

South African Kelp Farming Project (SA KFP) (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 & 4 (Oct'24 – Mar'25)

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.

POC YES/NO

BOM YES/NO Few small items must be found

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


Since Ms F Hill's last experiment is running into late April, the asset check will be done at the end of Apr'25.

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

02/04/2025

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Glossary of Terms

AASA	Aquaculture Association of Southern Africa
ADZ	Aquaculture Development Zone
AMC	Aquaculture Management Committee
ASTRAL	All Atlantic Ocean Sustainable, Profitable & Resilient Aquaculture
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
GeO ₂	Germanium dioxide
IUCN	International Union for Conservation of Nature
NOAA	National Oceanic and Atmospheric Administration
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
SARIH	Southern Africa Research and Innovation Hub
SOP	Standard Operating Procedures
TOR	Terms of Reference
UCT	University of Cape Town
UK	United Kingdom
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UWC	University of the Western Cape

1. Introduction

The Foreign, Commonwealth & Development Office (FCDO) deliver science and technology partnerships to maximise the UK's development impact internationally and it is within this context that the South African Kelp Farming project was commissioned.

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 BSASA's implementation team. The Saldanha Bay Aquaculture Development Zone (ADZ) was identified as the study area for grow-out trials where oyster and mussel farming infrastructure & structures (similar to what is required for kelp farming) as well as authorisations and leases were already in place. Phase 2 was conducted over a 30-month period, and focussed on the following activities:

- Refining kelp hatchery/nursery technologies
- Trialling kelp weaning/grow-out technologies in Saldanha Bay (SB)
- Assessing kelp quality for 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
- Developing a basic Excel spreadsheet-based kelp financial forecasting model & an associated Business Planning Guide for kelp farming in South Africa.

The overall goal of the project is to disseminate information and research results to a broad stakeholder base, including the existing kelp industry and potential new entrants to lay the foundations toward building a sustainable Kelp Aquaculture Industry in South Africa (SA) and the region.

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 (FCDO Programmes and Finance Manager for the SARIH)

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 Tiishetso Maswanganye (Farm Manager at Blue Ocean Mussels [BOM])
 Mr Japie Louw/Marais Smith (Paternoster Oyster Company [POC])
 Mr Kevin Ruck (Blue Sapphire Pearls)

BSASA appointed:
 Dr Lizeth Botes (Project Manager from Sound Interaxions)
 Mr Musadiq Schalkwyk (Project Assistant)
 Ms Frances Hill (Research Assistant)
 Ms Nontobeko Xulu (Research Assistant)

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

Ms Waqeehah Moosa (Collaboration with University of the Western Cape [UWC])

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)

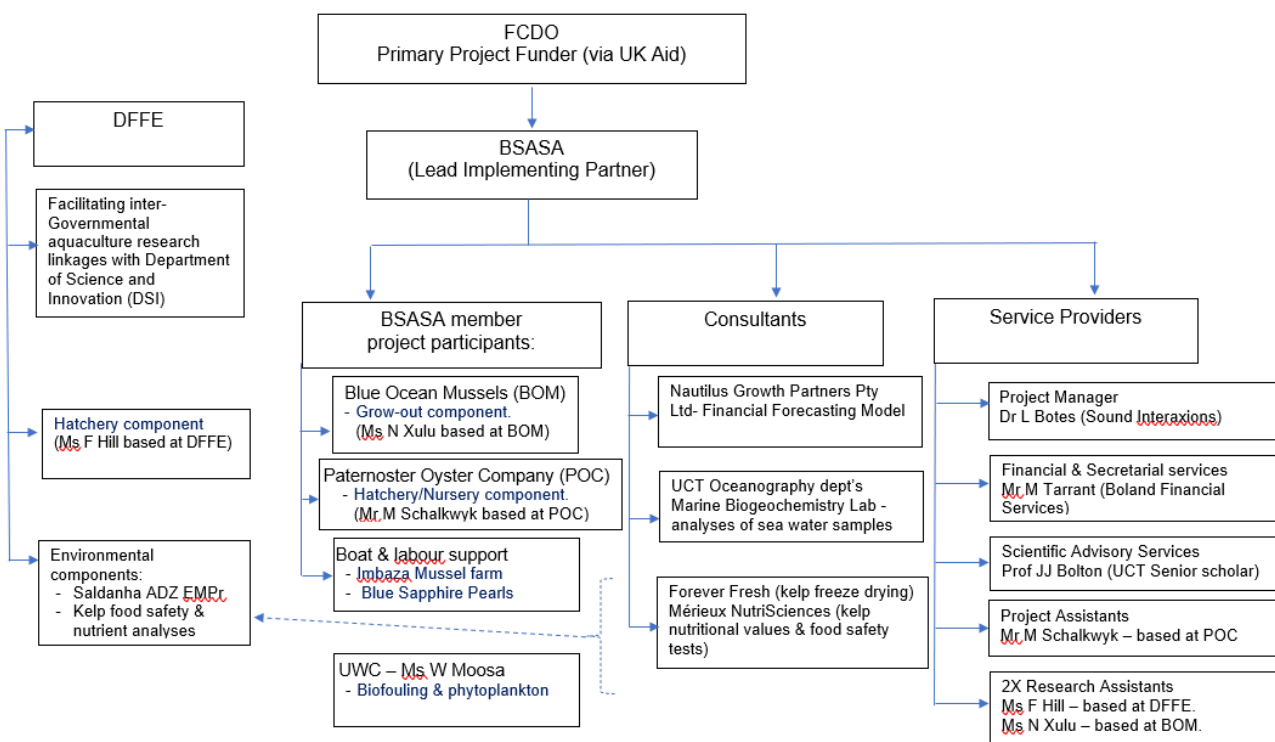


Figure 1. Diagrammatic summary of the Project Delivery Chain Map.

1.2 Project Oversight:

General monthly online Team meetings were held between the Project Implementation Team and the FDCO and feedback on the budget spent was provided on a quarterly basis by Mr Meiring Tarrant and Dr Lizeth Botes while strategic inputs were provided by Ms Kristin Klose, Ms Nyameka Mbete, Ms Andrea Bernatzeder and Mr Vos Pienaar.

Additionally, monthly in person Research Meetings were held at the DFFE Sea Point Marine Aquaculture Research Facility where research guidance and direction were provided by Dr Lizeth Botes, Dr Brett Macey, and Prof John Bolton (as the Project's Scientific Advisor). The two Research Assistants namely Ms Frances Hill and Ms Nontobeko Xulu (both registered with the UCT) were supervised by Prof. John Bolton, Dr. Lizeth Botes, Dr Brett Macey and Dr Mark Rothman, while Ms Waqeehah Moosa and Ms Zizopho Mfaku (both registered with the UWC) were supervised by Dr. Lizeth Botes and Prof. Gavin Maneveldt (UCW).

Dr Brett Macey and Dr Lizeth Botes provided day-to-day supervision and guidance to Ms Frances Hill while Dr Lizeth Botes provided day-to-day supervision and guidance to Mr Musa Schalkwyk and Ms Nontobeko Xulu.

1.3 Phase 2: Year 1 (2022-2023) summary:

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. Some of the milestones included undertaking the Risk Assessment and Environmental Monitoring Plan which contributed to the amendment to the Environmental Authorisation for the ADZ to include all indigenous seaweed species. More detail on progress during those months were captured in the 2022- 2023 Project year-end Report.

