cool blue: baltic

Data-Sharing Network

Funded by the European Union

About this deliverable

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List of Abbreviations:
ROF: regenerative ocean farming
CAPEX: capital expenditure
OPEX: operational expenditure
BRUV: baited remote underwater video
PAM: passive acoustic monitoring
eDNA: environmental DNA

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Executive summary

Regenerative Ocean Farming (ROF) is an emerging approach to sustainable aquaculture that offers multiple environmental and socio-economic benefits, including nutrient absorption, habitat restoration and livelihood creation for coastal communities. While not yet established in all Baltic Sea countries, its potential is significant. Effective monitoring and data exchange are essential to support its growth, improve regulatory frameworks, and ensure environmental sustainability.

This report focuses on low-cost monitoring solutions and a data-sharing network to consolidate and exchange ROF-related data. To assess the needs and challenges of ROF monitoring, we conducted a survey among project partners (see annex), gathering insights on the ecological, economic and social impacts of ROFs, essential operational data, and relevant data-sharing platforms.

The results include a webpage, a data-sharing platform (Zenodo community) and a tutorial (or "lesson") on monitoring in simple language, directed at incipient farmers and community members. The findings emphasise the need for standardised environmental and socioeconomic indicators, cost-effective data collection methods and structured data-sharing approaches to improve farm management, support licensing processes, and enhance stakeholder collaboration.

The CoolBlueFuture community is the first step towards consolidation of existing datasets, which is more specific, straightforward and user-friendly than submission of data to EMODNet via the data ingestion portal, though this is also encouraged. The justification is that with a significant proportion of data expected to come from citizen science initiatives, the submission of data must be as straightforward and accessible as possible.

As an annex to this report, we present survey findings, practical low-cost monitoring methods and real-world case studies from Cool Blue partners (see annex). These insights provide guidance for farmers, researchers and policymakers, helping to improve farm performance and potentially support new licensing applications. By expanding access to monitoring tools and data, this initiative strengthens the viability of ROF in the Baltic Sea and beyond.

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Table of Contents

Background

Deliverable D3.3 – Cool Blue ROF Data-sharing Network

Deliverable Number	D3.3	**Lead Beneficiary**	6. UTAR
Deliverable Name	Cool Blue ROF Data-sharing Network		
Type	DEC —Websites, patent filings, videos, etc	**Dissemination Level**	PU - Public
Due Date (month)	18	**Work Package No**	WP3

Description
Webpage or dashboard collating relevant data and/or data sources from each Baltic country (EN + Baltic languages)

As defined in the Grant Agreement:

p.17
KER4: a data-sharing network to exchange and consolidate monitoring efforts of ROFs:
Monitoring of environmental parameters varies widely, with a range of tools available. This KER will

1) map existing relevant data-sharing networks and collection methods and
2) define a standardised set of measurements, equipment and protocols for smart, low-cost monitoring of ROF sites.

Data gathered by local stakeholders will be uploaded to a Cool Blue data "dashboard" or basic webpage as part of the project's online presence (HAV website), providing regular and/or real-time measurements and insights into environmental parameters in and around regenerative aquaculture sites. This data can then be used to justify new licence applications under KER1 (common licensing framework). For future development, the data network can be extended to monitor economic as well as ecological parameters. For example, socioeconomic information on farm revenues can be used to develop a network similar to the Farm Accountancy Data Network (FADN) applied in agriculture to measure farm performance and economic resilience. By measuring both ecological and socioeconomic parameters, the data network will provide baseline indicators of socioecological performance and resilience.

Qualitative Indicators:
1. Sharing of data between regions (contributions to platform)
2. Knowledge sharing & learning (surveys, evidence of spin-off activities e.g. influencers, video bloggers)
3. Collaboration between target countries (public authorities, community groups, businesses)
4. Ecological indicators (continual monitoring of biodiversity, nutrient levels, turbidity, oxygen levels, pH, carbon storage, sedimentation)

p.33
KER4: *Data-sharing Network will be a web page with either links to existing data portals or a dashboard with real-time environmental indicators*

p.45
KER4 – Data-sharing Network: *In its most basic form, the network will consist of a webpage on the HAV website, with links to country-specific data portals (e.g. www.dabasdati.lv). In its most advanced form, this network will comprise a dashboard on the HAV website with real-time data displayed for each Baltic country. HAV will be responsible for the upkeep of this network, to be reviewed every year e.g. at the CBB festival (KER3).*

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Introduction

The challenges in monitoring regenerative ocean farming at the local level are multiple. Parameters include biodiversity, carbon, nutrients, economic, social, legal and educational. Due to high costs in Europe, monitoring a regenerative ocean farm to this extent is financially unrealistic. It is therefore necessary to choose low-cost, volunteer-based (e.g. citizen science), collaborative approaches that include experts efficiently and promote citizen participation at smaller scales across a wider mycelial network. The goal is to achieve a baseline of meta data – data about data – in terms of what data are being collected, by whom, where and how. This is an interdisciplinary approach that requires knowledge of ecology, economics, social, technological, legal and governance issues.

The first steps are to create a community of shared datasets on an open science, accessible platform (Zenodo), where regenerative ocean farmers can upload data – of any kind: ecological, environmental, social, technological or economic – to conduct an initial consolidation and mapping of what datasets already exist. Once they are collected, they can be easily sorted and categorised. From this exercise, we can map what data are available where, who the main actors are, what sector they are working in and so on, similar to a "Domesday Book" of regenerative aquaculture practitioners. This can then be used for horizontal and vertical integration through building a network of contacts and method of exchange (via BlueBioMatch and indirectly the CoolBlueFuture platform). The country facilitators (previously regional coordinators) are intended to facilitate networking and partnerships both within and beyond their borders. The data platform will therefore serve as a library, with BlueBioMatch a forum for stakeholders to build their businesses and make new connections.

Once sorted and categorised, monitoring at regular intervals should be conducted to develop a data timeline. This may also inform the selection of new cultivation sites, alongside existing platforms such as Copernicus and GIBF.

The CoolBlueFuture fundraiser would be a way to support communities with costs of monitoring, without getting over-committed to propping up small farms in the short term. Taking the substantial costs of monitoring off farmers' hands and handling data centrally could be a key enabler in making low-trophic aquaculture businesses more viable through the saving of costs and standardisation.

