



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 2024)
	Quarter 2 (Jul – Sept 2024)
	Quarter 3 (Oct – Dec 2024)
	Quarter 4 (Jan - March 2025)

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)



Project Manager

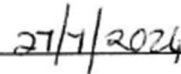


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Glossary of Terms

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 the Environment
DSI	Department of Science and Innovation
EA	Environmental Authorisation
EMPr	Environmental Monitoring Programme
FCDO	Foreign, Commonwealth & Development Office
FAO	Food and Agricultural Organisation
UNDP	United Nations Development Programme of the United Nations
GeO ₂	Germanium dioxide
POC	Paternoster Oyster Company
PM	Project Manager
PA	Project Assistant
PSSA	Phycological Society of Southern Africa
RAs	Research Assistants
RED	Research and Evidence Directorate within the FCDO
SA	South Africa
SB	Saldanha Bay
SABS	South African Bureau of Standards
SOP	Standard Operating Procedures
TOR	Terms of Reference
UNDP	United Nations Development Programme
UCT	University of Cape Town
UWC	University of the Western Cape
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 the 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 (SB)
- 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 to a broad stakeholder base, including the existing kelp industry and new potential entrants to lay down the stepping stones toward building a sustainable Kelp Aquaculture Industry in SA.

1.1 Project team & Project Delivery Chain Map:

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

The Project Sponsor/Funder representatives:

Ms Leanne Jones (Team Leader, Southern Africa Research and Innovation Hub [SARIH], FCDO).

Ms Kristin Klose (FCDO Technical Advisor - Science, Technology and Innovation)

Ms Nyameka Mbete// Mr Jaco Louw (FCDO Global Science Lead: Programmes and Finance)

The Implementation team:

Industry:

Mr Vos Pienaar (Chairperson of BSASA as lead implementation and host organisation, Imbaza Mussels)

Mr Meiring Tarrant (BSASA Secretary & Boland Financial Services)

BSASA member representatives and project participants:

Mr Schalk Visser (COO of Blue Ocean Mussels [BOM])

Mr Tiishetso Maswanganye (Farm Manager at BOM)

Mr Japie Louw/Marais Smith (Paternoster Oyster Company [POC])

BSASA appointed:

- Dr Lizeth Botes (Project Manager)
- Mr Musadiq Schalkwyk (Project Assistant)
- Ms Frances Hill (Research Assistant)
- Ms Nontobeko Xulu (Research Assistant)

Scientific Advisor: Emeritus Prof John J Bolton (Associated with University of Cape Town [UCT])

Government:

- Department of Forestry, Fisheries and Environment (DFFE) Representatives:
 - Ms Andrea Bernatzeder (Director of Aquaculture Innovations & Technology Development– strategic support)
 - Dr Brett Macey (Specialist Scientist: Aquatic Animal Health – scientific input)
 - Mr André du Randt (Scientific Technician: Environmental monitoring)
 - Ms Lisa Mansfield (Scientific Technician: Environmental interactions)
 - Dr Mark Rothman (Specialist Scientist: Inshore & Seaweed research)
 - Mr John Foord (Food Safety Officer)

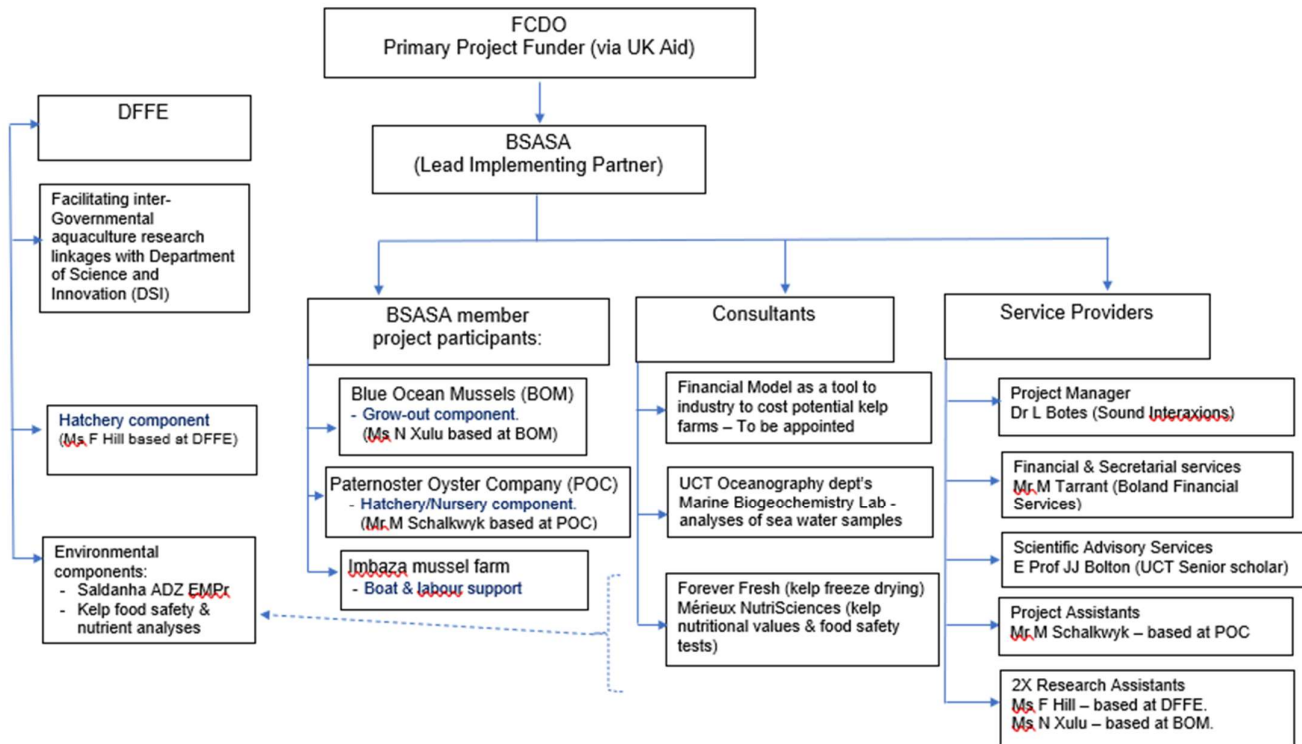


Figure 1. Diagrammatic summary of the Project Delivery Chain Map.

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

While the project only gained momentum around November 2022 when the Project Manager and the two Research Assistants were appointed, 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.

