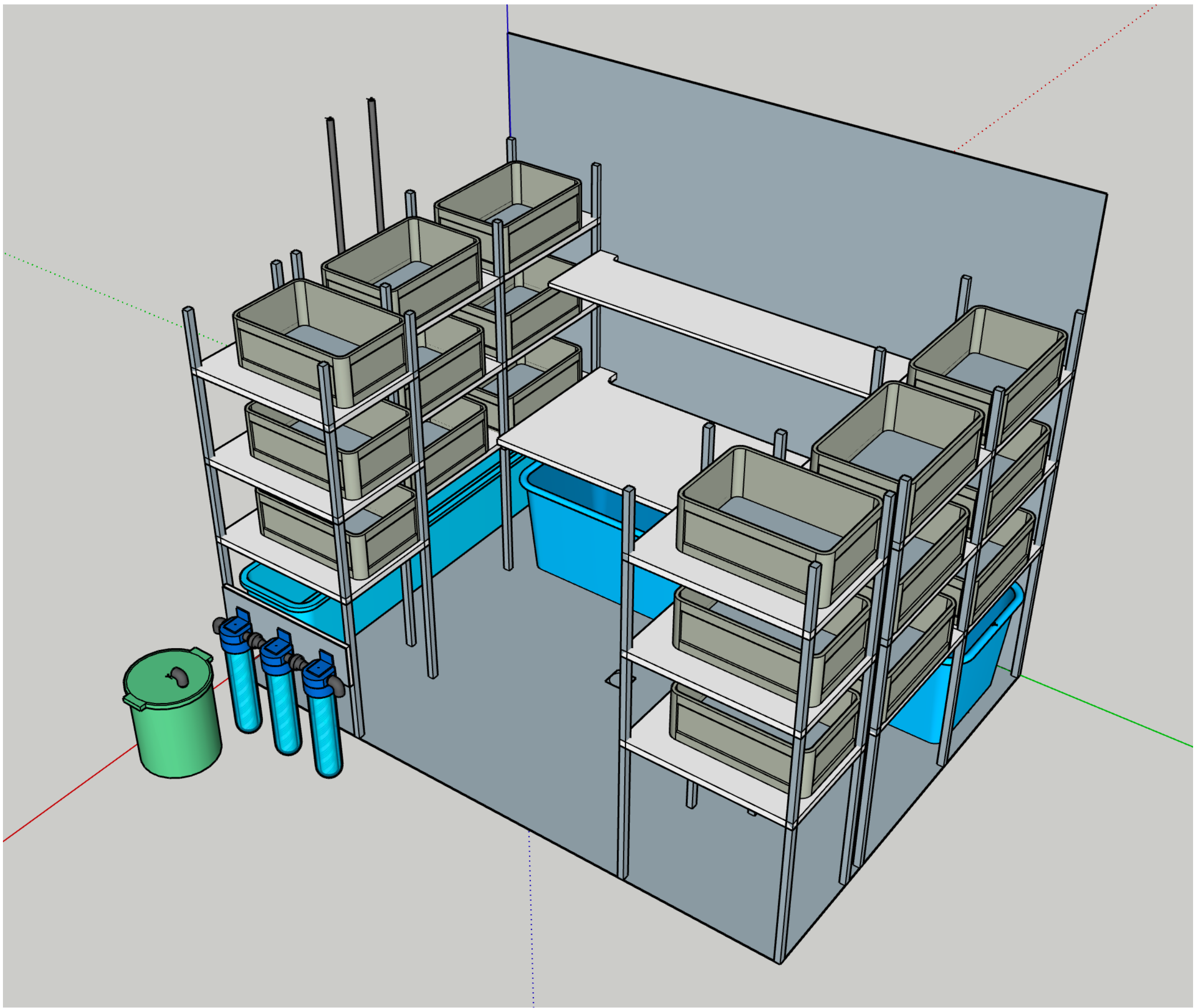
City University of Applied Sciences Bremen
in cooperation with the
Alfred Wegener Institute
Helmholtz Centre for Polar and Marine Research

Design, dimensioning and performance of a large-scale flat oyster (*Ostrea edulis*) broodstock conditioning at Helgoland Oyster Hatchery

Master thesis

Technical and Applied Biology (M. Sc.)



Jan Lammers
Matriculation Number 5004137

Supervisor: **Bérenger Colsoul (AWI)**
1st examiner: **Prof. Dr. Thomas Klefoth (HSB)**
2nd examiner: **Dr. Bernadette Pogoda (AWI)**

Declaration of oath

This Master thesis was written at the City University of Applied Sciences Bremen in the Faculty 5, Nature and Technology (Biology) and through a collaboration with the Alfred Wegener Institute at the Biological Institute Helgoland, from June to September 2021.

First examiner of the thesis: Prof. Dr. Thomas Klefoth
Faculty 5 Nature and Technology
University of Applied Sciences Bremen

Second examiner of the thesis: Dr. Bernadette Pogoda
Shelf Sea System Ecology and AWI North Sea Office
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

I hereby declare on my honor that:

1. I have written this Master thesis independently under supervision and have not used any sources or aids other than those indicated;

2. The adoption of literal quotations from literature/internet as well as the use of other authors' thoughts has been marked at the appropriate places within the thesis;

3. I have not submitted my Master thesis to any other examination.

I am aware that a false declaration will have legal consequences.

Student: Jan Lammers

Helgoland, 24th September 2021 Jan Lammers

Location, Date Signature

Acknowledgements

I would like to say Thank you to all those who supported and motivated me during the process of writing this Master thesis.

First, I would like to say thank you to Prof. Dr. Thomas Klefoth and Dr. Bernadette Pogoda, who supervised me in an excellent way and examined this Master thesis. Thank you for all the support, suggestions and helpful advices.

Thanks to the Alfred Wegener Institute, the Biological Institute Helgoland, the Ecological Restoration Research Group, and the Helgoland Oyster Hatchery to allow me the opportunity to carry on with my research and experimentation.

Thanks to Thu Thao Phung, Corina Peter, Lennard Klingforth, Dr. Aldi Nel and Clemens Kozian-Fleck, which had the patience to work with me for the past year and without whose contribution this thesis would not have been possible.

Thanks to Dr. Julien Di Pane, for supporting in the data analysis and also for the fishing trips in the free time that helped to compensate stressful times.

A very special thanks to Bérenger Colsoul for the great supervision, the close cooperation and the great trust to take on so many tasks.

I would also like to thank all those who have helped in any way by providing bibliographic material, comments, suggestions and corrections.

Finally, I would like to thank the ISTAB team at the University of Applied Sciences Bremen, who have introduced me to new topics again and again over the last few years and have always motivated me to take on new challenges with their dedicated manner.

Thank you, it was a pleasure to work with all of you!

Jan

Abstract

Restocking and conservation of European flat oyster (*Ostrea edulis*) populations is a major focus of ecological restoration efforts to benefit from the wide range of ecosystem functions and services that this species provides by building up biogenic reefs.

Today, *O. edulis* production is still largely based on seed collection through the placement of collectors in the wild. Given the specific requirements for ecological restoration, such as the absence of pathogens and the preservation of a high genetic diversity, the current supply with seed oysters within Europe is insufficient or inadequate. Moreover, in the German context where no native broodstock occurs and pathogens are absent, ecological restoration can only be carried out by establishing an innovative research oyster hatchery using appropriate imported oyster broodstock for controlled production. In this context this study was carried out on the island of Helgoland, addressing the requirements of: 1) substantial larval production, 2) design and construction of an effective broodstock conditioning system (against the constraints of converting an existing infrastructure from the 1970s and space limitations, 3) bio secure production.

The focus of the study was the design, implementation of the conditioning structures (broodstock maturation), the validation (conditioning) of the conditioning system and the performance evaluation (number of larvae, influence of temperature, influence of broodstock origin) of the implemented structure. The inseparable aspects of biosecurity (including quarantine, purification treatments), broodstock production and feeding, and pre-conditioning operations are also addressed here.

After planning period (February 2021 to April 2021), the designed system was build up (April 2021 to May 2021) and activated with broodstock oysters from two origins (Norway and Scotland) for a first conditioning cycle (June 2021 to September 2021). In total 32 million *O. edulis* larvae were produced successfully.

Table of Content

Captions

List of tables

1. Introduction

The global ecosystems undergo a steady change. Some are influenced by the raw power of nature, but most of them have to adapt to anthropogenic influences (Pogoda, 2019b). The intensive use of natural resources causes an increasing decline of biodiversity and thus an increased risk of permanent loss of these ecosystems.

Marine ecosystems in particular are exposed to this risk, as long-term impacts are not recognised immediately. The use of marine resources often depends on the season and, especially in the case of many fish species, on their migratory behaviour. A decline in fisheries is often only noticeable after years or decades. For sessile benthic organisms, like the European oyster *Ostrea edulis* (Linnaeus 1758), it is different, they - at least in their adult life stage - are bound to their location. In the North Sea, once rich oyster beds were intensively exploited to satisfy the growing demand for European oysters over centuries (Seaman and Ruth, 1997). But the increasing demand and improved harvesting techniques led to the destruction of oyster beds and their reef structures within the European North Sea (Korringa, 1946, Yonge, 1960, Pogoda, 2019a).

O. edulis was an important food source for coastal communities in Europe, also in prehistoric times. The fact that even the Romans already cultivated the oyster (Yonge, 1960, Günther, 1897) to satisfy the demand of this delicacy demonstrate their historical importance. The oyster fishery is considered the oldest commercial fishery besides the herring catch. Hundreds of years ago, the harvest of oysters was already regulated and managed to conserve this resource (Gercken and Schmidt, 2014). The oyster beds have been exploited too intensively, as there was a continuous removal of adult oysters. The harvesting techniques improved in efficiency and led to the destruction of the biogenic reef structures of the oyster beds. This resulted in a European-wide decline in fisheries during the 19th century (Korringa, 1946, Yonge, 1960).

The natural range of the European Oyster comprised the coastline from Norway to the North West of Africa (Morocco). Also, there were populations in the Mediterranean

Sea, mainly along the northern coast and the western part of the Black Sea (Yonge, 1960, Lotze, 2007).

In Germany, the former distribution included the North Frisian Wadden Sea, the East Frisian Wadden Sea, the Helgoland and the offshore oyster grounds. In North Friesland, the oyster fishery was the most important fishery in the Wadden Sea and represented an important economic factor, probably since the 13th century (Lotze, 2007).

Since the end of the 17th century, the yield in fisheries continuously decreased due to overfishing. The harvesting of oysters was temporarily interrupted by bans aiming to retore the populations. To prevent the decline of oyster populations, several restocking projects, mostly based on translocations, took place, but the steady decline of oyster stocks could not be prevented by these measures (Yonge, 1960, Gercken and Schmidt, 2014, Bromley et al., 2016). On the contrary, pathogens, parasites and diseases were probably introduced with those translocations of oysters' populations out of France and the Netherlands (Brenner et al., 2014, Bromley et al., 2016, Colsoul et al., 2021).

In addition to the economic relevance of the oysters, there are moreover important ecological aspects, e.g., oysters can build reef structures on the sea bottom that create a habitat for several marine species (Preston et al., 2020, zu Ermgassen et al., 2020). They offer important ecosystem services as increasing seawater clarity, increase fish production, denitrification, stabilization of sediments (Lee et al., 2020, Preston et al., 2020). Hence, the degraded oysters' beds of the European flat oyster are now in the focus of European conservation efforts to restore the local biodiversity in the North Sea. Additionally, filter feeders like oysters have also a significant value in improving water quality as well as substrate formation and biodiversity enhancement (Yonge, 1960, Lotze, 2007, Pogoda et al., 2020, Colsoul et al., 2021). It therefore contributes to objectives defined by 1) the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic, 2) the EU Habitats Directive (Directive 92/43/EEC) and 3) the EU Marine Strategy Framework Directive (Directive 2008/56/EC) (Pogoda et al., 2019, Colsoul et al., 2021).

Active oyster restoration measures can be divided into three different approaches: (i) releasing larvae; (ii) releasing produced spat; (iii) translocating adult oysters (Lallias et al., 2010, Colsoul et al., 2021). The first approach (i) is difficult to implement in the North Sea, because sufficient substrate for the settlement is missing, or only viable under optimal conditions (zu Ermgassen et al., 2020, Temmink et al.). The third approach (iii), as already mentioned above, can even have a negative effect on the existing flora and fauna by introducing pathogens or diseases to the restoration site, or by fishing and extracting oysters at the extraction site and should therefore not be applied (Pogoda et al., 2019, Fitzsimons et al., 2020). Consequently, the second approach (ii) should be followed by producing juvenile spat oysters in controlled conditions, which can then be released at the respective restoration site (Merk et al., 2020, Colsoul et al., 2021). The substantial and sustainable production of spat oysters for ecological restauration, however, is the limiting factor here (Pogoda et al., 2019, Colsoul et al., 2021, Bertolini and Pastres, 2021).

In commercial aquaculture, the production is focussed on an optimized amount and quality of the oysters. In ecological restoration however, the conservation of a high genetic diversity within the population is an important priority to ensure adaptability for future generations (Lallias et al., 2010, Šegvić-Bubić et al., 2020).

In 2016, the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) and the German Federal Agency for Nature Conservation (BfN) implemented the project RESTORE to create a framework for *O. edulis* restoration in the German North Sea and to identify the baselines for native oyster-stock recovery (Pogoda et al., 2019). Following important key findings of the project, the project PROCEED was founded in 2018, with the goal to implement a hatchery for a sustainable seed oyster production on the German offshore island Helgoland, in the North Sea (Pogoda, 2019b). Furthermore, in order to use oyster aquaculture for restoration projects and exchange knowledge in the European context, the Native Oyster Restauration Alliance (NORA) (Pogoda et al., 2019) was founded in 2017 with the aim of minimising limiting factors and of increasing the success of marine nature conservation (Pogoda, 2019b, Colsoul et al., 2021).

The objective of this work is the design and implementation of a broodstock conditioning to produce larvae for spat oyster production within the Helgoland Oyster Hatchery. Herein, the feasibility of the conditioning process and the response of the broodstock was recorded and evaluated. In addition, the performance within the implemented system is evaluated in relation to the origin of the broodstock, with a focus on larvae production and mortality. Further, the performance of two different size classes were compared, as the broodstock oysters differ greatly in size and weight, depending on their origin.

2. Helgoland Oyster Hatchery and Methods

The Helgoland Oyster Hatchery is aiming for mid- or largescale spat production for restoration measures in the North Sea using aquaculture bivalve hatchery techniques as a tool. Therefore, a steady optimisation and adaptation to the restoration is necessary, including a number of applied research questions. One of the primordial steps is the successful survival and growth of the larvae, which relies on ideal conditions, such as water quality, nutrition and biosecurity (Helm et al., 2004, Pogoda et al., 2020, Colsoul et al., 2021). Furthermore, successful seed oyster production is based on a sequence of well-coordinated steps (Figure 1), in order to prevent or minimise errors and risks (Walne, 1974, Helm et al., 2004, Colsoul et al., 2021).

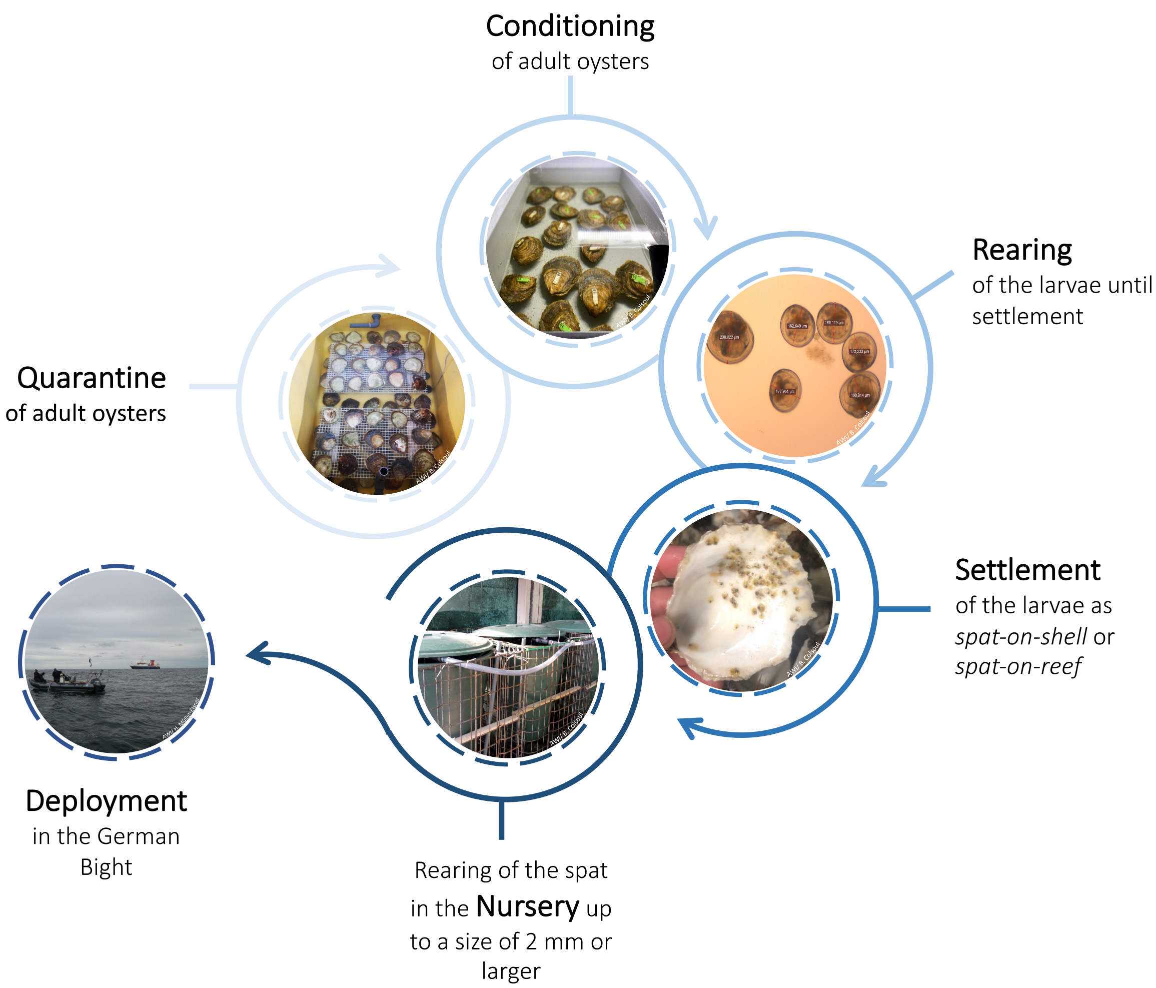


Figure 1: Step by step schematic for reproducing oysters in a hatchery, from quarantine over conditioning, rearing, settlement, nursery to deployment. © Corina Peter

2.1 Biosecurity

To prevent the introduction of invasive organisms, diseases or pests, a variety of standard operation protocols (SOP) as well as a biosecurity measures plan (BMP) were developed and are constantly adapted (Colsoul et al., 2020, zu Ermgassen et al., 2020). The routes of disease transmission are divided in three levels: Entry-level (transmission into hatchery), internal-level (transmission within the hatchery) and the exit-level (transmission from the hatchery). These transmission levels consider the transmission potential of all equipment, organisms used in the hatchery and all people (staff and visitors) (Colsoul et al., 2020, Colsoul et al., 2021).

For production of spat, adult oysters are supplied by fisheries or mariculture companies within Europe (i.e. Scotland or Norway) to serve as broodstock. The risk of transmission of any diseases/pests from a new livestock needed for the hatchery is rated “extreme” and an urgent intervention is required (zu Ermgassen et al., 2020). SOP are supporting and giving clear instructions and also lists of tasks to be followed.

Future broodstock oysters need screening (i.e. removal of dead and/or dying oysters, or other macro organisms not wished, as other species of oysters) before moving them to quarantine tanks, e.g. tanks separated from the main production area (see 2.3). Furthermore, this acclimation period for at least two weeks is important, as the animals adapt to the new water conditions after a potentially stressful transport (Arthur et al., 2008, zu Ermgassen et al., 2020, Colsoul et al., 2021). After the temporary quarantine, a mechanical and chemical cleaning of the livestock is necessary. In case of arriving livestock on Helgoland, each oyster is scraped and brushed by hand followed by a short bath in a highly diluted chlorine solution to kill microorganisms (Coatanea et al., 1992). Every movement of the livestock should be recorded to ensure traceability of possible biosecurity errors (zu Ermgassen et al., 2020).

