA not being able to deliver on its contractual obligations with the FCDO.

As far as the hatchery activities are concerned, the PM recommended that Ms Hill and Ms Meyer re-visit the widely used and already proven techniques outlined in the kelp farming manuals, and that the spools and equipment be sterilised before use to eliminate Cyanobacteria. Since then, there has been a significant improvement of the kelp spools at both sites. She further suggested that if diatom contamination persist, to consider lightly scraping the kelp blades (as described in the kelp farming manuals) to see if this will entirely eliminate the any further contaminants.

4.1.2 Grow-out trials & Monitoring of environmental parameters:

- **Grow-out facility at BOM's site**

  Now that two of the three kelp species are growing on the experimental mussel rafts and long-lines, it will likely become near impossible for Ms Xulu to manage all the grow-out tasks and environmental monitoring on her own if we were to out-plant all three target species on both mussel raft and long-lines. Biofouling on the rafts and long-lines have significantly increased the weight of the rope ladders, making it very difficult and time-consuming to lift them. Even the ladder anchors which are >6m deep are totally fouled, thereby increasing the weight of the rope ladders (see figure 7 a-c). As a result, too much time is spent on cleaning rope structures with too little time to monitor and measure the kelps. Mussels have started to populate the ladders from mid to late Dec'23 especially along the vertical sides of the ladders as well as around the holdfasts of the kelps and will likely soon start to spread along the horizontal rungs of the ladders. This will render it near impossible to lift the ladders by hand without having very strong gloves or a mechanised pulley with which to lift the ladders.

Recommendation:

The PM has discussed this matter with Mr V Pienaar who agreed to replace the ad-hoc assistance that was provided during the year with a permanent helper. With the additional hands provided by BOM for the land-based tasks like cleaning of rope ladders as well as with Imbaza's permanent person to assist with basic sea-based tasks, we hope that this will suffice for the upcoming year. Mr Pienaar has indicated that if the need arises, additional ad-hoc assistance can be provided.

It is recommended that the PM discuss the lifting of ladders with Mr V Pienaar in order to see if a solution can be found to make it easier and less time consuming when lifting the kelp ladders.