1.3 Phase 2: Year 2 (2023-2024):

During 2023-2024, the following milestones were achieved:

- ~ All three target species (namely *Laminaria pallida*, *Ecklonia maxima* and *Macrocystis pyrifera*) were successfully out-planted, although with varying success, on the grow-out structures within the first year of this project and preliminary data indicates that a seasonal opportunity for kelp farming in Saldanha Bay may exist (though we do not yet know if it will be possible to farm at a profit). This work is still on-going and will continue during 2024-2025.
- ~ In addition, *M. pyrifera* was grown from wild collected holdfast fragments and out-planted onto rope ladders suspended on mussel rafts and long-lines to evaluate the how the kelps grow on the different grow-out structures. In the new financial year, we will also explore two different rope structures (ladders vs droppers) suspended from long-lines.
- ~ *M. pyrifera* was sent for food safety and nutritional analyses including microbial tests. We aim to test *L. pallida* and *E. maxima* in the upcoming months which will mark the second season for grow-out in this project.
- ~ Environmental parameters were collected to obtain a full year's worth of data which is crucial for understanding the site-specific environmental trends that may influence the growth of the kelps in the bay.
- ~ A Value Chain Analysis, Market Assessment and Roadmap for the development of a kelp farming industry was successfully completed and well received at our annual Kelp Farming Information Session in Mar'24.
- ~ A collaboration with the UNDP has been established which will look at unpacking how best to involve coastal communities in the seaweed value chain.

1.4 Phase 2: Year 3 (2024-2025) Quarter 1 (Apr-Jun 2024):

With Ms I Meyer now working in the Netherlands, it was our hope that Ms F Hill could conduct the hatchery optimisation experiments as well as maintain the project spools at POC. However, the incubators again malfunctioned and it was subsequently agreed with the supplier to refurbish both incubators. While doing so, both incubators were upgraded with dimmable white lights to, in the short term, run the intended hatchery optimisation experiments. Both incubators were also fitted with red light fittings to use the incubators, in the long term, as a red-light chamber to keep gametophytes for extended periods of time. It was further decided that a Project Assistant (Mr Musadiq Schalkwyk) be employed at POC as of June 2024, so that Ms F Hill could focus on hatchery tasks at the DFFE based kelp hatchery. On the grow-out side, the unexpected success with the 8m long vertical droppers as opposed to the 2m wide ladders, with horizontal ladder rungs at 2m, 4m and 6m, resulted in the decision to move forward by out-planting additional droppers. Other than the collaboration with the UNDP to unpack the involvement of coastal communities in the seaweed value chain, a further development to collaborate with the University of the Western Cape (UWC) enabled the project to have Ms Waqeebah Moosa look into epiphytes and phytoplankton species which may affect the quality of kelp blades and possibly also the price when sold.

2. Progress on project objectives & deliverables

The sections below will build on the findings of the previous quarters in order to summarise the different project components and provide an overview of progress for the 2024-2025 financial year. The monthly progress reports of the Project Assistant and the two Research Assistants, attached as Annexures, provide more detail.

2.1 Hatchery technologies of targeted species:

➤ Kelp hatchery/nursery facility based at the DFFE Sea Point Research Aquarium:

The project spools that were seeded during the 3rd quarter of 2023 (at the end of Nov'23/beginning of Dec'23) of all 3 target species (collected from Jacobsbaai and Kommetjie) and maintained in the temperature-controlled rooms in the DFFE kelp hatchery were out-planted on rope ladder structures in mid-Apr 2024 and progress on the growth of these kelps are elaborated upon in the section 2.2. Subsequent to this outplant, it was decided to move forward in both hatcheries with the different stages as mentioned in the previous quarterly report (i.e. hatchery stage, nursery stage, weaning stage and the grow-out stage) which led to changes being made at the DFFE kelp hatchery to closely match the hatchery/nursery setup at POC. The main focus being, to reduce the time of the kelps in the DFFE based hatchery from ~4 months (as previously achieved) to ~2-2.5 months (which is the time the kelps at POC took to grow to 1cm and the preferred out-planting size in Saldanha Bay). In the new hatchery set-up, Ms F Hill has started new spools to compare the growth of the kelps in the new hatchery/nursery lay-out with those previously grown in jars for 4 months. Initial indications are that the sporophytes are already growing much better under the new lay-out. Additionally, Ms Hill used two different methods of blade processing and sporulation which at this early stage does not show any major differences, the progress of the sporophyte growth of these new trials will give clearer indications either way in the next quarter. For more details on the results to date, please see Annexure A.

In quarter 2, Ms Hill will be setting up the hatchery optimisation experiments in the incubators to test various parameters (i.e. different growth media, spore stocking densities, temperatures, light intensities etc.) in order to optimise kelp hatchery conditions.

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

Project spools emanating from Ms I Meyer's time at POC (Feb/Mar) were out-planted/hung on open holding ladders (weaning) on LL1 in May 2024 due to the challenges at the POC hatchery and no dedicated person to check on the spools. At the time of transferring the spools from the hatchery to grow-out, *M. pyrifera* was barely visible and, *E. maxima* was ~1mm, with only *L. pallida* at the desired size of up to ~1.5cm. All spools have remained in the weaning stage since. A check-up on the spools in Jun'24 indicated that *L. pallida* had grown to ~3cm which is ideal for unwinding (see figure 2), but the other two species did not show much progress in growth and are still too small for unwinding. A follow-up assessment on their growth will be done in Q2 and we are hopeful that all kelps will be large enough to be unwound onto vertical droppers during Jul'24.



Figure 2. *L. pallida* in weaning stage from 27 May – 19 June 2024. To be unwound in Jul'24 (photo credit Dr L Botes)

The on-going human resource challenges at both hatcheries has led to the appointment of a Project Assistant at POC in June 2024. Mr Musadiq Schalkwyk has had a steep learning curve and immediately had to set up new spools (with the assistance of Ms F Hill and Dr Botes) to verify the results previously obtained where kelps grew to 1cm within ~2.5 months. More information on the progress of these spools is available in Annexure B.

Moving forward, kelp spools will (at both hatcheries) be placed into jars for the first two weeks, which will serve as the hatchery stage. In the 1st week only Germanium dioxide (GeO₂) will be added, whereas in the 2nd week GeO₂ and growth medium (nutrients) will be added. The added benefit to using jars in the 1st two weeks is that it is more economical to add the costly GeO₂ to the smaller jar containers while reducing the risk of one contaminated spool affecting the whole batch. After two weeks, the kelps will be moved into larger tanks which will serve as the nursery stage with water changes and the addition of growth medium taking place once a week (the SOP outline in section 2.3 has therefore been amended accordingly). Once in the nursery stage (reaching ~1mm), filter pumps are added into the tanks to facilitate the movement of water, oxygen and nutrients and to help keep the water clean.

2.2 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 of the Bay (marked in red, see figure 3) and the other further away from the mouth (marked in blue, see figure 3). The ladder structures were 5m wide on the mussel rafts and are 2m wide on the long-lines. All ladders are a little over 6m long/deep with ladder rungs at 2m, 4m, and 6m depth. The intention with the ladder structures is to determine if the target species have a specific preference for a specific depth and if indeed the case, which depth that would be. This however provided a very one-dimensional view (i.e. horizontally) and the PM proposed to add vertical droppers to determine if the target species have a vertical range (i.e. summer range between 2-4m, and a winter range between 4-6m) which can be utilised which would be much more economical in terms of space as opposed to a horizontal long-line at a specific depth.