Biosecurity treatments are also needed for the water and the feed of the oysters. The incoming seawater filtrated is down to 1µm, by the use of bag/cartridge filters (this is necessary to protect the hatchery facilities from being infested with pathogens and parasites). Further, sterilisation with UVc lamps and a routine of microbiological monitoring to indicating the effectiveness of the water filtration is also required (zu

Ermgassen et al., 2020). Furthermore, the algae production for feeding requires further filtration (0.2 µm) and additional sterilisation methods (use of autoclaves), in order to prevent/limit bacterial growth within the feeding cultures. The use of standard strains culture of microalgae is recommended for their use in hatcheries (zu Ermgassen et al., 2020).

Equipment used in the hatchery needs regular cleaning and disinfection, especially when it is used in different production areas. A bath in a hypochlorite solution at 200 ppm concentration for 5 minutes is a suitable disinfection method (Arthur et al., 2008, zu Ermgassen et al., 2020).

A special biosecurity precaution is needed for all the people (staff, visitors, students) entering the production areas. The responsibility for clean work must be made clear from the beginning. Everyone should be aware of the risk of infection and follow the guidelines. Visitors must be made aware of all risks in advance and the access to sensitive areas (e.g. quarantine room) should be restricted (zu Ermgassen et al., 2020).

2.2 Food production

Cultures of marine algae are the main food source used in bivalve hatcheries (Helm et al., 2004, Colsoul et al., 2021). The volumes fed to the oysters depend on algae quality, cell density and cell size. The nutritional requirements vary between the developmental stages of the oysters. For the broodstock conditioning (adult oysters) the quantity of required microalgae is high (0,5 – 2 L of microalgae at a concentration of 6 x 10^6 cell ml^{-1} per day per oyster) compared to the amount needed during the larval rearing (15 – 20 L of microalgae at a concentration of 6 x 10^6 cell ml^{-1} per day per 10^6 larvae) (Muller-Fuega, 1997). High food quality is important as it

Figure 2: Large scale algae production in 500L photobioreactors (PBR), Thu Thao Phung (1,58m) for scale.

has direct impact gametogenesis and on larval development and also on gametogenesis (Colsoul et al., 2021). The Helgoland Oyster Hatchery contains a large-scale production area (PBR room) for the cultivation of microalgae (PBR room) in large scale is installed (500L photobioreactors, Figure 2). The algae species produced for the oysters are *Chaetoceros muelleri* (CCAP 1010/3), *Isochrysis galbana* (SAG 13/92), *Rhodomonas salina* (CCAP 1319) and *Tetraselmis suecica* (CCAP 66/4). The species are then mixed to the desired ratios, depending on the production step and life stages of oysters (Helm et al., 2004).

2.3 Quarantine and disinfection measures

An important first step of risk management in order to increase biosecurity is quarantine. The quarantine defines the maintaining of aquatic animals in isolation for a specific duration in order to prevent the introduction of animal diseases or pathogens(Arthur et al., 2008). During the isolation a first screening on epifauna and testing for possible parasites and pathogens is recommended (zu Ermgassen et al., 2020, Arthur et al., 2008).

After the quarantine a cleaning and a chemical disinfection is needed to prepare the oysters for the broodstock conditioning. The epifauna (algae, barnacles and tube worms) have to be removed mechanically by scraping with a knife or a hard brush. The chemical disinfection is introduced with a short bath (30 sec) in fresh water, which makes the oysters close up completely to prevent suffering from the chemical treatment. The closed oysters are then placed from the freshwater tank into a highly diluted hypochlorite solution (200ppm) for one minute to kill all microorganisms on the shell. To finish the disinfection, the oysters are rinsed with filtered seawater (1 µm) at least for two minutes, to remove any chemical residues and dead microorganisms on the shells (Colsoul, personal communication)

2.4 Conditioning of healthy oysters

Artificial broodstock conditioning describes the method of husbandry of adult oysters under controlled conditions with the goal to initiate swarming events and to extend the production season. Especially in colder climates it allows for production early in the season and for the development of the animals in an optimized environment (Helm et al., 2004, Colsoul et al., 2021).

The conventional method for bivalve conditioning is a flow-through system with controlled flow, food input and aeration (Figure 3). After the quarantine and disinfection measures (see 2.3) the adult oysters are placed in the broodstock tanks. The water level above the oysters is at least the same height as the oyster itself (Colsoul et al., 2021, Helm et al., 2004). The continuous water flow is at least at 25 ml per minute (1,5 L per hour) per adult oyster without recirculation (i.e., in 100% flow-through system) if heavily stocked. To ensure a steady water quality, all parameters (temperature, pH, salinity, dissolved oxygen) are controlled every day (Helm et al., 2004). The discharged water is treated again (UVc; and maintained weekly) to prevent the transfer of pathogens and parasites to the local environment (Helm et al., 2004, zu Ermgassen et al., 2020). A quiet area for the broodstock conditioning is recommended, as bivalves respond to disturbances (vibration, shadows or noises) by closing and stop feeding (Helm et al., 2004).

2.4.1 Feeding the oysters in the conditioning: determination of biomass

To calculate the food ration during the conditioning phase, the dry meat weight of the adult oysters is needed. Based on (Helm et al., 2004) a ration of 3% of the mean dry meat weight (DW) was determined for the start of the conditioning. After the photoperiod was increased to 24 hours a day, the ration was increased to 6% DW for the peak production season (González-Araya et al., 2012). Higher rations can result in less successful conditioning, because the oysters will start growing instead of producing larvae (Helm et al., 2004).
For the dry weight determination of the oysters, ten randomly picked oysters were sacrificed and the soft tissue inside the shell was removed. The soft tissue was dried in an oven at 60 to 80 °C for 48 to 72 hours and subsequently weighted on a fine scale. The amount of algae needed for sufficient nutrient input is further depending on the cell size of the algae species and the daily biomass of oysters in conditioning (Helm et al., 2004).
According to oyster biomass a specific quantify of microalgae is added to the oyster tanks, ideally with a programmable peristaltic pump, to ensure a steady algae

concentration in the oyster tanks at all time (Helm et al., 2004) (Figure 3). This step also requires the determination of the concentration of the algae (see 2.4.2).

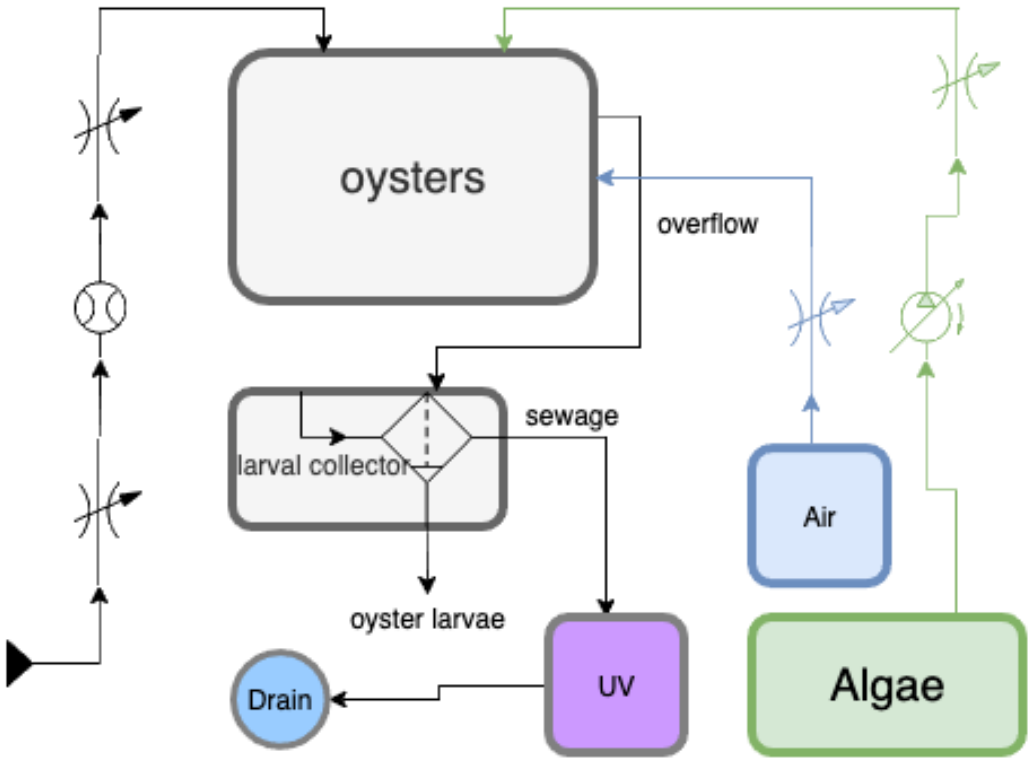


Figure 3: Schematic of a basic conditioning tank, with controlled flow through water supply, oyster tank, larval collector, sewage treatment (UV), aeration and adjustable food supply (Algae). © Jan Lammers

2.4.2 Broodstock conditioning in the Helgoland Oyster Hatchery

The development of an appropriate broodstock conditioning and a production plan for the production season 2021 was the key focus of this study. It aimed at incorporating all previously mentioned requirements: A temperature-controlled room was chosen for the conditioning to allow for constant temperature conditions and temperature adaptions during the conditioning phases, as well as preventing the oysters from any unwanted disturbances. A flow-through system was implemented for nine tanks in total. Each tank had a controlled water supply of filtered seawater (1µm) with a water replacement of 45% per hour, adequate aeration and light conditions. Due to logistic reasons, an individual water filtration was installed for the broodstock, to ensure a steady water quality (Figure 4).

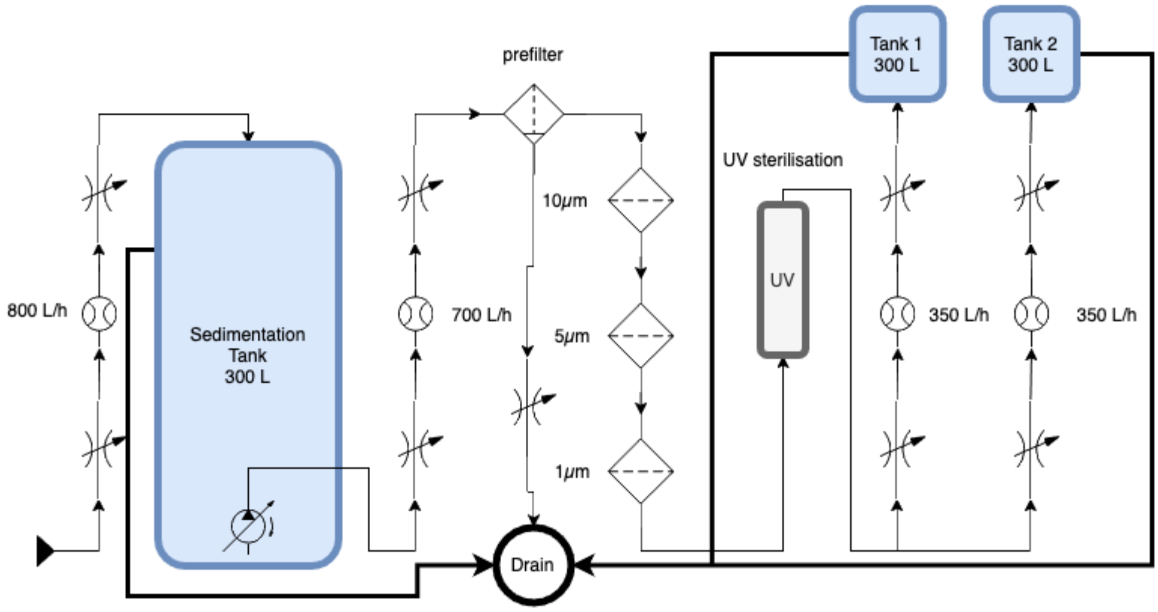


Figure 4: Schematic of the water filtration of the broodstock conditioning set up at the Helgoland Oyster Hatchery with a prefilter, filter line to 1µm, UV sterilization and adjustable flows. © Jan Lammers

The feeding mode was technically adapted to the system: The diet consisting of two algae species (*R. salina* and *C. muelleri*) was added to the water of the flow through system continuously via a reservoir tank, instead of a continuous in-flow to each oyster tank individually (Figure 5). Algae cell densities of the PBRs were checked every morning prior to feeding the oysters and the required volumes of each algae species were calculated accordingly (Table A).

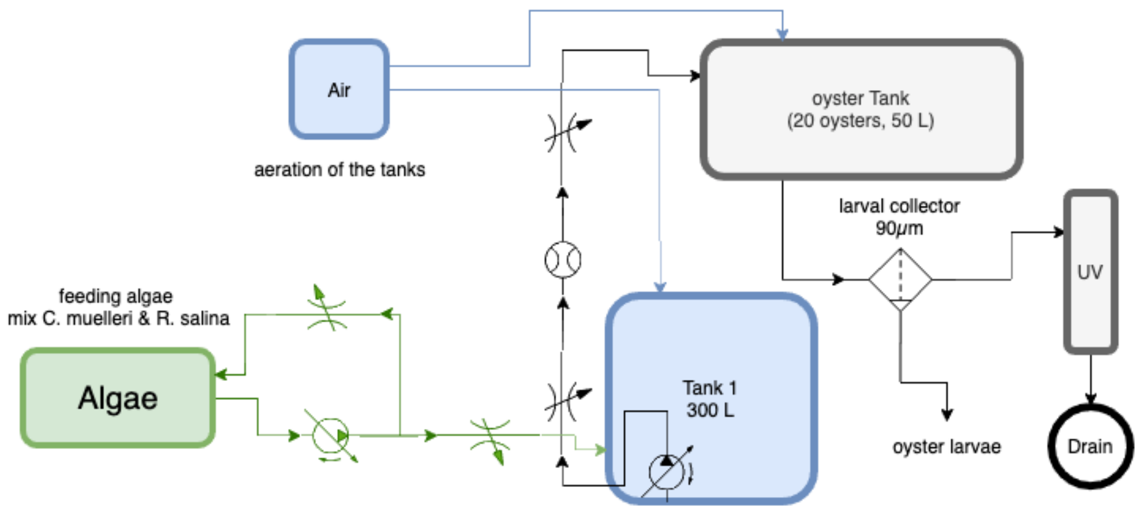


Figure 5: Schematic of a broodstock conditioning tank at the Helgoland Oyster Hatchery with controlled flow through water supply, oyster tank, larval collector, sewage treatment (UV), aeration and adjustable algae supply into the water supply (Tank 1). © Jan Lammers

The temperature-controlled room allowed to simulate the seasonally increase and decrease of temperatures. Timer-controlled lights were added to adjust the photoperiod. During the conditioning, temperature (12 – 25 °C), light (photoperiod; 8 – 24 h) and the food input were increased continuously (Figure 6) to induce the spawning (Helm et al., 2004, González-Araya et al., 2012, Maneiro et al., 2017, Colsoul et al., 2021).

In the production season 2021, nine conditioning tanks with 20 oysters each were operated at the Helgoland Oyster Hatchery. Four tanks were stocked with oysters from Scotland (UK) and four tanks with oysters from Norway (NO). One tank was stocked with ten oysters of each origin (NOUK). To ensure comparability, the nine tanks were placed randomly within the set up (Figure 7).

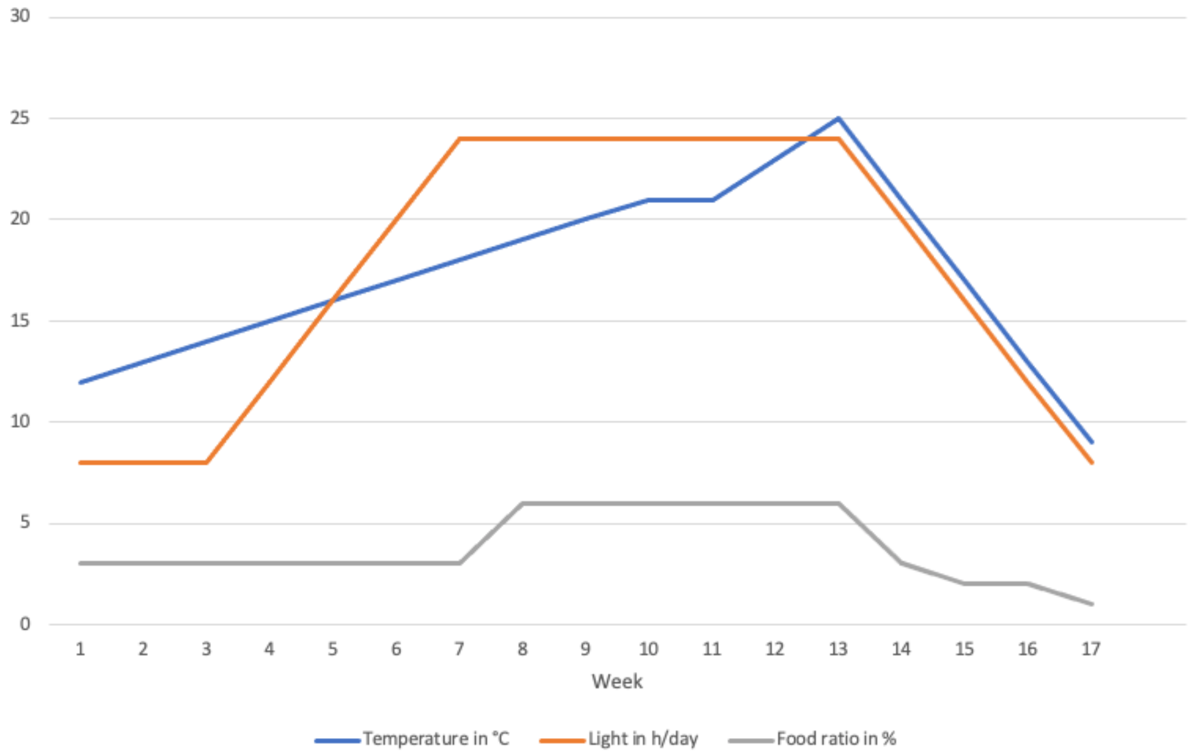


Figure 6: Diagram to display predefined conditions for the broodstock conditioning for the production season of 2021, showing temperature (°C; Blue), photoperiod (h/day; Orange) and food ratio (% Dry weight; Grey).

During the conditioning period, the water parameters were controlled (daily), mortalities of the stocked oysters were checked (daily) and the number of produced larvae were counted twice a day (morning/evening) to evaluate the performance of the oysters and to compare the different origins of the broodstock. To collect all data, an online dashboard was developed for documentation. The dashboard is an automated calendar, which was also used as an important tool to calculate the needed volumes of algae, depending on the daily algae concentration, the food ratio and the number of living oysters in the broodstock (Table A).

2.4.3 Collecting larvae

To prevent the swarming larvae (release of the larvae by the female oysters) from being flushed into the drain, the outflow of each tank was filtered through a ca.127µm mesh-diagonal-size larval collector (Colsoul et al., 2021, González-Araya et al., 2012), which was checked twice a day. The collected oyster larvae were examined under a stereomicroscope (Olympus SZX16) to ensure good condition of the larvae.