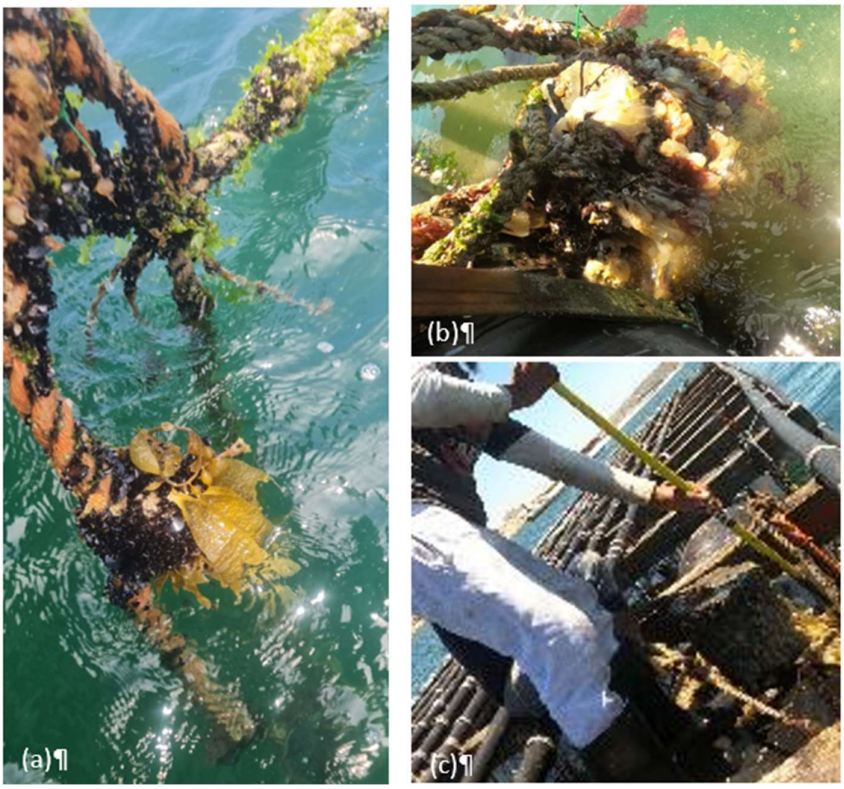


Figure 7. (a) mussels attaching to kelp holdfast and vertical sides of the rope ladder (b) rope ladder anchor before (c) and after cleaning (Photo credits: N Xulu, L Botes)

4.2. General recommendations:

The following matters need to be addressed during the next quarter to further progress:

- The focus for the fourth and last quarter of the 2023-2024 financial year, will be to address the situation around the hatcheries as a matter of urgency so that we are well positioned to go into the new financial year and to obtain reliable hatchery and grow-out data for all 3 target species. These results will inform the last deliverable, which is to investigate the financial feasibility of kelp farming in South Africa.
- As part of the stakeholder engagements to disseminate information, another focus area for Q4 is to conduct a workshop on the progress of the project's kelp farming technologies as well as further deliberation of the roadmap that was proposed in the Value Chain Analysis & Market Assessment study. Discussions are currently underway to establish a collaboration with the United Nations Development Programme (UNDP) that will allow for additional follow-up workshops to unpack how best to integrate communities into the kelp value chain.

5. Lessons learnt, Closing remarks & Thinking ahead

5.1 Lessons learnt and observations relevant to industry

Despite some operational challenges and set-backs, data has been generated from which valuable lessons were learned. For ease of explanation, the lessons learnt will be elaborated upon under the two separate components namely hatchery and grow-out components:

- Hatchery component

  Although we have not yet been in the position to take any healthy hatchery spools of the three target species through all their developmental stages, nor to obtain detailed hatchery optimisation results for the development of future kelp hatcheries, the diagram below aims to provide a general timeline that will be useful to a future kelp farmer ito planning bearing in mind that this time-line may or may not be entirely different for each of the target species. In the case of this project, there are early indications that this time-line may even be different at the two hatchery project sites possibly due to differences in water quality at the two sites (see diagram 1).

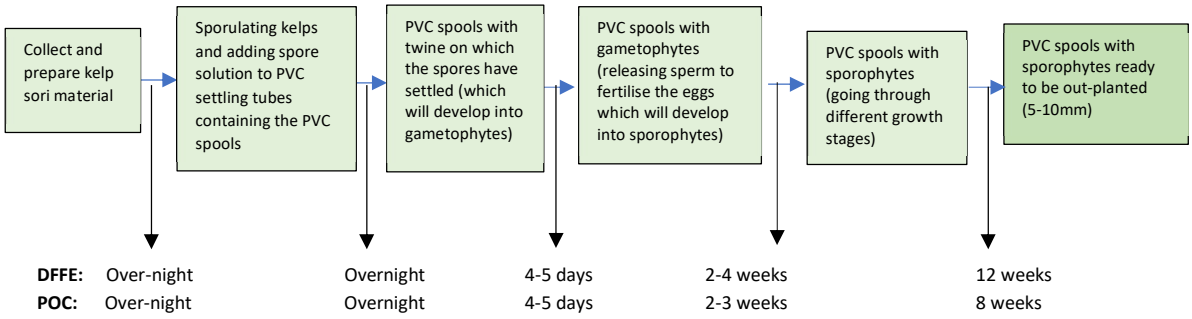


Diagram1: Time-line of all 3 species from collection of kelp sori to sporophytes ready for out-planting (~ 2 months at POC and ~3 months at the Sea Point based hatchery). **(Note: (1) This time-line and colour coding should be viewed together with the time-line diagram in the grow-out component (2) the diagram will be updated in the coming months once the hatcheries have been stabilised and if/when more species-specific data becomes available).**

~ Although it may be the case that collection of sori material for different kelp species are more successful during certain months of the year, to date we have been collecting sorus material of all three species throughout the year and have had successful sporulation.

