Field report installation test reef and research into reef conditions

Gemini OWF

Client:
De Rijke Noordzee

Date:
01/12/2021

Clients Reference:
-

Our Reference:
WP1220_R2r0

Version:
Final

WATER PROOF Marine Consultancy & Services BV.

Bureau Waardenburg Ecologie & Landschap

WAGENINGEN UNIVERSITY & RESEARCH

NIOZ Royal Netherlands Institute for Sea Research

Title

Field report installation test reef and research into reef conditions. Gemini OWF

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Reference

WP1220_R2r0

Keywords

Flat oyster reef, restoration, research, OWF, Gemini, measurements, WINOR.

Version	Date	Author	Review & Approval
WP1212_R2r0	01/12/2021	R.C. Snoek E. Kardinaal P. Kamermans T. Bouma	M. Olivierse

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1 BACKGROUND

1.1 INTRODUCTION

The Dutch government has set ambitious targets for the development of offshore wind energy. The development of these various offshore wind farms has an impact on the marine ecosystem, which is being closely monitored by the Dutch government.

Hard substrate reefs, which include oyster reefs, are known to attract and promote biodiversity hotspots within marine ecosystems.

The project aims to:

- enhance the ecological value of offshore windfarms
- gain understanding in the establishment and development of flat oyster reefs
- reintroduce a native species to the North Sea which has been dominated over recent history by invasive species.

To enhance the ecological value of the GEMINI offshore windfarm with native species the (re)introduction of native flat oysters in the North sea will be spread over an area within the GEMINI offshore windfarm.

Since offshore windfarms have already partially replaced the soft sediment with hard substrates the region offers viable options for the successful establishment of a native oyster reef. With the knowledge that this brings, future reef establishments may find key aspects to consider before an effort is conducted.

1.2 OBJECTIVES

The target of this project is to develop a self-sustaining oyster reef which will enhance the biodiversity within the GEMINI offshore windfarm.

The project aims to answer the following research question:

Will flat oyster reefs within offshore windfarms promote biodiversity and enhance the ecological value of offshore windfarms?

More specifically, to answer the following research questions:

1) What factors drive successful flat oyster reef establishment?
2) How is the region affected by the presence of an established flat oyster reef?

1.3 TEAM

The project is executed by a combined team of experts of the following institutes:

- WaterProof Marine Consultancy & Services BV
- Bureau Waardenburg
- Wageningen Marine Research
- Royal Netherlands Institute for Sea Research (NIOZ)

1.4 FIELD CAMPAIGN 2021

The field campaign planned for 2021 aimed at the following activities:

- Building the reef by deployment of substrate
- Building the reef by deployment of adult oysters
- Research on remote settling of oyster larvae and deployment of spat on shell if successful
- Placement of measurement frame with various sensors in the Gemini OWF
- Research on hydro-morphodynamic conditions in the Gemini OWF
- Drop-cam monitoring before and after deployment.

The location of the oyster reef and WINOR research location is shown in Figure 1.1.

Figure 1.1 Selected flat oyster reef and WINOR location.

2 PREPARATIONS

In preparation of the field campaign, the following activities have been conducted:

- Operational preparations (Risk Assessment Method Statement documentation, logistics)
- Hydrodynamic assessment of the area
- Experimental treatment of substrate with BESE reef paste
- Flume experiments for stability
- Stability assessment measurement frame
- Purchase of adult oysters
- Remote larvae settling research
- Preparation of measurement frame with various sensors.

These activities are described in more detail below.

2.1 OPERATIONAL PREPARATIONS

As part of the fieldwork campaign, extensive operational preparations have been conducted. Since the works are conducted offshore in a harsh environment, solid preparation and risk management is key.

To get permission from Gemini OWF to conduct the work in their OWF, we have prepared a detailed Risk Assessment Method Statement (RAMS) document. This document described all the activities and procedures followed offshore, accompanied by an extensive risk assessment and mitigation.

The RAMS document has been provided to Gemini and has been thoroughly reviewed. After several iterative versions, a final version of the RAMS document has been agreed upon and approved by Gemini.

Furthermore, the activities offshore in the Gemini OWF are coordinated by the Operational Control Center of Gemini, which is based in Emden. To get permission, an access permit and permit to work have been applied for and certificates of the crew going offshore were verified and approved.

Also, the activities van been aligned with the Dutch Coastguard.