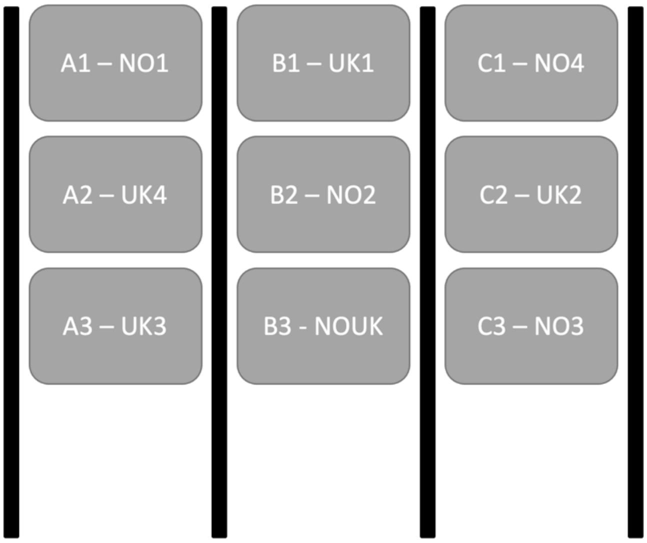


Figure 7: Schematic visualization to display the arrangement of the broodstock tanks in three shelfs, with four tanks of Norway oysters (NO), four tanks of oysters from Scotland (UK) and one mixed tank of both origins (NOUK). © Jan Lammers

The collected veliger larvae were then counted to estimate the amount of released oyster larvae each day. Therefore, a standardized method was developed. The collected larvae were placed in a measuring cylinder (500ml) and mixed gently to ensure an even distribution of larvae in the water. While mixing, an aliquot sample (1ml) was taken using a pipette. The total amount of veliger larvae per sample was counted under the stereomicroscope, dead and underdeveloped individuals were counted separately. This method was repeated three times, in order ensure repeatability. Size was determined by measuring the longest distance between the umbo and ventral area (Figure 8) of ten to hundret randomly selected individuals (Helm et al., 2004). The collected and counted larvae were then ready to be transferred to the larval rearing cylinders or in the case of the Helgoland Oyster Hatchery production season 2021, directly into the settlement tanks.

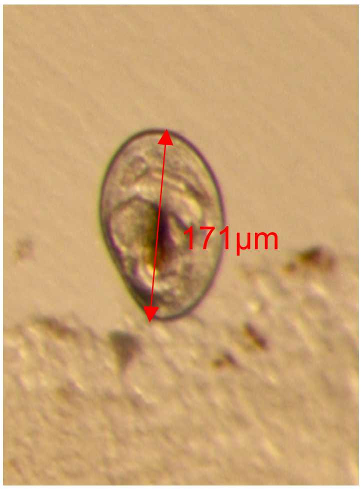


Figure 8: Example of how to measure the size of oyster larvae, longest distance between umbo and ventral area. © Jan Lammers

3. Results

3.1 Biosecurity and quarantine

The livestock of adult oysters from Scotland (UK) was already involved in the production season 2020. After the production of last year, the oysters were kept in a separate flow-through tank of 1100 L with a water replacement of 30% (330L/h) of filtered seawater (1µm). A maintenance plan was developed to ensure steady water quality and a clean tank. For the arriving livestock consisting of Norwegian oysters (NO), separate tanks were set up, minimising the transmission risk of any diseases, pests or. The set up was identical to the previous above/ described shelter tanks with the addition of an included UV-sterilisation at the outlet to eliminate the risk of transmission of unwanted pathogens or organisms to the local environment. These tanks functioned as quarantine tanks prior to the conditioning. After three weeks of quarantine, every oyster was investigated for epifauna and visible diseases.

The epifauna/-flora on the oysters were removed by scraping and they were disinfected with hypochlorite solution, like previously described (see 2.1). The removed epifauna/-flora consisted mainly out of macroalgae, crustaceans, tubeworms and sponges, but occasionally also of other molluscs (*Mytilus edulis, Crassostrea gigas*).

3.2 Set-up and commissioning

The design of the broodstock conditioning system and the implementation plan was tailored to the existing resources and infrastructure dimensions: The available thermo-controlled room space has the basic dimensions of approx. 2.m x 2.85 m (5.7 m^2) and a buildable height of 1.85 m. The room has a sea water connection, a compressed air connection, an air conditioning system and several floor drains. In order to use the available space as efficiently as possible, various 3D model (Sketch-Up PRO) were created visually before starting the construction. The final plan (Figure 9), consisting of six shelves with three tanks each, individual water filtration and a central workstation, was then implemented. First, the water filtration was installed, around which the framework for the broodstock tanks was built (Figure 10). The control panel was then implemented, on which the flow for 18 tanks can be set individually. Since the available width of the room is very limited (1.5 m), a solution had to be found to build 18 flowmeters side by side. The solution was affectionately called "The Organ" (Figure 11). It also allows further experiments with eight additional small tanks in future.

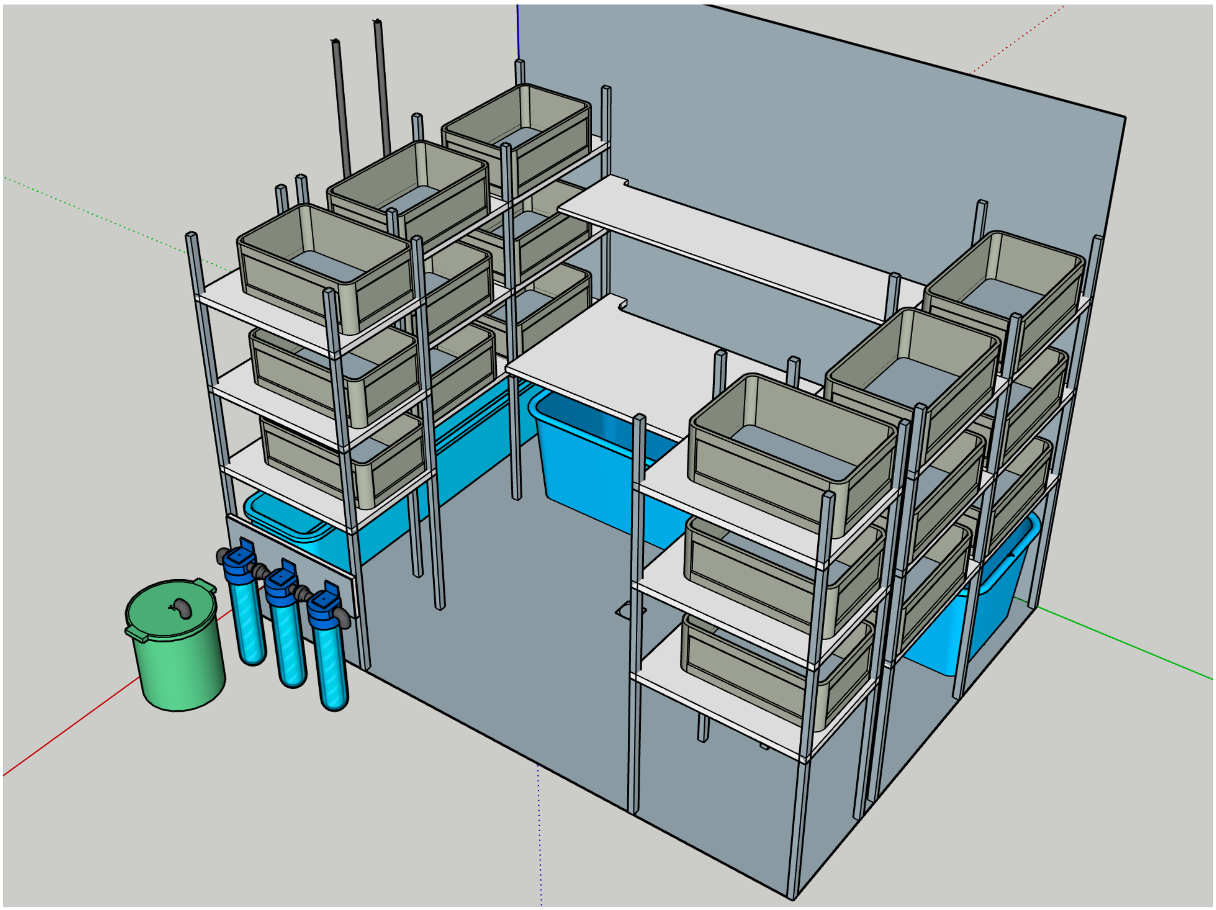


Figure 9: 3D model (sketchUP PRO) of the planned broodstock conditioning, with seawater filtration, six shelves with three tanks each and central workplace. © Jan Lammers

Figure 10: Position of the filtration tanks, sedimentation tank (left), filtered seawater storage (middle and right) and the shelve frames for the conditioning tanks. © Jan Lammers

Figure 11: Central control panel ("The Organ"), to control the flow-through of each broodstock tank individually. © Jan Lammers

Figure 12: The set-up of nine broodstock tanks with larval collector tank (front center) being flushed before the conditioning starts. © Jan Lammers

For the production season 2021 the set up was completed for nine conditioning tanks, holding 180 oysters in total (Figure 12). At off-season the rest of the set up will be completed, to allow for the conditioning of up to 400 oysters in 2022. The system started running on the 20th of May with flushing the pipes with seawater to remove adhesive residues prior to start of the conditioning.

3.3 Conditioning

With the end of the quarantine, the oysters were measured in length, width, height and weight and every oyster was tagged with a coloured number code to identify each individual (Figure 13). Broodstock oysters were then organised in groups of 20 in each conditioning tank, considering origin and biomass (the same biomass of oysters in each tank per origin) (Table 1).

The conditioning started on the 4th of June 2021 with 180 oysters (90 NO; 90UK) in nine tanks and a total biomass of 36.734g (24405g NO; 11328g UK) of adult oysters.

Table 1: Biomass in each conditioning tank in the production season of 2021 of the Helgoland hatchery

A1 – NO1 6097g	B1 – UK1 2833g	C4 – NO4 6103g
A2 – UK4 2832g	B2 – NO2 6104g	C2 – UK2 2835g
A3 – UK3 2829g	B3 -NOUK 4758g	C3 – NO3 6102g

3.4 Water quality and parameters

The daily check and maintenance ensured a steady water quality and predefined conditions over the course of the conditioning period (Table A), except with a minor deviation in water temperature (Figure 14). In the beginning of the conditioning the water was slightly higher than aimed (+2.8°C) and the wanted peak temperature of 25°C could not be reached (max 23.8°C) within the set-up over a longer period. To prevent errors in the filtration, the cartridge filters and also the filter material in the prefilter were changed twice over the conditioning period.

Figure 13: Tagged oysters with numbers and colored tags, to identify each individual. © Jan Lammers

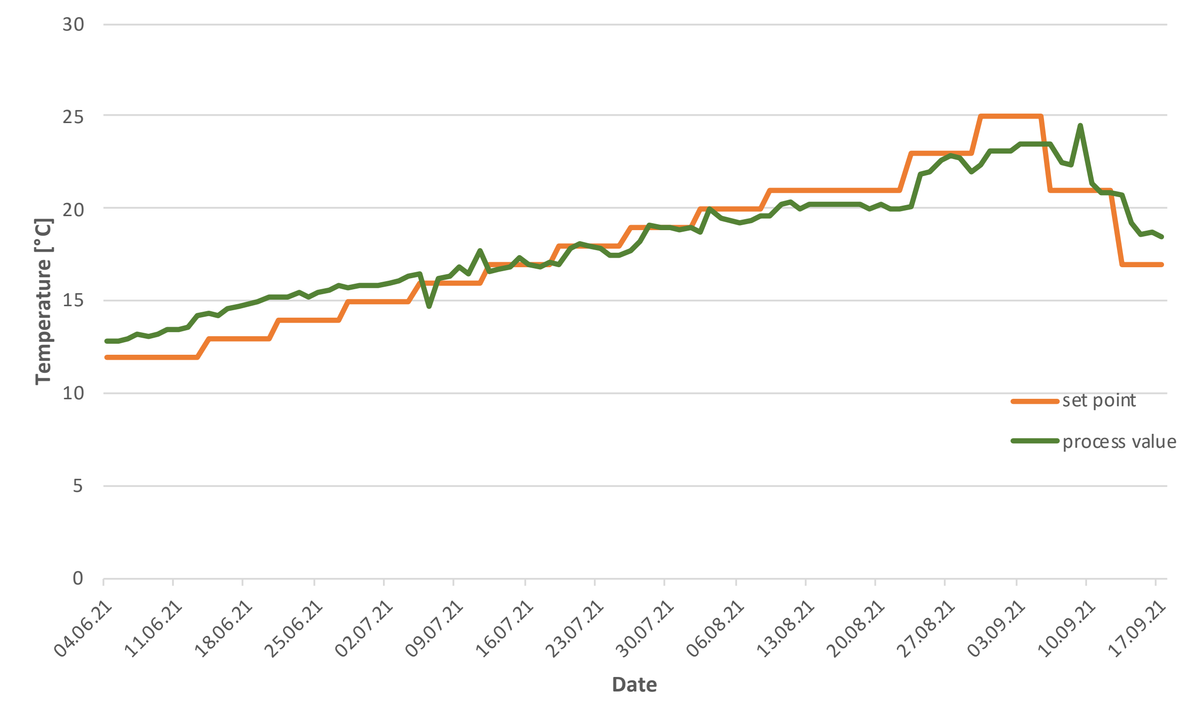


Figure 14: Aimed water temperatures (set point; Orange) compared to the actual measured temperatures (process value; Green) of the broodstock conditioning of the production season (2021).

3.5 Food production and feeding in conditioning

The algae production of the two required species for the broodstock was almost adequately supplied throughout the production period. An average of 333 L of algae were fed daily and there was no need to use alternative feeds for the broodstock at any time. However, in preconditioning, *R. salina* could not be fed at some days because the respective concentrations were too low. The algae were cultivated in batch or semi-continuous cultures in 500 L PBRs. Based on the algae densities in the PBRs, the daily required volumes were calculated every morning and filled in a 300 L trolley tank. After the algae were brought to the broodstock conditioning, an adjustable pump was set up to pump a steady volume into the water supply of the conditioning system throughout the day. To ensure high quality of the diet, the algae cultures were screened daily for contaminations and old cultures were discarded. During the conditioning *C. muelleri* reached concentrations up to $7.35*10^6$ cells per ml under optimal conditions, *R. salina* peeked at $1.4*10^6$ cells per ml in the 500 L cultures. At smaller scale production at the end of the season (5 – 20 L cultures) concentration of over $4.78*10^6$ cells were reached with *R. salina* (Table A).

3.6 Larvae collection and production

The larvae collectors were checked twice a day. During peak production times they were controlled several times a day to minimise the risk of blocking. The first swarm event was recorded in the end of the 7th week of conditioning (25th July 2021) in tank C2 of UK oysters with a counted number of 32,150 larvae. In week nine to eleven of the conditioning all other tanks started to release larvae as well (Figure 15, Table B).

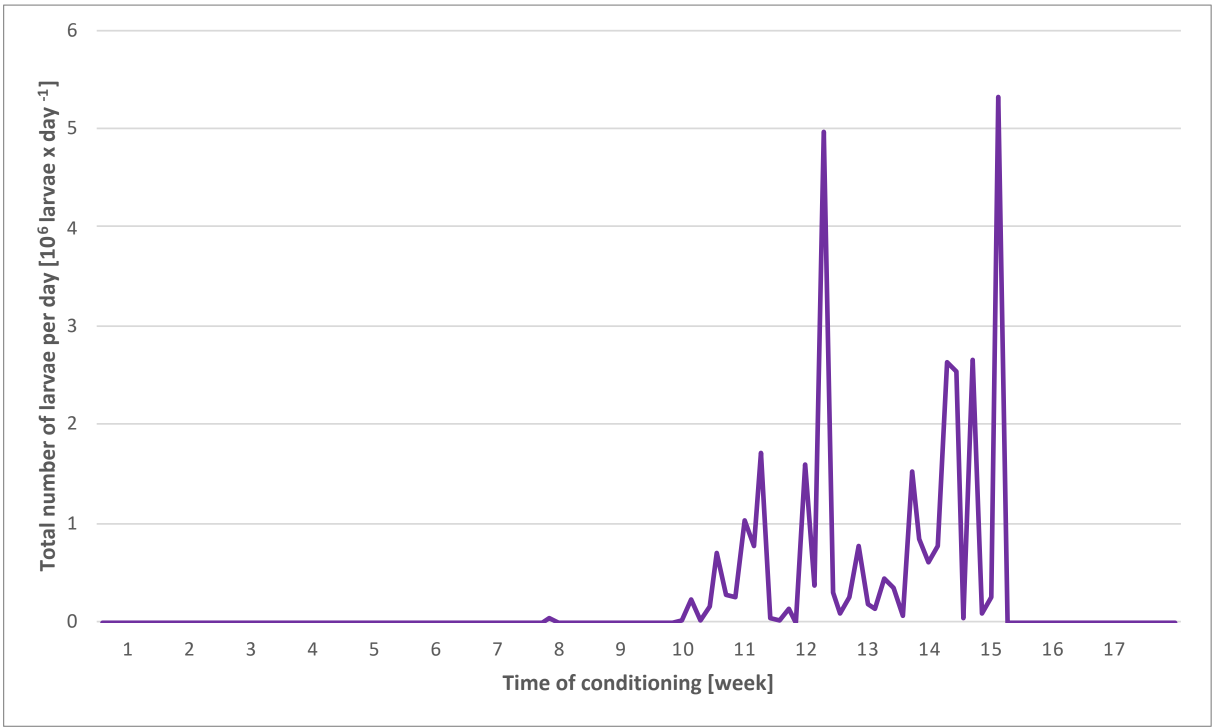


Figure 15: Total collected larvae of the broodstock conditioning of the production season (2021), displaying the swarming events in relation to the time of conditioning in weeks.

3.7 Total larvae production

From 4th June to 14th September 2021, a total number of over 32,000,000 larvae was counted from the nine tanks (Figure 16). The number of swarmed larvae from the NO broodstock was 9,943,600 larvae, of which almost half swarmed on the 25th of August (mid-week 12) in tank A1. Compared to the NO larvae, the swarming of the UK larvae was more evenly distributed over the conditioning period (Figure 17). The UK oysters produced 16,872,258 larvae in total (Table B). The mixed tank (B3 - NOUK) had one big swarming event at the end of the season, consisting of 5,115,500 larvae on one day.

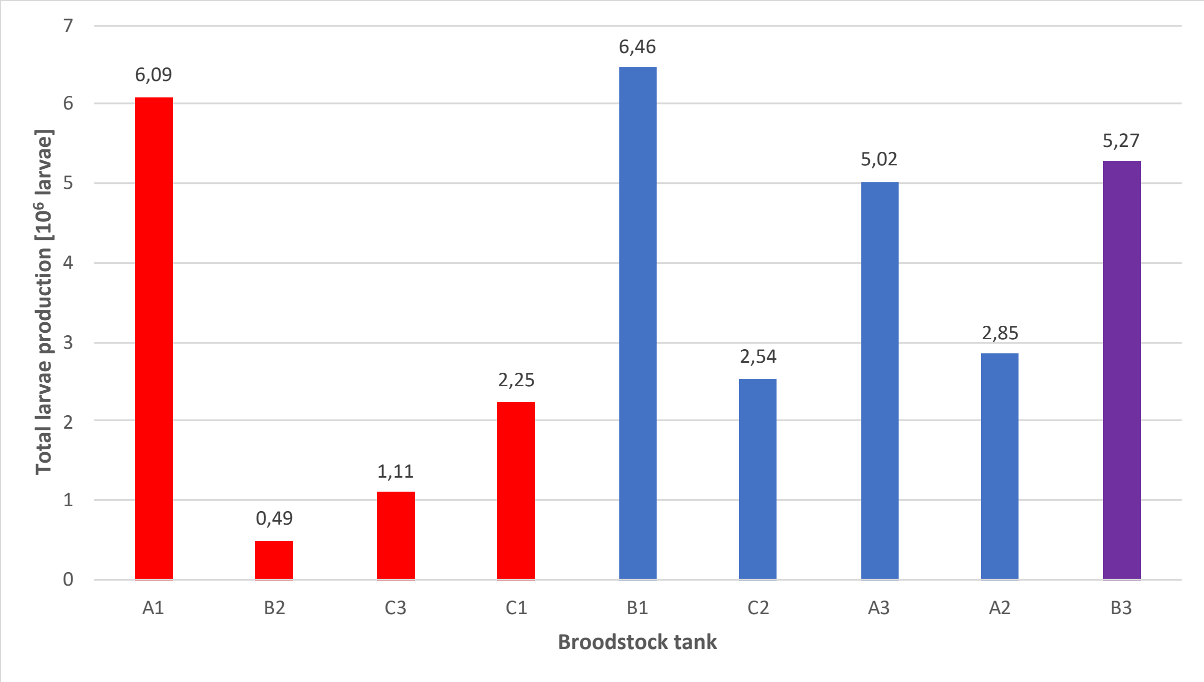


Figure 16: Total larvae production per broodstock tank, divided by origin (NO: Red; UK: Blue; Mixed: Purple).