Purpose of this document

This document is intended as a handbook to provide context primarily to public authorities for the monitoring of regenerative ocean farms in the coming years, and for communities looking to start their own initiative. Public authorities are likely to conduct their own studies if regenerative ocean farming becomes an interesting enterprise for municipalities with education, environmental or commercial purposes.

The CoolBlueFuture community is the first step towards consolidation of existing datasets, which is more specific, straightforward and user-friendly than submission of data to EMODNet via the data ingestion portal, though this is also encouraged. The justification is that with a significant proportion of data expected to come from citizen science initiatives, the submission of data must be as straightforward and accessible as possible.

Existing relevant data-sharing networks in each Baltic country

Cross-Baltic data platforms (covering all countries):

- **HELCOM Map & Data Service (MADS)** – Regional hub for Baltic Sea thematic datasets (biodiversity indicators, pressures, ship density, 1×1 km grid, HOLAS products). Downloadable GIS layers and dashboards. (HELCOM Maps)
- **EMODnet** – EU backbone for marine data (bathymetry, chemistry incl. dissolved oxygen, biology/alien species, human activities), with a geoviewer and downloads specific to the Baltic basin. (EMODnet)
- **Copernicus Marine (BAL MFC)** – Baltic Sea physics/biogeochemistry reanalyses and near-real-time forecasts (sea level, T/S profiles, ice, currents; DMI SST analyses). (Copernicus Marine)
- **ICES portals (fisheries)** – Stock assessment graphs, survey data (DATRAS), and working group outputs for Baltic stocks; downloads and DOIs. (Standard Graphs)
- **WISE-Marine (EEA/EC)** – EU reporting and assessments under MSFD/WFD with Baltic region and country pages. (Water Information System for Europe)

Data platforms by theme:

- **Biodiversity:** Artportalen (SE), OBIS via national contributors, HELCOM biodiversity indicators. (SLU)
- **Weather/Ocean & Temperature:** FMI (FI), DMI (DK), SMHI SHARK (SE), Copernicus Marine (regional). (Finnish Meteorological Institute)
- **Pollution/Water Quality:** National monitoring portals (AAA LT, GIOŚ PL), HELCOM thematic datasets, SYKE APIs (FI). (aaa.lrv.lt)
- **Economic/Fisheries:** ICES stock assessments, national stats agencies (LUKE FI, Statistics Denmark), EU Blue Economy Observatory profiles. (Standard Graphs)

Open Science & Data Repositories:

Platform	Type	What it provides (relevant to water/biodiversity)
Zenodo (EU Open Science Repository)	Research data repository	Upload/download datasets, reports, models, scripts. Used by many EU-funded marine projects to publish monitoring data and MPA science datasets (DOI assigned automatically).
European Open Science Cloud (EOSC)	Federated research cloud & data catalog	Gateway into thousands of marine & environmental datasets, services, and Cloud compute — helps discover Copernicus, EMODnet, ICES, and national datasets in one searchable environment.
PANGAEA – Data Publisher for Earth & Environmental Science	Scientific dataset archive	Marine measurements, CTD profiles, biogeochemistry samples, benthic biodiversity, etc. Widely used by Baltic research institutes and HELCOM partners.
GBIF – Global Biodiversity Information Facility	Open biodiversity occurrence database	Species observations from museums & citizen science platforms. Baltic data aggregated via national nodes (Sweden, Finland, Denmark, etc.).
OBIS – Ocean Biodiversity Information System (IOC–UNESCO)	Marine species database	Marine-only biodiversity occurrences, including Baltic Sea monitoring data.

Citizen science platforms:

Platform	Focus	Description
Zooniverse	Citizen science project hosting	Where projects like microplastic image tagging or species recognition tasks are run. Anyone can upload a project (many marine ones exist).
EU-Citizen.Science (citizen-science.eu)	European citizen science hub	Catalog of citizen science projects, training materials, and toolkits — includes Baltic marine monitoring projects and environmental campaigns.

iNaturalist (Europe regional nodes also exist)	Biodiversity species observations	Massive species observation platform used by Baltic NGOs and MPAs for coastal & marine records. Data flows into GBIF.
ObsMapp / Observation.org	Biodiversity & waterbirds	Coastal waterbird records used in several Baltic MPAs and Natura 2000 monitoring efforts.
Marine Debris Tracker	Pollution & microplastics	Global citizen science for tracking litter (used in several Baltic beach monitoring initiatives).
Pl@ntNet	AI-based plant detection	Useful for identifying coastal vegetation, wetland plants in Baltic lagoons & estuaries.

Denmark:

- **Danish Environmental Portal (Danmarks Miljøportal)** – Gateway to environmental/water datasets; includes **VanDa** surface-water database (pollution & monitoring; login for full tools). (Danmarks Miljøportal)
- **DMI ocean & Copernicus SST** – Ocean forecasts and DMI-produced Baltic Sea SST gridded products (L3S/L4). (ocean.dmi.dk)
- **GEUS – Jupiter & groundwater/water quality** – National well/groundwater database and quality monitoring (supports water abstraction and quality stats). (Wiley Online Library)
- **Fisheries economics & stats** – Statistics Denmark “Accounts statistics for aquaculture” and “Water & wastewater” (prices, accounts, abstractions). (Danmarks Statistik)
- **Danish Fisheries Agency – Fishery in numbers** – Aggregated fisheries tables; links to detailed (DK) dashboards. (lfst.dk)

Germany:

- **BSH GeoSeaPortal** – Central access to BSH marine geodata (bathymetry, water pollution, currents) for North & Baltic Seas; map viewer & services. (geoseaportal.de)
- **BSH Data pages** – Entry points to BSH chemical-physical and geospatial marine datasets. (BSH)
- **MDI-DE (Marine Data Infrastructure Germany)** – Supra-institutional portal aggregating coastal/marine data (engineering, environmental protection, nature conservation) incl. Baltic coast. (projekt.mdi-de.org)
- **Marine Data Portal (research)** – Central access to German marine research data and reports. (marine-data.de)

Sweden:

- **SMHI SHARK/SHARKweb** – National marine environmental monitoring archive (biology, physics, chemistry) for Swedish seas incl. the Baltic; search & download. (jerico-ri.eu)
- **Artportalen (Artdatabanken)** – National species observation system (100M+ records), open biodiversity data (incl. coastal/marine). (SLU)
- **VISS – Water Information System Sweden** – WFD-driven coastal & inland waterbody status, pressures, and measures. (viss.lansstyrelsen.se)
- **Blue-economy snapshots** – EU Blue Economy Observatory profile for Sweden (sectoral jobs/GVA). (EU Blue Economy Observatory)

Finland:

- **Finnish Meteorological Institute (FMI) – Marine weather & Baltic Sea** – Live observations & maps (sea level, waves, ice, water temperature, etc.). (Finnish Meteorological Institute)
- **SYKE – Environmental data APIs** – Open interfaces for water quality, hydrology, algal blooms; modelling resources. (syke.fi)
- **Itämeri.fi data services (Merihavainnot.fi)** – Joint FMI/SYKE portal for Baltic state observations and downloads. (Itämeri)
- **LUKE (Natural Resources Institute Finland)** – Fisheries & aquaculture statistics and analyses (production volumes, value, licensing). (Luonnonvarakeskus)

Estonia:

- **Keskkonnaportaal – Marine monitoring** – Links to national KESE monitoring database and marine reports; sea/ice map products from the Environment Agency. (keskkonnaportaal.ee)
- **TalTech Marine Systems (MSI) – Marine Information** – Sea level info system, METOC portal, and FerryBox data for Estonian waters; research & models. (taltech.ee)
- **Copernicus use case (Estonia)** – Daily 3D marine parameters supporting Estonian monitoring/forecasting (HBM-EST setup). (Copernicus Marine)
- **Statistics Estonia – Fishing** – Official Baltic Sea catches, aquaculture production, and MPA shares. (stat.ee)

Latvia:

- **LEGMC – marine.meteo.lv** – Open marine data browser with official marine meteorology, forecasts, and warnings for the Baltic/Gulf of Riga. (Copernicus)
- **BIOR (Institute of Food Safety, Animal Health and Environment)** – Fisheries research data support (BIODATA) and sector information. (bior.lv)
- **Water/Literacy resources** – Public Baltic oceanography services and data literacy initiatives. (water.lv)
- Lithuania
- **Environmental Protection Agency (AAA) – Baltic & Curonian Lagoon monitoring** – Official monitoring stations and results (hydrology, hydrochemistry, biology, specific pollutants). Open datasets also mirrored on the national open data portal. (aaa.lrv.lt)
- **Lithuanian Hydrometeorological Service (LHMT) – Hydrological information** – Operational water level/temperature network (incl. marine/coastal context). (meteo.lt)

Poland:

- **IMGW-PIB** – National institute for meteorology & hydrology; oceanographic information for the Baltic (monitoring and forecasts). (imgw.pl)
- **GIOŚ (Chief Inspectorate of Environmental Protection)** – State environmental monitoring incl. **Baltic Sea monitoring** (INSPIRE WMS/view services). (Gov.pl)
- **MSP/Hydrographic resources** – National hydrographic service reporting (bathymetry layers & spatial plan context). (iho.int)

Set of measurements, equipment and protocols for smart, low-cost monitoring of ROF sites

This part of the report will be condensed into a lesson on monitoring at CoolBlueFuture.org website (see annex).

Regenerative ocean farming (ROF) is a sustainable aquaculture approach that cultivates seaweed and shellfish without inputs like feed or fertilizer, enhancing marine biodiversity, improving water quality, and sequestering carbon. Monitoring ROF is important for ensuring sustainability, preventing overharvesting, and assessing ecological benefits like nutrient cycling, carbon sequestration, and biodiversity restoration. It also helps improve farming techniques for better environmental and economic outcomes. In the Baltic Sea, ROF is expected to play a key role in reducing eutrophication by absorbing excess nutrients, restoring habitats, enhancing marine biodiversity, and providing sustainable seafood and alternative income for coastal communities.

Low-Cost Monitoring Methods

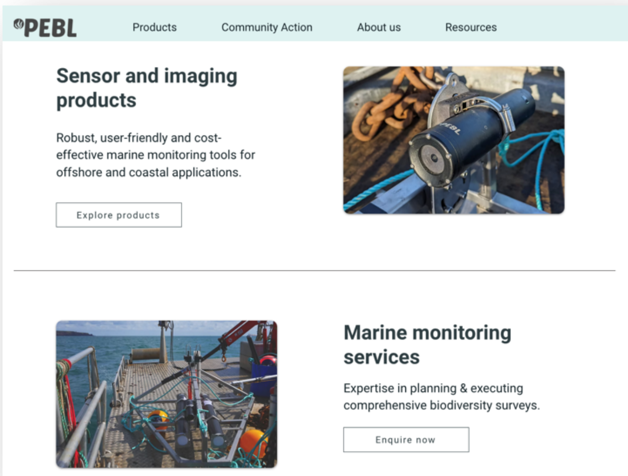
Monitoring can be done effectively with a mix of simple and advanced tools. Three monitoring methods were applied in the sister project COOL BLUE (Horizon CSA) including Baited Remote Underwater Video (BRUV), environmental DNA (eDNA) and Autonomous Reef Monitoring Structures (ARMS). The following section includes an overview of practical and affordable ways to track your farm:

1. Visual Inspections

- **Regular Boat Checks** – Use a small boat or kayak to inspect your farm weekly for damage, entanglements, or missing lines.
- **Underwater Camera** – A GoPro or waterproof phone case with a pole-mounted or tethered camera helps check mussel and seaweed health and farm infrastructure.
- **Snorkeling or SCUBA diving**
- **Underwater drone (such as Chasing M2 S 200m)**

2. Monitoring water quality and growth-supporting variables

Some environmental variables, such as salinity, nutrients, and food availability, help explain and predict seaweed and mussel growth, while others, like Secchi depth and turbidity, are useful for tracking the positive outcomes of ROF activities. Monitoring equipment and services also offers an attractive business model for third party service providers, at a different step of the value chain. For example, a non-profit (PEBL, see below graphic) in Wales has started producing low-tech monitoring equipment and services that could be replicated in the EU:



- **Simple Test Kits** – Use low-cost kits to measure salinity, temperature, dissolved oxygen, dissolved nutrients (e.g., nitrogen, phosphorus) and pH.
- **Floating Sensors** – Deploy floating buoys with sensors for salinity, temperature, available light, turbidity and phytoplankton (chlorophyll a) such as HOBO Pendant Temperature/Light 64K Data Logger.
  - Smart Buoys (e.g., OpenCTD, Arduino-based sensors)
  - Thermometers (digital or analog)
- **Secchi Disks** (manual water clarity checks)

3. Growth Tracking

- **Marking Ropes or Ruler**– Attach markers at fixed intervals on growth ropes to track growth over time.
- **Photo Documentation** – Take weekly or biweekly photos to monitor growth, detect diseases, bleaching, or fouling organisms. Including a measurement scale in the images helps accurately assess organism size.
- Grazing pressure and epiphytic cover for algae.
- **Weigh samples to track biomass growth, assess health, and detect changes over time.**

4. Invasive Species Control

- **Check for Biofouling** – Inspect ropes and structures regularly for invasive species, excessive algae, or barnacle overgrowth.
- **Use Remote Cameras** – Place wildlife cameras underwater or near the surface to monitor unwanted species and environmental changes.

5. Digital Tools for Easy Tracking

- **Mobile Apps** – Free apps for monitoring:
  - Secchi App (water clarity tracking)
  - Tide Charts App (plan inspections based on tides)
  - Marine Debris Tracker (log floating trash or entanglements)
  - HOBOconnect Monitoring App (pH measurements)
- **Google Sheets or Notebook** – Maintain simple records of observations, including date, weather, and growth conditions.

6. Low-Cost Drones for Aerial Surveys

- A basic waterproof drone can provide aerial views of your farm, especially after storms.

7. Community & Citizen Science

- **Collaborate Locally** – Work with local fishers, divers, or marine scientists already collecting data.
- **Join Monitoring Projects** – Participate in community efforts to track environmental changes.
- **Share Your Data** – Inform your Cool Blue country facilitator about your data collection.
- **Submit Data to European Marine Observation and Data Network (EMODnet)**
  EMODnet collects and shares marine data to support better decision-making across Europe. Public sector marine data is often underutilized, and contributing your observations helps improve ocean monitoring, sustainable management, and scientific research.
  - **How to Contribute:** Follow this instructional video for a step-by-step guide on submitting data.
  - **Why It Matters:** Learn more about the importance of adding data to EMODnet in this background video.

Baltic Sea: Health and Safety Testing of the Harvest

After harvesting seaweed and shellfish from the Baltic Sea, it is important to ensure they are safe for consumption. Since reliable home testing kits are not widely available, consider reaching out to experts and initiatives with experience in the region to see if they have conducted relevant tests. Additionally, you can collaborate with a laboratory to analyze your samples for key safety and nutritional parameters.

Areas to Investigate

Water Contamination: Contact a lab to test for pollutants such as nitrates, phosphates, heavy metals (lead, mercury), or other contaminants absorbed by seaweed and shellfish.

Bacterial Risks: Shellfish can carry harmful bacteria like *E. coli* or *Vibrio*. Testing through an accredited lab ensures food safety.

Nutritional Content: To assess iodine levels, mineral composition (calcium, magnesium, iron), and protein content, consult a lab specializing in marine food analysis.

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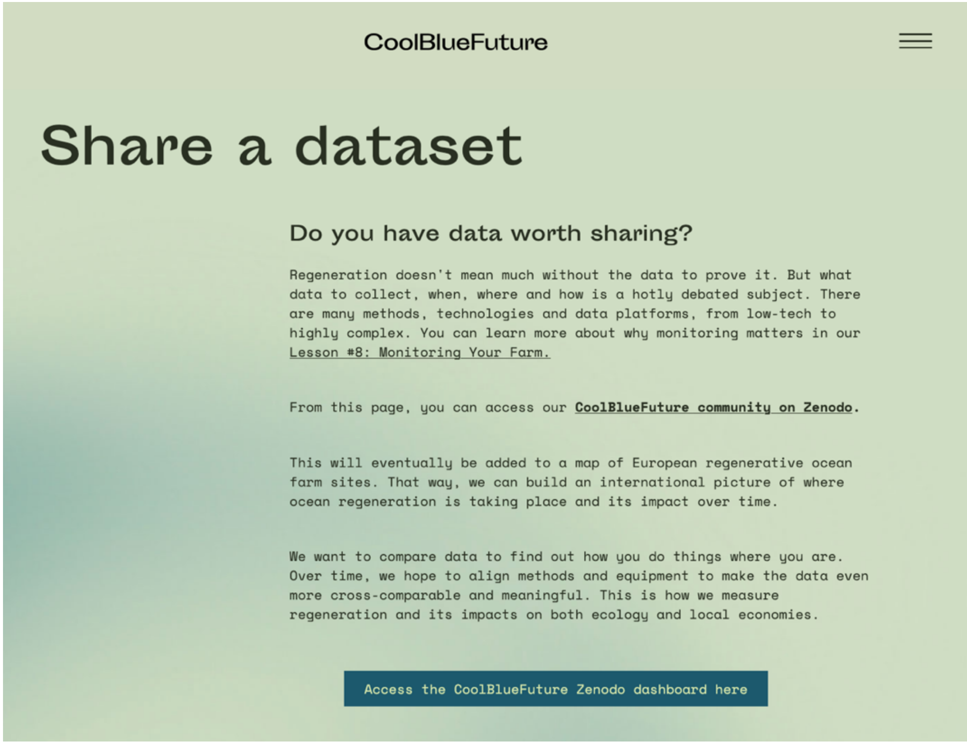
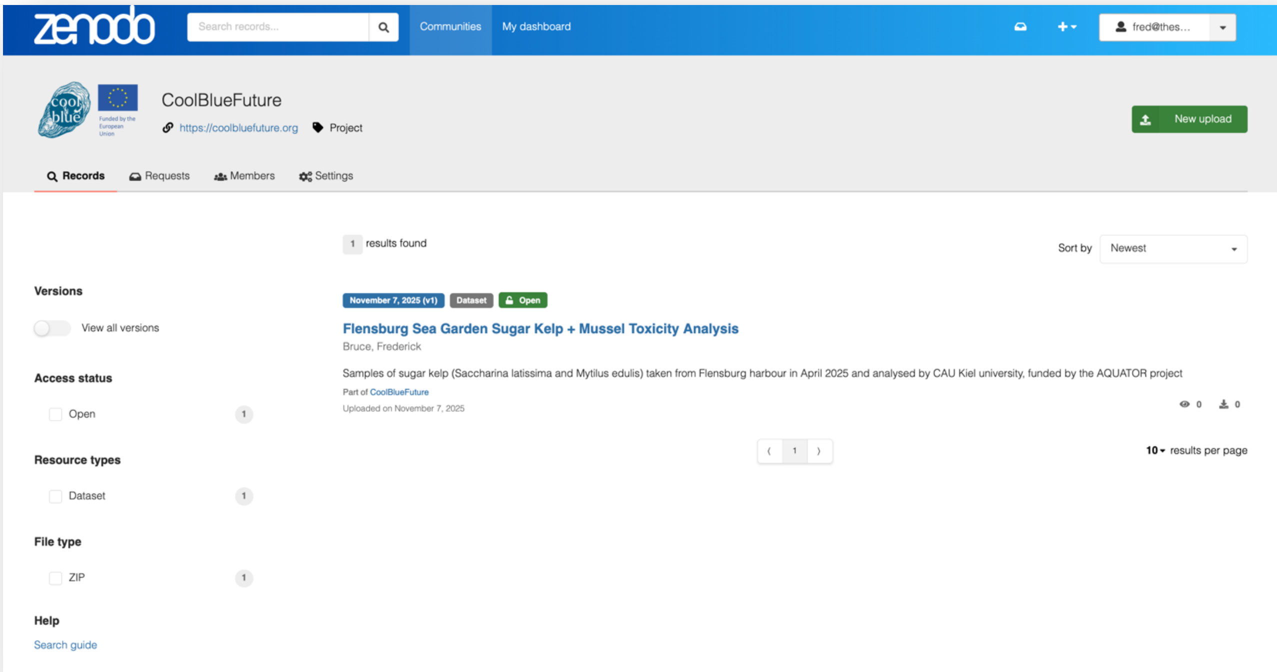
Annex I