1.4 Phase 2: Year 2 (2023-2024) summary:

During 2023-2024, the following milestones were achieved:

~ All three target species (namely *Laminaria pallida*, *Ecklonia maxima* and *Macrocystis pyrifera*) were successfully cultured and 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 how the kelps would grow on the different grow-out structures. In 2024-2025, two different rope structures (ladders vs droppers) suspended from long-lines will be investigated.

~ *M. pyrifera* was sent for food safety and nutritional analyses including microbial tests with the intention to continue this work to include testing of *L. pallida* and *E. maxima* during the second grow-out season in 2024-2025.

~ Environmental parameters were monitored in detail 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 Sharing Workshop in Mar'24.

~ A collaboration with the United Nations Development Programme (UNDP) was established which will focus on exploring involvement of coastal communities in the seaweed value chain. The project "Exploring Seaweed Cultivation and Value Chains for Enterprise Development" will be rolled out in 2024-2025.

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

After the Ms Imke Meyer (the Oyster hatchery manager at POC) who was trained in hatchery kelp methodologies during Phase 1 of the SA KFP, left South Africa to take an exciting opportunity at Seaweedland in the Netherlands, we had hoped that the Research Assistant, Ms F Hill, could conduct the hatchery

optimisation experiments at POC while maintaining the project spools at DFFE. However, when the incubators malfunctioned it was agreed with the supplier to refurbish both incubators with dimmable white lights to, in the short term, run the intended hatchery optimisation experiments as well as to fit red light fittings to, in the long term, use the incubators as a red-light chamber to keep gametophytes for extended periods of time. To address the staff shortage, it was decided that a Project Assistant (Mr Musadiq Schalkwyk) be employed at POC as of June 2024, so that Ms F Hill could focus on the hatchery tasks at the DFFE based kelp hatchery. On the grow-out side, the 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. Additional to the collaboration with the UNDP project “Exploring Seaweed Cultivation and Value Chains for Enterprise Development” 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 (MSc) assisted by Ms Zizipho Mfaku (Honours), to look into kelp epiphytes/biofouling and phytoplankton assemblages which may affect the quality of kelp blades and possibly also the price when sold.

1.6 Phase 2: Year 3 (2024-2025) Quarter 2 (Jul-Sept 2024) summary:

Over and above the on-going project activities, the PM (BSASA), Project Scientific Advisor (UCT) and DFFE of the South African Kelp Farming Project (SA KFP) participated in the UNDP community workshops that were held in Saldanha Bay, Velddrif and St Helena Bay during Aug’24 to “Exploring Seaweed Cultivation and Value Chains for Enterprise Development”. The SA KFP scope and progress was presented as well as the background on various seaweed species, and the regulatory and policy environment for seaweed farming.

The Project Manager (PM) was also invited by Conservation SA (local branch of Conservation International) to present at the Blue Carbon Event in the 1st week of Sept’24 which was organised by Conservation International, the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Union for Conservation of Nature (IUCN) in order to explore potential of Blue Carbon around seaweed farming.

Additionally, during the 2nd week of Sept’24, presentations were given by the two RAs, the PA and the PM at the Aquaculture Association of Southern Africa’s (AASA) Conference [co-hosted by EU Horizon 2020 All Atlantic Ocean Sustainable, Profitable & Resilient Aquaculture (ASTRAL) funded project].

During the AASA Opening Welcome address by the Deputy Minister Singh of the DFFFE, the value of the SA KFP and collaboration with the UK through the FCDO was mentioned and the project webpage was launched at the event during the PM’s presentation.

The Conference activities were followed by a visit from the international delegation from the EU Horizon2020 integrated aquaculture project ASTRAL, and soon thereafter, the filming for the project promotional video commenced which stretched over the 2nd and 3rd quarters. The UNDP at the same time also commenced with filming footage for their project video, but with a slightly broader objective (i.e. seaweeds in general) including kelp farming and some of the team members also participated in that.

The quarter ended on a high note when kelps from the *Macrocystis* and *Laminaria* droppers were harvested to determine the yields as well as pre-processing options after which samples were sent for nutritional and food safety testing. During the last days of Sept’24, the Terms of Reference for the development of a kelp financial forecasting model was developed by the PM in collaboration with the DFFE, and the service provider (Nautilus Growth Partners) was subsequently appointed.

1.7 Phase 2: Year 3 (2024-2025) Quarter 3 & 4 (Oct 2024-Mar2025) summary:

While the hatchery and grow-out activities were still on-going throughout Q3 and Q4, the PM continued to work with the external consultants on the development of the short project videos as well as the development

of the Business Planning Guide and the associated Financial Model throughout October-December 2024 and the Festive Season in order to have deliverables produced timeously. As such, the Q3 and Q4 reports were combined to also allow more time for the data from the food safety and nutritional analyses (which were received at the end of 2024) to be analysed and included in the report. Project participants presented and provided inputs in the “Seaweed Road to UNOC 2025 Workshop” on the back of the prestigious Earthshot Prize week which took place in Cape Town during the 1st week of Nov’24. The SA KFP’s promotional video was released (on its webpage and its YouTube channel) during the last week of Nov’24. The Business Planning Guide for Kelp Framing in SA and the associated Financial Forecasting Model were completed in Jan’25 and the rest of the shorter project videos in support of the Standard Operating Procedures (SOPs) were completed during the first week of Mar’25.

2. Progress on project objectives & deliverables

The sections below will build on the findings of the previous quarters to summarise the different project components and provide an overview of progress for the 2024-2025 financial year.

2.1 Hatchery technologies of targeted species:

- **Kelp hatchery/nursery facility based at the DFFE Sea Point Marine Aquaculture Research Facility:**
Ms Hill completed the hatchery optimisation experiments in the two project incubators. These experiments entailed settling kelp spores on glass slides within crystallizing dishes under different combinations of parameters such as growth media (half strength PES & F/2), temperatures (12°C & 15°C), spore concentrations (2000 spores/ml & 5000 spores/ml), light intensities (30 & 60 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$). The results were based on photographic observations of sporophyte health as well as microscope measurements of the growth and development of gametophytes and sporophytes. Initial data suggests that *E. maxima*, *L. pallida* and *M. pyrifera* performed better under 15°C temperature and that either nutrient media and spore stocking density can be used to grow the three species. However, the light intensity results were inconclusive with no clear indication either way and remained as gametophytes well beyond the ~2 week period when sporophytes usually start to develop. All the experiments indicated that beyond 35 days, the growth and development of the sporophytes started plateauing and/or decreasing suggesting that the design of the experiment was perhaps too small and that it would need to be repeated on a larger scale. Currently Ms Hill is in the process of statistically verifying her data. For more details on progress to date, please see Annexure A.