3.8 Comparison of origin

The oysters of different origins within the broodstock conditioning showed major differences in size and in their response to the given conditions. Contrary to expectations, the smaller UK oysters produced more larvae (Figure 17) and also generally performed better with respect to survival. Within the conditioning period 91.25% of the UK oysters survived, in contrast the NO oysters had a mortality of 40% (tank B3 – NOUK is excluded from this calculation). Swarming events of the UK oysters were more distributed over the conditioning period, with several swarming's over 1,000,000 larvae (Figure 18). The NO oysters had much less big spawning events, with one just over 1,000,000 and another of over 4,500,000. Both broodstock showed a response to the increasing temperature (Figure 18). A swarming event was defined at a release of more than 1000 larvae per day.

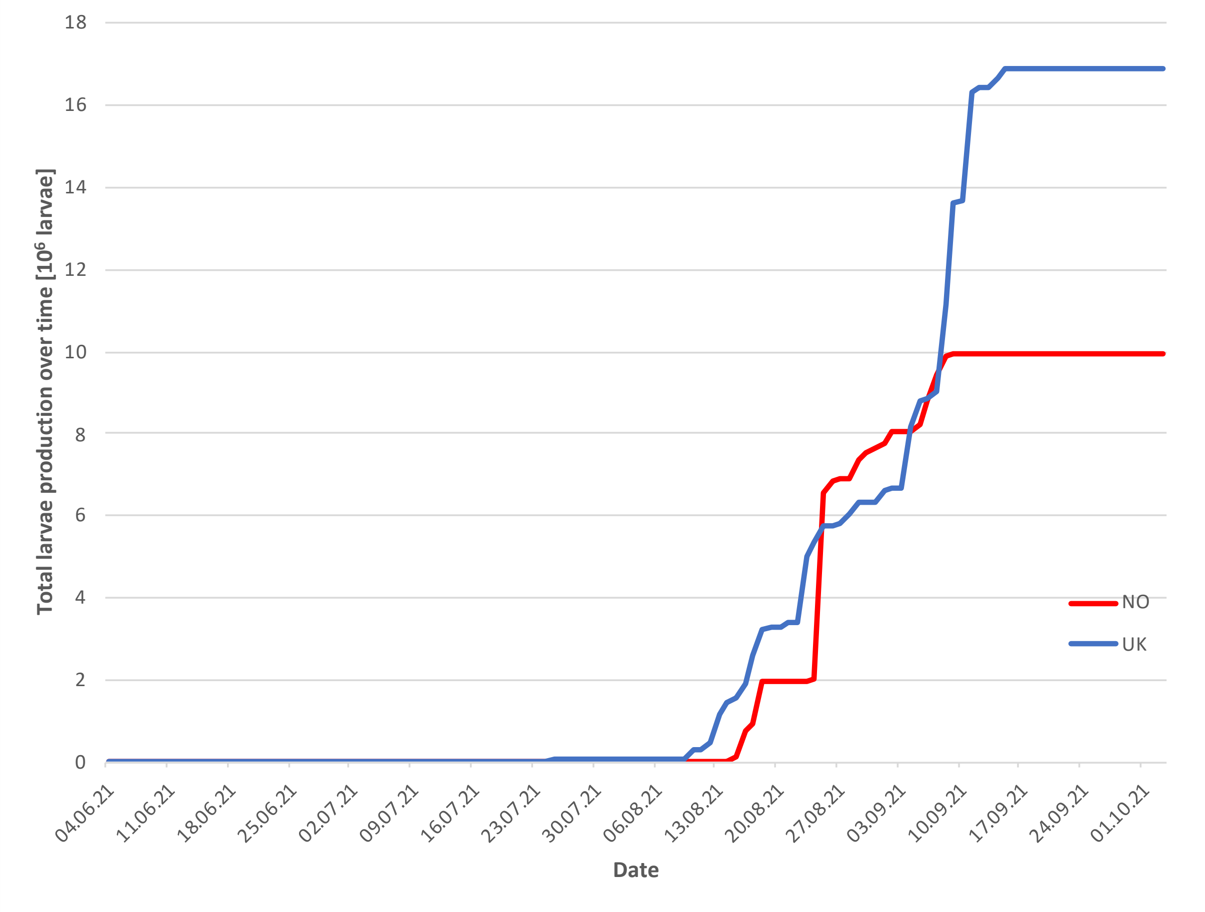


Figure 17: Total larvae production by origin (NO = Red, UK = Blue) over the production season 2021.

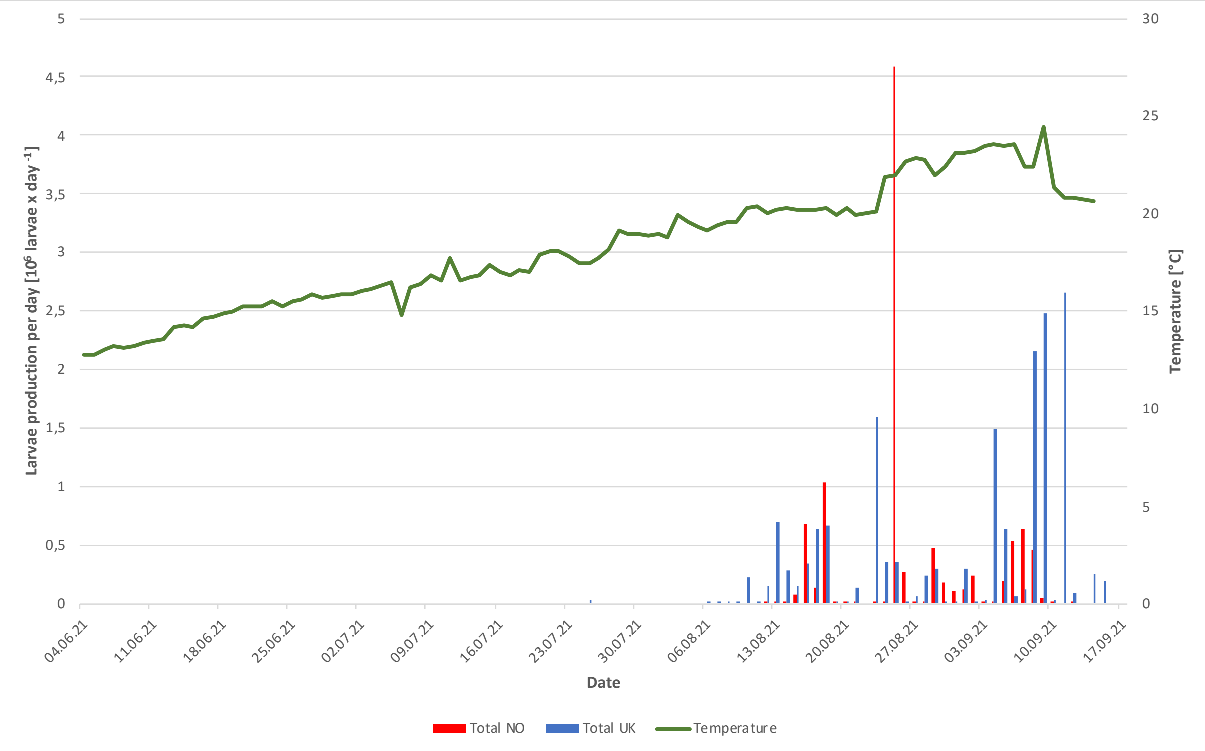


Figure 18: Spawning events by origin (NO = Red, UK = Blue), displayed over the production season 2021, including the measured temperature (Green) in the broodstock tanks.

3.9 Larvae production compared to biomass

The two broodstock origins were also divided in two weight classes and larvae production differed in relation to the biomass (Figure 19). The UK broodstock total biomass was 11,238 g (start) (average of 140.48 g per oyster) and 10,336 g (end), considering a 8.75% mortality. UK oysters produced 1,632.25 larvae/g (total biomass UK). The NO broodstock total biomass was 24,405g (start) (average of 305.06 g per oyster), and 14,643 g (end), considering 40% mortality. NO oysters produced 679.07 larvae/g (total biomass NO). UK oysters produced 2.4 times more larvae in relation to the biomass than NO oysters.

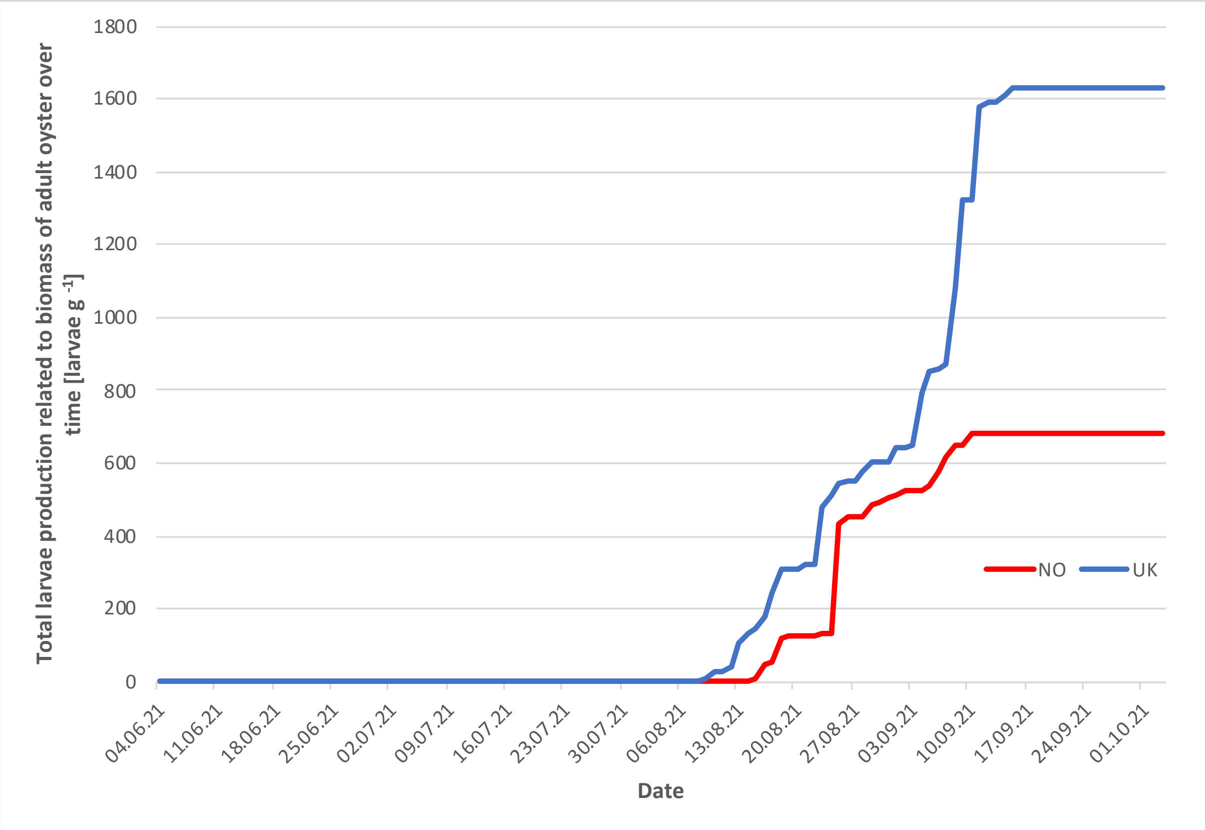


Figure 19: Larvae production by origin (NO = Red, UK = Blue) in relation to the biomass of the broodstock over the production season 2021.

Correlating these results to individual swarming events, shows that the large NO oysters are capable of producing large numbers of larvae. The larval releases over time show that larvae from the UK oysters swarmed several times over the production period, whereas almost half of the total production of NO oysters being attributable to one massive swarming event (Figure 20). It is nevertheless clearly visible that the spawning events have a comparable number of larvae in relation to the broodstock biomass.

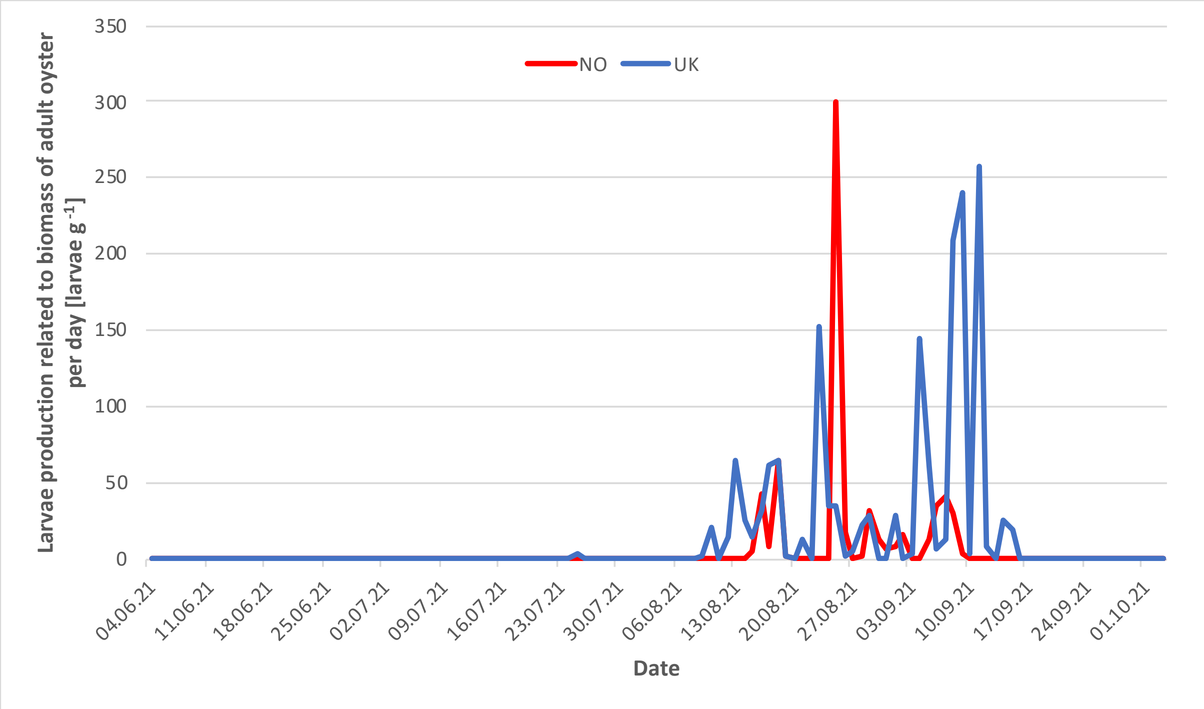


Figure 20: Larvae production by origin (NO = Red, UK = Blue) in relation to biomass and day (spawning event).

3.10 Larvae size by origin/size of oyster

The average size of the larvae ranged from 155 µm to 206 µm in the production season 2021, with no appreciable difference in size of UK and NO oyster larvae. The average size of the NO larvae was 170.88 µm compared to the slightly bigger UK larvae with 172.72µm. The majority of spawned larvae showed the expected size classes of 165 – 179 µm (Figure 21).

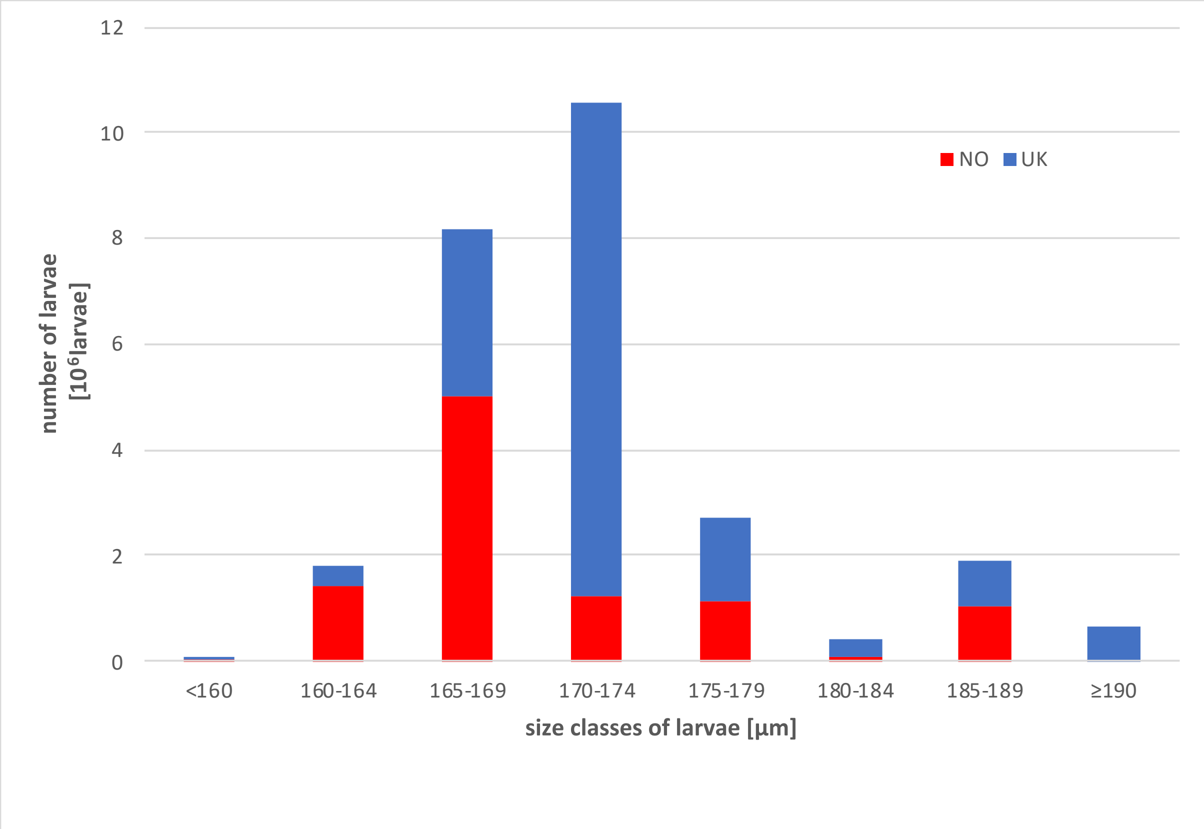


Figure 21: Total number of larvae divided in the different measured size classes (NO = Red, UK = Blue).

3.11 Further information

During the conditioning, also the swarming of underdeveloped oyster larvae (embryos of <150 µm) occurred. In the tanks with a comparable low larvae output high mortalities (Figure 22) of the livestock and growth of the adult oysters were recorded (Figure 23). Also, in some tanks the growth of fouling organisms (copepods and macroalgae) was detected. However, no impact on larval production, such as the larval output was recorded.

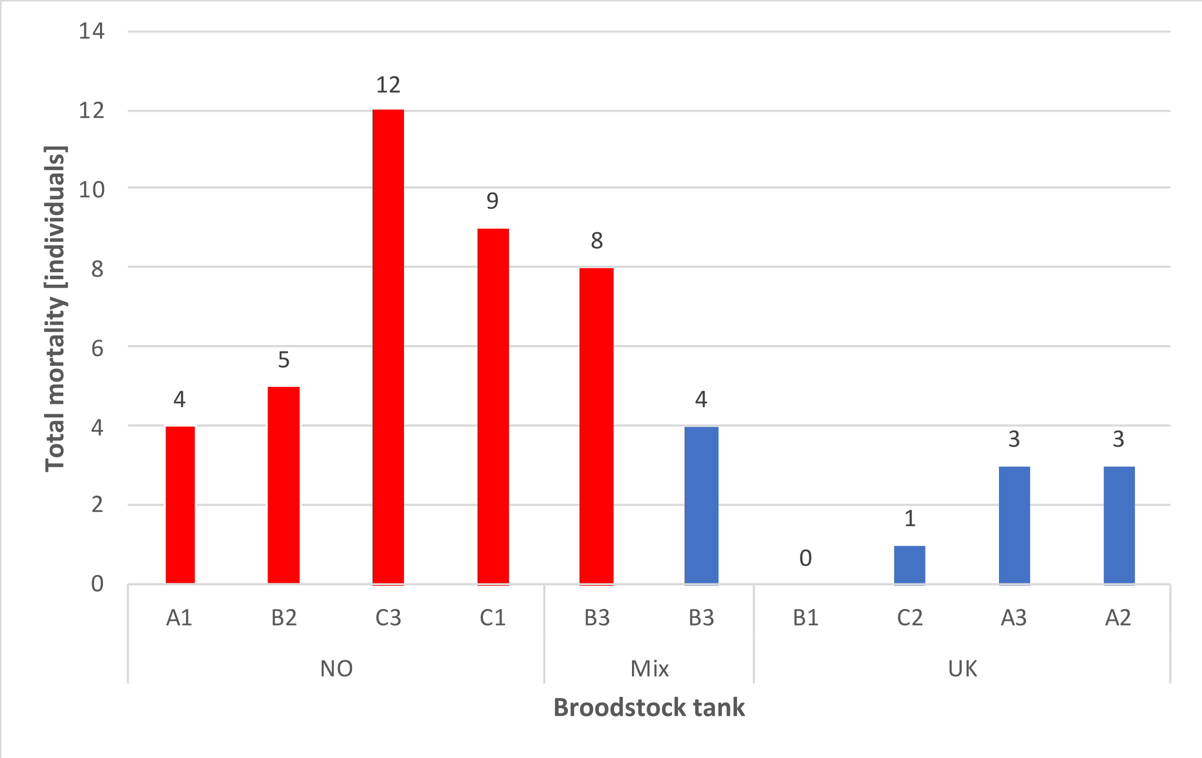


Figure 22: Mortalities in each broodstock tank after the production season 2021, divided by origin (NO = red, UK = blue).