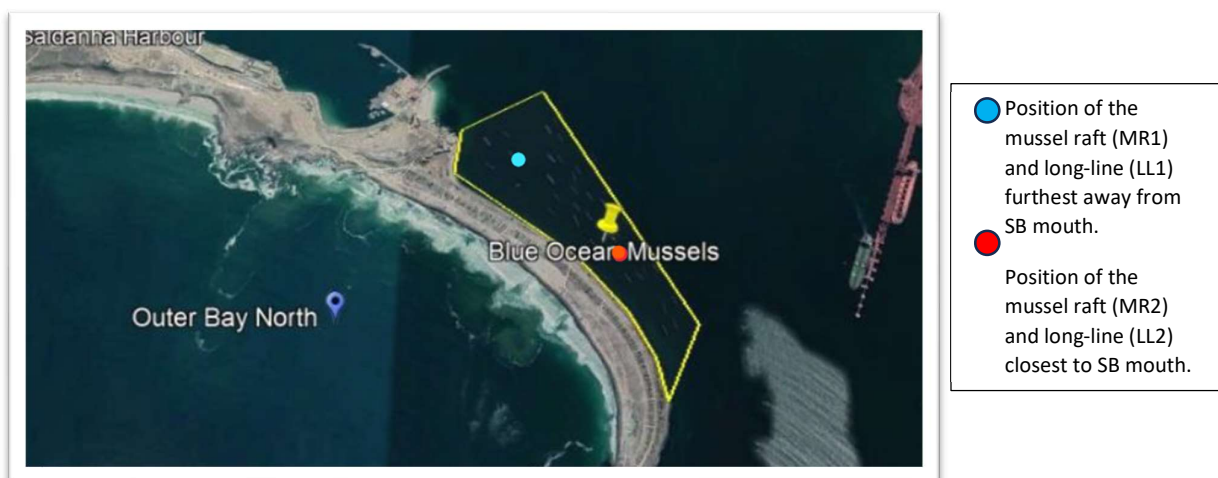


Figure 3. Blue Ocean Mussels (BOM) study site in Saldanha Bay (SB)

Second grow out season:

The project is now entering its second grow out season, and we have worked tirelessly to keep the momentum going despite the challenges that we experienced in the hatchery component. Figure 4 provides an overview of the kelps that have been out-planted in 2024.

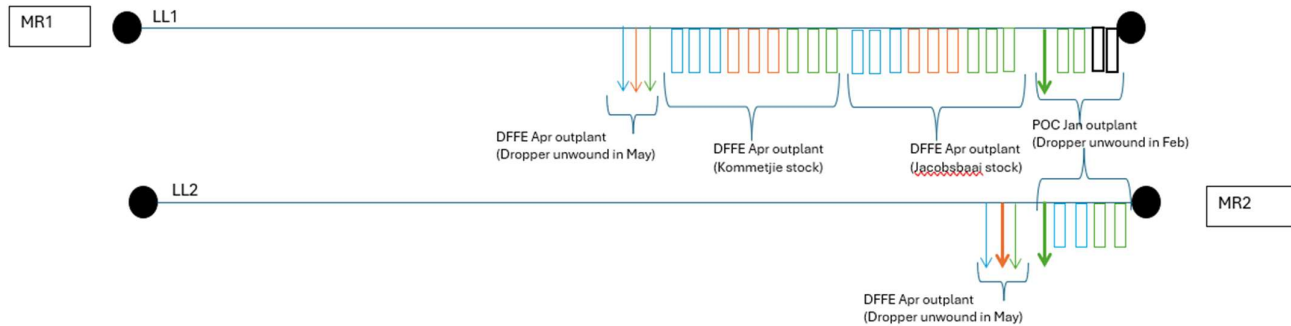


Figure 4. Summary of spools out-planted during 2024 on long-line 1 (LL1) and long-line 2 (LL2) with rectangles depicting ladders and arrows depicting droppers (Green=*M. pyrifera*, Orange=*L. pallida*, Blue=*E. maxima*). MR1 and MR2 indicate the two mussel rafts.

Jan/Feb'24 Cohort: *Ecklonia* and *Macrocystis* spools from POC

The best spools of this POC batch (initiated at the end of Oct'23) were out-planted on 26Jan'24 onto ladders, while those that looked a bit pale were hung (weaning stage) at LL1 on an open ladder until Feb'24, before being unwound onto droppers on 29Feb'24. This batch only contained *E. maxima* and *M. pyrifera* (*L. pallida* was lost during the festive season) and only *M. pyrifera* were out-planted on a vertical dropper at both long-lines as a trial. In the 2023-2024 Q4 report, a table was provided which captured the difference in the growth of *M. pyrifera* on the ladders and the droppers as well as the difference in biofouling on the grow-out ropes. A follow-up on the 2023-2024 Q1 report follows below:

On the ladders:

Initially, after a month, both species were very healthy and similar in size (~5cm) in the early stages, but by 20 Mar'24, although individuals of both species were reaching <20cm, *M. pyrifera* were much denser and appeared to be coping better with the competition (in particular from mussels and tunicates) than *E. maxima* that declined in numbers (with only 4 kelps left) likely due to it not being as able to compete for space as *M. pyrifera*. The kelps on the ladders have since grown with *M. pyrifera* reaching at most ~1.6m and *E. maxima* reaching at most ~60cm but it's worth noting that the blades of *E. maxima* at this point is in a very bad state likely due to the fact that it is growing much slower than *M. pyrifera* and thus less able to rid itself from the increasing biofouling/epiphytes. (see Appendix C - Ms Xulu's June report for more information).

On the droppers:

As previously mentioned, only *M. pyrifera* was, as a trial, out-planted on a vertical dropper (on both long-lines) in Jan'24. Ironically the kelps on the droppers have since outpaced those on the ladders despite the fact that they started off with a slight disadvantage as explained above. The mean total length measurements that were done by Ms Xulu and the Imbaza boat crew provide us with a good indication of the range where the kelps grew best in the period **between Jan-Jun'24** (see figure 5). On both long-lines the bulk of the yield were between 1-5m by Jun'24. It's worth noting that measuring the kelps were rather challenging due to the denseness of the kelps on both long-lines between 1-4m depth and thus worth double checking the measurements at 3m on LL2. As we get more comfortable working with the

vertical droppers, more measurements per depth will be taken to improve accuracy. Note that no kelps survived between 0-1m depth.