Submission Form for ROF data





Annex II

Webpage - Lesson 8: Monitoring Your Farm

Screenshots from Lesson 8: Monitoring Your Farm online on the HAV website (coolbluefuture.org) under Guide to Regenerative Ocean Farming. The lesson materials are simplified versions of the project deliverables designed for a general audience. Relevant deliverables are linked at the end of each lesson.

URL: https://coolbluefuture.org/guide-to-regenerative-ocean-farming/lesson-8/

CoolBlueFuture

Lesson 8
Introduction
Why Monitoring Matters
Low-Cost Monitoring in Practice
Health and Safety: Testing Your Harvest
Reflection
Key Takeaways

Lesson 8: Monitoring Your Farm

LESSONS ARE CURRENTLY AVAILABLE IN ENGLISH

Introduction

Regenerative ocean farming is about more than producing food – it is also about restoring ecosystems. But how can you tell if your farm is really making a difference? How do you know if your seaweed is absorbing nutrients, if your mussels are thriving, or if unwanted species are creeping in? The answer lies in monitoring.

Monitoring is like keeping a diary of your farm. It reveals the rhythms of the sea, the challenges that arise, and the positive changes your work is creating. With good monitoring, you can catch problems early, protect consumers, and show your community that your farm is truly regenerative. Over time, careful records help you improve your farming methods, strengthen your story, and demonstrate the ecological value of your work.

English (UK)

Why Monitoring Matters

Monitoring is not just a regulatory requirement. It is the heartbeat of a regenerative farm. Without it, you are farming blind; with it, every decision becomes sharper and more informed. Farmers who monitor closely can see when growth slows down, when water clarity improves, or when new species appear on their ropes. This knowledge allows them to adjust techniques, plan harvests around natural cycles, and avoid costly mistakes.

Monitoring also builds trust. By showing clear evidence of water quality, growth, or biodiversity, farmers reassure consumers, regulators, and local communities that their operations are safe and sustainable. For shellfish and seaweed producers, this is particularly important: these organisms filter or absorb substances from the water, which can include both nutrients and pollutants. Monitoring ensures that benefits are maximised while risks are controlled.

Finally, monitoring allows farmers to tell their story. A mussel farmer who can show that water clarity improved around the farm has a powerful narrative. A seaweed farmer who shares growth photos across the season not only tracks progress but also educates the public about the condition of the ocean. Monitoring, in this sense, becomes a form of storytelling that builds pride and connection.

Low-Cost Monitoring in Practice

Effective monitoring doesn't have to be expensive. Many of the most useful methods are simple, affordable, and easy to integrate into routine farm work.

Visual Checks

A regular trip around the farm – by boat, kayak, or even from the shoreline – helps you spot issues such as tangled ropes, broken lines, or unusual growth patterns. Waterproof cameras or drones can extend your view below and above the surface, while snorkeling or scuba diving provides direct impressions of farm health.

Water Quality

The surrounding water determines much of your farm's success. Simple test kits measure temperature, salinity, dissolved oxygen, and nutrient levels. A Secchi disk, lowered into the water until it disappears, offers a quick measure of water clarity and light penetration. Floating sensors or smart buoys can log conditions continuously, revealing patterns such as seasonal changes or sudden fluctuations after storms.

Tracking Growth

Seaweed and mussels grow in visible, measurable ways. Marking ropes at set intervals makes it easier to follow growth, while photographs with a ruler or scale in the frame document changes in size, colour, or fouling. Sampling and weighing a small portion of biomass helps track productivity over time. These simple steps provide a reliable picture of farm performance across the season.