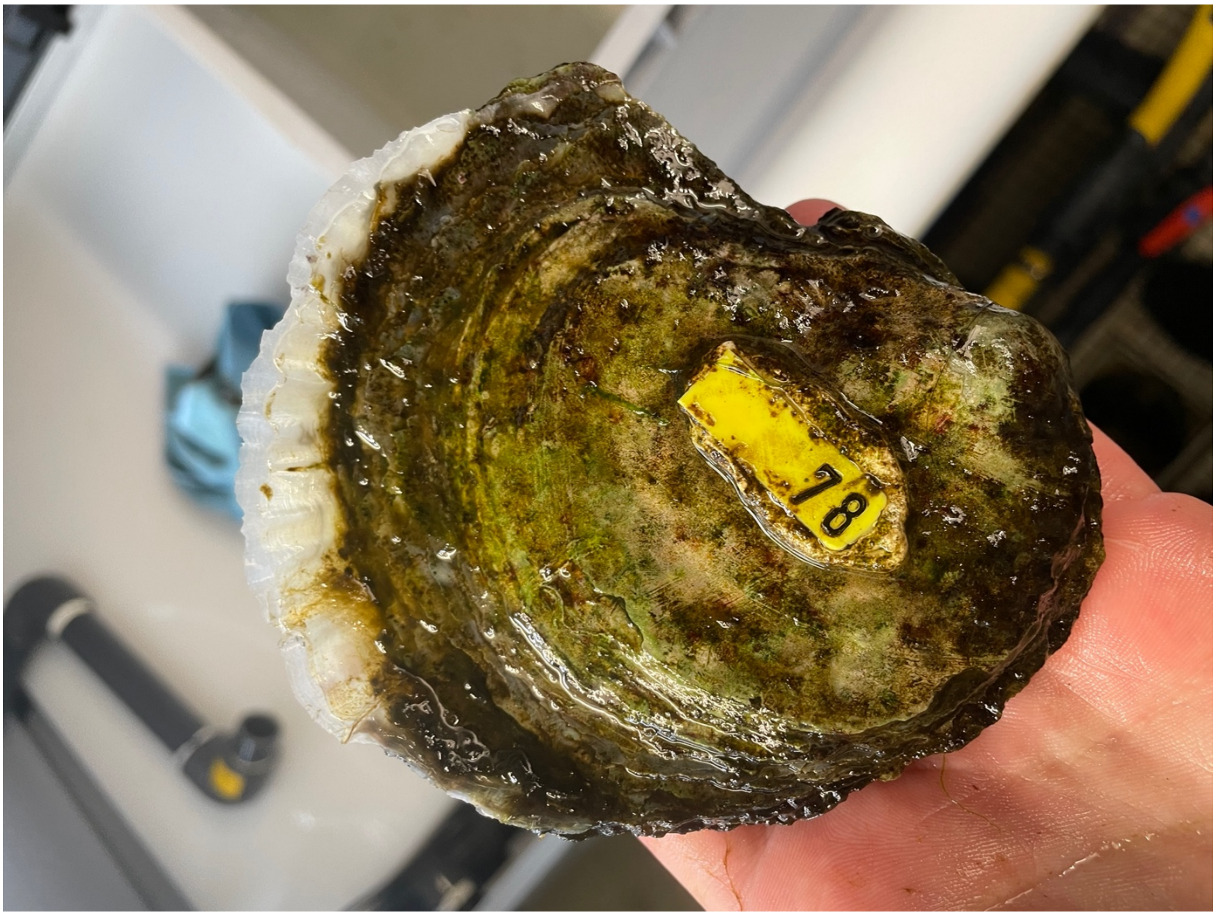


Figure 23: Example of shell growth of individual oysters in the broodstock conditioning.

4. Discussion

4.1 Quarantine, disinfection and scrapping

The quarantine of the newly obtained broodstock was successful, but as the size of the NO oysters was about three times larger than expected (and originally ordered from the supplier), additional tanks were required and built. After quarantine, oysters were disinfected according to the developed SOPs and prepared for broodstock conditioning. However, it was noticeable that despite all the effort, not only oyster larvae were collected in the collectors. Especially at temperatures around 19°C, copepods such as *Tispe* spp. were increasingly found and growth of macroalgae (*Ulva* spp.) was substantial and required regular cleaning of the broodstock tanks. Fouling (= occurrence and growth of unwanted organisms) was particularly noticeable in the NO tanks. Fouling can be prevented by an adapted and improved disinfection protocol. Due to the water purification unit (Figure 4, filter line down to 1 µm and UVc sterilisation), it is unlikely, that fouling organisms entered the system via the water supply. The large size of the NO animals, may also be the problem as eggs, larvae and spores of fouling organisms may be present in the inhaled water of the mantle cavity (zu Ermgassen et al., 2020). If necessary, the disinfection method must be adapted to the size of the oysters.

4.2 Conditioning

During conditioning, an increase in temperature and photoperiod was planned to create a natural production season for the broodstock oysters. However, the desired temperatures could not be fully achieved. At the beginning of the conditioning the temperatures were always slightly too high and at the end the high temperatures could not be reached: Since the temperatures of the water supply corresponded to the water temperature of the surrounding North Sea, the temperature was already higher than planned (0.8 – 2,8°C) in the conditioning protocol due to the relatively late start of the conditioning in June. Technically, it was not possible to cool the water down again. On the other hand, the water could not reach the desired 25°C at the end of the season because the heating capacity in the conditioning was not sufficient. The water temperature in the North Sea around Helgoland was 18°C in summer and would have had to be heated by a further 7°C. This was not feasible with the required flow rate in the system. The heating system of the broodstock conditioning need to be improved in the future and a cooling system should be added as well. This temperature challenge may have impacted the gametogenesis, the brooding process of oysters and production of larvae (Merk et al., 2020, Colsoul et al., 2021). Furthermore, the elevated temperature in the beginning of the conditioning could cause stress for the animals which may resulted in less larvae. Not reaching the peak temperature of 25°C could result the same, because of a missing signal to release the larvae on time.

The already mentioned size of the NO oysters did also cause problems in the set-up, as the tanks were planned to store 20 oysters in a single layer. For the UK oysters this was implemented as planned, but for the NO oysters the space was too small and they had to be stacked on top of each other to fit in the tank. High density in the tanks resulted limited aeration (oxygen supply) and food supply, as the animals block each other from opening/filtering (Helm et al., 2004). This might be an explanation for elevated mortalities in the NO broodstock.

4.3 Feeding the broodstock

During the conditioning period, the broodstock was supplied with the required volumes of algae almost at all times, only during a few days there was no *R. salina* feed available due to too low concentrations in the PBR production. Missing pumps for the feeding (see 4.6) led to the decision, that the oysters were fed with the steady water supply. This resulted in each tank receiving the same amount of feed regardless of the biomass of oysters inside. This may of course also explain the elevated mortality rate of NO oysters since food supply might have been too low for the high biomass of these NO tanks (Maneiro et al., 2020). However, this stands in contrast to a considerable growth of the oysters, which primarily occurred in the NO oysters (Figure 23). Accordingly, these results allow different conclusions to be drawn, which will have to be studied as part of an optimization of the hatchery operation in the next conditioning season.

4.4 Larvae collection and production

Despite multiple daily checks, overflows of the collectors were detected from time to time. This is mainly due to the growth of algae and sedimented dead algae cells that blocked the mesh. Occasionally, also larvae were the reason for blockages, particularly during large swarming events. In the course of the experiment, some larvae were certainly lost without being counted, as they were able to escape from the blocked collectors. For the outcome of the experiment this means, that probably even more larvae were produced in the production season 2021 without being recognizable due to loss of these larvae.

In a next step, the method to estimate the number of larvae per swarm could be improved (and further automized). It showed quite accurate numbers, but especially in big swarming events the sample had to be highly diluted to result in countable numbers of larvae. Therefore, depending on the size of the swarming, the dilution rate had to be adapted. The changing dilution rate over the several swarming events consequently caused that at some point single individuals were counted (small swarming) whereas at big swarming events, only rough estimations of thousands or ten-thousands of larvae were possible.

Nevertheless, the number of larvae collected was higher than expected, despite the high mortality of the NO broodstock. The swarming season of the UK oysters was noticeably more divided and temporally distributed than that of the NO oysters. Furthermore, the number of larvae produced per biomass of the oyster show distinct differences. Whereas the swarming of a NO oyster produced almost 4.5 million larvae in one day, several UK oysters produced less individually, but still significantly more in total. Based on these results, future experiments to determine optimal size of broodstock oysters for larval production the Helgoland Oyster Hatchery are an important next step.
Concluding from these results, UK oysters were better adapted to the rearing within the Helgoland Oyster hatchery and showed more stable larval numbers than NO oysters, simultaneously having a lower mortality rate. These insights influence the selection process of future broodstock oysters and the optimization of the large-scale production of seed oysters for restoration purposes.

4.6 Larvae size

The UK larvae were in average slightly bigger compared to the NO larvae. The difference can be explained by the simple factor, that the UK oysters had bigger swarmings of healthy larvae and produced more larvae overall. Larvae size was measured in subsamples (N = 10-100 larvae) per event as it is not possible to measure millions of larvae one by one. The measured values indicate that the larval size is not related to the oyster size and biomass of broodstock, but underline that larvae show a similar size when swarming. The size of some larvae outside the expected range is to explain with an early release (swarming of embryos) or that some larvae remained in in the broodstock tank for longer time periods than others. The growth of macroalgae in the tanks is a possible reason for this, because they slowed down the recirculation of the water within the tank. However, the number of larvae per swarming was greater in large oysters.

4.6 Limiting factors

The production season 2021 had to withstand a variety of limiting factors. New systems were planned and build in the beginning of the year. Therefore, a lot of material was necessary. The isolated location of the island Helgoland, only accessible by boat, ferry or small planes is limiting the supply chain and delaying delivery times. Especially for bulky items, like PVC pipes (normally delivered at 5m units) delivery could easily take up to two months, which often caused delays in the construction.
Peristaltic pumps required for the feeding, which were not available, because some manufacturers shut down their production due to the covid-19 pandemic. These pumps increase the feeding accuracy to a maximum. Instead, a temporary solution had to be installed, in which the algae were only added to the water supply. The disadvantage of this was that the volumes of algae needed in each tank could not be distributed precisely. With this solution every tank got the same volume of algae without the possibility to adapt it precisely to the biomass per tank. Compared to the UK oysters, the NO oysters had a higher mortality in the beginning of the conditioning and they were also much bigger and heavier. The high mortality of NO oysters at the beginning of the conditioning period could be explained by the limited food availability, as described above. After the decrease of oyster biomass caused by the high mortality of

NO oysters, the amount of food was eventually sufficient for the remaining NO broodstock oysters as the mortality rate decreased to a minimum. After the 30^{th} July (water temperature >20°C), where nine NO oysters died within a day, the mortality of the NO broodstock was comparable to the UK broodstock.

This decrease, however, validates the functioning of the method of evenly distributing the diet over the water supply into the tanks from this point on. The UK oysters started producing early and had low mortalities during the complete conditioning period. From an economic point of view, this solution was way cheaper, than an individual dosing with peristaltic pumps (price 100-150€ /pump). It could be a good solution if biomass of oysters in each broodstock tank is similar regardless of the number of oysters. For an ideal nutrition supply and therefore high survival and larval production rates, the use of precise peristaltic pumps is inevitable. A subsequent installation of these at the Helgoland Oyster Hatchery will therefore be carried out at any time, as soon as they are available again.

The algae production and feeding of the broodstock was also limiting the production. Like already mentioned, the availability of filtered seawater is the key part of algae production. The newly build water purification system was planned to deliver up to 4000 L filtered seawater per hour. Due to wrong deliveries and long waiting times for the sufficient parts (e.g., flowmeters with a range of 500-5000L), a transitional solution was installed. Until well into the main production phase, work was therefore carried out with a water filtration system that only supplied 1000 litres per hour. This resulted in a limited microalgae production.
The temperature in the algae production area (PBR room) also had a huge impact on the food quality and densities of the algae cultures. The PBR room is equipped with an air conditioning system to keep the production area at an optimal production temperature. Unfortunately, during peak production season, the AC system failed to temperate the production area, caused by unexpected high temperatures in summer 2021. The high temperatures were limiting the growth of some cultures, especially *C. muelleri* which is the main feeding algae for the broodstock. At times, the cultures of *C. muelleri* did not exceed a concentration of 2.000.000 cells/ml, whereas under optimal conditions they easily reached concentrations of 5.000.000 cells/ ml. This meant that the required volumes for sufficient broodstock feeding increased

considerably, and since the algae volumes still had to be brought to the broodstock by hand, this also meant an increased workload. On top of that, several failures of the freight elevator, resulted in carrying up to 600L of microalgae solution per day from the PBR room (ground floor) to the conditioning system (basement). This unplanned extra work meant that other work was completed late, as the priority was always the health of the oysters and the smooth running of the trial.

All these factors combined led to the decision that the production season 2021 was scaled down, with only 180 oysters in the conditioning. Also, the larval rearing was not viable to implement and further experiments were cancelled. But by addressing these limitations and by implementing and optimising the respective adapted set-ups, future production seasons can easily start with a conditioning of 400 oysters, as most of the systems are now ready to run.

Conclusion

The establishment of broodstock conditioning according to Helm et al. (2004) was successfully implemented. The set-up was adapted to the given circumstances, e.g. the feeding of the broodstock. The collected results are discussed with other hatcheries within the NORA network in order to optimise production across Europe. Furthermore, this should create the basis for new hatcheries that pursue the common goal of a healthy oyster population in Europe.

In summary, larval production at the Helgoland Oyster Hatchery was successfully completed for the season 2021. The further success of the production of seed oysters now depends on the next steps within the hatchery production cycle (Figure 1). The construction and conditioning itself has largely worked out as planned. Despite the production success, some deficiencies were discovered but these will be addressed in the off-season. In addition, the foundation for further research was laid and the question of the origin of the broodstock or broodstock densities can be addressed in greater depth in the coming season.

References

ARTHUR, J. R., BONDAD-REANTASO, M. G. & SUBASINGHE, R. P. 2008. Procedure for the quarantine of live aquatic animals - A manual. *FAO Fisheries Technical Paper,* 502**,** 74.

BERTOLINI, C. & PASTRES, R. 2021. Identifying knowledge gaps for successful restorative aquaculture of Ostrea edulis: a bibliometric analysis [version 1; peer review: awaiting peer review]. *Open Research Europe,* 1.

BRENNER, M., FRASER, D., VAN NIEUWENHOVE, K., O'BEIRN, F., BUCK, B. H., MAZURIE, J., THORARINSDOTTIR, G., DOLMER, P., SANCHEZ-MATA, A., STRAND, O., FLIMLIN, G., MIOSSEC, L. & KAMERMANS, P. 2014. Bivalve aquaculture transfers in Atlantic Europe. Part B: Environmental impacts of transfer activities. *Ocean & Coastal Management,* 89**,** 139-146.

BROMLEY, C., MCGONIGLE, C., ASHTON, E. C. & ROBERTS, D. 2016. Bad moves: Pros and cons of moving oysters – A case study of global translocations of *Ostrea edulis* Linnaeus, 1758 (Mollusca: Bivalvia). *Ocean & Coastal Management,* 122**,** 103-115.

COATANEA, D., OHEIX, J., MAZZARA, L. & HAMON, P. Y. 1992. Essais de télécaptage de l'huître plate *Ostrea edulis* en Méditérranée : Bilan 1991 [Remote setting trials of the flat oyster *Ostrea edulis* in the Mediterranean: Review 1991]. *IFREMER Report RIDRV-92.021 RA.* Palavas-les-Flots, France: French Research Institute for Exploitation of the Sea.

COLSOUL, B., BOUDRY, P., PÉREZ-PARALLÉ, M. L., BRATOŠ CETINIĆ, A., HUGH-JONES, T., ARZUL, I., MEROU, N., WEGNER, K. M., PETER, C., MERK, V. & POGODA, B. 2021. Sustainable large-scale production of European flat oyster (*Ostrea edulis*) seed for ecological restoration and aquaculture: a review. *Reviews in Aquaculture***,** 1-46.

COLSOUL, B., POUVREAU, S., DI POI, C., POUIL, S., MERK, V., PETER, C., BOERSMA, M. & POGODA, B. 2020. Addressing critical limitations of oyster (*Ostrea edulis*) restoration: Identification of nature-based substrates for hatchery production and recruitment in the field. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 30**,** 2101-2115.

FITZSIMONS, J. A., BRANIGAN, S., GILLIES, C. L., BRUMBAUGH, R. D., CHENG, J., DEANGELIS, B. M., GESELBRACHT, L., HANCOCK, B., JEFFS, A. & MCDONALD, T. 2020. Restoring shellfish reefs: Global guidelines for practitioners and scientists. *Conservation Science and Practice***,** e198.

GERCKEN, J. & SCHMIDT, A. 2014. Current status of the European oyster (*Ostrea edulis*) and possibilities for restoration in the German North Sea. *Bfn-Skripten 379***,** 88.

GONZÁLEZ-ARAYA, R., LEBRUN, L., QUÉRÉ, C. & ROBERT, R. 2012. The selection of an ideal diet for *Ostrea edulis* (L.) broodstock conditioning (part B). *Aquaculture,* 362-363**,** 55-66.

GÜNTHER, R. T. 1897. The Oyster Culture of the Ancient Romans. *Journal of the Marine Biological Association of the United Kingdom,* 4**,** 360-365.

HELM, M. M., BOURNE, N. & LOVATELLI, A. (eds.) 2004. *Hatchery culture of bivalves. A practical manual.,* Rome, FAO: FAO Fisheries Technical Paper.

KORRINGA, P. 1946. The decline of natural oyster beds. *Basteria,* 10**,** 36-41.

LALLIAS, D., BOUDRY, P., LAPÈGUE, S., KING, J. W. & BEAUMONT, A. R. 2010. Strategies for the retention of high genetic variability in European flat oyster (*Ostrea edulis*) restoration programmes. *Conservation Genetics,* 11**,** 1899-1910.

LEE, H. Z. L., DAVIES, I. M., BAXTER, J. M., DIELE, K. & SANDERSON, W. G. 2020. Missing the full story: First estimates of carbon deposition rates for the European flat oyster, *Ostrea edulis*. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 30**,** 2076-2086.

LOTZE, H. K. 2007. Rise and fall of fishing and marine resource use in the Wadden Sea, southern North Sea. *Fisheries Research,* 87**,** 208-218.

MANEIRO, V., PÉREZ-PARALLÉ, M. L., SILVA, A., SÁNCHEZ, J. L. & PAZOS, A. J. 2017. Conditioning of the European flat oyster (*Ostrea edulis*,
Linnaeus 1758): effect of food ration. *Aquaculture Research,* 48**,** 4363-4370.

MANEIRO, V., SANTOS, Y., PAZOS, A. J., SILVA, A., TORRES-CORRAL, Y., SÁNCHEZ, J. L. & PÉREZ-PARALLÉ, M. L. 2020. Effects of food ration, water flow rate and bacteriological levels of broodstock on the reproductive conditioning of the European flat oyster (*Ostrea edulis*, Linnaeus 1758). *Aquaculture Reports,* 18**,** 100412.