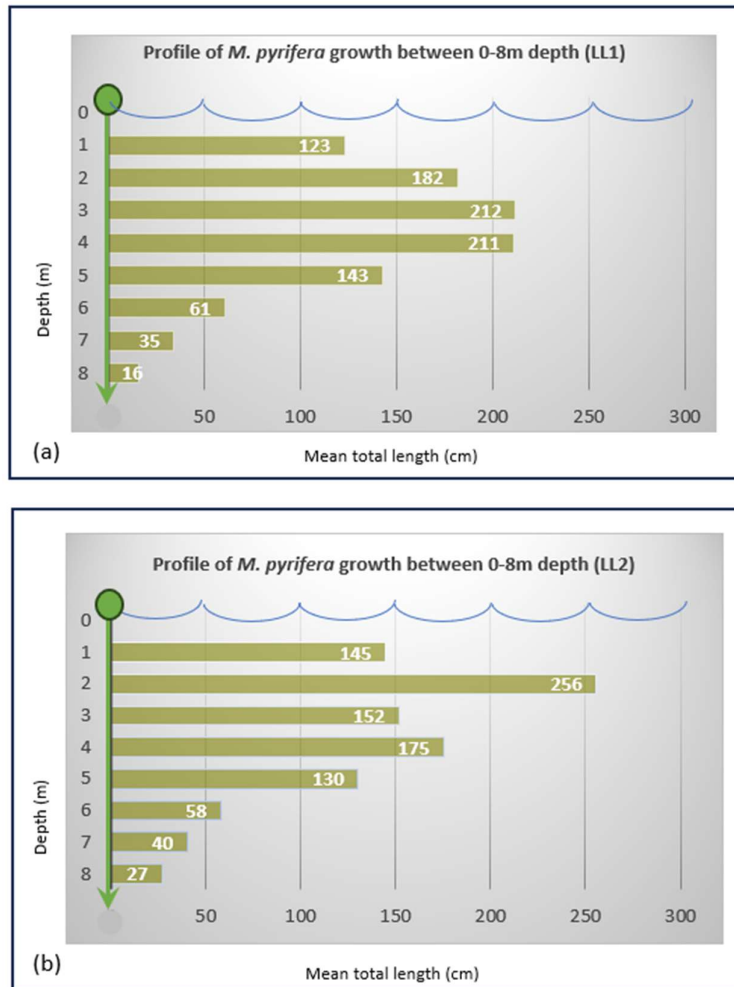


Figure 5. Mean total length of *M. pyrifera* on (a) long-line1 (LL1) and (b) long-line2 (LL2). The green arrow and float on top depict the actual dropper with the bars depicting the kelps at each depth within the water column (mean total length were calculated using the 3 longest kelps at each depth).

Apr/May Cohort: Spools of all three target species from DFFE

The best spools of this DFFE batch (initiated late Nov/beginning Dec’23) were out-planted on 17-18 Apr’24 onto ladders, while those that looked a bit small were hung (weaning stage) on an open ladder until May’24 when it was unwound onto droppers on 27May’24. This batch unfortunately was exposed to a temperature shock in transit from DFFE to BOM which resulted in most of the sporophytes of all three species to fall off the spools (see figure 6).



Figure 6. Kelp sporophytes that fell off the spools lying at the bottom of the transporting canister due to a temperature shock (Photo credit: Dr L Botes)

While we in the previous quarterly report referred to the fact that the kelps at 6m coped better due to periodic upwelling events from Oct'23 to May'24, this cohort shows that the kelps at 6m are doing better in comparison with 2m and 4m but this is a function of the set-up at the DFFE based kelp hatchery which at the time had the light source from the top resulting in the majority of the kelps developing better around the top of the spools (resulting in kelps being up to 1cm in size at the top and only a few millimetres at the bottom of the spool at the time of out-planting). When the spools were out-planted, the spools were unwound from 6m to 4m to 2m with the bigger kelps on the 6m rungs and the smallest kelps on 2m. Worth mentioning is that out of all the spools, the *Laminaria* spools were in the best condition at the time of out-planting.

On the ladders:

By the end of Jun'24, *Laminaria* ranged in size up to ~11cm, *Ecklonia* range in size up to ~1.5cm while *Macrocystis* range in size up to 2.5cm. The difference between species sizes is a function of the conditions and growth within the hatchery as explained above.

On the droppers:

While measurements are still to be made, inspections of the droppers by the end of Jun'24 indicated that since May'24 only *Laminaria* on LL2 made good progress with an even distribution of kelps from 1m down to 7m and ranging in size up to ~12cm. It does not appear that the quality and the size of the other two species were of such a nature that it could withstand the temperature shock experienced during transit.

May/Jul'24 Cohort 3: Spools of all the three target species from POC

The spools from POC (initiated in Feb/Mar'23) were out-planted on 27May'24 due to the staff shortage at POC to care for them and are currently hanging in weaning (see figure 7) and will all be unwound onto droppers in Jul'24.



Figure 7. *L. pallida* spool in weaning (Photo credit: Dr L Botes)

(b) Progress on monitoring of environmental parameters:

A full year of environmental parameters (i.e. water temperature, dissolved O₂ and pH) have now been collected with seasonal patterns between Jul'23 to Jun'24 clearly visible. It seems that from May through to October the water column (between 2-6m) is well-mixed and thus likely the best time period (as indicated in Diagram 2) to grow *M. pyrifera* in Saldanha Bay if grown on horizontal rope structures (this may however be different for vertical droppers). We hope to obtain more definitive data for *E. maxima* and *L. pallida* in the current grow-out season.

We are awaiting the last quarter's nutrient analyses data from the UCT Oceanography Department's Biogeochemistry lab but the data to date shows a steady decline in nutrients from Jul'23 to near zero between Oct'23-Nov'23 (and again briefly in Feb'24). It would be interesting to see if this year's data

shows a similar trend as it would confirm the likelihood of the end of the kelp growing season in Saldanha Bay as per Diagram 2.

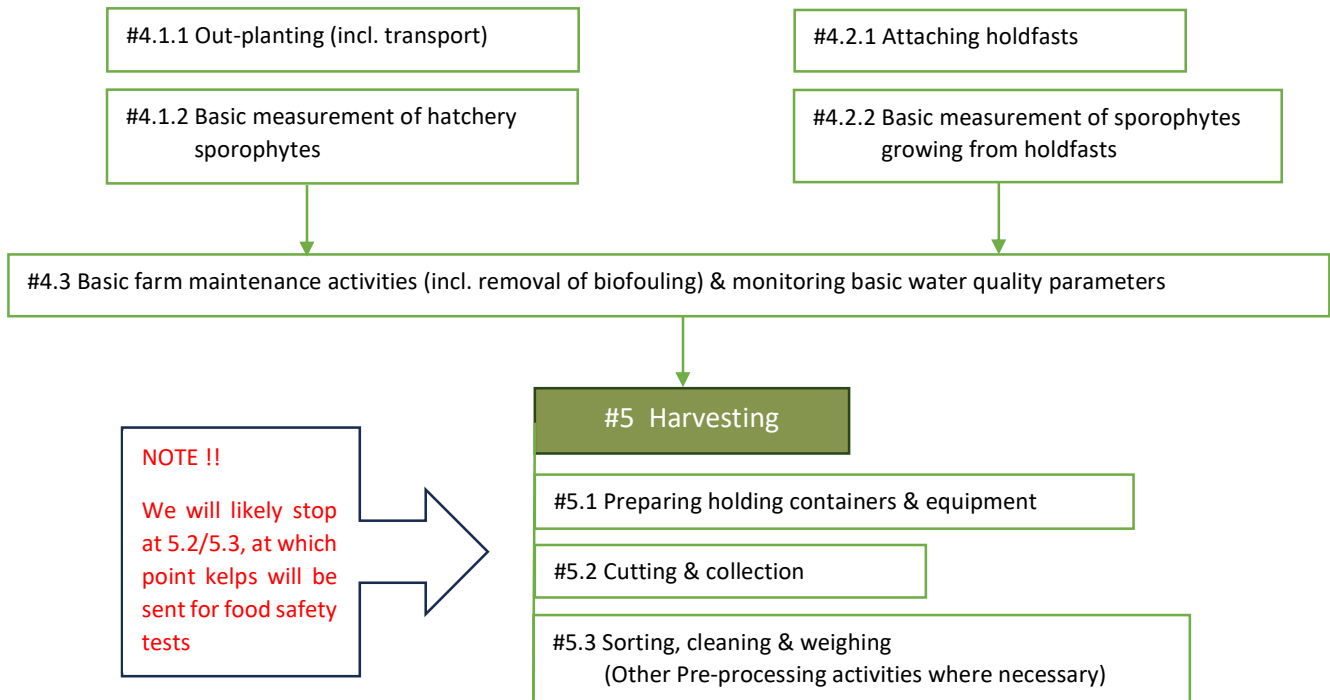
2.3 Updating of Project Plan (containing Research protocols & SOPs):

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 2.3 and 2.4 are attached and 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.