Invasive Species and Biofouling

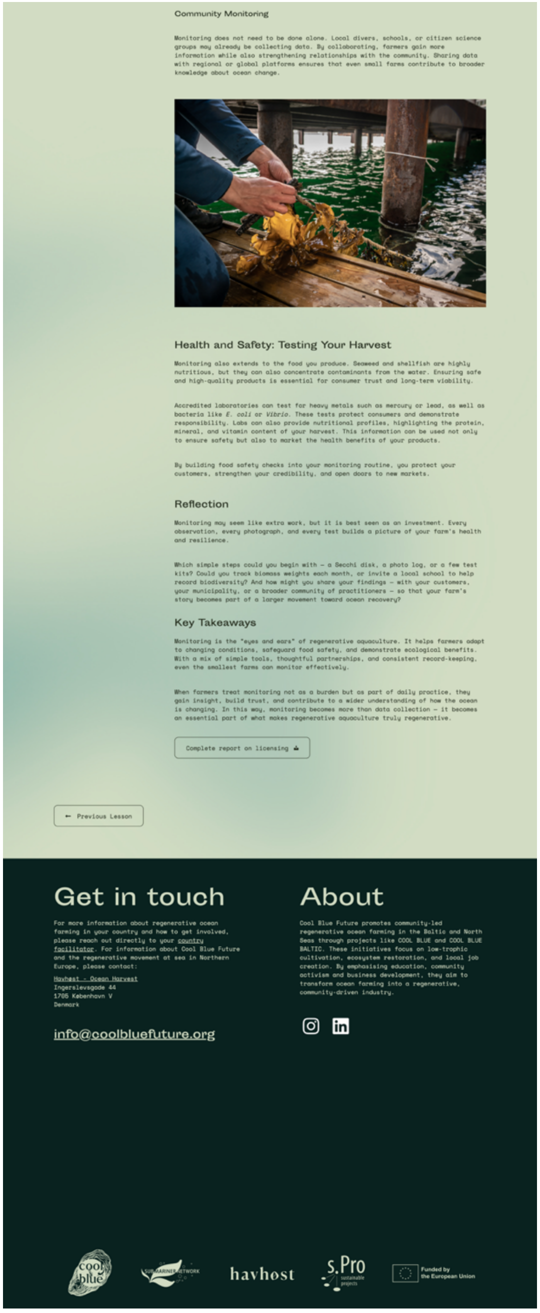
Unwanted organisms – from barnacles to invasive algae – can quickly overwhelm gear and reduce productivity. Regular inspections, combined with photo or video records, make it easier to detect these issues early. By noting when fouling is worst, you can adjust cleaning schedules or test different materials and techniques.

Digital Tools

Even basic apps can turn your smartphone into a monitoring tool. Free platforms let you log water clarity, track debris, or record tide information. A simple spreadsheet or notebook can capture dates, weather, and observations, building a valuable farm record that becomes more useful year after year.

Aerial Surveys

Aerial views, especially after storms, help assess whether equipment has shifted or lines have been damaged. Waterproof drones offer a low-cost way to see the big picture without visiting every rope individually.



Community Monitoring

Monitoring does not need to be done alone. Local divers, schools, or citizen science groups may already be collecting data. By collaborating, farmers gain more information while also strengthening relationships with the community. Sharing data with regional or global platforms ensures that even small farms contribute to broader knowledge about ocean change.

Health and Safety: Testing Your Harvest

Monitoring also extends to the food you produce. Seaweed and shellfish are highly nutritious, but they can also concentrate contaminants from the water. Ensuring safe and high-quality products is essential for consumer trust and long-term viability.

Accredited laboratories can test for heavy metals such as mercury or lead, as well as bacteria like *E. coli* or *Vibrio*. These tests protect consumers and demonstrate responsibility. Labs can also provide nutritional profiles, highlighting the protein, mineral, and vitamin content of your harvest. This information can be used not only to ensure safety but also to market the health benefits of your products.

By building food safety checks into your monitoring routine, you protect your customers, strengthen your credibility, and open doors to new markets.

Reflection

Monitoring may seem like extra work, but it is best seen as an investment. Every observation, every photograph, and every test builds a picture of your farm's health and resilience.

Which simple steps could you begin with – a Secchi disk, a photo log, or a few test kits? Could you track biomass weights each month, or invite a local school to help record biodiversity? And how might you share your findings – with your customers, your municipality, or a broader community of practitioners – so that your farm's story becomes part of a larger movement toward ocean recovery?

Key Takeaways

Monitoring is the "eyes and ears" of regenerative aquaculture. It helps farmers adapt to changing conditions, safeguard food safety, and demonstrate ecological benefits. With a mix of simple tools, thoughtful partnerships, and consistent record-keeping, even the smallest farms can monitor effectively.

When farmers treat monitoring not as a burden but as part of daily practice, they gain insight, build trust, and contribute to a wider understanding of how the ocean is changing. In this way, monitoring becomes more than data collection – it becomes an essential part of what makes regenerative aquaculture truly regenerative.

Complete report on licensing

← Previous Lesson

Get in touch

For more information about regenerative ocean farming in your country and how to get involved, please reach out directly to your country facilitator. For information about Cool Blue Future and the regenerative movement at sea in Northern Europe, please contact:

Havhøst - Ocean Harvest
Ingerslevsgade 44
1705 København V
Denmark

info@coolbluefuture.org

About

Cool Blue Future promotes community-led regenerative ocean farming in the Baltic and North Seas through projects like COOL BLUE and COOL BLUE BALTIC. These initiatives focus on low-trophic cultivation, ecosystem restoration, and local job creation. By emphasising education, community activism and business development, they aim to transform ocean farming into a regenerative, community-driven industry.

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Annex III

Survey results

To better understand the key data needs and challenges related to ROF, a survey was conducted among COOL BLUE BALTIC project partners. The survey focused on identifying the ecological, economic and social impacts of ROFs, as well as the essential data needed for farm operations and potential data-sharing platforms. The responses highlight the importance of accessible, standardised monitoring methods and the need for a structured data-sharing approach to support farm development, licensing and long-term sustainability. The full survey can be found in D2.2 COOL BLUE BALTIC Regenerative Action Plan. Below is summary of the survey results:

What data are needed to show the ecological impacts of community farms?

Measuring the ecological impact of ROFs requires a combination of low-cost, frequent monitoring by farmers and high-tech, periodic assessments by regional or national authorities (e.g. toxicology testing prior to human consumption). Exact parameters to measure will depend on the use-case and the requirements of the national authority. However, as a general guideline, ecological parameters to measure include:

- **Water quality** (temperature, salinity, oxygen levels, pH, nutrients, chlorophyll a)
- **Biodiversity and benthic impacts** (species monitoring, habitat changes)
- **Nutrient and carbon absorption** (vs. harvest volumes)
- **Waste management and emissions**

Monitoring should be conducted before, during and after farm operation. Local authorities can support assessments using eDNA and seafloor observatories, with potential for citizen science involvement to expand data collection. An example of this is the Koster Seafloor Observatory[1].