MERK, V., COLSOUL, B. & POGODA, B. 2020. Return of the native: Survival, growth and condition of European oysters reintroduced to German offshore waters. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 30**,** 2180-2190.

MULLER-FUEGA, A. 1997. Les enjeux de la recherche. *Microalgae marines***,** 35.

POGODA, B. 2019a. Current Status of European Oyster Decline and Restoration in Germany. *Humanities,* 8**,** 12.

POGODA, B. 2019b. Wiederansiedlung der heimischen Europäischen Auster in der Nordsee. *Klarer Kurs - Naturschutz: Jahrbuch für Naturschutz und Landschaftspflege,* 62**,** 74-83.

POGODA, B., BROWN, J., HANCOCK, B., PRESTON, J., POUVREAU, S., KAMERMANS, P., SANDERSON, W. G. & VON NORDHEIM, H. 2019. The Native Oyster Restoration Alliance (NORA) and the Berlin Oyster Recommendation: bringing back a key ecosystem engineer by developing and supporting best practice in Europe. *Aquatic Living Resources,* 32**,** 9.

POGODA, B., COLSOUL, B., HAUSEN, T., MERK, V. & PETER, C. 2020. Wiederherstellung der Bestände der Europäischen Auster (*Ostrea edulis*) in der deutschen Nordsee (RESTORE Voruntersuchung). *Bfn-Skripten 582.* Bonn.

PRESTON, J., FABRA, M., HELMER, L., JOHNSON, E., HARRIS-SCOTT, E. & HENDY, I. W. 2020. Interactions of larval dynamics and substrate preference have ecological significance for benthic biodiversity and *Ostrea edulis* Linnaeus, 1758 in the presence of *Crepidula fornicata*. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 30**,** 2133-2149.

SEAMAN, M. N. L. & RUTH, M. 1997. The molluscan fisheries of Germany. *In:* MACKENZIE, C. L., BURRELL, V. G., ROSENFIELD, A. & HOBART, W. L. (eds.) *The History, Present Condition, and Future of the Molluscan Fisheries of North and Central America and Europe.* Seattle, USA: Scientific Publications Office, NMFS, NOAA.

ŠEGVIĆ-BUBIĆ, T., ŽUŽUL, I., TALIJANČIĆ, I., UGRIN, N., LEPEN PLEIĆ, I., ŽUVIĆ, L., STAGLIČIĆ, N. & GRUBIŠIĆ, L. 2020. Translocation and Aquaculture Impact on Genetic Diversity and Composition of Wild Self-Sustainable Ostrea edulis Populations in the Adriatic Sea. *Frontiers in Marine Science,* 7**,** 84.

TEMMINK, R. J. M., ANGELINI, C., FIVASH, G. S., SWART, L., NOUTA, R., TEUNIS, M., LENGKEEK, W., DIDDEREN, K., LAMERS, L. P. M., BOUMA, T. J. & VAN DER HEIDE, T. Life cycle informed restoration: Engineering settlement substrate material characteristics and structural complexity for reef formation. *Journal of Applied Ecology,* n/a.

WALNE, P. R. 1974. Structure, physiology and reproduction of oysters. *In:* WALNE, P. R. (ed.) *Culture of Bivalve Molluscs: 50 Years Experience at Conwy.* Surrey, UK: Fishing News Books Limited.

YONGE, C. M. 1960. *Oysters,* London: Collins, The new naturalist.

ZU ERMGASSEN, P. S. E., GAMBLE, C., DEBNEY, A., COLSOUL, B., FABRA, M., SANDERSON, W. G., STRAND, Å. & PRESTON, J. 2020. European Guidelines on Biosecurity in Native Oyster Restoration. *In:* ZU ERMGASSEN, P. S. E., GAMBLE, C., DEBNEY, A., COLSOUL, B., FABRA, M., SANDERSON, W. G., STRAND, Å. & PRESTON, J. (eds.). The Zoological Society of London, UK., London, UK.

Appendix

- Dashboard Helgoland Oyster Hatchery production season 2021 –

-

- Larval Collection 2021 -

Table A: Dashboard of the broodstock conditioning season 2021, at Helgoland Oyster Hatchery, from 4th of June 2021 to 13th June 2021, showing the water parameter, the number of oysters, cleaning maintenance and the food supply.

Broodstcok conditioning		Juni Friday 04.06.2021	Juni Saturday 05.06.2021	Juni Sunday 06.06.2021	Juni Monday 07.06.2021	Juni Tuesday 08.06.2021	Juni Wednesday 09.06.2021	Juni Thursday 10.06.2021	Juni Friday 11.06.2021	Juni Saturday 12.06.2021	Juni Sunday 13.06.2021
Light	Photoperiod (daylight/24h)	8	8	8	8	8	8	8	8	8	8
	Lights check [X]	x	x	x	x	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	12	12	12	12	12	12	12	12	12	12
	Temperature (real: A1) [°C]										
	Temperature (real: B2) [°C]										
	Temperature (real: C3) [°C]										
	Temperature (real: average) [°C]	12,80	12,80	13,00	13,20	13,10	13,20	13,40	13,50	13,60	14,20
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]										
	Salinity (real: B2) [PSU]										
	Salinity (real: C3) [PSU]										
	Salinity (real: checked) [PSU]	31,00	30,90	31,20	31,10	31,20	31,20	30,90	31,20	31,00	30,90
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)										
	pH (real: B2)										
	pH (real: C3)										
	pH (real: checked)	8,11	8,09	8,13	8,15	8,15	8,16	8,11	8,18	8,14	8,14
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	119	122	122	124	126	125	123	125	125	125
	Diss. oxy. (real: A1) [mg/l]										
	Diss. oxy. (real: B2) [mg/l]										
	Diss. oxy. (real: C3) [mg/l]										
	Diss. oxy. (real: average) [mg/l]	10,36	10,64	10,58	10,69	10,88	10,80	10,64	10,69	10,68	10,59
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	11	11	11	11	11	11	11	11	11	11
	Aeration/Mixing [checked=X]	x	x	x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	180	180	180	180	180	180	180	180	180	180
	Broodstock mortality [#]	0	0	0	0	0	0	0	0	0	0
	Broodstock maintenance [should be]	ABC									
	Broodstock maintenance [done=X]	ABC									
	Average meat dry-weight per oyster (g)	5,66									
	Average meat dry-weight per stock (g)	1018,80	1018,80	1018,80	1018,80	1018,80	1018,80	1018,80	1018,80	1018,80	1018,80
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	-	-	-	0,97	0,92	0,94	0,32	0,40	0,52	0,60
	Mean dry weight [mg/10^6cells]	0,13									
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	-	-	-	3,30	3,40	2,50	3,50	2,90	2,51	2,90
	Mean dry weight [mg/10^6cells]	0,03									
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	3	3	3	3	3	3	3	3	3	3
	Daily food ration per oyster: part M1 [%]	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56
	Daily food ration per oyster: part M2 [%]	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44
	Daily food (M1) ration per stock [10^6 cells]	44083	44083	44083	44083	44083	44083	44083	44083	44083	44083
	Daily food (M2) ration per stock [10^6 cells]	827775	827775	827775	827775	827775	827775	827775	827775	827775	827775
	Daily need in volume of *R. salina* [litres]	#WERT!	#WERT!	#WERT!	45	48	47	138	110	85	73
	Daily need in volume of *C. muelleri* [litres]	#WERT!	#WERT!	#WERT!	251	243	331	237	285	330	285

Table A (continued): Dashboard from 14th June 2021 to 23rd June 2021.

Broodstcok conditioning		Juni	Juni	Juni	Juni	Juni	Juni	Juni	Juni	Juni	Juni
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday
		14.06.2021	15.06.2021	16.06.2021	17.06.2021	18.06.2021	19.06.2021	20.06.2021	21.06.2021	22.06.2021	23.06.2021
Light	Photoperiod (daylight/24h)	8	8	8	8	8	8	8	8	8	8
	Lights check [X]	x	x	x	x	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	13	13	13	13	13	13	13	14	14	14
	Temperature (real: A1) [°C]										
	Temperature (real: B2) [°C]										
	Temperature (real: C3) [°C]										
	Temperature (real: average) [°C]	14,30	14,20	14,60	14,70	14,90	15,00	15,20	15,20	15,20	15,50
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]										
	Salinity (real: B2) [PSU]										
	Salinity (real: C3) [PSU]										
	Salinity (real: checked) [PSU]	31,10	31,00	31,30	31,30	31,10	31,20	31,10	30,90	30,90	30,90
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)										
	pH (real: B2)										
	pH (real: C3)										
	pH (real: checked)	8,09	8,16	8,18	8,09	8,03	8,15	8,14	8,15	8,08	8,17
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	124	124	123	124	123	124	122	123	123	113
	Diss. oxy. (real: A1) [mg/l]										
	Diss. oxy. (real: B2) [mg/l]										
	Diss. oxy. (real: C3) [mg/l]										
	Diss. oxy. (real: average) [mg/l]	10,49	10,53	10,36	10,38	10,23	10,31	10,15	10,19	10,18	9,33
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	11	11	11	11	11	11	11	11	11	11
	Aeration/Mixing [checked=X]	x	x	x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	180	180	180	180	178	174	174	174	174	174
	Broodstock mortality [#]	0	0	0	2	4	0	0	0	0	3
	Broodstock maintenance [should be]				AB	BC					AB
	Broodstock maintenance [done=X]				AB	BC					AB
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	1018,80	1018,80	1018,80	1018,80	1007,48	984,84	984,84	984,84	984,84	984,84
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	0,40	0,35	0,30	0,30	0,40	0,00	0,00	0,30	0,00	0,00
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	3,80	3,40	3,40	2,80	2,50	3,19	2,58	3,00	2,00	2,00
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	3	3	3	3	3	3	3	3	3	3
	Daily food ration per oyster: part M1 [%]	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56
	Daily food ration per oyster: part M2 [%]	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44
	Daily food (M1) ration per stock [10^6 cells]	44083	44083	44083	44083	43593	42613	42613	42613	42613	42613
	Daily food (M2) ration per stock [10^6 cells]	827775	827775	827775	827775	818578	800183	800183	800183	800183	800183
	Daily need in volume of *R. salina* [litres]	110	126	147	147	109	#DIV/0!	#DIV/0!	142	#DIV/0!	#DIV/0!
	Daily need in volume of *C. muelleri* [litres]	218	243	243	296	327	251	310	267	400	400

Table A (continued): Dashboard from 24th June 2021 to 3rd July 2021.

Broodstcok conditioning		Juni Thursday 24.06.2021	Juni Friday 25.06.2021	Juni Saturday 26.06.2021	Juni Sunday 27.06.2021	Juni Monday 28.06.2021	Juni Tuesday 29.06.2021	Juni Wednesday 30.06.2021	July Thursday 01.07.2021	July Friday 02.07.2021	July Saturday 03.07.2021
Light	Photoperiod (daylight/24h)	8	8	8	8	12	12	12	12	12	12
	Lights check [X]	x	x	x	x	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	14	14	14	14	15	15	15	15	15	15
	Temperature (real: A1) [°C]										
	Temperature (real: B2) [°C]										
	Temperature (real: C3) [°C]										
	Temperature (real: average) [°C]	15,23	15,50	15,60	15,90	15,70	15,80	15,90	15,90	16,00	16,10
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]										
	Salinity (real: B2) [PSU]										
	Salinity (real: C3) [PSU]										
	Salinity (real: checked) [PSU]	30,90	30,80	30,60	30,80	30,70	30,50	30,60	30,60	30,60	30,70
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)										
	pH (real: B2)										
	pH (real: C3)										
	pH (real: checked)	8,17	8,12	8,14	8,13	8,21	8,17	8,16	8,19	8,18	8,18
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	124	124	123	125	124	123	123	123	124	124
	Diss. oxy. (real: A1) [mg/l]										
	Diss. oxy. (real: B2) [mg/l]										
	Diss. oxy. (real: C3) [mg/l]										
	Diss. oxy. (real: average) [mg/l]	10,30	10,26	10,18	10,22	10,22	10,16	10,10	10,13	10,13	10,12
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	11	11	11	11	11	11	11	11	11	11
	Aeration/Mixing [checked=X]	x	x	x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	171	168	168	168	168	166	165	164	164	164
	Broodstock mortality [#]	3	0	0	0	2	1	1	0	0	0
	Broodstock maintenance [should be]	BC				A	B	C			
	Broodstock maintenance [done=X]	BC				A	B	C			
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	967,86	950,88	950,88	950,88	950,88	939,56	933,90	928,24	928,24	928,24
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	0,76	0,85	0,95	0,95	1,10	1,50	0,50	0,52	0,67	0,81
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	2,00	2,80	2,60	2,70	2,80	2,00	3,10	3,00	3,00	2,93
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	3	3	3	3	3	3	3	3	3	3
	Daily food ration per oyster: part M1 [%]	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56
	Daily food ration per oyster: part M2 [%]	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44
	Daily food (M1) ration per stock [10^6 cells]	41879	41144	41144	41144	41144	40654	40409	40164	40164	40164
	Daily food (M2) ration per stock [10^6 cells]	786386	772590	772590	772590	772590	763393	758794	754195	754195	754195
	Daily need in volume of *R. salina* [litres]	55	48	43	43	37	27	81	77	60	50
	Daily need in volume of *C. muelleri* [litres]	393	276	297	286	276	382	245	251	251	257

Table A (continued): Dashboard from 4th July 2021 to 13th July 2021.

Broodstock conditioning		July Sunday 04.07.2021	July Monday 05.07.2021	July Tuesday 06.07.2021	July Wednesday 07.07.2021	July Thursday 08.07.2021	July Friday 09.07.2021	July Saturday 10.07.2021	July Sunday 11.07.2021	July Monday 12.07.2021	July Tuesday 13.07.2021
Light	Photoperiod (daylight/24h)	12	16	16	16	16	16	16	16	20	20
	Lights check [X]	x	x	x	x	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	15	16	16	16	16	16	16	16	17	17
	Temperature (real: A1) [°C]			14,5	16,30	15,70	16,50	16,30	17,50	16,40	16,5
	Temperature (real: B2) [°C]			14,20	16,30	16,70	17,00	16,70	17,90	16,80	17,00
	Temperature (real: C3) [°C]			15,60	16,00	16,70	17,10	16,60	17,60	16,60	16,80
	Temperature (real: average) [°C]	16,30	16,50	14,77	16,20	16,37	16,87	16,53	17,67	16,60	16,77
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]			30,9	31,00	30,90	31,20	31,40	31,40	31,40	31,60
	Salinity (real: B2) [PSU]			31,00	31,00	31,10	31,30	31,30	31,50	31,30	31,50
	Salinity (real: C3) [PSU]			31,00	31,00	31,40	31,20	31,40	31,40	31,40	31,50
	Salinity (real: checked) [PSU]	30,80	30,90	30,97	31,00	31,13	31,23	31,37	31,43	31,37	31,53
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)			7.99	8,02	7,99	8,03	8,02	8,20	8,00	8,06
	pH (real: B2)			8,05	8,00	8,08	8,11	8,06	8,23	8,06	8,04
	pH (real: C3)			8,05	8,02	8,11	8,10	8,05	8,26	8,09	8,09
	pH (real: checked)	8,15	8,08	8,05	8,01	8,06	8,08	8,04	8,23	8,05	8,06
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	123	123	116	119	119	120	120	117	120	115
	Diss. oxy. (real: A1) [mg/l]			9,63	9,68	9,58	9,53	9,52	9,06	9,44	9,43
	Diss. oxy. (real: B2) [mg/l]			10,03	9,61	9,66	9,74	9,69	9,24	9,70	8,73
	Diss. oxy. (real: C3) [mg/l]			9,49	9,79	9,76	9,72	9,73	9,51	9,80	9,44
	Diss. oxy. (real: average) [mg/l]	9,99	9,95	9,72	9,69	9,67	9,66	9,65	9,27	9,65	9,20
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	11	12	13	13	13,3	13,3	13	13,3	13,4	13
	Aeration/Mixing [checked=X]	x	x	x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	164	164	163	163	163	162	160	160	160	156
	Broodstock mortality [#]	0	1	0	0	1	2	0	0	4	0
	Broodstock maintenance [should be]		ABC		A	B	C			AB	
	Broodstock maintenance [done=X]		ABC		A	B	C			AB	
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	928,24	928,24	922,58	922,58	922,58	916,92	905,60	905,60	905,60	882,96
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	0,89	0,63	0,85	0,79	0,90	0,93	0,93	0,67	0,50	0,67
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	2,45	3,00	2,70	2,50	3,10	2,20	2,45	1,70	3,00	3,00
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	3	3	3	3	3	3	3	3	3	3
	Daily food ration per oyster: part M1 [%]	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56
	Daily food ration per oyster: part M2 [%]	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44
	Daily food (M1) ration per stock [10^6 cells]	40164	40164	39919	39919	39919	39674	39185	39185	39185	38205
	Daily food (M2) ration per stock [10^6 cells]	754195	754195	749596	749596	749596	744998	735800	735800	735800	717405
	Daily need in volume of *R. salina* [litres]	45	64	47	51	44	43	42	59	78	57
	Daily need in volume of *C. muelleri* [litres]	308	251	278	300	242	339	300	433	245	239

Table A (continued): Dashboard from 14th July 2021 to 23rd July 2021.

Broodstcok conditioning		July Wednesday 14.07.2021	July Thursday 15.07.2021	July Friday 16.07.2021	July Saturday 17.07.2021	July Sunday 18.07.2021	July Monday 19.07.2021	July Tuesday 20.07.2021	July Wednesday 21.07.2021	July Thursday 22.07.2021	July Friday 23.07.2021
Light	Photoperiod (daylight/24h)	20	20	20	20	20	24	24	24	24	24
	Lights check [X]	x	x	x	X	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	17	17	17	17	17	18	18	18	18	18
	Temperature (real: A1) [°C]	16,70	17,10	16,80	16,70	17,10	16,80	17,50	17,90	17,80	17,50
	Temperature (real: B2) [°C]	17,00	17,50	17,20	17,00	17,20	17,20	18,10	18,20	18,20	18,00
	Temperature (real: C3) [°C]	16,90	17,40	17,10	16,90	17,10	17,10	18,00	18,10	18,10	17,90
	Temperature (real: average) [°C]	16,87	17,33	17,03	16,87	17,13	17,03	17,87	18,07	18,03	17,80
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]	31,90	32,00	32,00	32,00	31,60	32,10	31,80	31,60	31,50	31,60
	Salinity (real: B2) [PSU]	31,90	31,90	32,20	32,20	32,00	32,00	31,90	31,70	31,60	31,60
	Salinity (real: C3) [PSU]	31,90	32,00	32,10	32,10	32,10	32,10	31,90	31,70	31,60	31,50
	Salinity (real: checked) [PSU]	31,90	31,97	32,10	32,10	31,90	32,07	31,87	31,67	31,57	31,57
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)	8,10	8,03	7,97	8,01	8,07	8,07	8,01	8,05	8,04	8,06
	pH (real: B2)	8,11	8,09	8,06	8,13	8,17	8,06	8,09	8,12	8,13	8,18
	pH (real: C3)	8,11	8,10	8,12	8,17	8,19	8,07	8,12	8,14	8,12	8,13
	pH (real: checked)	8,11	8,07	8,05	8,10	8,14	8,07	8,07	8,10	8,10	8,12
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	120	121	125	125	124	123	124	122	123	124
	Diss. oxy. (real: A1) [mg/l]	9,49	9,40	9,66	9,80	9,66	9,60	9,62	9,49	9,53	9,49
	Diss. oxy. (real: B2) [mg/l]	9,63	9,61	10,04	10,01	9,93	9,84	9,71	9,57	9,67	9,86
	Diss. oxy. (real: C3) [mg/l]	9,72	9,63	10,13	10,12	10,09	9,85	9,73	9,61	9,65	9,87
	Diss. oxy. (real: average) [mg/l]	9,61	9,55	9,94	9,98	9,89	9,76	9,69	9,56	9,62	9,74
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	X	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	X	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	13,3	13,1	13,1	13,2	12,9	13,4	13,2	13	12,9	13
	Aeration/Mixing [checked=X]	x	x	x	X	X	X	x	x	x	x
Oysters	Broodstock [#]	156	156	156	156	155	154	154	154	154	154
	Broodstock mortality [#]	0	0	1	0	1	0	0	0	0	0
	Broodstock maintenance [should be]	C									
	Broodstock maintenance [done=X]	-									
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	882,96	882,96	882,96	882,96	877,30	871,64	871,64	871,64	871,64	871,64
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	0,90	0,93	0,99	1,05	1,05	0,68	0,67	0,68	0,67	0,89
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	3,00	2,20	3,00	3,33	3,40	3,30	2,80	3,00	3,13	2,40
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	3	3	3	3	3	3	3	3	3	3
	Daily food ration per oyster: part M1 [%]	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56	0,56
	Daily food ration per oyster: part M2 [%]	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44
	Daily food (M1) ration per stock [10^6 cells]	38205	38205	38205	38205	37960	37715	37715	37715	37715	37715
	Daily food (M2) ration per stock [10^6 cells]	717405	717405	717405	717405	712806	708208	708208	708208	708208	708208
	Daily need in volume of *R. salina* [litres]	42	41	39	36	36	55	56	55	56	42
	Daily need in volume of *C. muelleri* [litres]	239	326	239	215	210	215	253	236	227	295

Table A (continued): Dashboard from 24th July 2021 to 2nd August 2021.