~ Initial indications are that the growth of the sporophytes of all 3 species at the kelp hatchery based at POC, is faster than those at the Sea Point based kelp hatchery but these results must still be confirmed in the upcoming months.

~ For kelp farming to take place from hatchery grown sporophytes in Saldanha Bay, it is important to establish the best time to out-plant each of the 3 target species. While one must be mindful that the risk for contamination increase if sporophytes are left too long in the hatchery, one also must be mindful of the fact the high level of siltation and fouling in the Saldanha Bay may prevent the sporophytes from photosynthesizing if out-planted too small even if the sporophytes have self-cleaning mechanisms. It may well be necessary to out-plant the sporophytes at around 1cm in length to ensure that they are able to photosynthesize and not be covered with siltation before having a chance to grow. This however, will be further investigated in the upcoming months. For kelp farming at a site other that in Saldanha Bay, this may be different.

~ It seems that adding the Iodine sterilising solution (before sporulation) and Germanium Dioxide (after sporulation) do initially have a delaying effect on kelp development but seems necessary to control contamination which would otherwise suffocate the sporophytes. These methods are also prescribed in the kelp farming manuals and have been trialled and tested by many in the industry.

~ In general, the hatchery procedures which we have followed to date are similar to those outlined in the publicly available kelp farming manuals thus these remain valuable sources to consult together with the SOP's developed by this project.

- Grow-out component

<u>Observations based on hatchery spools that were out-planted</u>:

Since we have not yet been in a position to out-plant healthy hatchery spools of the three target species, the diagram below provides a general timeline (based mostly on *M. pyrifera*) that will be useful to a future kelp farmer ito planning. This time-line may or may not be entirely different for each of the target species.

The lessons learnt and a general timeline are outlined below (until such a time that we can verify and add species-specific data):

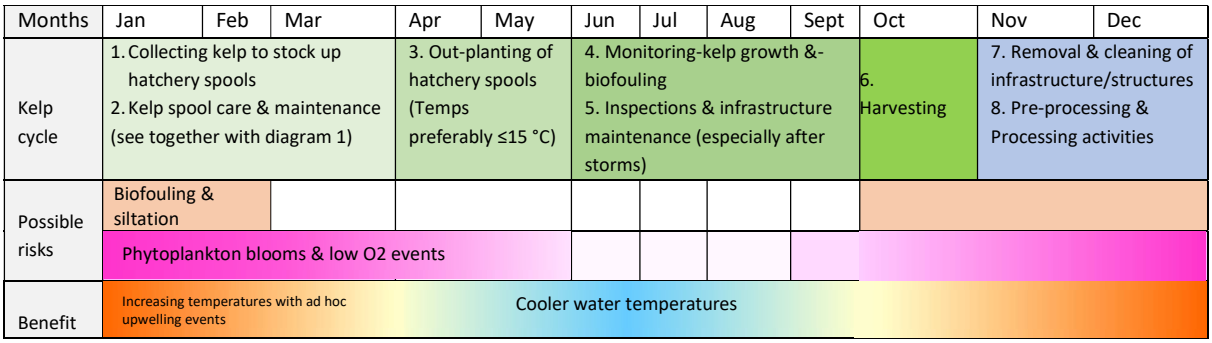


Diagram 2: Kelp farming cycle time-line (from hatchery spool out-planting to harvesting takes approximately 6 months (TBC/spp)
Note: the diagram will be updated in the coming months if/when more species-specific data becomes available.