- **Kelp Hatchery/Nursery Facility based at Paternoster Oyster Company (POC)**
Following the out-plant of Mr Schalkwyk’s previous batch of spools (which took 8 weeks to reach ~1cm), it was decided that Mr Schalkwyk would run a trial (during Oct-Dec’24) based on the early findings of the hatchery optimisation experiments done by Ms Hill, where all 3 species were set-up at POC at 15°C (as opposed to 2 different temperatures), using half strength F/2 growth media (as opposed to half strength PES) as it is readily available within the industry, kelp blades were cleaned with distilled water (as opposed to using 3% iodine solution) prior to sporulation, and a 2000 spores/l spore concentration was used to seed the hatchery spools of all 3 species. The results from this trial were very disappointing in that there were hardly any sporophytes on the spools and hence we decided to run the same trial (during Feb-Mar’25) with all 3 species at 15°C but, to go back to half strength PES and a spore concentration of 2000

spores/ml for *L. pallida* and *E. maxima* and 5000 spores/ml for *M. pyrifer*. To date, this set of parameters by far produced the best results as seen in figure 2 a-c.

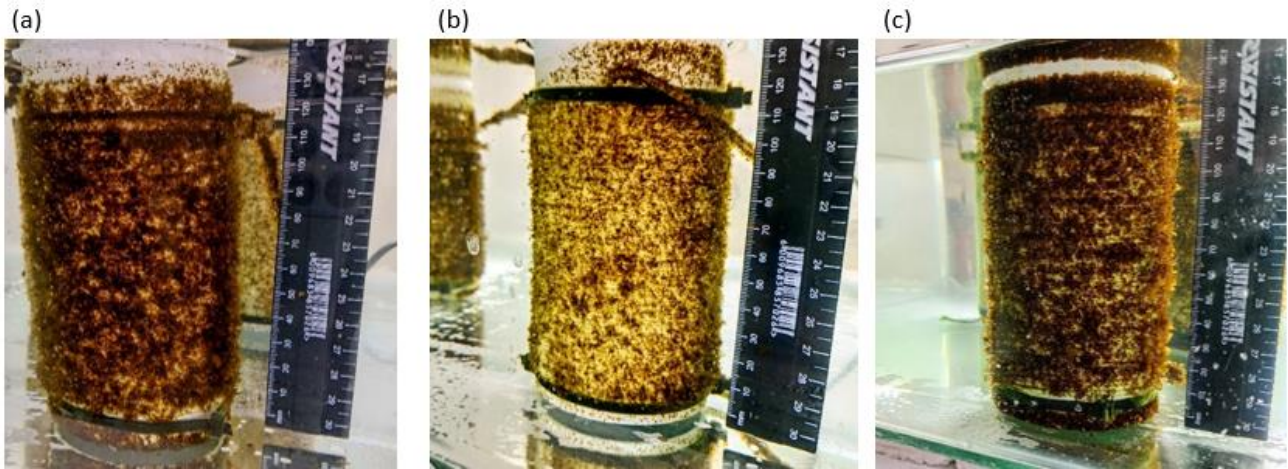


Figure 2. Visual appearance after 35 days (a) *L. pallida* (b) *E. maxima* and (c) *M. pyrifer*. (Photo credits: Musa Schalkwyk)

With the above-mentioned parameters, all 3 species reached ~1cm within 7 weeks (as opposed to 8 weeks) as seen in figure 3 a-b. As a last attempt to obtain food safety data for farmed *E. maxima*, these spools were out-planted on 17 Mar'25 which will be maintained by Mr M Schalkwyk during the project write-up extension period from Apr-Jun'25. For more details on progress to date, please see Mr M Schalkwyk's monthly reports attached in Annexure B.

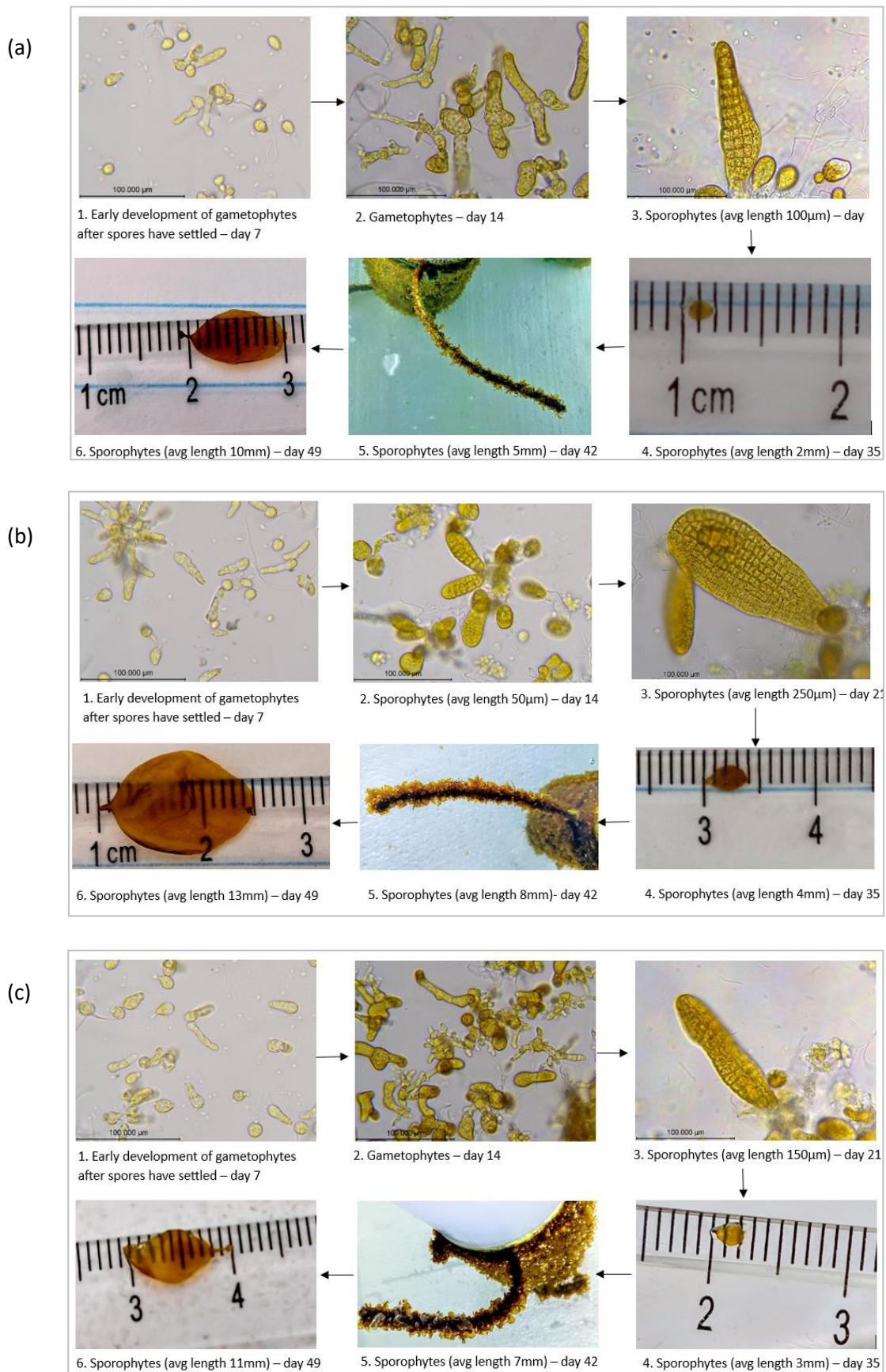


Figure 3. Developmental stages up to day 49 in the Hatchery/Nursery of (a) *Ecklonia maxima*, (b) *Laminaria pallida* and (c) *Macrocytis pyrifera* as tracked by Mr M Schalkwyk at POC (Photo credits: Musa Schalkwyk)

2.2 Grow-out trials & monitoring of environmental parameters:

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

As mentioned in the previous quarterly report (Q2), we have unfortunately not been able to outplant *E. maxima* during the months of March/April as planned. As suspected, the POC spools that were outplanted in Aug'24 did not survive past Oct'24 when inorganic nitrogen nutrient concentrations declined to near zero (as it had done during 2023). After harvesting *L. pallida* & *M. pyrifera* at the beginning of Oct'24 for food safety testing and nutritional analyses, all rope structures were systematically removed and cleaned for storage while monitoring of environmental parameters continued. For more details on progress to date, please see Annexure C.