Broodstock conditioning		July Saturday 24.07.2021	July Sunday 25.07.2021	July Monday 26.07.2021	July Tuesday 27.07.2021	July Wednesday 28.07.2021	July Thursday 29.07.2021	July Friday 30.07.2021	July Saturday 31.07.2021	August Sunday 01.08.2021	August Monday 02.08.2021
Light	Photoperiod (daylight/24h)	24	24	24	24	24	24	24	24	24	24
	Lights check [X]	x	x	x	x	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	18	18	19	19	19	19	19	19	19	20
	Temperature (real: A1) [°C]	17,00	17,20	17,80	18,10	18,90	18,70	18,80	18,80	18,90	18,60
	Temperature (real: B2) [°C]	17,70	17,70	17,70	18,10	19,20	19,00	18,90	18,90	18,90	18,80
	Temperature (real: C3) [°C]	17,60	17,50	17,50	18,30	19,30	19,10	19,10	19,00	19,00	18,90
	Temperature (real: average) [°C]	17,43	17,47	17,67	18,17	19,13	18,93	18,93	18,90	18,93	18,77
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]	31,70	31,80	31,70	31,20	31,70	32,00	31,70	31,70	31,70	32,20
	Salinity (real: B2) [PSU]	31,70	31,70	31,60	31,50	31,70	31,70	31,80	31,70	31,60	32,20
	Salinity (real: C3) [PSU]	31,70	31,70	31,70	31,80	31,60	31,70	31,70	31,60	31,70	32,00
	Salinity (real: checked) [PSU]	31,70	31,73	31,67	31,50	31,67	31,80	31,73	31,67	31,67	32,13
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)	8,07	8,03	8,05	8,10	8,11	8,09	8,06	8,09	8,12	8,04
	pH (real: B2)	8,21	8,19	8,20	8,17	8,09	8,07	8,08	8,10	8,14	8,06
	pH (real: C3)	8,14	8,15	8,17	8,14	8,15	8,14	8,11	8,16	8,20	8,11
	pH (real: checked)	8,14	8,12	8,14	8,14	8,12	8,10	8,08	8,12	8,15	8,07
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	122	123	123	122	116	115	116	115	116	117
	Diss. oxy. (real: A1) [mg/l]	9,54	9,56	9,49	9,52	8,81	8,85	8,87	8,85	8,92	8,87
	Diss. oxy. (real: B2) [mg/l]	9,75	9,76	9,72	9,46	8,74	8,73	8,79	8,75	8,77	9,06
	Diss. oxy. (real: C3) [mg/l]	9,76	9,78	9,76	9,70	9,04	9,00	9,03	9,01	9,02	9,15
	Diss. oxy. (real: average) [mg/l]	9,68	9,70	9,66	9,56	8,86	8,86	8,90	8,87	8,90	9,03
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	13	13,2	12,9	14,2	15,1	14,9	14,9	14,5	14,9	15,5
	Aeration/Mixing [checked=X]	x	x	x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	154	154	154	154	141	141	141	141	141	141
	Broodstock mortality [#]	0	0	0	13	0	0	0	0	0	0
	Broodstock maintenance [should be]				ABC						
	Broodstock maintenance [done=X]				ABC						
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	871,64	871,64	871,64	871,64	798,06	798,06	798,06	798,06	798,06	798,06
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	1,12	1,15	1,40	1,10	1,10	1,20	0,80	0,88	0,98	0,77
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	2,45	2,90	2,80	3,20	3,10	3,00	2,60	2,60	2,20	3,50
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	3	3	6	6	6	6	6	6	6	6
	Daily food ration per oyster: part M1 [%]	0,56	0,56	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13
	Daily food ration per oyster: part M2 [%]	2,44	2,44	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88
	Daily food (M1) ration per stock [10^6 cells]	37715	37715	75430	75430	69063	69063	69063	69063	69063	69063
	Daily food (M2) ration per stock [10^6 cells]	708208	708208	1416415	1416415	1296848	1296848	1296848	1296848	1296848	1296848
	Daily need in volume of *R. salina* [litres]	34	33	54	69	63	58	86	78	70	90
	Daily need in volume of *C. muelleri* [litres]	289	244	506	443	418	432	499	499	589	371

Table A (continued): Dashboard from 3rd August 2021 to 12th of August 2021.

Broodstcok conditioning		August	August	August	August	August	August	August	August	August	August
		Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday
		03.08.2021	04.08.2021	05.08.2021	06.08.2021	07.08.2021	08.08.2021	09.08.2021	10.08.2021	11.08.2021	12.08.2021
Light	Photoperiod (daylight/24h)	24	24	24	24	24	24	24	24	24	24
	Lights check [X]	x	x	x	x	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	20	20	20	20	20	20	21	21	21	21
	Temperature (real: A1) [°C]	19,70	19,10	18,90	18,80	19,00	19,20	19,20	19,90	20,10	19,70
	Temperature (real: B2) [°C]	19,90	19,90	19,60	19,40	19,70	19,80	19,80	20,50	20,50	20,30
	Temperature (real: C3) [°C]	20,20	19,60	19,50	19,30	19,40	19,70	19,67	20,40	20,40	20,10
	Temperature (real: average) [°C]	19,93	19,53	19,33	19,17	19,37	19,57	19,56	20,27	20,33	20,03
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]	32,30	32,20	32,20	32,20	32,10	32,20	32,10	32,20	32,00	32,10
	Salinity (real: B2) [PSU]	32,30	32,30	32,20	32,30	32,10	32,10	32,20	32,30	32,20	32,20
	Salinity (real: C3) [PSU]	32,30	32,50	32,20	32,20	32,20	32,10	32,10	32,20	32,20	32,20
	Salinity (real: checked) [PSU]	32,30	32,33	32,20	32,23	32,13	32,13	32,13	32,23	32,13	32,17
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)	8,09	7,93	8,03	8,06	7,97	8,06	8,12	8,10	8,10	8,07
	pH (real: B2)	8,07	7,99	8,03	8,06	8,00	8,09	8,19	8,21	8,20	8,21
	pH (real: C3)	8,12	8,05	8,15	8,17	8,05	8,10	8,19	8,19	8,20	8,22
	pH (real: checked)	8,09	7,99	8,07	8,10	8,01	8,08	8,17	8,17	8,17	8,17
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	116	118	117	120	113	118	122	124	127	124
	Diss. oxy. (real: A1) [mg/l]	8,61	8,76	8,91	8,94	8,43	8,78	9,16	8,97	9,14	9,07
	Diss. oxy. (real: B2) [mg/l]	8,50	8,84	8,66	8,94	8,59	8,93	9,30	9,42	9,76	9,41
	Diss. oxy. (real: C3) [mg/l]	9,07	9,14	9,22	9,65	8,78	9,02	9,33	9,38	9,57	9,51
	Diss. oxy. (real: average) [mg/l]	8,73	8,91	8,93	9,18	8,60	8,91	9,26	9,26	9,49	9,33
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	15,5	16	16,3	16	16	16	17,3	17,1	17,3	17,2
	Aeration/Mixing [checked=X]	x	x	x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	141	140	136	136	136	136	136	136	136	136
	Broodstock mortality [#]	1	4		0	0	0	0	0	0	0
	Broodstock maintenance [should be]	A	B		C			A		B	
	Broodstock maintenance [done=X]	X	X		x			x		x	
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	798,06	792,40	769,76	769,76	769,76	769,76	769,76	769,76	769,76	769,76
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	0,67	0,65	0,60	0,61	0,80	0,89	0,96	1,00	0,96	0,89
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	2,50	4,00	3,80	4,70	4,80	5,10	5,17	5,30	5,20	5,20
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	6	6	6	6	6	6	6	6	6	6
	Daily food ration per oyster: part M1 [%]	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13
	Daily food ration per oyster: part M2 [%]	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88
	Daily food (M1) ration per stock [10^6 cells]	69063	68573	66614	66614	66614	66614	66614	66614	66614	66614
	Daily food (M2) ration per stock [10^6 cells]	1296848	1287650	1250860	1250860	1250860	1250860	1250860	1250860	1250860	1250860
	Daily need in volume of *R. salina* [litres]	103	105	111	109	83	75	69	67	69	75
	Daily need in volume of *C. muelleri* [litres]	519	322	329	266	261	245	242	236	241	241

Table A (continued): Dashboard from 13th August 2021 to 22nd August 2021.

Broodstcok conditioning		August	August	August	August	August	August	August	August	August	August
		Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
		13.08.2021	14.08.2021	15.08.2021	16.08.2021	17.08.2021	18.08.2021	19.08.2021	20.08.2021	21.08.2021	22.08.2021
Light	Photoperiod (daylight/24h)	24	24	24	24	24	24	24	24	24	24
	Lights check [X]	x	x	x	x	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	21	21	21	21	21	21	21	21	21	21
	Temperature (real: A1) [°C]	19,80	19,90	20,00	19,80	19,70	19,80	19,40	19,80	19,40	19,50
	Temperature (real: B2) [°C]	20,50	20,50	20,40	20,60	20,50	20,70	20,30	20,60	20,30	20,30
	Temperature (real: C3) [°C]	20,20	20,40	20,30	20,30	20,30	20,30	20,10	20,40	20,10	20,20
	Temperature (real: average) [°C]	20,17	20,27	20,23	20,23	20,17	20,27	19,93	20,27	19,93	20,00
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]	32,20	32,20	32,10	32,40	32,40	32,40	32,50	32,40	32,30	32,30
	Salinity (real: B2) [PSU]	32,30	32,20	32,20	32,40	32,40	32,50	32,50	32,40	32,40	32,40
	Salinity (real: C3) [PSU]	32,30	32,20	32,30	32,50	32,50	32,40	32,40	32,40	32,30	32,40
	Salinity (real: checked) [PSU]	32,27	32,20	32,20	32,43	32,43	32,43	32,47	32,40	32,33	32,37
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)	8,12	8,08	8,10	8,12	8,08	8,09	8,10	8,11	8,08	8,09
	pH (real: B2)	8,21	8,20	8,19	8,47	8,09	8,09	8,08	8,16	8,19	8,15
	pH (real: C3)	8,29	8,26	8,25	8,21	8,14	8,14	8,12	8,13	8,15	8,16
	pH (real: checked)	8,21	8,18	8,18	8,27	8,10	8,11	8,10	8,13	8,14	8,13
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	127	127	127	129	117	116	116	122	123	123
	Diss. oxy. (real: A1) [mg/l]	9,14	9,14	9,15	8,95	8,82	8,80	8,93	9,07	9,23	9,23
	Diss. oxy. (real: B2) [mg/l]	9,54	9,48	9,47	10,02	8,62	8,52	8,51	9,10	9,31	9,30
	Diss. oxy. (real: C3) [mg/l]	9,96	9,87	9,80	10,00	8,76	8,69	8,78	9,08	9,30	9,28
	Diss. oxy. (real: average) [mg/l]	9,55	9,50	9,47	9,66	8,73	8,67	8,74	9,08	9,28	9,27
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	17,1	17	17	17,3	17,4	17,4	17	17,2	17,1	17,2
	Aeration/Mixing [checked=X]	x	x	x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	136	136	136	136	134	134	134	134	134	134
	Broodstock mortality [#]	0	0	0	2	0	0	0	0	0	0
	Broodstock maintenance [should be]	C			A		B		C		
	Broodstock maintenance [done=X]	x			ABC (if no larvae)						
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	769,76	769,76	769,76	769,76	758,44	758,44	758,44	758,44	758,44	758,44
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	0,78	0,72	1,10	0,95	1,07	1,30	1,10	1,30	1,27	1,10
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	3,50	4,67	4,83	4,65	3,90	4,20	4,30	5,40	4,31	3,40
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	6	6	6	6	6	6	6	6	6	6
	Daily food ration per oyster: part M1 [%]	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13
	Daily food ration per oyster: part M2 [%]	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88
	Daily food (M1) ration per stock [10^6 cells]	66614	66614	66614	66614	65634	65634	65634	65634	65634	65634
	Daily food (M2) ration per stock [10^6 cells]	1250860	1250860	1250860	1250860	1232465	1232465	1232465	1232465	1232465	1232465
	Daily need in volume of *R. salina* [litres]	85	93	61	70	61	50	60	50	52	60
	Daily need in volume of *C. muelleri* [litres]	357	268	259	269	316	293	287	228	286	362

Table A (continued): Dashboard from 23rd August 2021 to 1st September 2021.

Broodstcok conditioning		August	August	August	August	August	August	August	August	August	September
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday
		23.08.2021	24.08.2021	25.08.2021	26.08.2021	27.08.2021	28.08.2021	29.08.2021	30.08.2021	31.08.2021	01.09.2021
Light	Photoperiod (daylight/24h)	24	24	24	24	24	24	24	24	24	24
	Lights check [X]	x	x	x	x	x	x	x	x	x	x
Seawater	Temperature (should be) [°C]	23	23	23	23	23	23	23	25	25	25
	Temperature (real: A1) [°C]	19,50	21,50	21,60	22,40	22,50	22,40	22,20	22,10	22,90	23,00
	Temperature (real: B2) [°C]	20,60	22,20	22,10	22,90	23,10	23,00	21,80	22,70	23,40	23,40
	Temperature (real: C3) [°C]	20,30	21,90	22,10	22,60	22,80	22,80	22,00	22,30	23,10	22,90
	Temperature (real: average) [°C]	20,13	21,87	21,93	22,63	22,80	22,73	22,00	22,37	23,13	23,10
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]	31,90	31,90	32,10	32,00	31,60	31,60	31,70	31,70	31,70	31,60
	Salinity (real: B2) [PSU]	32,00	32,10	32,00	31,50	31,70	31,60	31,70	31,90	31,80	31,60
	Salinity (real: C3) [PSU]	31,90	32,00	32,00	31,80	31,70	31,70	31,70	31,70	31,60	31,70
	Salinity (real: checked) [PSU]	31,93	32,00	32,03	31,77	31,67	31,63	31,70	31,77	31,70	31,63
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)	8,05	8,03	8,02	8,14	8,06	8,07	8,24	8,12	8,01	8,04
	pH (real: B2)	8,19	8,09	8,10	8,21	8,19	8,20	8,25	8,25	8,11	8,11
	pH (real: C3)	8,16	8,14	8,11	8,21	8,19	8,18	8,22	8,26	8,19	8,19
	pH (real: checked)	8,13	8,09	8,08	8,19	8,15	8,15	8,24	8,21	8,10	8,11
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	123	117	117	121	122	122	119	129	118	119
	Diss. oxy. (real: A1) [mg/l]	9,05	8,30	8,35	8,51	8,48	8,45	8,56	8,63	7,99	7,94
	Diss. oxy. (real: B2) [mg/l]	9,26	8,56	8,50	8,75	8,86	8,90	8,25	9,88	8,55	8,42
	Diss. oxy. (real: C3) [mg/l]	9,30	8,79	8,73	8,89	8,94	8,92	9,11	9,38	8,76	9,16
	Diss. oxy. (real: average) [mg/l]	9,20	8,55	8,53	8,72	8,76	8,76	8,64	9,30	8,43	8,51
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	17,3	19,3	19,3	19,2	19,1	19,3	19,2	19,3	21	21,1
	Aeration/Mixing [checked=X]	x	x	x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	134	131	131	131	131	131	131	131	131	130
	Broodstock mortality [#]	3	0	0				0		1	
	Broodstock maintenance [should be]	A		B		C			A		B
	Broodstock maintenance [done=X]	ABC (if no larvae)								Siphon ABC	
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	758,44	741,46	741,46	741,46	741,46	741,46	741,46	741,46	741,46	735,80
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	0,92	0,97	1,03	0,83	1,00	1,30	0,92	0,71	0,87	1,07
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	5,20	4,50	4,40	4,50	4,60	5,00	4,90	4,70	4,90	4,70
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	6	6	6	6	6	6	6	6	6	6
	Daily food ration per oyster: part M1 [%]	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13	1,13
	Daily food ration per oyster: part M2 [%]	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88	4,88
	Daily food (M1) ration per stock [10^6 cells]	65634	64165	64165	64165	64165	64165	64165	64165	64165	63675
	Daily food (M2) ration per stock [10^6 cells]	1232465	1204873	1204873	1204873	1204873	1204873	1204873	1204873	1204873	1195675
	Daily need in volume of *R. salina* [litres]	71	66	62	77	64	49	70	90	74	60
	Daily need in volume of *C. muelleri* [litres]	237	268	274	268	262	241	246	256	246	254

Table A (continued): Dashboard from 2nd September 2021 to 11th September 2021.

Broodstcok conditioning		September Thursday 02.09.2021	September Friday 03.09.2021	September Saturday 04.09.2021	September Sunday 05.09.2021	September Monday 06.09.2021	September Tuesday 07.09.2021	September Wednesday 08.09.2021	September Thursday 09.09.2021	September Friday 10.09.2021	September Saturday 11.09.2021
Light	Photoperiod (daylight/24h)	24	24	24	24	20	20	20	20	20	20
	Lights check [X]	x	x	x	x	x	x		x	x	x
Seawater	Temperature (should be) [°C]	25	25	25	25	21	21	21/25	21	21	19
	Temperature (real: A1) [°C]	23,00	23,20	23,40	23,40	23,40	22,30	22,60	24,30	21,50	20,70
	Temperature (real: B2) [°C]	23,50	23,70	23,90	23,60	23,90	22,80	22,70	24,70	21,40	21,00
	Temperature (real: C3) [°C]	23,00	23,40	23,30	23,40	23,30	22,20	22,40	24,40	21,00	20,70
	Temperature (real: average) [°C]	23,17	23,43	23,53	23,47	23,53	22,43	22,57	24,47	21,30	20,80
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]	31,60	31,40	31,30	31,10	31,20	31,40	31,40	31,60	31,50	31,40
	Salinity (real: B2) [PSU]	31,50	31,30	31,40	31,30	31,40	31,50	31,50	31,50	31,40	31,50
	Salinity (real: C3) [PSU]	31,60	31,40	31,20	31,30	31,40	31,80	31,60	31,30	31,50	31,50
	Salinity (real: checked) [PSU]	31,57	31,37	31,30	31,23	31,33	31,57	31,50	31,47	31,47	31,47
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)	7,97	7,99	8,04	8,06	7,95	8,18	8,19	7,66	8,01	8,25
	pH (real: B2)	8,03	8,10	8,11	8,09	7,95	8,21	8,24	7,87	8,11	8,25
	pH (real: C3)	8,15	8,25	8,27	8,29	8,10	8,29	8,30	7,90	8,14	8,27
	pH (real: checked)	8,05	8,11	8,14	8,15	8,00	8,23	8,24	7,81	8,09	8,26
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>85	>85	>85	>85
	Diss. oxy. (real translated in [%])	119	121	124	125	125	122	123	123	119	122
	Diss. oxy. (real: A1) [mg/l]	8,10	8,13	8,12	8,36	8,45	8,57	8,56	8,50	8,74	8,95
	Diss. oxy. (real: B2) [mg/l]	8,33	8,52	8,94	8,91	8,95	8,84	8,90	8,59	8,69	9,10
	Diss. oxy. (real: C3) [mg/l]	8,97	9,11	9,26	9,31	9,11	9,08	9,05	8,65	8,79	9,13
	Diss. oxy. (real: average) [mg/l]	8,47	8,59	8,77	8,86	8,84	8,83	8,84	8,58	8,74	9,06
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45	45	45	45	45
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x	x	x	x	x
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x	x	x	x	x
Air	Ambiant/TK room temperature [°C]	21	21	21,2	21,2	21,1	19,1	22,6	23	17	17
	Aeration/Mixing [checked=X]	x		x	x	x	x	x	x	x	x
Oysters	Broodstock [#]	130	130	130	130	130	130	130	130	130	127
	Broodstock mortality [#]									3	0
	Broodstock maintenance [should be]		C			A		B		C	
	Broodstock maintenance [done=X]									ABC	
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	735,80	735,80	735,80	735,80	735,80	735,80	735,80	735,80	735,80	718,82
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	1,30	0,75	0,96	1,16	1,50	1,80	1,90	1,48	1,62	1,59
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	3,40	3,40	4,20	5,25	4,60	4,15	4,75	5,02	4,48	3,46
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	6	6	6	6	3	3	2	1	1	1
	Daily food ration per oyster: part M1 [%]	1,13	1,13	1,13	1,13	0,56	0,56	0,38	0,19	0,19	0,19
	Daily food ration per oyster: part M2 [%]	4,88	4,88	4,88	4,88	2,44	2,44	1,63	0,81	0,81	0,81
	Daily food (M1) ration per stock [10^6 cells]	63675	63675	63675	63675	31838	31838	21225	10613	10613	10368
	Daily food (M2) ration per stock [10^6 cells]	1195675	1195675	1195675	1195675	597838	597838	398558	199279	199279	194680
	Daily need in volume of *R. salina* [litres]	49	85	66	55	21	18	11	7	7	7
	Daily need in volume of *C. muelleri* [litres]	352	352	285	228	130	144	84	40	44	56

Table A (continued): Dashboard from 12th September 2021 to 21st September 2021.