~In terms of out-planting:

Although we have out-planted between May and August during 2023, from an industry point of view it may be preferable to out-plant after February or as soon as biofouling and siltation subsides, and possibly even after March when low oxygen events subside, and water temperatures drop below 15 °C. This has proven to work well for *M. pyrifera,* which grew well over the winter months through to spring (Oct) as it is more cold tolerant than *L. pallida*. The time frame may also work well for *E. maxima* (in wild populations the secondary blades develop between late winter until November) but may be problematic with *L. pallida* (in wild population blades grow faster between Nov -Apr). See Phase 1 pre-feasibility study for more details on kelps in their natural environments.

~ In terms of growth:

Although both *M. pyrifera and L. pallida* were out-planted at the same time between May and August 2023, *L. pallida* out-planted from the rescued hatchery spools remained <50cm. On the other hand, *M. pyrifera* out-planted before the challenges at the DFFE based hatchery started, reached ~2m and those out-planted from the rescued hatchery spools remained <80cm thus possibly affected during the hatchery challenges. It is not clear if *L. pallida's* growth has also been affected during the Jun-Jul 2023 hatchery challenges or if the growth

will start to increase toward late summer/early autumn or if *L. pallida* is indeed a slow growing species or all of the above. This will have to be confirmed in the next few months.
Furthermore, while the blade tips of both species deteriorated significantly in Nov/Dec'23 (possibly due a combination of increasing biofouling, increasing water temperatures and decreasing nutrient levels), the blades of *L. pallida* were still growing at 6m depth. However, the blades of *M. pyrifera* started to deteriorate at all depths. We are still monitoring *M. pyrifera* to see if new sporophyte uprights will form in the upcoming months after harvesting some of the blades. In addition, we are also checking whether *L. pallida* will be able to grow during the summer months despite the excessive biofouling currently in the bay.
Size variation in both species is significant, with new sporophytes of both species still appearing months after the initial outplant (making it very difficult to plot growth curves).
When the growth of the kelps on the mussel rafts were compared during Oct'23, those growing on the raft closer to the mouth appeared generally to be in a better condition than those growing on the raft further away from the mouth but toward Dec'23 biofouling covered most of the kelps at both sites. This however will have to be further investigated in the next out-planting cycle to see how the 3 target species fare and how the higher wave action/water flow (which is important for bringing nutrients to the kelps) affect the blades as it is known that some kelp species are better adapted than others to wave action (for example in the wild, *E. maxima* is better adapted to more exposed areas, with *M. pyrifera* better adapted to sheltered areas, and *L. pallida* better adapted to less wave action in small embayments). For more details on the three wild kelps in their natural environment, please see the pre-feasibility study.

~ In terms of the growth of the kelps at different depths:
Although sporadic upwelling events seem to have taken place between the end of Sep'23 and mid-Dec'23, the general upward trend in water temperatures at all 3 depths continued all the way to the end of Nov'23 when temperatures reached around 20°C. By mid-Dec'23 temperatures decreased again to below 16 and 17°C. The inverse was true for all the nutrients (in particular nitrates and phosphates which are essential for the growth of kelps) across all three depths (2m, 4m, and 6m) where it gradually decreased from Jul'23 through to late Oct'23 (Note: Nov'23 and Dec'23 results were not yet available at the time of writing the report). By Nov'23 and Dec'23, the kelps have clearly deteriorated at 2m and 4m due to increased light intensity, warming water temperatures, decreasing nutrients (even though multiple upwelling events were observed) as well as significant biofouling.

We were hopeful that the kelps at 6m would be able to cope throughout summer if/when in reach of cooler water temperatures and nutrients due to the upwelling events and although *M. pyrifera* did initially seem to cope better at 6m than those at 2-4 m, the biofouling toward the end of Dec'23 completely covered the entire plants. This was also the case for *L. pallida*, but since this species is supposedly more heat tolerant, we will keep monitoring it to ascertain its battle against the biofouling over the summer months.
Future farmers of *M. pyrifera* may therefore want to consider dropping the depth of the main rope-line to 6m as they are heading toward late spring where kelps will be within reach of upwelling events and where there is less intense sunlight during the day. During winter months the main rope-line between 2-4m may be sufficient, although the above will hopefully be tested for the three target species in the next grow-out cycle provided the hatcheries are stabilised.