Kelp Standard Operating Procedures (SOP) Outline





2.4 Financial feasibility study for kelp farming in South Africa (re-directed to Integrated Financial Planning Model for Kelp Aquaculture in South Africa):

This component has been redirected to developing a financial forecasting model to provide those that are interested in starting a kelp farming business with a tool that will assist in making a "go /no-go" decision.

3. Challenges & Recommendations

3.1. Challenges experienced in each project component with accompanying recommendations

3.1.1 Hatchery technologies of targeted species:

Subsequent to the 2023-2024 Q3 & Q4 reports where concern was expressed regarding the shortage of staff to adequately address the various project components and to allow for healthy sporophytes to be out-planted during the second grow-out season, the PM requested a meeting toward the middle of the 1st quarter of the 2024-2025 financial year where the decision was made to appoint a Project Assistant that would be based at POC. Mr Musadiq Schalkwyk was subsequently appointed on 1 Jun'24 which then allowed for Ms F Hill to focus on hatchery activities at the DFFE based kelp hatchery and conduct the hatchery optimisation experiments in the refurbished incubators at Sea Point.

Recommendation:

It was recommended that the Ms F Hill purchase and install the necessary items for the DFFE based kelp hatchery to closely match the set-up in the POC based kelp hatchery and that trials be run at both

hatcheries as before. It has also been recommended that Ms Hill use the 0.22µm filtered and autoclaved sea water in the DFFE based kelp hatchery to reduce contamination.

POC is currently undergoing a lot of changes in their entire system as they are revamping the oyster hatchery and the associated inlet pipes. These changes have not yet been discussed with us and some concerns are now growing regarding how these changes will be affecting the incoming water at the POC based kelp hatchery and as such this needs to be investigated with recommendations to be made in due course.

3.1.2 Grow-out trials & monitoring of environmental parameters:

➤ **Grow-out facility at BOM's site**

During Q1 of 2024-2025, it became clear that the kelps on the horizontal rope ladder structures were not performing as well as those that were out-planted on the trial vertical rope dropper structures that were initiated by the PM in the beginning of Jan'24. Although it is not yet clear as to why this would be, it has since been confirmed by a research group in New Zealand that this phenomenon was not unique to our project, but that they too found that their kelps (even though the species used was *Ecklonia radiata*, a species also present in South Africa from our south coast up to the east coast) grew better on droppers rather than the long-lines commonly used in Europe and parts of the USA.

In terms of environmental monitoring, the difference in light intensity between the seasons is a rather important piece of the puzzle in our understanding of what the 3 target kelp species require. However, the light intensity data and the position of the HOBO light sensors have been in question and need to be investigated. Perhaps the sensors need to be moved to one of the long-lines (especially considering that this year all our kelps will be growing on the long-lines).

Recommendation:

During Q1 it was thus agreed that we would move forward with out-planting our next batches of spools on droppers (as opposed to ladders).

Mr Andre du Randt from DFFE has kindly agreed to visit the grow-out site on their next trip to Saldanha, as the PM explained that she suspects that since the equipment are being tied to a mussel raft that the shade from the mussel raft might interfere with the light sensor and it would be helpful if Mr du Randt could investigate a better way of attaching it (or moving it to LL2) .

3.2. General recommendations:

In Q4 it was recommended that the partners meet to discuss a co-funding model to further the support for the project.

Furthermore, the DFFE engagements with the Food and Agricultural Organisation (FAO) has led to funding that has been secured to "Catalysing Sustainable Aquaculture Systems for South Africa" where opportunities for kelp farming have been identified as one of the focus areas. Following the workshop that was held on 18 March 2024, the DFFE has indicated that further engagement with broader stakeholders will be held, and that co-funding would be key to cover all the 'wish list items' that require funding support.

To this end, the PM has called a meeting with the project partners to discuss possible co-funding opportunities and a list of possible funders with contact details are currently being compiled. Once this has been completed,

it is recommended that we put a project sub-committee together to assist the project with the best way to apply for co-funding aimed at specific funders which could co-fund specific project components.

4. Collaborations

4.1. Collaboration with the University of the Western Cape (UWC):

As the SA Kelp Farming project progressed, it became evident that more information would be required about factors which could potentially influence the blade quality of farmed kelp. Since the project deliverables did not originally include investigations into kelp blade quality, Dr Lizeth Botes obtained approval from the project partners to establish a collaboration with the UWC (via Prof Gavin Maneveldt) in the form of a Master's degree to identify the epiphytic species that grow on the farmed kelps, determine their onset and track their overall distribution across the kelp blades over time. The blades of each species will be harvested monthly at various depths, photographed for the determination of the fouled area using ImageJ, and processed accordingly for the identification of the various epiphytic species. Additionally, the surrounding water will be sampled to survey the presence of toxic phytoplankton species and their potential to possibly becoming epiphytic. The results of this study will provide potential kelp farmers with insights into which epiphytes and phytoplankton species may affect the quality of the kelp blades and possibly also the price when sold.

Apart from the library of species that are being compiled since the start of monitoring in May'24 on *M. pyrifera*, the data collected to date shows that there was an increase in the different types of epiphytes present from May'24 to Jun'24. Similarly, the %coverage on the kelp blades increased from May'24 to June'24 on LL1 by 28.5% and on LL2 by 38.72%. This is in agreement with our observations during 2023-2024 where we observed more fouling on the structures and kelps closer to the mouth. For more information and pictures of the epiphyte species present on *M. pyrifera*, please see Ms Waqeebah Moosa's monthly reports attached in Annexure D.

Preliminary phytoplankton data of samples taken on 9 May 2024, shows that phytoplankton were more abundant in the upper layer (0 – 3 m) of the water column compared to the lower layer (4 – 6 m). In the upper layer, dinoflagellates were more abundant, specifically those within the *Ceratium* genus (e.g. *C. dens*, *C. furca* and *C. lineatum*). There were fewer diatoms in the upper layer and those that were present, were centric diatoms from the *Coscinodiscus* genus (mainly *C. granii* and *C. sterallii*). In contrast, diatoms were more abundant in the lower layer of the water column, especially chain-forming centric diatom species. Chain-forming diatoms were largely from the *Chaetoceros* and *Leptocylindricus* genera. For both the upper and lower layer it appeared that flagellate species were a rare occurrence, except for the *Dictyocha octonaria* species, which was only found at LL2 at a depth of two meters.