2.3. Outcomes of food safety testing, nutritional analyses and pre-processing experiments:

As mentioned previously, over the course of this project wild and farmed kelp specimens were collected for food safety tests, nutritional analyses and to conduct pre-processing experiments to determine whether two blanching methods can lower the content of certain heavy metals, arsenic and iodine in the kelps (methods and details described in Annexure D). The long-term goal was to work toward assessing the quality of the South African kelps for use in human food and animal feeds and to generate information for food safety certification, in addition to ascertaining if some basic blanching techniques (i.e. boiling and steaming) could lower the content of potentially hazardous heavy metals, arsenic and iodine.

The detailed report (see Annexure D) compares the nutritional composition of farmed and wild *E. maxima*, *L. pallida* and *M. pyrifera* and compares it with studies elsewhere. It further discusses and compares the minerals, fatty acids, selected heavy metals and pesticides determined for the three kelps (wild and cultured) and discusses their content in relation to other published literature and puts it in context with regulations set by the European Commission, France and Germany. In the pre-processing experiment it was found that while both blanching methods reduced Iodine (I) content, boiling was more effective than steaming. However, the effect of both blanching methods was less effective in reducing the levels of Cadmium (Cd), Lead (Pb), Mercury (Hg), and Arsenic (As) thus warranting further investigation into appropriate methods to lower levels of the latter, particularly Cd and As.

An important takeaway from the tests and analyses is that the kelps have a high nutritional content and that there is no indication that farmed specimens are better or worse than wild harvested specimens (and vice versa) but that the results are likely site specific and species dependent, and influenced by the habitat, life-stage, environmental or culture conditions and maturity (in other words how long the blades had been in the water to extract certain compounds).

2.4. Ecological impact of epiphytes and phytoplankton on kelps - [Collaboration with UWC]:

As mentioned in the Q2 report, this component of the project forms part of a collaboration with the UWC (via Prof Gavin Maneveldt) in the form of a Masters (Ms Waqeevah Moosa) and Honours degree (Ms Zizipho Mfaku who since graduated and is currently doing a 1 year full-time MSc in Applied Ocean Sciences at UCT), and is aimed at identifying the epiphytic species that grow on the farmed kelps, determining their onset and tracking their overall distribution across the kelp blades over time. Kelp blades were monitored monthly at various

depths (from 1-6m), photographed for the determination of the percentage fouled area using ImageJ, and processed accordingly for the identification of the various epiphytic species. Additionally, the surrounding water column (from 0-6m) was being sampled monthly to survey the presence of phytoplankton species (especially those that can be harmful). Ms Moosa collected the data from May-Dec'24 and 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. Due to fact that Ms Moosa prioritised the biofouling aspect for the sake of the project in her monthly reports and that her monthly reports were only due until Dec'24, the phytoplankton aspect will for the most part be reflected in her thesis. Hence, some of the initial patterns that have emerged are highlighted here, however Ms Moosa is currently conducting statistical analyses of her data to determine statistically significant differences. For more information on the progress of this work, please see the Ms Moosa's monthly reports attached as Annexure D.

Biofouling:

Ms Moosa has been monitoring two *Macrocystis* droppers (one at long-line 1 [LL1] furthest away from the mouth and the other at long-line 2 [LL2] closest to the mouth) since May'24, out-planted in Jan'24 and unwound in Feb'24. Similarly, two *Laminaria* droppers were monitored since Sept'24 (which were out-planted in May'24 and unwound in Jul'24) when the kelps were large enough and started exhibiting signs of biofouling. She also started monitoring two *E. maxima* droppers at both long-lines (which were out-planted in mid-Aug'24 and unwound at the end of Aug'24), these specimens only started to show signs of biofouling when they were a bit bigger during Oct'24 but did unfortunately not survive beyond that point.

In the case of *Macrocystis* (figure 4), the percentage of biofouling (%biofouling) on the kelp blades across the two long-lines were similar during the months of May to Jul'24 when the kelps were growing well and fast enough to rid itself from biofouling while having access to sufficient nutrients in a well-mixed water column. However, from Sept'24 onwards the %biofouling on the blades were significantly higher at LL2 than at LL1.

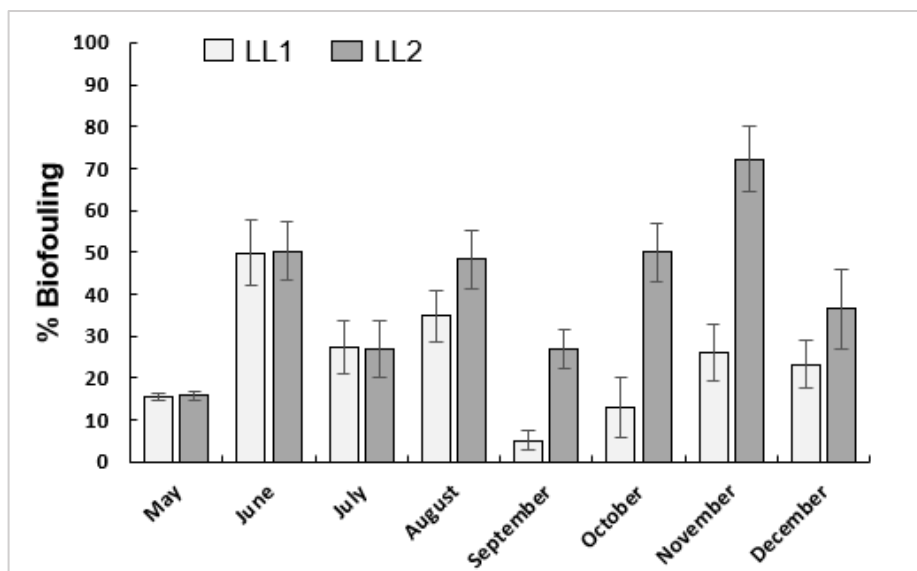


Figure 4. The % biofouling (± SE) on *M. pyrifera* droppers at LL1 and LL2 from May-Dec 2024. (Graph credit: Waqeebah Moosa)

This does not seem to be the case for *Laminaria* (figure 5) where it appears that the %biofouling from Sept'24 is higher at LL1 than at LL2 (although these still need to be statistically analysed), except in Dec'24 when the %biofouling was the same across the two long-lines and significantly higher than the months prior. While this

data provide insight into the temporal variation over these months, sampling was also done between 1-6m and insight of the spatial variation is available in Ms Moosa’s reports (see Annexure D).