~ In terms of biofouling:
Biofouling is the biological fouling of other organisms which degrade the quality of the kelp blades, compete for light, dissolved nutrients and space on the grow-out ropes and interfere with kelp farming infrastructure.

Although investigating biofouling on kelps per se was not one of the listed deliverables of the project, it seems that it may well play a very important role (and possibly a big stumbling block in Saldanha bay particularly for *L. pallida*). Biofouling starts as early as October and only seem to dissipate after February each year (S Visser pers. comm.). It has been interesting to note the extent to which biofouling differs in different areas in the bay where mussel and oyster farmers have noted that biofouling in Big Bay is worse (majority of which are barnacles) than in Small Bay (SJ Poggenpoel pers. comm.). Within Small Bay, there was an unexpected difference in the composition of biofouling species between the project site at BOM which comprised mostly of *Ulva* species and in particular bryozoans (see list provided by JJ Bolton in the following table) which can cover an entire plant, whereas biofouling at Oceangrown Aquaculture comprised mostly of red seaweed species and mussels which can cover the entire rope and even between and on holdfasts (see list provided by JJ Bolton in the following table). Mussels are particularly worrisome as they can cut kelp blades like razors which was the reason why the Sea Harvest *Gracilaria* project was discontinued (V. Pienaar pers. comm.).

Some of the biofouling species that were identified by Emeritus Professor John J Bolton (based on one visit which took place on 17 Nov 2023) are listed in the following table (thus not a comprehensive list over months):

Biofouling spp. identified at BOM	Biofouling spp. identified at Oceangrown Aquaculture
1. On the blades of the *M. pyrifera*, areas of the crustose Bryozoan *Membranipora*.	1. Blades fairly clean (not sure if cleaning took place prior to their harvesting)
2. On the ropes there was many filter- and particle-feeding animals (sponges, tunicates, anemones) and also short (a few cm) but dense turf of small seaweeds (particularly *Ceramium*, *Ectocarpus*, *Polysiphonia* filamentous types, and quite a bit of foliose *Ulva*).	2. On the ropes there were mussels and seaweeds. The seaweeds were mostly 10-30cm long, and mostly red seaweeds: 2 species of *Grateloupia*, one bladed, probably *G. turuturu*, one branched blade (maybe *Grateloupia* sp.), bright red very thin sheet-like red which may be *Myriogramme livida*; *Chylocladia capensis*. These are likely to also be edible if kelp harvested as abalone feed (*Grateloupia turuturu*, for example, is eaten by people in Asia).
3. The fouling community was quite slimy, some of the kelp blades were also covered in a thin layer of mucus containing small invertebrates, especially Caprellids – (type of amphipod which often live on seaweeds, sometimes known as 'skeleton shrimps'). [Note: sliminess comes and goes, present during some months but not in others]	3. Absence of sliminess

Another surprising observation was the difference in biofouling within BOM's site that was observed in Nov'23 versus that observed by the end of Dec'23/beginning Jan'24. In Nov'23, as previously mentioned, the biofouling at BOM had hardly any mussels, but by the end of Dec'23 the mussels (~1.5cm in size) were packed densely around the holdfasts of the kelps and in some cases the mussel's byssus threads attached to both the kelp stipes and the blades, pulling the blades back onto itself and onto the mussels. On the vertical sides of the ladders, the mussels at places were so densely packed that it made it very difficult to get a grip on the ropes while pulling the ladders up without cutting one's hands. The ladder anchors too, were so densely packed with biofouling (especially with the tunicate *C. intestinalis*) that the total weight of the actual ladder required two people to pull up at each side of the ladder (thus 4 workers in total). On the long-line and mussel raft closer to the mouth, the biofouling on some blades and holdfasts were severe (see figure 8 a-c) while on the structures further away from the mouth, tunicates and a slimy covering on the ropes severely hampered the growth of the kelps (see figure 8 d-e). The kelp blades however, generally looked healthier on the long-lines than those on the mussel rafts possibly due to the fact that there are generally more suspended solids

and biofouling around the mussel rafts due to routine mussel cleaning activities taking place while mussels are being harvested.