However on 12 June'24, species richness was much higher in the upper layer between 0 – 2 m of the water column compared to deeper down in the water column where hardly any phytoplankton were present on the day of sampling. In samples that did contain phytoplankton, the most abundant species were dinoflagellates (specifically the *Ceratium* spp.) and flagellates (specifically *Dictyocha octonaria*).

Ms Moosa is still in process of ascertaining how best to present the data as she is currently having challenges with light exposure while capturing images of the blades on the boat, species identification as well as mastering the phytoplankton cell counts on the Sedgewick rafter chamber.

4.2. Collaboration with the United Nations Development Programme (UNDP):

During our March 2024 Kelp Information Session, Ms Simone Smit provided background to the activities of the UNDP related to seaweeds and indicated that the collaboration with the Kelp Farming Project to unpack the involvement of coastal communities in the seaweed value chain is crucial and will involve a further three workshops over the coming months.

Since then, Bio Soluciones Técnicas (BST) has been appointed as the service provider to roll out the UNDP Project namely: “Exploring Seaweed Cultivation and Value Chains for Enterprise Development” and the workshop dates have been released and will take place on 12 Aug’24 (Saldanha Bay), 14 Aug’24 (Velddrif) and 16 Aug’24 (St Helena Bay). It will be followed by a virtual workshop to close the series off, the date of which to still be announced.

As part of the collaboration, the PM will on behalf of the project present the progress and lessons learnt to date on the aforementioned dates.

4.3. Collaboration with the Phycological Society of Southern Africa (PSSA):

Following fruitful discussions between the Project Manager and the current President of the Phycological Society of Southern Africa (PSSA), Dr Mark Rothman (previous PSSA President) facilitated a meeting with the PSSA website designer to include a page dedicated to the SA Kelp Farming Project where stakeholders and interested parties can access relevant information on the project, research outcomes and reports etc.

5. Lessons learnt and observation relevant to industry

For the sake of continuity, this section will remain in the report to be updated and expanded upon as data becomes available. For ease of reading, the newly added sections will be in added in blue text.

➤ Production cycle

In land-based aquaculture farm facilities the Production Cycle is well known to include the following production stages i.e. Hatchery (where parent stock are maintained indoors to produce offspring), Nursery (where offspring are reared indoors until big enough to be introduced to a semi-outdoors area), Weaning (where offspring are being transitioned to better equip them to being grown outdoors), Grow-out (where offspring are maintained outdoors until market size is reached).

[Note Processing related activities are not being discussed here as it has not yet been our focus].

Initially we have taken the approach to move kelp sporophytes which are barely visible with the eye from the hatchery directly to grow-out and immediately out-planting and exposing them to the outside environmental elements without intermediary stages. While this approach may well work elsewhere (in calmer waters with less biofouling), we have found that having all the stages as explained above are more successful in Saldanha Bay as the out-planting site. The inclusion of the intermediary stages i.e. nursery (where sporophytes were grown to ~1cm even though we eventually end up having to accept some degree of green algae contaminants) and weaning (where spools were hung for ~3 weeks before being unwound) have allowed the kelps from the nursery to have a better chance to compete with siltation and biofouling when out-planted in Saldanha Bay while the weaning stage has repeatedly proven to be successful

providing the kelp sporophytes approximately 2-3 weeks to acclimatize especially if the travel distance between the hatchery site and the grow-out site is far. However, the other school of thought to outplant the hatchery spools as soon as possible before hatchery contamination sets in and when the sporophytes are less than 1cm in average length, is equally valid thus each potential kelp farmer will have to assess the two options and see which will work the best depending on the distance between the hatchery and grow-out as well the conditions at the grow-out site.

Hatchery/Nursery component

Although we are still in the process to research the developmental stages of the three target species and hoping to obtain detailed hatchery optimisation results for the development of future kelp hatcheries, diagram 1 aims to provide a general timeline that will be useful to a future kelp farmer in terms of planning bearing in mind that this time-line may or may not be different for each of the target species. In the case of this project, we have also seen that the time-line between the two hatchery sites is different and we hope to streamline the set-ups in the coming months to see if we can get similar outcomes at the two sites.

Transporting from Hatchery/Nursery facility to Weaning/Grow-out facility

When transporting the kelp sporophytes to the grow-out site, it is important to be acutely aware of the fact that this very activity, if not done carefully, could potentially be the cause of obliterating 2-3month's worth of nurturing one's kelps. Therefore, when planning to transport one's kelp sporophytes from the hatchery to the grow-out site (and depending on the distance to be travelled) it is important to choose a cool overcast day especially if one does not have access to a vehicle with air conditioning. Care should be taken to maintain the appropriate temperature (which is dependent on the species that are being transported) in the transporting canisters and cooler containers, and to note the sea temperatures where the kelps will be out-planted to as far as possible prevent the kelps from getting a temperature shock either from heating up in the vehicle and then out-planted in cold water or from putting it into canisters and coolers where it is too cold and then being out-planted in water that is much warmer.

Out-planting

When considering a day to out-plant, it is important to select a day (www.windguru.cz) that is cool with little to no wind for ease of working on the boat. If the boat has a cabin, put the coolers with canisters containing the spools with sporophytes in the cabin until you reach the out-planting rope structures. It would be advantageous to look at the days prior to the out-plant day and consider which winds were blowing and what the prevailing sea surface temperatures are (and even to obtain a vague idea of which winds may have resulted in a nutrient influx). If possible, overcast days during April with water temperatures between 12-15°C would be ideal. When the coolers with canisters (containing the hatchery spools) arrive, it is worth recording the air temperature inside the cooler, as well as the water temperature inside the canister for record keeping purposes. If possible, all should be between 12-15°C and as closely matched to the sea surface temperature where the unwinding of spools onto the grow-out rope structures will take place if one chooses to unwind the spools immediately. Alternatively, if it is preferred to attach the spools at a certain depth (see weaning paragraph below) for the sporophytes to acclimatise then it would be better to consider the water temperature at the preferred depth to avoid giving the sporophytes a temperature shock.

Weaning/Grow-out component

We have repeatedly had success with the method of hanging spools at the preferred depth for 3-4 weeks

(depending on the size of the sporophytes when out-planted) without unwinding the spools, serving as a weaning stage. As soon as sporophytes reached 2-3cm, the spools were removed and unwound on the desired out-planting rope structures, serving as the grow-out stage and at which point kelps can be monitored for growth on a monthly basis. It should be noted though that it is advised to unwind the spools when the sporophytes reach 3cm and not to wait until they are 4cm or bigger, as at that point the holdfasts of the sporophytes extend over the hatchery twine and when being unwound one run the risk of damaging the holdfasts.

➤ General time-line

Diagram 1 & 2 provides a general timeline (based mostly on *M. pyrifera*) that will be useful to a future kelp farmer in terms of planning. This timeline may or may not be entirely different for each of the target species and we hope to update it in the coming months once the hatcheries have been stabilised and if/when more species-specific data becomes available.