Furthermore, various logistics preparations have been conducted, such as the transport of substrate from Zeeland to Harlingen, oyster larvae from the UK to NL and adult oysters from Norway to NL. In case necessary, permits have been required for these activities from the Dutch Government (Min. LNV).

2.2 HYDRODYNAMIC ASSESSMENT OF THE AREA

For operational and research purposes, the hydrodynamic conditions at the area of the reef in the Gemini OWF have been assessed. Based on the outcome of the hydrodynamic modelling, flow velocities have been calculated for the deployment campaign and deployment of the research frame was timed during minimal flow velocities.

Furthermore, setup and instrumentation of the measurement fished Blue Marlin and Barracuda were determined based on the output of this assessment.

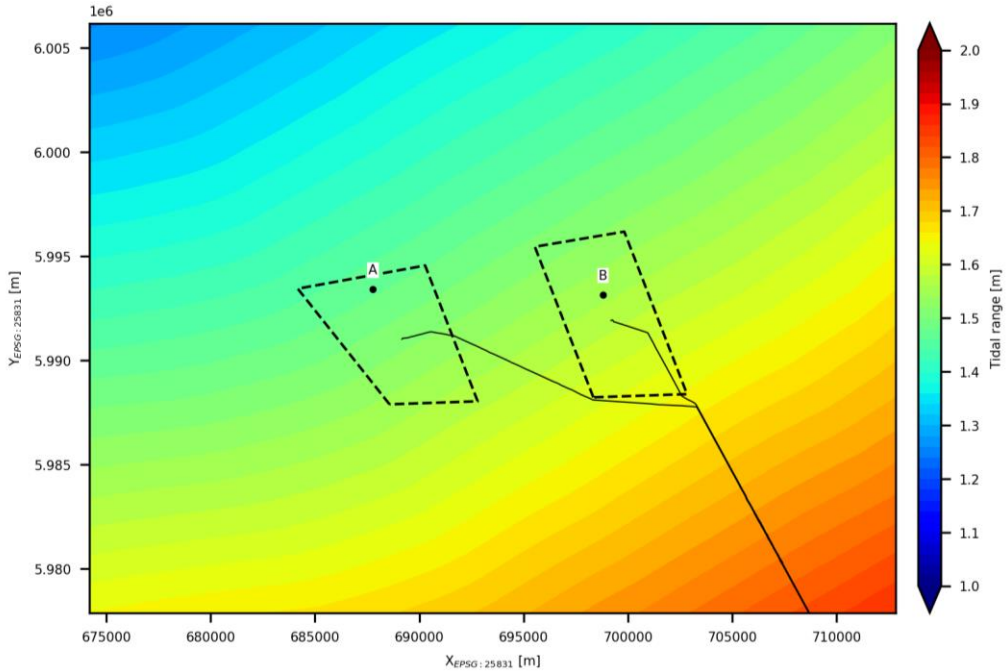

Figure 2.1 Modelled tidal range during springtide.