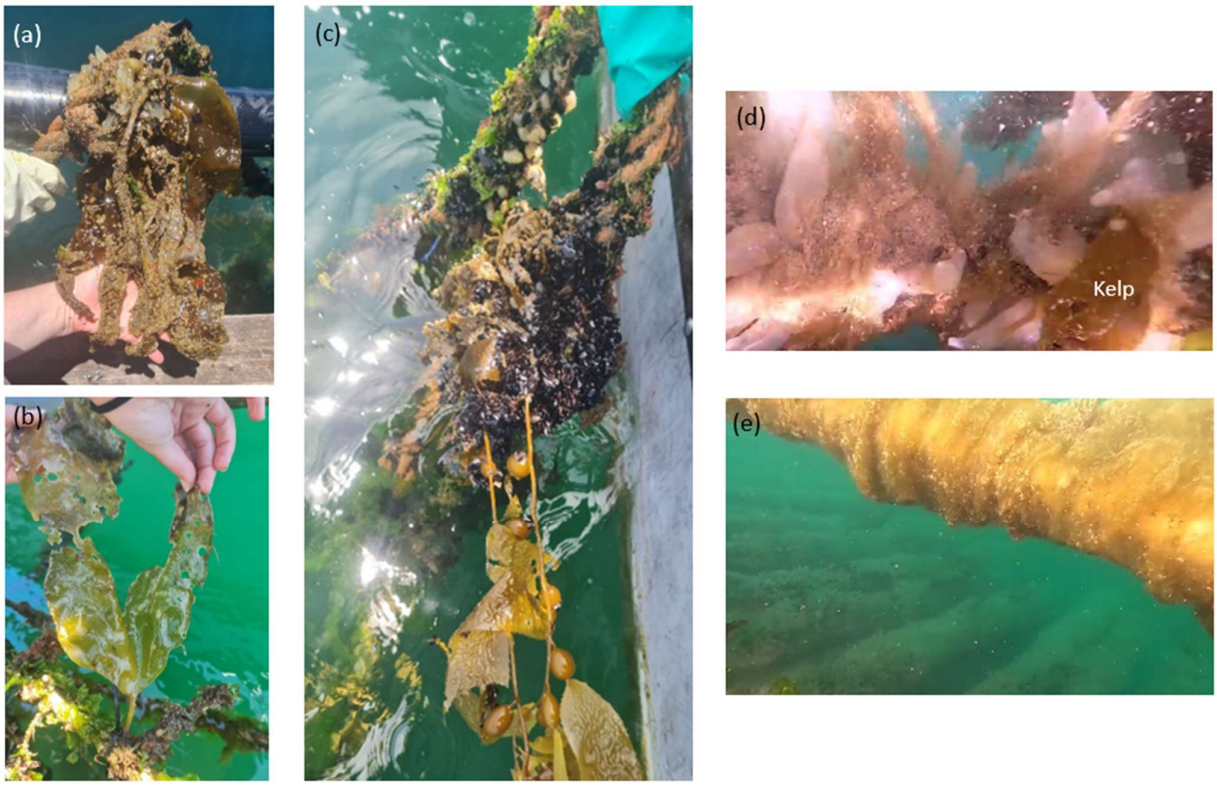


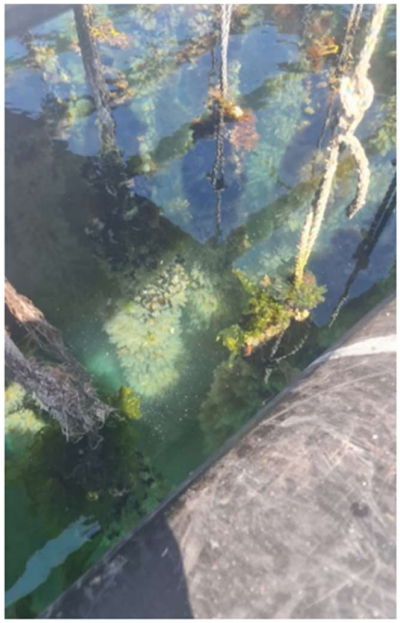
Figure 8. By late Dec 2023, biofouling almost entirely covered some of the *M pyrifera* blades (a) with many blades showing signs of significant deterioration such as the *L. palida* (b) while mussels were densely packed around many of the kelp holdfasts (c). Tunicates (d) and a slimy covering (e) also competed with the kelps for space on the grow-out ropes. (Photo credits: L Botes, N Xulu)

Interestingly though, upon investigating the biofouling on the actual mussel ropes itself, we were surprised with how distinctly different it was. On the raft closer to the mouth, the first three meters or so of the mussel ropes were densely covered in green *Ulva* spp. with the odd patch of brownish-red seaweed amongst the *Ulva* spp. and below that it was totally covered in white sea squirts (see figure 9).

Figure 9 a & b. Biofouling on mussel ropes of the experimental raft closer to the mouth. Mainly *Ulva* for the 1st 3m or so, below that white sea squirts (tunicates). (Photo credits: L Botes)

On the other hand, on the mussel ropes of the raft further away from the mouth, the entire mussel rope from the top to as far down as the eye could see was totally covered in white sea squirts (see figure 10). The thought of farming with *Ulva* spp. on structures closer to the mouth in summer and *M. pyrifera* during winter certainly does come to mind.