Broodstcok conditioning		September Sunday 12.09.2021	September Monday 13.09.2021	September Tuesday 14.09.2021	September Wednesday 15.09.2021	September Thursday 16.09.2021	September Friday 17.09.2021	September Saturday 18.09.2021	September Sunday 19.09.2021	September Monday 20.09.2021	September Tuesday 21.09.2021
Light	Photoperiod (daylight/24h)	20	16	16	16	16	16	16	16	16	16
	Lights check [X]	x	x	x	x	x	x				
Seawater	Temperature (should be) [°C]	18	17	<17	<17	<17	<17	<18	<19	<20	<21
	Temperature (real: A1) [°C]	20,80	20,60	18,90	18,90	18,60	18,40				
	Temperature (real: B2) [°C]	20,90	20,80	19,40	18,70	18,70	18,50				
	Temperature (real: C3) [°C]	20,80	20,60	19,20	18,90	18,90	18,50				
	Temperature (real: average) [°C]	20,83	20,67	19,17	18,83	18,73	18,47	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Salinity (should be) [PSU]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]	[30-35]
	Salinity (real: A1) [PSU]	31,40	31,40	31,50	32,00	31,90	31,60				
	Salinity (real: B2) [PSU]	31,40	31,50	31,60	31,60	31,50	31,60				
	Salinity (real: C3) [PSU]	31,50	31,40	31,50	31,60	31,60	31,70				
	Salinity (real: checked) [PSU]	31,43	31,43	31,53	31,73	31,67	31,63	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	pH (should be)	8	8	8	8	8	8	8	8	8	8
	pH (real: A1)	8,26	8,24	8,35	8,29	8,30	8,32				
	pH (real: B2)	8,26	8,26	8,43	8,42	8,32	8,40				
	pH (real: C3)	8,28	8,25	8,32	8,23	8,28	8,34				
	pH (real: checked)	8,27	8,25	8,37	8,31	8,30	8,35	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Diss. oxy. (should be) [%]	>85	>85	>85	>85	>85	>85	>86	>87	>88	>89
	Diss. oxy. (real translated in [%])	122	122	124	124	124	124	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Diss. oxy. (real: A1) [mg/l]	9,02	9,05	9,40	9,23	9,36	9,41				
	Diss. oxy. (real: B2) [mg/l]	9,10	9,11	9,60	9,81	9,80	9,79				
	Diss. oxy. (real: C3) [mg/l]	9,14	9,13	9,45	9,65	9,59	9,61				
	Diss. oxy. (real: average) [mg/l]	9,09	9,10	9,48	9,56	9,58	9,60	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Water renewal (should be) [%/hour]	max. 45	max. 45	max. 45	max. 45	max. 45	max. 45	max. 46	max. 47	max. 48	max. 49
	Water renewal (real: checked) [% or l/hour]	45	45	45	45	45	45				
	Filtration [1-2µm; checked=X]	x	x	x	x	x	x				
	Sterilisation UV inlet [ON=X]	x	x	x	x	x	x				
Air	Ambiant/TK room temperature [°C]	17,1	17,1	15,1	15,1	15,4	15,3				
	Aeration/Mixing [checked=X]	x	x	x	x	x	x				
Oysters	Broodstock [#]	127	127	127	127	127	127	127	127	127	127
	Broodstock mortality [#]	0	0	0	0	0	0				
	Broodstock maintenance [should be]										
	Broodstock maintenance [done=X]										
	Average meat dry-weight per oyster (g)										
	Average meat dry-weight per stock (g)	718,82	718,82	718,82	718,82	718,82	718,82	718,82	718,82	718,82	718,82
Algae	1st Microalgae sp. [M1]	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*	*R. salina*
	Microalgae harvest. concent. [10^6 cells/ml]	1,64	3,13	2,85	2,81	4,78	1,42			3,62	1,97
	Mean dry weight [mg/10^6cells]										
	2nd Microalgae sp. [M2]	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*	*C. muelleri*
	Microalgae harvest. concent. [10^6 cells/ml]	3,43	4,26	5,20	5,84	7,35	3,54			6,63	7,18
	Mean dry weight [mg/10^6cells]										
	Diet (M1:M2 Equivalent cell weight) [%]	50	50	50	50	50	50	50	50	50	50
	Daily food ration per oyster//stock [%]	1	1	1	1	1	1	1	1	1	1
	Daily food ration per oyster: part M1 [%]	0,19	0,19	0,19	0,19	0,19	0,19	0,19	0,19	0,19	0,19
	Daily food ration per oyster: part M2 [%]	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81
	Daily food (M1) ration per stock [10^6 cells]	10368	10368	10368	10368	10368	10368	10368	10368	10368	10368
	Daily food (M2) ration per stock [10^6 cells]	194680	194680	194680	194680	194680	194680	194680	194680	194680	194680
	Daily need in volume of *R. salina* [litres]	6	3	4	4	2	7	#DIV/0!	#DIV/0!	3	5
	Daily need in volume of *C. muelleri* [litres]	57	46	37	33	26	55	#DIV/0!	#DIV/0!	29	27

Table B: Larval collection in each broodstock tank, from first hatch (25th July 2021) to last hatch (17th September 2021).

Larval collection		Norwegian-origin broodstock oysters				Scottish-origin broodstock oysters				Mix-origin oysters
Date	Checked parameters	A1-NO1	B2-NO2	C3-NO3	C1-NO4	B1-UK1	C2-UK2	A3-UK3	A2-UK4	B3-NOUK
25.07.2021	Alive amount [larvae]						32.150			
	Mortality/malform. rate [%]						12			
	Mobility [1:high;2:medium;3:low]						2			
	Average size [µm]						155			
	Notes									
26.07.21										
27.07.21										
28.07.21										
29.07.21										
30.07.21										
31.07.21										
01.08.21										
02.08.21										
03.08.21										
04.08.21										
05.08.21										
06.08.21	Alive amount [larvae]								1.000	
	Mortality/malform. rate [%]								0	
	Mobility [1:high;2:medium;3:low]								2	
	Average size [µm]								150	
	Notes									
07.08.21	Alive amount [larvae]								666	
	Mortality/malform. rate [%]								0	
	Mobility [1:high;2:medium;3:low]								2	
	Average size [µm]								150	
	Notes									
08.08.21	Alive amount [larvae]							386	389	
	Mortality/malform. rate [%]							0	0	
	Mobility [1:high;2:medium;3:low]							2	2	
	Average size [µm]							164	164	
	Notes									
09.08.21	Alive amount [larvae]							22.096	2.421	
	Mortality/malform. rate [%]							5	8	
	Mobility [1:high;2:medium;3:low]							2	2	
	Average size [µm]							166	166	
	Eye-spot observ. >50% larvae [Y/N]							n	n	
	Notes									
10.08.21	Alive amount [larvae]							10.000	210.600	
	Mortality/malform. rate [%]							6	5	
	Mobility [1:high;2:medium;3:low]							2	3	
	Average size [µm]							185	168	
	Notes							collector blocked->overflow in the morning		
11.08.21	Alive amount [larvae]							2.500	4.500	
	Mortality/malform. rate [%]							0	0	
	Mobility [1:high;2:medium;3:low]							3	3	
	Average size [µm]							195	170	
	Notes									
12.08.21	Alive amount [larvae]	300	100	200	1.800		1.200	157.500	200	
	Mortality/malform. rate [%]	0	0	0	0		0	14	50	
	Mobility [1:high;2:medium;3:low]	1	1	1	1		1	2	3	
	Average size [µm]			155	160		170	180	178	
	Notes	embryos	embryos	small and swimming			some embryos		most dead	
13.08.21	Alive amount [larvae]	2.000			500		43.250	648.000	1.800	
	Mortality/malform. rate [%]	0			0		0	1	1	
	Mobility [1:high;2:medium;3:low]	2			2		2	2	2	
	Average size [µm]	155			190		172	195	160	
	Notes	embryos							160	

Table B (continued): Larval collection from 14th August 2021 to 25th August 2021.

Larval collection		Norwegian-origin broodstock oysters				Scottish-origin broodstock oysters				Mix-origin oysters
Date	Checked parameters	A1-NO1	B2-NO2	C3-NO3	C1-NO4	B1-UK1	C2-UK2	A3-UK3	A2-UK4	B3-NOUK
14.08.21	Alive amount [larvae]	3.000			3.000	1.200	275.400	2.100		
	Mortality/malform. rate [%]	5			2	2	0	10		
	Mobility [1:high;2:medium;3:low]	3			3	3	2	3		
	Average size [µm]	160			175	170	178	190		
	Notes									
15.08.21	Alive amount [larvae]	20.000			62.000		157.500			
	Mortality/malform. rate [%]	10			1		1			
	Mobility [1:high;2:medium;3:low]	3			3		3			
	Average size [µm]	164			180		180			
	Notes									
16.08.21	Alive amount [larvae]	8.500			670.000		343.500			
	Mortality/malform. rate [%]	0			0		1			
	Mobility [1:high;2:medium;3:low]	3			2		3			
	Average size [µm]	176			178		174			
	Notes									
17.08.21	Alive amount [larvae]	80.000	43.000	1.200	12.000	457.500	185.000			
	Mortality/malform. rate [%]	1	0	1	2	1	0			
	Mobility [1:high;2:medium;3:low]	2	1	3	3	2	2			
	Average size [µm]	178	132	190	168	177	188			
	Notes		embryos							
18.08.21	Alive amount [larvae]	1.031.000	600	300	4.800	14.000	658.000	600	900	200
	Mortality/malform. rate [%]	1	5	5	5	10	1	30	10	5
	Mobility [1:high;2:medium;3:low]	2	3	3	3	3	2	3	3	2
	Average size [µm]	188	192	200	176	178	185	206	182	158
	Notes	Banjo was	missing the	first few seconds	when I filled	the larvae into	the nursery tanks	(5sec max.)		
19.08.21	Alive amount [larvae]	27.500				15.000	5.000			
	Mortality/malform. rate [%]	1				1	1			
	Mobility [1:high;2:medium;3:low]	3				3	3			
	Average size [µm]	173				179	198			
	Notes									
20.08.21	Alive amount [larvae]	7.500				4.000				
	Mortality/malform. rate [%]	1				1				
	Mobility [1:high;2:medium;3:low]	3				3				
	Average size [µm]	189				180				
	Notes									
21.08.21	Alive amount [larvae]	3.000				130.000	600	200	1.000	600
	Mortality/malform. rate [%]	10				0	5	5	5	0
	Mobility [1:high;2:medium;3:low]	2				2	3	3	3	3
	Average size [µm]	177				160	170	166	171	181
	Notes					some embryos				
22.08.21										
23.08.21	Alive amount [larvae]	2.000				1.597.700	600			
	Mortality/malform. rate [%]	5				0	10			
	Mobility [1:high;2:medium;3:low]	3				2	3			
	Average size [µm]	180				172	174			
	Notes					2h after cleaning tank (overflow of collector)				
24.08.21	Alive amount [larvae]	11.500				366.400				
	Mortality/malform. rate [%]	3				1				
	Mobility [1:high;2:medium;3:low]	2				2				
	Average size [µm]	162				175				
	Notes									
25.08.21	Alive amount [larvae]	4.585.000				319.000				
	Mortality/malform. rate [%]	1				1				
	Mobility [1:high;2:medium;3:low]	2				2				
	Average size [µm]	168				174				
	Notes	overflow, emptied the tank to collect larvae)				overflow in the morning				

Table B (continued): Larval collection from 26th August 2021 to 5th September 2021.

Larval collection		Norwegian-origin broodstock oysters				Scottish-origin broodstock oysters				Mix-origin oysters
Date	Checked parameters	A1-NO1	B2-NO2	C3-NO3	C1-NO4	B1-UK1	C2-UK2	A3-UK3	A2-UK4	B3-NOUK
26.08.21	Alive amount [larvae]	277.500			200		1.200	14.100	3.000	11.600
	Mortality/malform. rate [%]	1			1		1	1	1	1
	Mobility [1:high;2:medium;3:low]	3			3		3	3	3	3
	Average size [µm]	162			160			153	160	160
	Notes	overflow in morning								
27.08.21	Alive amount [larvae]	15.000				3.000	2.000	42.000	13.000	
	Mortality/malform. rate [%]	1				1	1	1	1	
	Mobility [1:high;2:medium;3:low]	3				3	3	3	3	
	Average size [µm]	170				166	177	168	163	
	Notes									
28.08.21	Alive amount [larvae]	14.600		8.000			224.400	8.500	1.200	
	Mortality/malform. rate [%]	5		1			3	3	3	
	Mobility [1:high;2:medium;3:low]	3		3			3	3	3	
	Average size [µm]	163		171			161	180	165	
	Notes						overflow in the morning			
29.08.21	Alive amount [larvae]	3.000		469.000	2.000		2.000	30.000	264.500	
	Mortality/malform. rate [%]	10		1	1		5	1	1	
	Mobility [1:high;2:medium;3:low]	3		3	3		3	3	3	
	Average size [µm]	172		170	172		170	180	179	
	Notes	overflow in	all collectors							
30.08.21	Alive amount [larvae]	1.200		170.400	14.000				3.300	
	Mortality/malform. rate [%]	10		1	1				1	
	Mobility [1:high;2:medium;3:low]	3		3	3				3	
	Average size [µm]	173		171	167				178	
	Notes									
31.08.21	Alive amount [larvae]			57.500	55.000		9.500			
	Mortality/malform. rate [%]			1	1		3			
	Mobility [1:high;2:medium;3:low]			3	3		3			
	Average size [µm]			174	169		172			
	Notes									
01.09.21	Alive amount [larvae]			41.500	78.500	800	290.000		6.000	25.400
	Mortality/malform. rate [%]			1	1	5	1		10	1
	Mobility [1:high;2:medium;3:low]			3	3	3	3		3	3
	Average size [µm]			171	176	171	174		175	168
	Notes									
02.09.21	Alive amount [larvae]			3.000	233.500	600	3.600			104.000
	Mortality/malform. rate [%]			1	1	1	1			1
	Mobility [1:high;2:medium;3:low]			3	3	3	3			3
	Average size [µm]			173	179	171	175			176
	Notes									
03.09.21	Alive amount [larvae]			800	12.000	19.500	5.000	7.200		8.000
	Mortality/malform. rate [%]			1	1	1	1	1		1
	Mobility [1:high;2:medium;3:low]			3	3	3	3	3		3
	Average size [µm]			173	178	172	176	169		175
	Notes									
04.09.21	Alive amount [larvae]		6.000	600	6.000	188.500		1.309.500		4.000
	Mortality/malform. rate [%]		1	3	2	1		1		1
	Mobility [1:high;2:medium;3:low]		3	3	3	2		2		3
	Average size [µm]		171	178	178	167		171		174
	Notes									
05.09.21	Alive amount [larvae]		15.000	1.000	182.000	350.000	272.000	15.000		800
	Mortality/malform. rate [%]		1	3	1	1	1	1		1
	Mobility [1:high;2:medium;3:low]		3	3	3	3	3	3		3
	Average size [µm]		171	178	173	168	173	171		174
	Notes									

Table B (continued): Larval collection from 6th September 2021 to 16th September 2021.

Larval collection		Norwegian-origin broodstock oysters				Scottish-origin broodstock oysters				Mix-origin oysters
Date	Checked parameters	A1-NO1	B2-NO2	C3-NO3	C1-NO4	B1-UK1	C2-UK2	A3-UK3	A2-UK4	B3-NOUK
	Alive amount [larvae]		231.000	4.000	296.500	61.500	3.000	3.000		
	Mortality/malform. rate [%]		2	3	1	3	2	1		
06.09.21	Mobility [1:high;2:medium;3:low]		2	3	3	3	3	3		
	Average size [µm]		162	179	168	176	173	170		
	Notes									
	Alive amount [larvae]		108.000	28.500	498.000	126.000				
	Mortality/malform. rate [%]		1	1	1	1				
07.09.21	Mobility [1:high;2:medium;3:low]		3	3	3	3				
	Average size [µm]		164	171	164	176				
	Notes									
	Alive amount [larvae]		85.000	265.000	117.500	2.107.000			48.000	
	Mortality/malform. rate [%]		1	1	1	0			1	
08.09.21	Mobility [1:high;2:medium;3:low]		3	3	3	3			3	
	Average size [µm]		172	164	174	165			170	
	Notes					short overflow				
	Alive amount [larvae]		5.000	45.000	1.000	201.500	2.000	3.000	2.274.000	
	Mortality/malform. rate [%]		1	1	1	1	1	1	0	
09.09.21	Mobility [1:high;2:medium;3:low]		3	3	3	3	3	3	3	
	Average size [µm]		171	168	171	166	169	179	171	
	Notes					overflow in morning			short overflow	
	Alive amount [larvae]			9.000		16.000		3.000	12.000	
	Mortality/malform. rate [%]			3		1		1	1	
10.09.21	Mobility [1:high;2:medium;3:low]			3		3		3	3	
	Average size [µm]			167		169		180	170	
	Notes									
	Alive amount [larvae]							2.658.000		
	Mortality/malform. rate [%]							0		
11.09.21	Mobility [1:high;2:medium;3:low]							3		
	Average size [µm]							174		
	Notes									
	Alive amount [larvae]			1.000	1.000	600		88.000		
	Mortality/malform. rate [%]			2	3	2		1		
12.09.21	Mobility [1:high;2:medium;3:low]			3	3	3		3		
	Average size [µm]			169	175	171		174		
	Notes									
	Alive amount [larvae]					256.000				
	Mortality/malform. rate [%]					1				
13.09.21	Mobility [1:high;2:medium;3:low]					3				
	Average size [µm]					171				
	Notes									
	Alive amount [larvae]					172.000	27.000			5.115.500
	Mortality/malform. rate [%]					1	1			1
14.09.21	Mobility [1:high;2:medium;3:low]					3	3			3
	Average size [µm]					172	169			166
	Notes									
	Alive amount [larvae]						20.000			66.000
	Mortality/malform. rate [%]						1			1
15.09.21	Mobility [1:high;2:medium;3:low]						3			3
	Average size [µm]						169			168
	Notes									
	Alive amount [larvae]						30.000	2.000		6.000
	Mortality/malform. rate [%]						1	1		3
16.09.21	Mobility [1:high;2:medium;3:low]						3	3		3
	Average size [µm]						171	173		170
	Notes									