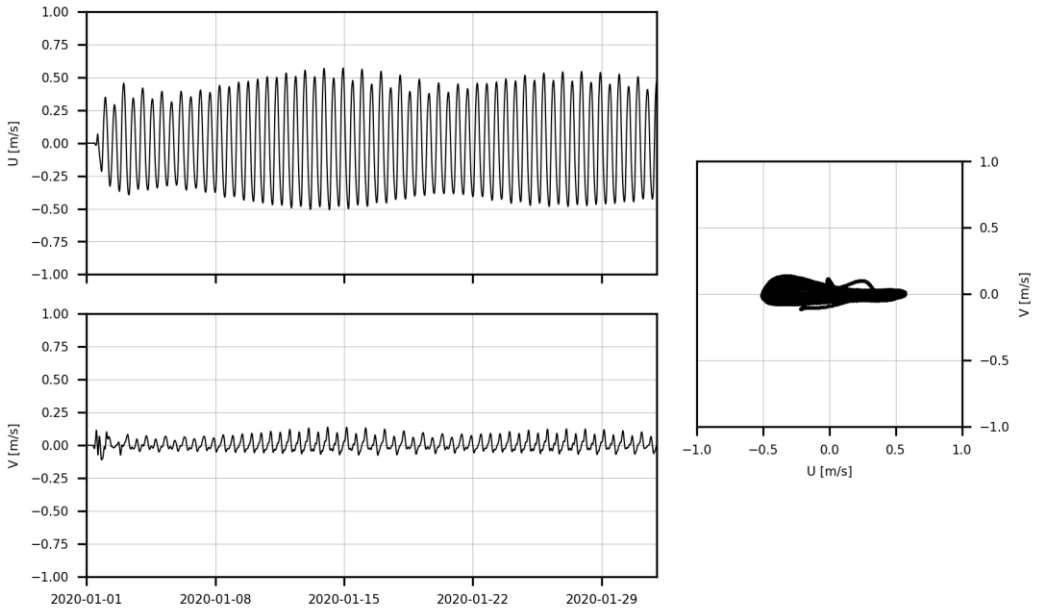

Figure 2.2 Timeseries of depth averaged current velocity at a selected location in the ZeeEnergie OWF (U: current velocities in x-direction, positive values represents current from west to east; V: current velocities in y-direction, positive values represent current from south to north).

2.3 EXPERIMENTAL TREATMENT OF SUBSTRATE WITH BESE REEF PASTE

To build the reef, substrate needs to be added to the seafloor, to provide suitable substrate for oyster larvae to settle on. As part of the research, substrate (shells) are treated with BESE reef paste, to enhance stability of the substrate once deployed. Moreover, several studies showed oyster spat is attracted to settle on material treated with BESE reef paste. Before treatment, several experiments were conducted to determine the best ratio of different substances.

Treatment of the substrate with BESE paste is shown in Figure 2.3.

Figure 2.3 Treatment of substrate with BESE paste at Bureau Waardenburg.

2.4 FLUME EXPERIMENTS FOR STABILITY

Stability of the substrate with and without treatment has been assessed by means of various flume experiments in the WaterProof lab (Figure 2.4). Based on the experiments and supplementary calculations, the substrate was concluded to be sufficiently stable to withstand hydrodynamic conditions on the project location. Also, treatment with BESE paste was concluded to enhance stability.

Figure 2.4 Flume experiments WaterProof BV.

2.5 STABILITY ASSESSMENT MEASUREMENT FRAME

Part of the project / WINOR research is to collect measurements of the hydrodynamic conditions. For this purpose, a measurement frame with various equipment of the NIOZ needs to be placed on the seafloor. Since high waves and strong currents can occur during severe storm conditions, the stability of the frame was assessed prior to deployment.

Based on calculations, several recommendations were made to the design and weight of the frame. The optimized frame that was concluded to be stable under the calculated storm conditions is shown in Figure 2.5. The NIOZ has fabricated and prepared the MIXLander measurement frame according to the specifications derived from the stability assessment.

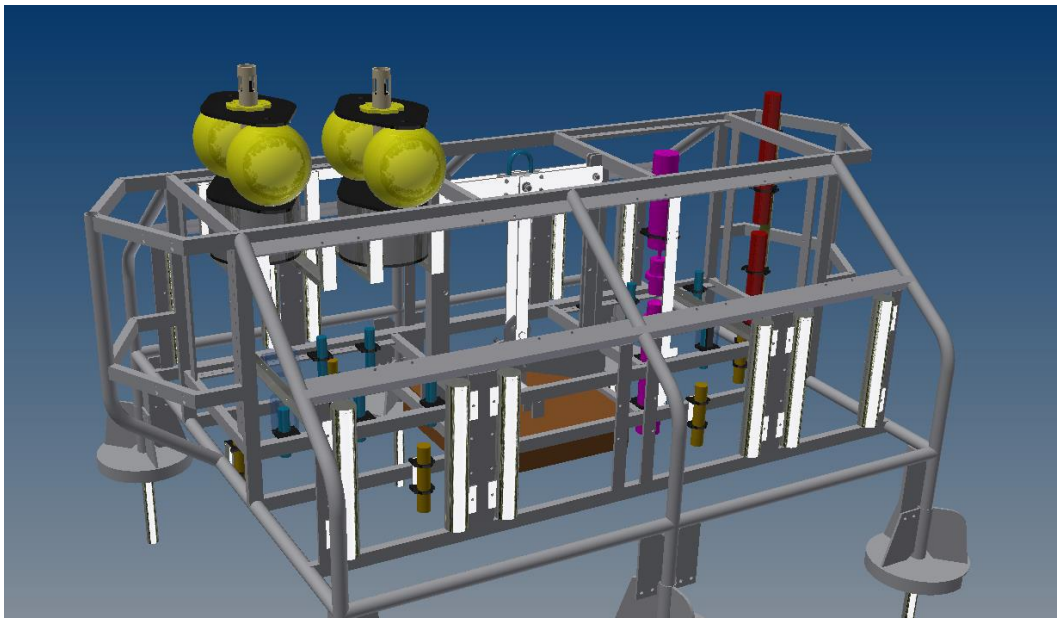

Figure 2.5 MIXLander measurement frame of the NIOZ.