What data are needed to show the economic impacts of community farms?

To assess the economic impacts of community farms, key data points include:

- harvest volumes
- market value
- local job creation
- CAPEX
- OPEX
- profitability (return on investment, profit margins)

Tracking capital expenditures (CAPEX) and operational expenditures (OPEX) is essential for understanding financial sustainability, along with identifying market channels that connect products to consumers. Additionally, data on subsidies and grants can provide additional insights into long term profitability. Establishing baseline economic data prior to farm setup allows for meaningful comparisons over time, particularly in relation to conventional aquaculture and agriculture. Finally, tracking establishment and decommissioning costs helps measure the full financial lifecycle of community farms, informing future investment and policy decisions.

What data are needed to show the social impacts of community farms?

Measuring the social impact of community farms requires data on:

- public access
- participation rates (e.g. volunteers)

[1] https://www.zooniverse.org/projects/victorav/the-koster-seafloor-observatory

- demographics
- qualitative indicators (e.g. social acceptance)

Tracking revenues in local businesses, dietary impacts and educational offerings highlight economic and knowledge-sharing benefits. Community engagement metrics, such as local cooperation, events and qualitative feedback, provide insights into social cohesion. Additionally, data on mental health benefits, dietary habits, cost of living (e.g. local food prices) and accessibility ensure inclusivity and broader societal impact.

What data do sea farming communities need to help the operation of the farm, and how can they collect it in a simple, affordable, robust way?

Sea farming communities need water quality data (temperature, salinity, pH, dissolved oxygen, and nutrients) collected through affordable test kits, low-cost sensors and public weather data. Farm health and growth tracking can be done via photographic records and simple logs, while biodiversity and environmental impacts can be monitored with the help of divers, underwater cameras, and sensors. Farm layout maps, maintenance logs, and equipment tracking support operational efficiency. Financial management can be improved using affordable accounting software, and regulatory compliance can be streamlined with checklists, mobile apps, and training workshops. Collaborating with universities, research institutions, and local authorities can provide access to advanced testing, contaminant analysis, and designated regulatory contacts.

To begin, check whether your country is part of the Cool Blue Future network and whether a facilitator is available to help you connect with the right contacts and access the necessary information. Cool Blue Future is a network of country facilitators across Northern Europe, working both individually and collaboratively to advance regenerative ocean cultivation. Their efforts align with the principles outlined in the Manifesto for Regenerative Ocean Farming, ensuring a sustainable and ecosystem-friendly approach.

Find the contact details for country facilitators here: https://coolbluefuture.org/country-facilitators/

Please list any relevant national or transnational data platforms here (e.g. EMODNet)

- **Lithuania**: The Open Data Portal is a single point of access to all open datasets in Lithuania: https://data.gov.lt/
- **Sweden**: SHARK SharkWeb (smhi.se), SGU Marin miljöövervakning (sgu.se), VISS Välkommen till VISS (lansstyrelsen.se), Dryad Dryad (datadryad.org)
- **Poland** https://www.findfish.pl/
- **Estonia**: EELIS (Estonian Nature Information System) offers environmental data https://infoleht.keskkonnainfo.ee/artikkel/1525036761, KESE (database of environmental data collected under the National Environmental Monitoring Programme and related environmental research projects) https://kese.envir.ee/kese/welcome
- **Germany**: Dataportal for German coastal waters: https://deutsche-kuestenforschung.de/datenportal.html

Any other ideas, comments or suggestions?

Danish partner, Havhøst, plans to enhance its educational platform, *Haven i havet*, by introducing a citizen science module. This initiative will involve school classes from 18 locations across Denmark, enabling students to contribute marine environmental data to a centralized database. The platform will offer various data views and comparative tools to enrich the educational experience.

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Annex IV

Real-world examples of ROF monitoring in the Baltic Sea

Estonia

Seaweed cultivation and monitoring in Estonia

Jonne and his son Mihkel are exploring seaweed cultivation near Saaremaa Island, Estonia. In October 2023, they began by collecting wild drifting bladderwrack and placing it in a net cage in the sea, allowing it to grow naturally without intervention. The farm successfully endured its first winter, and the initial production season exceeded expectations, with the seaweed tripling in size within just a few months. Now, Jonne is refining the cage design to enhance efficiency, reduce labor at sea, and introduce additional species like sea lettuce to the farm.

To track the growth and environmental conditions at the farm, biomass yield measurements (see figure below) are taken once a month during the cold season and twice a month in the warm season, providing continuous data on seaweed growth rates throughout the entire cultivation period. In addition, underwater oceanographic instruments monitor key factors influencing seaweed growth, including light availability, temperature, and current velocity. Nutrient concentrations in the area remain relatively stable and do not limit seaweed growth. The same instruments also record water quality parameters such as turbidity and phytoplankton abundance (chlorophyll a). These instruments take measurements every 15 minutes, offering a solid dataset to understand the environmental conditions that promote optimal seaweed growth and indicate periods when biofouling is more likely to occur.

This initiative is carried out in cooperation with the AlgaeProBanos project, which supports sustainable algae production and innovation in the Baltic and North Sea regions. The project helps improve methodologies for seaweed cultivation, monitoring, and utilization while promoting collaboration between farmers, researchers, and policymakers.

Sweden

Monitoring in the Swedish Algae Industry

The *Development of the Swedish Algae Industry* report, commissioned by the Swedish Board of Agriculture in 2023, highlights the critical role of monitoring in ensuring sustainable algae farming. As the industry grows, effective monitoring is essential to track environmental impacts, optimize farming methods, and meet regulatory requirements.
Key aspects of monitoring in Swedish algae farming include:

- **Water Quality Monitoring** – Tracking nutrient levels, salinity, and pollutants to assess farm impact on the marine environment.
- **Ecosystem Monitoring** – Observing biodiversity changes, potential habitat impacts, and biofouling risks.
- **Farm Infrastructure Monitoring** – Ensuring farm structures remain intact to prevent marine debris and habitat disruption.
- **Regulatory Compliance** – Using data to demonstrate the environmental benefits of algae farming, such as nutrient absorption and carbon sequestration.