The obvious question as to whether the wild kelps were also affected immediately came to mind, and upon investigation from above on the front deck of the boat, we established that the wild *Ecklonia* beds close by (which are obviously much older than our farmed kelps) were also in a bad state (see figure 11). Perhaps not as severely covered with biofouling as the farmed kelps but it did have a significant number of patches where many of the kelp blades were lightly coloured, fouled and damaged with the tips withering away.



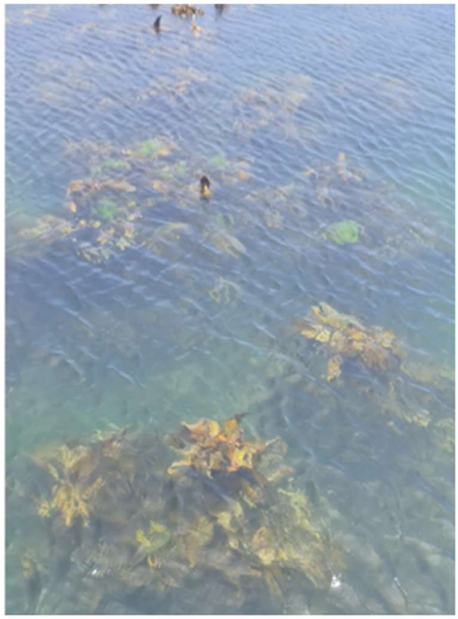


Figure 10. Biofouling on mussel ropes of the experimental raft further away from the mouth – mainly white sea squirts (tunicates).
Figure 11. Condition of *Ecklonia* beds close to experimental kelp structures. (Photo credits: L Botes)

It was also noteworthy how quickly the biofouling spread and re-established within 2 weeks after cleaning (N. Xulu pers. comm.). If the kelps are not harvested before the biofouling season starts, farmers will have to consider labour intensive manual removal of biofouling. If manual removal of biofouling will be considered, it is important to consider how best to do this as one should be careful not to damage the self-protecting mucous layer covering the kelp blades and therein making the blades more susceptible to biofouling attaching and smothering the blades.