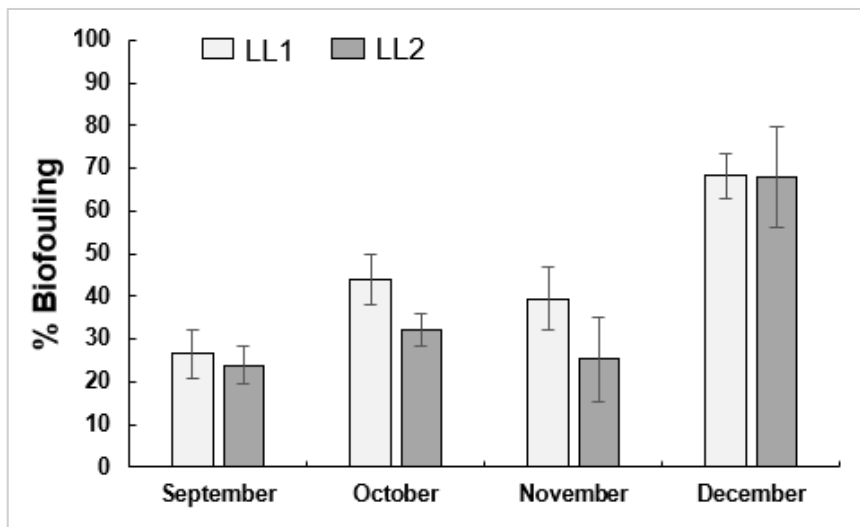


Figure 5. The % biofouling (\pm SE) on *L. pallida* droppers at LL1 and LL2 from Sept-Dec 2024. (Graph credit: Waqeeh Moosa)

A list of epiphytic species occurring on *Macrocystis*, *Laminaria* and *Ecklonia* is available in Ms Moosa’s monthly reports. Once identification of all species has been completed, we will be better able to ascertain if the epiphytic species occurring on the kelp species are mostly similar or different between kelp species. An interesting observation from the list of epiphytes in Ms Moosa’s Dec’24 monthly report, was the male and female skeleton shrimps with an abundance of newly hatched juveniles which may explain why our ropes in Jan’23 were totally covered in skeleton shrimps (Figure 6). It is also noteworthy that the photographs show that a lot of eggs from various species were also present (this ties in with the comment in the phytoplankton section at the top of pg15).

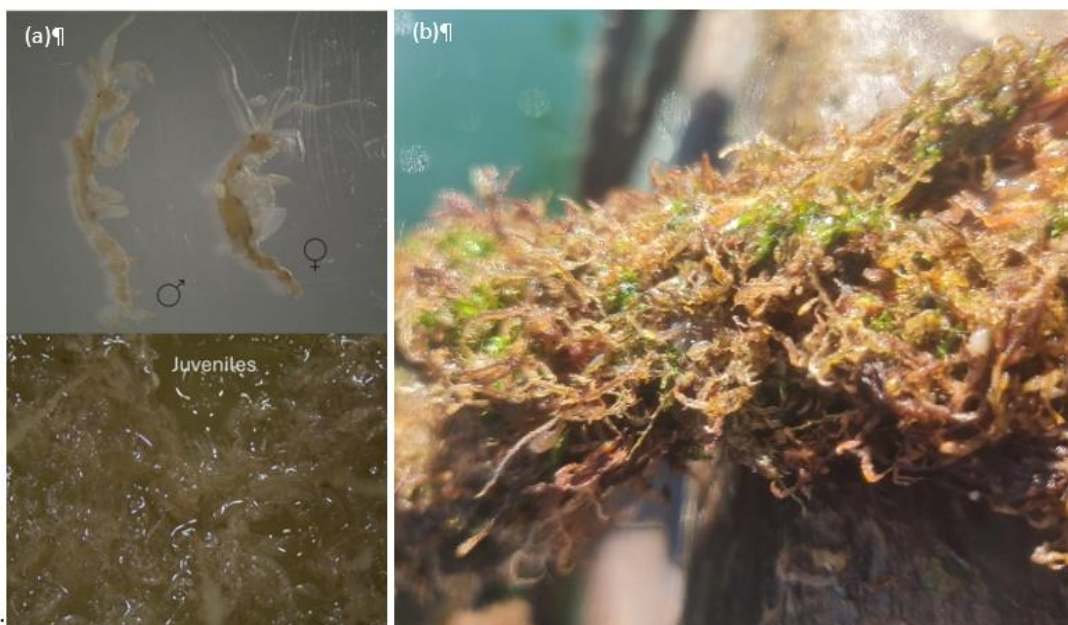


Figure 6. (a) Male, female and juvenile skeleton shrimp on kelp blades in Dec’24 (photo credit Waqeeh Moosa) (b) Skeleton shrimp on grow-out ropes in Jan’23 (photo credit: Lizeth Botes)

Phytoplankton:

During the sampling period from May-Dec'24 at BOM, there appears to be a very similar trend of the total average phytoplankton cell concentrations across LL1 and LL2 (Figure 7) even though cell concentrations are somewhat higher during May and June at LL2 which is closer to the mouth with water containing higher nutrient concentrations. The latter part of the year is characteristic of a phytoplankton succession which follows colder months, when diatoms typically start blooming due to their ability to utilize silica-rich nutrients available after winter mixing. This is usually followed by dinoflagellates which are mobile and able to migrate up and down the water column (to photosynthesize during the day in the top warmer layers and consume nutrients during the night in the colder bottom layers) through the thermocline when the water gets stratified during warmer months. However, as was explained in the Q2 report, the phytoplankton assemblage at BOM, Small Bay, for the most part is dominated by diatoms throughout the year with generally negligible concentrations of dinoflagellates. This does not however mean that lower concentrations of harmful dinoflagellates are not able to cause harmful blooms, as indeed it is possible as was explained in the Q2 report when *Akashiwo sanguinea* was the dominating bloom forming species during Jul'24 stretching from the west coast as far down as the Gansbaai on the south coast.