The report emphasizes the need for **cost-effective and scalable monitoring solutions**, calling for collaboration between farmers, researchers, and authorities. Improved monitoring frameworks will help balance industry growth with environmental protection, making algae farming a sustainable and viable food source in Sweden.

Seaweed Coast project in Sweden
The Seaweed Coast project report focuses on effective environmental monitoring for sustainable seaweed farming in the Baltic Sea. Monitoring plays a crucial role in ensuring minimal ecological impact while supporting farm productivity and regulatory compliance.
Once the farm is operational, regular inspections are necessary to maintain infrastructure stability, check line integrity, and ensure anchors remain properly placed (Visch et al., 2024; Greenwave, 2024). Monitoring helps detect potential issues such as line wear, which can prevent marine debris, and ensures that mooring systems do not disturb the seabed.

Monitoring Practices:

- **Water Quality Monitoring** – Farmers can track temperature, salinity, turbidity, and nutrient levels using **simple test kits, digital meters, and Secchi disks** (Flavin et al., 2013; Greenwave, 2024). Monitoring nutrient uptake can demonstrate the positive environmental impact of seaweed farming in reducing eutrophication (Armoskaite et al., 2021).
- **Biodiversity and Habitat Monitoring** – To track species interactions and detect invasive organisms, farms can use underwater cameras, baited remote underwater video (BRUVs), passive acoustic monitoring (PAM), and environmental DNA (eDNA) analysis (Berger et al., 2024). These methods provide insights into ecosystem responses and help identify marine fauna presence.
- **Seabed and Infrastructure Monitoring** – Regular seabed surveys assess sedimentation, shading effects, and biofouling. Anchoring systems should be checked to minimize disturbance to marine habitats (Barda et al., 2022).
- **Adaptive Monitoring** – Continuous adjustments to monitoring protocols based on seasonal changes and farm expansion improve long-term sustainability. Collaboration with researchers and stakeholders helps refine best practices and contributes to broader environmental data collection (Visch et al., 2024).
The project highlights that cost-effective, scalable monitoring solutions can support the growth of seaweed farming while protecting the marine environment.

Funded by the European Union

Denmark

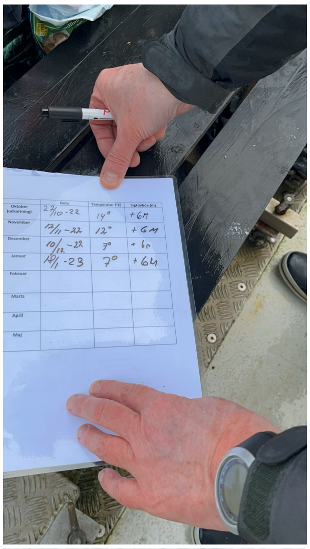
Monitoring seaweed in the marine gardens in Denmark

Aim of this project ("Marine Virkemidler", DTU Aqua and Aarhus Universitet 2022-2023) was to see how sugarkelp grows in different parts of Danish seawaters, where salinity, and other parameters differ. Hence 16 sites were selected and handed out seed lines of sugar kelp to be monitored from startup October 2022 until harvest in May 2023.

Once a month the sites were visited to record a small series of data:

- Water samples were collected in small test tubes and stored locally in fridges.
- Water temperatures were measured and noted on a spread sheet
- Water clearness was measured using a simple disc painted with a black/white pattern. The disc was lowered down until just barely visible. The length of the rope was then noted.
- Growth was recorded by taking pictures. When harvesting, the weight was recorded, and samples of seaweed were saved for analysis in laboratory.

At the end of the project, data was collected from all the sites.



Nye Tangarter project in Denmark

In this project by DTU Aqua, starting 2025, the focus is on growing new seaweed types on seed lines, to broaden the types of seaweed species growing in the sea gardens. Knowledge has been built up on preparing and growing sugar kelp. In this project other species will be tried out – toothed wrack, bladder wrack spaghetti kelp, purple laver seaweed and other.

These examples from Estonia, Sweden, and Denmark showcase effective ROF monitoring strategies, emphasising water quality, biodiversity, and infrastructure stability. Collaboration between farmers, researchers, and policymakers is key to improving monitoring, optimizing farming, and ensuring regulatory compliance. Cost-effective, scalable solutions will support the sustainable expansion of ROF in the Baltic Sea.

References

Armoskaite, A., Barda, I., Purina, I., Sprukta, S., Fedorovska, A., & Strake, S. (2021) Report on ecological impacts of macroalgae cultivation in the Baltic Sea region. Latvian Institute of Aquatic Ecology. https://2020.submariner-network.eu/images/grass/outputs/GoA_23_Report_on_ec ological_impacts_of_macroalgae_cultivation_in_the_Baltic_Sea_region_final3.pdf

Barda, I., Ikauniece, A., Armoskaite, A, ... Wahl, M. (2022) *Ensuring environmental safety - necessary monitoring practices for seaweed cultivation and harvesting in the Baltic Sea.* Report for the "Safe Seaweed Coalition" project "BalticSeaSafe", Deliverable O.1. https://submariner-network.eu/wp-content/uploads/2024/01/BalticSeaSafe_seawe ed_monitoring_O1_report_Final.pdf

Berger, C., Marshall, B., Papazova, P., Evans, F. & Williams, Craig. (2024). Integrating environmental and ecological monitoring with seaweed farming. https://doi.org/10.1101/2024.02.15.580450

Flavin, K., Flavin, N. & Flahive, B. (2013). Kelp farming Manual: A guide to the processes, techniques, and equipment for farming kelp in New England waters.

Portland: Saco, ME, Ocean Approved LLC. https://maineaqua.org/wp-content/uploads/2020/06/OceanApproved_KelpManual LowRez.pdf

Greenwave (2024) Regenerative Ocean Farming Hub. Greenwave. Retrieved June 20 from https://www.greenwave.org/hub

Visch, W., Biancacci, C., Farrington, G., J. C. Sanderson, J.C., Nardelli, A.,

Schwoerbel, J., Lamb, P., Evans, B., Hurd, C.L., Bellgrove, A., & Macleod, C. (2024). Aquaculture Production of the Australian Laminarian Kelps: A manual and research recommendations for Ecklonia radiata, Lessonia corrugata, and Macrocystis pyrifera. Institute for Marine and Antarctic Studies, University of Tasmania. 86pp (ISBN 978-1-922708-76-2).