~ In terms of maintenance:

Once out-planted (during Apr-May), it is crucial to regularly investigate the integrity of farm structures and mooring blocks during winter storms. Toward spring, biofouling on the floats and boys of the main rope-lines need to be regularly cleaned and maintained to prevent structures from getting too heavy.

5.2 Closing remarks

It is pivotal that the hatchery challenges be addressed and sorted out to ensure completion of the deliverables as per the BSASA contract with the FCDO. Essentially, if the first four months of 2024 are not utilised to successfully cultivate the three target species in the hatchery, then we will not have any kelps (apart from the wild *M. pyrifera* holdfast fragments) to monitor during the remainder of the year.

5.3 Anticipated work for the 2023-2024 (and beyond)

2023-2024												
	Quarter 1			Quarter 2			Quarter 3			Quarter 4		
Project deliverable	April	May	June	July	August	September	October	November	December	January	February	March
Hatchery/Nursery trials												
Grow-out trials												
Environmental monitoring												
Food Safety Testing												
1. Analysing results obtained in March 2023												
2. Testing farmed kelp								??			??	
Value Chain Analysis & Market assessment												
1. Drafting of TOR												
2. Sourcing consultant												
3. Study commence												
Stakeholder Engagements:												
1. Drafting of TOR												
2. Mini-workshop/meeting with community members to unpack possible involvement												
3. Value-chain workshop focussed on kelp farming component												
PM physical check of assets at all sites												
PM output report & budgeting												

Considerations for 2024-2025

Over and above the on-going research on the hatchery and grow-out components to optimise farming techniques and to determine which of the 3 species will be most suitable for cultivation in Saldanha Bay, the following items may also considered if time allows (some of which is also reflected in the Kelp Value Chain and Market Assessment study):

- Portal for information dissemination

  Developing a portal of sorts where interested parties and possible new-entrants can access relevant information on the project, available kelp farming manuals and research outcomes (from our projects and elsewhere in the world), funding avenue, links to government departments providing assistance to start-ups etc. Since BSASA does not have a website, we may want to explore options to either set something up or making use of a platform already in place.

- Volunteer & training programme for new-entrants

  The PM could possibly start giving some thought to explore how endeavours such as these can be implemented.

- Kelp traceability/tracker system

  As in any other food industry, tracking systems to trace products back to its origin will become important in the kelp industry. A very basic manual tagging system could be looked at as a starting point which could form the basis of more automated systems once an industry is established.

6. Acknowledgements

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Much appreciation goes toward the two Research Assistants who persevered through many a challenge since the start of the project.

7. Annexures

(Note: please contact the project manager to access the annexures)

6.1. Annexure A: Ms F Hill monthly reports


FHill October2023 Monthly Report.pdf


FHill November 2023 Monthly Report.pdf


F. Hill Dec 2023 Monthly report.pdf

6.2. Annexure B: Ms I Meyer monthly reports


POC kelp hatchery report - Oct 2023.pdf


POC kelp hatchery report - Nov 2023.pdf


POC kelp hatchery report - Dec 2023.pdf

6.3. Annexure C: Ms N Xulu monthly reports


N Xulu Oct 2023 Monthly Report.pdf


N Xulu Nov 2023 Monthly Report.pdf


N Xulu Dec 2023 Monthly Report.pdf

6.4. Annexure D: Project Plan (Research Protocol & SOPs)

To be attached as part of the Q4 report

6.5. Annexure E: Food Safety Tests & Nutritional analyses

To be attached as part of the Q4 report

6.6. Annexure F: Value Chain Analysis, Market Assessment & Roadmap for the development of a kelp farming industry


South African Kelp Value Chain Analysis,