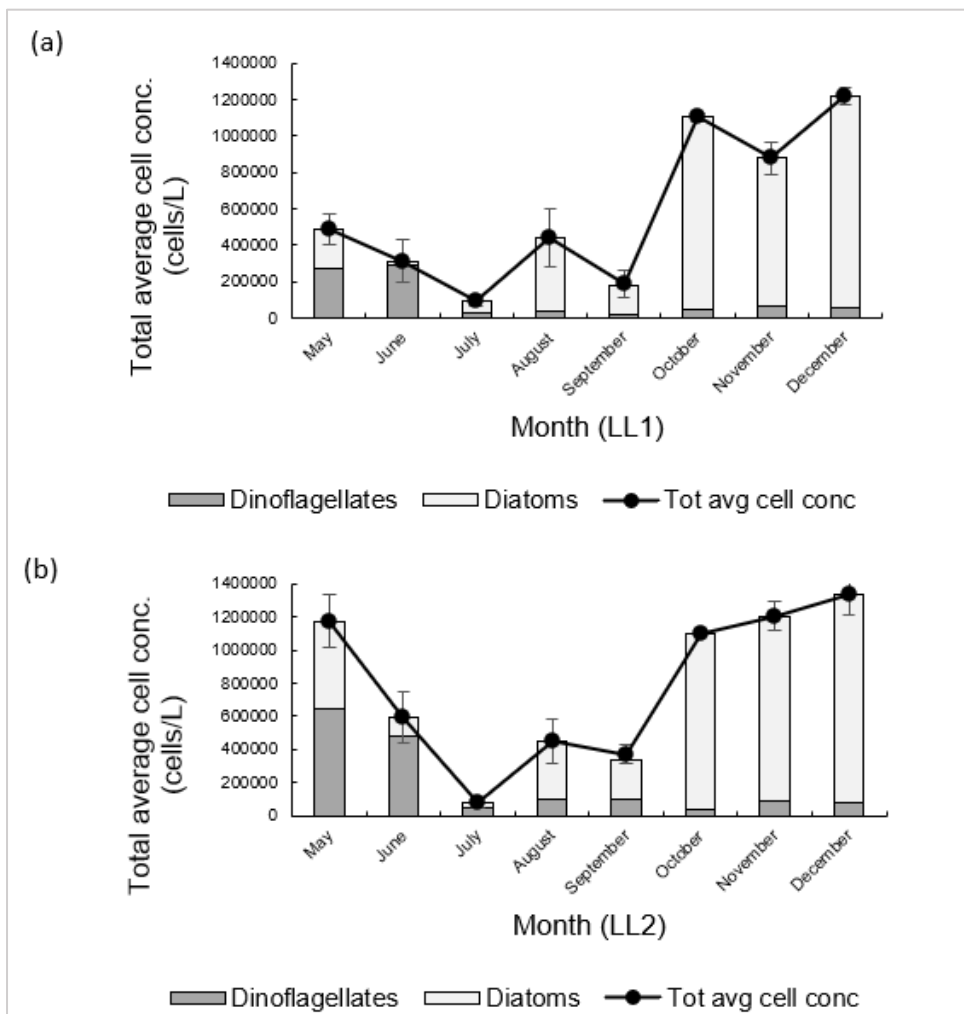


Figure 7. Total average phytoplankton cell concentrations at LL1 (a) and LL2 (b) during May-Dec'24 (Graph credit: Waqeeh Moosa)

Although cell concentration and species composition varied slightly, the spatial variation of the phytoplankton assemblage between 0-6m across LL1 & LL2 were also very similar (not shown here).

It is worth noting that the higher average phytoplankton cell concentrations during Oct-Dec'24 (figure 7) certainly contribute to the drop in nutrient levels (important to both phytoplankton and kelps) to near zero during these months (as explained in the Q2 report). This increased phytoplankton biomass (responsible for primary production) sustains the zooplankton (responsible for secondary production) which in turn sustains the entire food web in the months to follow, including the diversity of biofouling species as is seen in the lists that Ms Moosa has been compiling. Moreover, it should be remembered that non-toxic micro-algae is crucial to the filter-feeding oysters and mussels being grown in the bay. It would be worth considering an experimental set-up in a follow-up Phase 3 study to sufficiently investigate the correlation and interactions between the macro- and microalgae, and how it may affect water quality and bioremediation in the bay alongside the current oyster and mussel industry.

While the Q2 report contained pictures of the dark golden-brown blade colour during the colder months when the water column is well mixed with cold nutrient-rich water, the compilation of the colour of the blades in figure 8 show how the blades deteriorated from Oct'24 onwards when nutrient concentrations drop to near zero between Oct-Dec annually even though periodic upwelling events are bringing nutrients in mainly at 6m depth (discussed in previous reports) which unfortunately is not enough to sustain the growth of quality kelp blades beyond October (besides the fact that the farmed kelps get totally overgrown by biofouling beyond October). This deterioration in kelp blade colour was also observed in the wild kelp beds along the shoreline approximately 80m from the grow-out ropes (picture available in the 2023-2024 Q3 report)

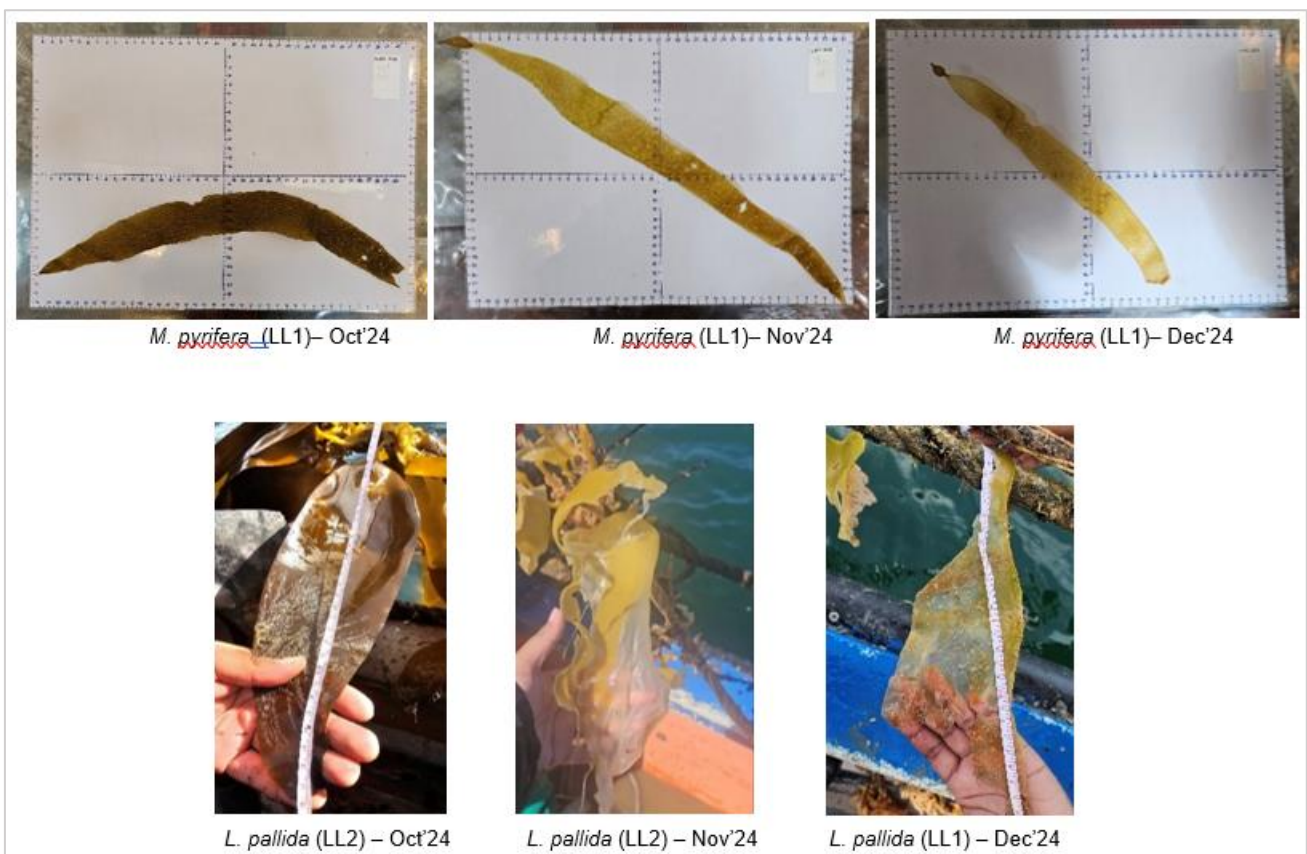


Figure 8. Deterioration of blade quality of *M. pyrifera* and *L. pallida* from Oct'-Dec'24. (Photo credit: Waqeeh Moosa)

2.5 Business Planning Guide for Kelp Farming & Financial Forecasting Model:

This component is aimed at assisting those that are interested in starting a kelp farming business and was done in collaboration with the American National Seaweed Hub (funded by the NOAA Sea Grant).