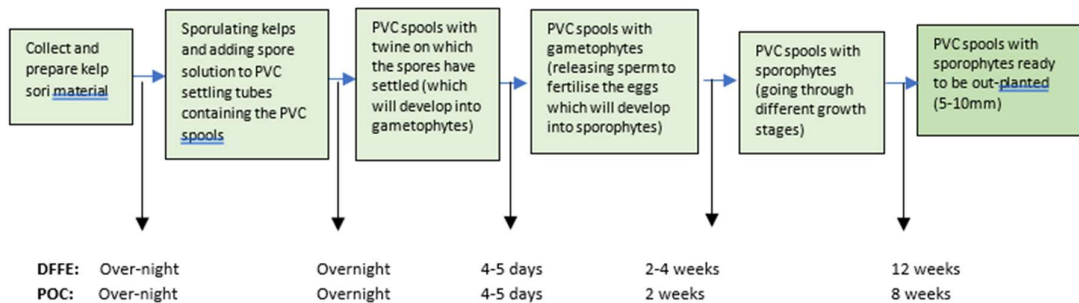


Diagram1: Time-line of all 3 species from collection of kelp sori to sporophytes ready for out-planting (~ 2 months at POC and ~3 months at the Sea Point based hatchery).

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Kelp cycle	1. Collecting kelp to stock up hatchery spools 2. Kelp spool care & maintenance (see together with diagram 1)			3. Out-planting of hatchery spools (Temps preferably ≤15 °C)		4. Monitoring-kelp growth & biofouling 5. Inspections & infrastructure maintenance (especially after storms)			6. Harvesting		7. Removal & cleaning of infrastructure/structures 8. Pre-processing & Processing activities	
Possible risks	Biofouling & siltation season									Extremely low Nitrogen based nutrient conc's		
										Biofouling & siltation season		
	Phytoplankton blooms & low O2 events											
Benefit	Decreasing temperatures with ad hoc upwelling events			Cooler water temperatures						Increasing water temperatures with ad hoc upwelling events		

Diagram 2: Kelp farming cycle time-line (from hatchery spool out-planting to harvesting takes approximately 6 months (TBC/spp))

~ In terms of sori collection:

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.

~ In terms of the production stages:

For hatchery grown sporophytes that will be grown in Small Bay (Saldanha Bay), it is important to establish the time necessary for each of the 3 target species in the hatchery and the time available to grow the target species out in the bay. 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 biofouling in 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. For kelp farming site in Big Bay (Saldanha Bay) or a site other than in Saldanha Bay, this may be different.

We trialled two different techniques:

- At the DFFE based hatchery; we kept sporophytes of all three species for as long as possible in jars to minimise contamination and to see how big the sporophytes would get. Here we found that the sporophytes eventually stagnated around a few millimetres and struggled to reach the desired size of 1cm while contamination was generally kept to a minimum but eventually crept in after 3months.
- At the POC based hatchery; we kept the spools in jars for ~3weeks (with no water movement and/or aeration) serving as the hatchery stage. After ~ 3 weeks we moved the spools into tanks (with no water movement and/or aeration) but when the sporophytes reached 2-3mm, we introduced a filter pump to add air and water movement to circulate the nutrient containing water until the sporophytes reached approximately 1cm (serving as the nursery stage and taking ~2.5 months) and at which point they could be out-planted. The trade-off here is that if any contaminants are present at this stage, that these too would start to make its appearance and start to grow. At this point it is important to assess the sporophyte sizes and contamination present in the tanks vs the biofouling present at the grow-out site and make a judgement call as to where the sporophytes would cope the best in order to determine the best time for out-planting. In our case at our Saldanha bay site at BOM, we found that out-planting ~1cm sporophytes had a better chance of survival.

~ In terms of out-planting:

Based on observations on our out-plantings at BOM in Small bay (Saldanha Bay), which have taken place between May and August during 2023 and January 2024, from an industry point of view it may be preferable to out-plant after February or as soon as biofouling and siltation subsides (possibly even after March) and water temperatures drop below 15 °C. This has proven to work well for *M. pyrifera* in Small Bay (Saldanha Bay), which grew well over the winter months through to spring (Oct) as it is likely to be 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.

However, the above may be different if these three species were out-planted in Big Bay (Saldanha) which is likely to have more water motion. It may well be that *E. maxima* will grow better in Big-Bay (as opposed to *M. pyrifera* that seems to grow well in Small Bay). In areas more exposed to the open ocean such as Kommetjie and St Helena Bay, mean water temperatures may well be cooler in summer than in winter due to upwelling events during the summer months and thus result in a different outcome.

~ In terms of growth rate:

Although our grow-out site at BOM is closely situated to the mouth of Saldanha Bay, it is important to keep

in mind that it is based within Small Bay (Saldanha Bay) which is very sheltered with little water flow/circulation during summer resulting in minimal nutrient influx between October and December. In this context, of the 3 target species, *Macrocystis* (which grew well over the cooler winter months) has to date been the only species that has grown fast enough to outcompete the biofouling species and be harvested for food safety tests. *Laminaria* (although a species which we expected to cope better over the summer months) did not grow fast enough over the warm summer months to outcompete the biofouling and deal with the deteriorating water quality and low level of nutrients over the summer months. Although *Ecklonia* was successfully out-planted in Jan'24, it too was not able to outcompete the competing biofouling species and by Mar'24 very few individuals were present on the rope structures. However, it is still too early to make a final verdict on any of the 3 target species as we have had to deal with many challenges in the hatchery and grow-out components which affected our ability to out-plant healthy specimens when the timing would have been more appropriate.

~ In terms of the growth of the kelps at different depths and different grow-out rope structures:

From the data that we have collected to date on the rope ladder structures (although not finalised), it appears that for future kelp farmers wanting to farm with horizontal rope structures, that their main rope-line may have to be between 2-4m during winter while 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.

From the data that we have collected to date on the vertical dropper rope structures, initial data confirms that droppers of ~6m long/deep will likely be a better option and certainly more economical in terms of space. In the case of *M. pyrifera* the bulk of the yield by Jun'24 was between 1-5m on both long-lines. This may indicate that if one were to out-plant on droppers that it may well be possible to outplant as soon as January which would provide for a significantly longer out-planting season than indicated in Diagram 2 (which was based on data collected from rope ladders). Although the droppers were seeded from the surface (0m) all the way down to 8m, no kelps survived between 0-1m thus it will likely only be necessary to seed the dropper from 1m downwards so no hatchery twine with healthy sporophytes goes to waste. During upcoming months, it will be interesting to observe if the *M. pyrifera* sporophytes which contain floats and situated between 5-8m are able to grow toward the surface. Similarly, we are look forward to report on the droppers with *L. pallida* and hope to add *E. maxima* droppers to establish their vertical profiles and how they would fare on the droppers.

~ In terms of nutrients

Nutrient data from Jul'23- Mar'24 (see N. Xulu March 2024 report containing nutrient analyses conducted by UCT) shows nutrient concentrations at 2m, 4m, and 6 meters at the BOM grow-out site. Although site-specific, the data shows how nutrient concentrations decrease from Jul'23 to Oct'23 with extremely low concentrations during Oct-Nov'23 which extends in the case of Nitrate, Nitrite and Ammonium into Jan'24 likely due to the high productivity in Small Bay during this period and certainly creating a challenging environment for kelps to cope with and grow in.