The 'Business Planning Guide for Kelp Farming: South Africa' (see Annexure E) covers topics like writing a business plan with considerations for marketing, operations, financing and legal requirements. It is meant to be used with the Financial Forecasting Model worksheets while considering information available in the Kelp Value Chain Analyses & Market Assessment Report (all of which available on the SA KFP webpage). The Financial Forecasting Model worksheets (see Annexure E) will assist with financial projections meant to feed into financial plans.

3. Lessons learned and observations 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.

➤ **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), and Grow-out (where offspring are maintained outdoors until market size is reached).

Initially, we took the approach to move kelp sporophytes which are barely visible by eye, from the hatchery directly to grow-out and exposing them to the outside environmental elements without intermediary stages. While this approach may well work elsewhere, we have found that having all the stages as explained above are more successful in Saldanha Bay. 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 in the sea for ~2-3 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. 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 diagram 1 provides a general timeline that will be useful to a future kelp farmer in terms of planning, one should be mindful that differences between hatchery set-ups may exist, for example, at POC

all 3 kelps species grew to ~1cm within 7 weeks, whereas at the DFFE Research Aquarium *Ecklonia* and *Laminaria* grew to 0.5cm in 12 weeks and *Macrocystis* grew to 1cm in 12 weeks.

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

When transporting the kelp sporophytes to the grow-out site, temperatures during transit must be kept stable and preferably between 12-15°C. Therefore, when planning to transport 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 without having access to an air-conditioned vehicle. Care should be taken to maintain the appropriate temperature (which is dependent on the species being transported) in the transporting canisters and cooler containers, and to note the sea water 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 are 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 early 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 a preferred depth (i.e. 3m) for 2-3 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. It should be noted though that it is recommended to unwind the spools before 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 there is a risk of damaging the holdfasts. Once in grow-out, kelps should be monitored on a monthly basis. This would be especially important during the month in which the kelps will be harvested in order to get the best quality blades with as little as possible fouling.

➤ **General time-line**

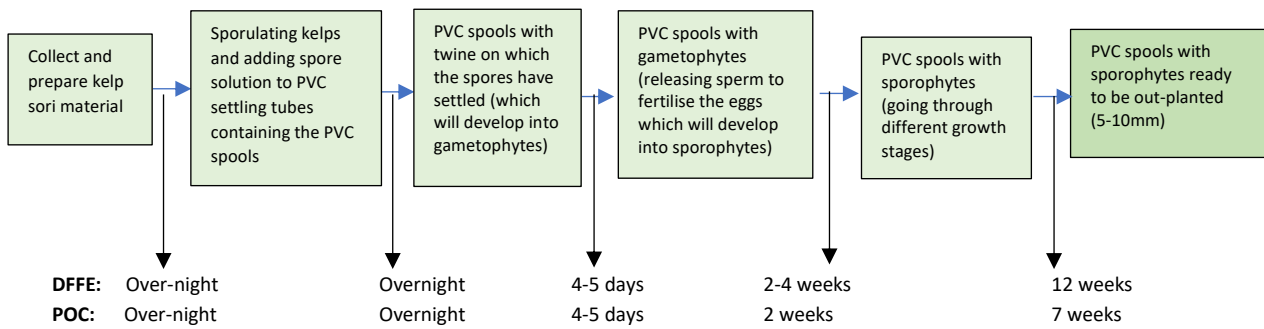


Diagram1: Time-line of all 3 species from collection of kelp sori to sporophytes ready for out-planting. (Diagram credit: Lizeth Botes) (~ 7weeks at POC and ~12 weeks at the Sea Point based hatchery).

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 season											
	Low N-based nutrients conc's				High nutrient conc's				Extremely low N-based nutrient conc's			
	Phytoplankton blooms											
Benefit	Decreasing temperatures with ad hoc upwelling events			Cooler water temperatures						Increasing water temperatures with ad hoc upwelling events		

Diagram 2 provides a general timeline of the kelp production cycle together with environmental parameters in Small Bay of Saldanha Bay (Diagram credit: Lizeth Botes)

~ **In terms of sori collection:**

Although it may be the case that collection of sori material for different kelp species are only available during certain months of the year, to date we have been collecting sori material of all three local species throughout the year and have had successful sporulation. That said, it should be noted that there may be variation in quality of spore-producing sori, either seasonally and/or over a low-tide cycle.

~ **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 the risk for contamination increases if sporophytes are left too long in the hatchery, 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 sites in Big Bay (Saldanha Bay) or a site other than in Saldanha Bay, this may be different.

~ In terms of out-planting:

Based on observations of our out-plantings at BOM's grow-out site in Small Bay (Saldanha Bay), from an industry point of view it may be preferable to out-plant around the end of March when water temperatures drop below 15 °C. Alternatively, in the case of *Macrocystis* it could even be possible to out-plant in January and again April to enable two harvests in the grow-out season.

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* may be more adapted to higher wave action and grow better in Big Bay but this is yet to be tested (as opposed to *M. pyrifera* that seems to grow well in Small Bay on BOM's site). In areas more exposed to the open ocean at upwelling centres such as Kommetjie and St Helena Bay, average 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:

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.

From the data that we have collected to date, 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 rope-line to 6m when heading toward late spring where kelps will be within reach of upwelling events. 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. Although the droppers were seeded from the surface (0m) all the way down to 7m, 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.

~ In terms of nutrients

Nutrient data from Jul'23- Dec'24 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 Feb'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 over that period (as indicated in Diagram 2).

~ In terms of biofouling/epiphytes on kelp blades and phytoplankton present in the bay:

Although phytoplankton and biofouling are present all year round at BOM (situated in Small Bay of Saldanha Bay), increased phytoplankton and biofouling over the summer months together with low nutrient levels provides for a particularly difficult environment for farmed kelps to survive in from Oct to March. This will likely not be the case at an open ocean site where more typical upwelling conditions will provide for access to cold nutrient-rich water throughout the upwelling season, which is driven by south-easterlies during summer.

~ In terms of yield:

The total wet weight for the *M. pyrifera* vertical dropper on LL2 was 26.55kg and for the *L. pallida* dropper was 12.28kg. If one were to add 65 droppers onto a 100m long-line it would amount to just short of 2 tonne (t) in the case of *M. pyrifera* and just short of 1t in the case of *L. pallida*. This is comparable to the yields

obtained with *Saccharina* (~ 10kg/m thus ~1t/100m long-line) which are being farmed profitably in the USA.

4. Networking, Events & Project promotion

4.1 Information sharing: Kelp project website – [Collaboration with the PSSA]

The project webpage (hosted on the Phycological Society of Southern Africa's [PSSA] website) provides a platform where stakeholders and interested parties can access all the project outcomes, be that in the form of videos and/or documents. In the months from now until the end of June, all outstanding deliverables will be loaded. Interested parties can access these on: <https://www.phycologysa.co.za/kelp-farming-project>

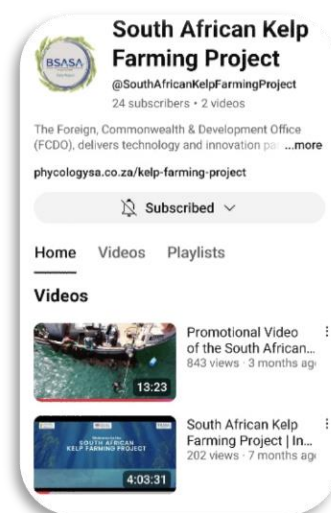


4.2 Information sharing: YouTube Channel

The process of shooting footage of the various project components has been under way since Sept'24. To date, the Information sharing workshop of Mar'24, the project's promotional video and four additional short videos have been loaded (<https://youtube.com/@southafricankelpfarmingproject>) namely:

1. The SA KFP- goals & objectives
2. The SA KFP- capacity building & training
3. SA KFP's hatchery & nursery activities
4. SA KFP's nursery & grow-out activities

It is highly recommended that those interested in #3 and #4, view these two short videos together with the SOPs which will be made available on the webpage in due course.



4.3 Information sharing: Seaweed Road to UNOC 2025 Workshop

The 2024 Earthshot prize awards (founded by Prince William) took place during the 1st week of Nov'24 in Cape Town. During this week the **Seaweed Road to UNOC 2025 Workshop** (hosted by the Global Seaweed Coalition [GSC]) was held to convene policymakers, funders, corporates, NGOs, scientists, and UN member states to discuss the potential of seaweed to repair and regenerate our planet. The workshop is part of the GSC's efforts to highlight and promote the potential of sustainable seaweed cultivation as a climate solution. It further explored with stakeholders the challenges and opportunities in the African context where Ms A Bernatzeder, Prof. Emeritus John Bolton gave presentations, and they as well as the PM participated in breakaway sessions where the challenges were further un-packed. Prof Bolton is a member of the Scientific Council of the GSC,

since its inception, and after the workshop was invited to be a member of the Expert Advisory Panel of the Earthshot Prize for 2025.



5. Closing remarks & thinking ahead

5.1 Closing remarks:

Despite this project being the first serious attempt to carry out kelp aquaculture in SA, the project achieved several milestones and generated important new information in a very short period of time, namely:

- identifying 9 potentially suitable areas for kelp farming along the west coast of South Africa,
- successfully advocating for legislative changes to include indigenous seaweed species (Amendment of Environmental Authorisation for the Saldanha Bay ADZ),
- tailoring available hatchery and nursery culturing methods for all 3 local kelp species,
- trialling various grow-out production systems and obtained yields on vertical droppers comparable to that obtained in countries such as the USA where kelps are farmed profitably,
- determining which biofouling species occur on the 3 species that could possibly affect blade quality and ultimately the price when sold,
- by monitoring environmental parameters and kelp growth, determined the season most suitable for these kelps to be grown in Small Bay of Saldanha Bay,
- analysing all 3 local kelps to assist with food safety standards and certification,
- conducting preliminary pre-processing trials to establish if two methods of blanching (i.e. boiling and steaming) could reduce potentially harmful heavy metals, arsenic and iodine,
- developing a Business Planning Guide for Kelp Farming in South Africa and an associated Financial Forecasting Model with worksheets to assist with financial planning,
- and producing a comprehensive kelp market assessment, value chain analysis and roadmap for the expansion and strengthening of the kelp value chain in South Africa to enable the development of an environmentally and financially sustainable kelp farming industry in South Africa.

In conclusion, we feel that Phase 2 sufficiently derisked parameters to justify the continuation to a Phase 3 small-scale demonstration pilot project (in Small Bay and Big Bay of Saldanha Bay) to determine which of the 3 species can be farmed profitably, and how this may be integrated with other aquaculture activities to inform the development of a financially and environmentally sustainable kelp farming industry.

5.2 Anticipated work for 2024-2025 (with write-up extension)

Project deliverable	2024-2025												2025-2026			
	Quarter 1			Quarter 2			Quarter 3			Quarter 4			Quarter 1			
	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	
Hatchery/Nursery trials	[Yellow bar]															
Grow-out trials	[Green bar]															
Environmental monitoring	[Green bar]															
Epiphyte & phytoplankton monitoring		[Yellow bar]														
Food Safety Testing							[Blue bar]									
1. Testing farmed kelp - food safety tests & nutritional analyses							[Blue bar]									
2. Pre-processing experiment							[Blue bar]									
Budiness Planning Guide & Financial Forecasting model					[Pink bar]			[Pink bar]								
Project webpage to be embedded with PSSA website					[Green bar]			[Green bar]								
Stakeholder Engagements:																
1. UNDP workshop/meeting with community members to unpack possible involvement					[Orange bar]											
2. Kelp project close-out workshop														[Orange bar]		
PM physical check of assets at all sites																
Reports & Budgeting																
Project write-up															[Blue bar]	


6. Acknowledgements

The PM would like to thank (on behalf of the BSASA and the implementation team) the FCDO for the continued funding support, the entire project team as well as the external consultants and collaborating partners for their respective contributions to the deliverables of Q3 & 4 which contributed toward the contents of this report.







7. Annexures

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

7.1. Annexure A: Ms F Hill monthly reports

- 
F.Hill October 2024
Monthly Report.pdf
- 
F.Hill November 2024
Monthly Report.pdf
- 
F.Hill December 2024
Monthly Report.pdf
- 
F.Hill January 2025
Monthly Report.pdf
- 
F.Hill February 2025
Monthly Report.pdf
- 
F.Hill Mar'25 Monthly
Report.pdf

7.2. Annexure B: Mr M Schalkwyk monthly reports

- 
M. Schalkwyk- Oct '24M.
monthly report.pdf
- 
Schalkwyk Nov '24M.
monthly report.pdf
- 
Schalkwyk Dec' 24
monthly report.pdf
- 
M. Schalkwyk Jan'
2025 monthly report,ç
- 
M. Schalkwyk Feb' 25
Monthly report.pdf
- 
M. Schalkwyk Mar'25
monthly report.pdf

7.3. Annexure C: Ms N Xulu monthly reports



N. Xulu October 2024 Monthly Report.pdf N. Xulu November 2024 Monthly Report.pdf N. Xulu December 2024 Monthly Report.pdf N. Xulu January 2025 Monthly Report.pdf N. Xulu February 2025 Monthly Report.pdf N. Xulu Mar'25 Monthly Report.pdf

7.4. Annexure D: Ms W Moosa UWC monthly reports



WMoosa Oct'24 monthly report.pdf WMoosa Nov24 monthly report.pdf WMoosa Dec'24 monthly report.pdf

7.5. Annexure E: Food Safety Tests, Nutritional Analysis and Pre-processing report



SA KFP Food Safety, Nutritional Analyses a

7.6. Annexure E: Business Planning Guide for Kelp Farming & Financial Forecasting model



SA KFP-Business Planning Guide-Feb'24 SA%20KFP%20Financi Forecasting%20