~ In terms of biofouling succession:

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*). Based on our observations, biofouling starts annually as early as

October and only seem to dissipate during March. On our structures at BOM, over the last year we started seeing a crustose Bryozoan *Membranipora* species on the blades from Oct'23 and some *Ulva* spp. on the ropes. By Nov'23 biofouling on the ropes progressed to 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*. From time to time, we also experienced a slimy covering on our ladders. 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. During Jan'24, we installed new rope structures and soon thereafter all the rope structures were completely covered with skeleton shrimps so much so that it was impossible to see any rope. However, during Feb'24, skeleton shrimps and small mussel spat were only present on the rope of the 6m ladder rung, while the 2m and 4m rungs were mostly covered in *Ulva* species. By Mar'24 the mussels and tunicates populated the ladders rungs to the degree that it is literally squeezing out the kelps.

Although there appear to be differences between sites in biofouling, and even within sites, it is almost certain that all sites will experience some degree of siltation and biofouling annually during October - March and therefore, the biofouling season as indicated in diagram 2 is something that will have to be considered when farming with kelps in Saldanha Bay.

6. Networking

The PM attended the Earthshot prize networking evening with Ms Kristin Klose from the FCDO on 29 Apr'24 where discussions with Ms Kitty Garraway (Earthshot prize Chief of Staff) around building a Seaweed Networking platform with their Global Alliance of partners took place.



Figure 8. From left to right Ms Kristin Klose, Ms Kitty Garraway, Dr Lizeth Botes

7. Project partner support and skills transfer

Over and above the research guidance and mentorship that the Research Assistants and the Project Assistant receive from Dr Lizeth Botes, Emeritus Professor John Bolton, Dr Brett Macey and Dr Mark Rothman as their supervisors, there has been a constant two-way workplace skills transfer with the project partners assisting, supporting and teaching the young Research Assistants and Project Assistant the necessary skills to do their respective tasks but also for the Research Assistants and the Project Assistant to transfer the knowledge they are gaining to the respective project partner employees.

(a) At the hatchery sites:

At POC, the skills transferred from Ms Imke Meyer to Mr Philip Sithole were key in assisting the project with hatchery preparations and daily monitoring of kelps which is now being conducted by the recently appointed Project Assistant Mr Musadiq Schalkwyk who were trained up by Dr Lizeth Botes and Ms Frances Hill.

Figure 9. Mr Musadiq Schalkwyk (Project Assistant) to the left and Mr Philip Sithole (POC employee) to the right, both attending to the daily hatchery tasks.



At DFFE, laboratory skills are being transferred from Ms Lisa Mansfield to Ms Frances Hill while Ms L Mansfield learns about kelp hatchery methodologies.

Figure 8. Ms Frances Hill and MS Lisa Mansfield attending to the kelps in the DFFE based kelp hatchery.



(b) At Grow-out:

At BOM, the assistance and support from Mr Tiishetso Maswanganye (BOM farm manager) and other BOM employees to the project is crucial to the project's success while workplace skills are transferred between BOM employees and the Grow-out Research Assistant Ms Nontobeko Xulu.

Figure 9. Ms Xulu in the front left, Mr Maswanganye to the right and Mr Phumlani Ngomsi (BOM employee) at the back busy with rope preparations for out-planting.



Figure 10. Mr A. du Randt from the **DFFE** providing technical assistance with monitoring equipment.



The **Imbaza** Mussel farm boat crew members have been a constant support to the project in every out-plant to date, assisting us with installing and cleaning rope structures for out-planting, and monitoring the growth of the kelps as well as taking part in the environmental monitoring activities.

Figure 11. Kelp out-planting team:

Back row left to right (Imbaza employees):

Mr Cobi Adams, Mr Luntu Magopeni, Mr Elvis Ngwenze, Mr Benny Sikolweni

Front row left to right:

Ms Nontobeko Xulu, Dr Lizeth Botes, Ms Frances hill



The Out-planting team teaching the UWC students (Ms Waqeebah Moosa and Ms Zizopho Mfaku) how to take water samples with a Niskin bottle.



Figure 12. From left to right; Mr Elvis Ngwenze, Ms Nontobeko Xulu, Ms Zizopho Mfaku and Ms Waqeebah Moosa.

8. Closing remarks & thinking ahead

8.1 Closing remarks:

We are hopeful that the changes that have been made in the hatchery components will deliver exciting data, a sneak peek into the Jul'24 data certainly is indicating that the two hatcheries are now on track to deliver similar results in which case the lessons learnt section will be updated once confirmed. We are also looking forward to the much-needed hatchery optimisation results as well as the data on the progress of the percentage cover of epiphytes on the kelp blades over time. The progress on the collection of phytoplankton data will likely also dovetail well with the environmental data in particular the dissolved O₂ and nutrient data. In Q2 we also hope to send blades of *M. pyrifera* for biotoxin analysis to the University of Stellenbosch's Mass Spectrometry Unit to provide insights into whether or not the kelps bioaccumulated phycotoxins during the toxic phytoplankton blooms which occurred during the first half of the year which affected the surrounding mussel and oyster farmers.

8.2 Anticipated work for 2024-2025

2024-2025												
Project deliverable	Quarter 1			Quarter 2			Quarter 3			Quarter 4		
	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Hatchery/Nursery trials												
Grow-out trials												
Environmental monitoring												
Epiphyte & phytoplankton monitoring												
Food Safety Testing												
1. Testing farmed kelp - biotoxin analyses												
2. Testing farmed kelp - nutritional analyses												
Financial model- kelp farming forecasting tool for industry												
1. Drafting of TOR												
2. Sourcing consultant												
3. Study commence												
Project webpage to be embedded with PSSA website												
Stakeholder Engagements:												
1. UNDP workshop/meeting with community members to unpack possible involvement												
2. Kelp project Information session												
PM physical check of assets at all sites												
Reports & Budgeting												

9. Acknowledgements

The PM would like to thank (on behalf of the BSASA and the implementation team) the FCDO for the continued funding support, and the entire project team as well as the external consultants for their respective contributions to the deliverables of Q1 which contributed toward the contents of this report.

10. Annexures

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

10.1. Annexure A: Ms F Hill monthly reports



F. Hill- Apr'24
report.pdf



F. Hill- May'24
report.pdf



F. Hill- Jun'24
report.pdf

10.2. Annexure B: Mr M Schalkwyk monthly reports



M. Schalkwyk - Jun'24
report.pdf

10.3. Annexure C: Ms N Xulu monthly reports



N.Xulu- Apr'24
report.pdf



N.Xulu- May'24
report.pdf



N.Xulu- Jun'24
report.pdf

10.4. Annexure D: Ms W Moosa UWC monthly reports



W. Moosa- May'24
report.pdf



W. Moosa- Jun'24
report.pdf

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

Please note that the SOP's are currently work in progress and thus drafts. All SOP's will be updated and finalised toward the end of the project.



SOP 2.3.pdf



SOP 2.4.pdf