2.6 PURCHASE OF ADULT OYSTERS

1512 oysters were purchased in Norway, transported by cooled truck in 7 days to the Netherlands, kept in cold and filtered seawater (see Figure 2.6) for 12 days with only 5 mortalities.

Figure 2.6 Tanks at WMR with adult flat oysters.

2.7 REMOTE LARVAE SETTLING RESEARCH

As part of the project, oyster spat on shell was planned to be ordered from a hatchery on the Orkney islands. Due to difficulties with supplying the spat on shell from various hatcheries in Europe, it was decided to study the possibility of remote settling of oyster larvae. For remote settling, the oyster larvae are transported to the Netherlands before actually settling on empty shells. In case this method is successful, this could greatly enhance possibilities of acquiring a large number of oyster larvae for this project. After transport, the larvae should settle on suitable substate in the controlled environment at WMR.

A large number of oyster larvae have been transported from the hatchery in the Orkney islands to the Netherlands. However, despite careful planning and preparations, a delay occurred at Customs in the Netherlands. Due to this delay, the larvae were longer on transport than planned which might have impacted the condition of the larvae once arriving at WMR.

WMR initiated the remote settling process at their basins to let the larvae settle on substrate (see Figure 2.7). However, the condition of the larvae was unfortunately insufficient for successful settlement. Several lessons learned are taken from this experiment and optimizations of this procedure can be made.

Figure 2.7 Remote settling experiments at WMR.

2.8 PREPARATION OF MEASUREMENT FRAME WITH VARIOUS SENSORS

Extensive preparations have been made with the setup of the various sensors on the measurement frame (see Figure 2.8). The MIXLander frame has been customized to host all the sensors. The following sensors are placed on the frame:

- ADCP HR-system;
- ADCP HR-system;
- C3-Turner (turbidty, chlorophyl);
- C3-Turner (turbidty, chlorophyl);
- A-SED sensors;
- BioPhys sensors – valve-gape monitoring
- One basket with flat oyster shells (spat on shell not placed – see Section 2.6)
- Two baskets with flat oysters (41 in total)
- Time laps camera

- Shells with acceleration sensor

Figure 2.8 Various NIOZ sensors equipped on the measurement frame.

2.9 MEASUREMENT FISHES

To measure actual sediment transport and sediment in the water at the oyster reef location, the Blue Marlin and Barracuda measurement fishes are prepared for sediment and water sampling. The water sampling cabinet used for this is shown in Figure 2.9.

Figure 2.9 Water sampling cabinet and Blue Marlin measurement fish of WaterProof

3 REEF INSTALLATION AND MEASUREMENTS

3.1 VESSEL

Works have been carried out from the vessel Zwerver III, operated by Van Stee Offshore (see Figure 3.1).

Figure 3.1 Zwerver III, van Stee Offshore.

3.2 MOBILIZATION

For mobilization in the Port of Harlingen, the following activities have been conducted:

Transport of:

- bigbags from Zeeland to Harlingen;
- bigbags treated with BESE from Bureau Waardenburg to Harlingen;
- measurement frame from NIOZ (Texel) to Harlingen;
- various measurement equipment from WaterProof to Harlingen
- adult oysters from WMR to Harlingen.

On the 15th of November 2021, mobilization of all equipment to the vessel was done (Figure 3.2).

Furthermore, all planned activities were discussed with the Captain and crew of the vessel.

A vessel familiarization was done by the entire team going offshore and a HAZID safety meeting / briefing was conducted. Prior to sail out, a safety drill on board of the vessel was practiced.

Figure 3.2 Mobilization of measurement frame on the Zwerver III.

3.3 EXECUTION

Execution of the works was done on 15-17 November 2021. All activities conducted are listed in the Daily Progress Reports, included in Appendix 1.

The deployment location of the frame and substrate with adult oysters are shown in Figure 3.3.

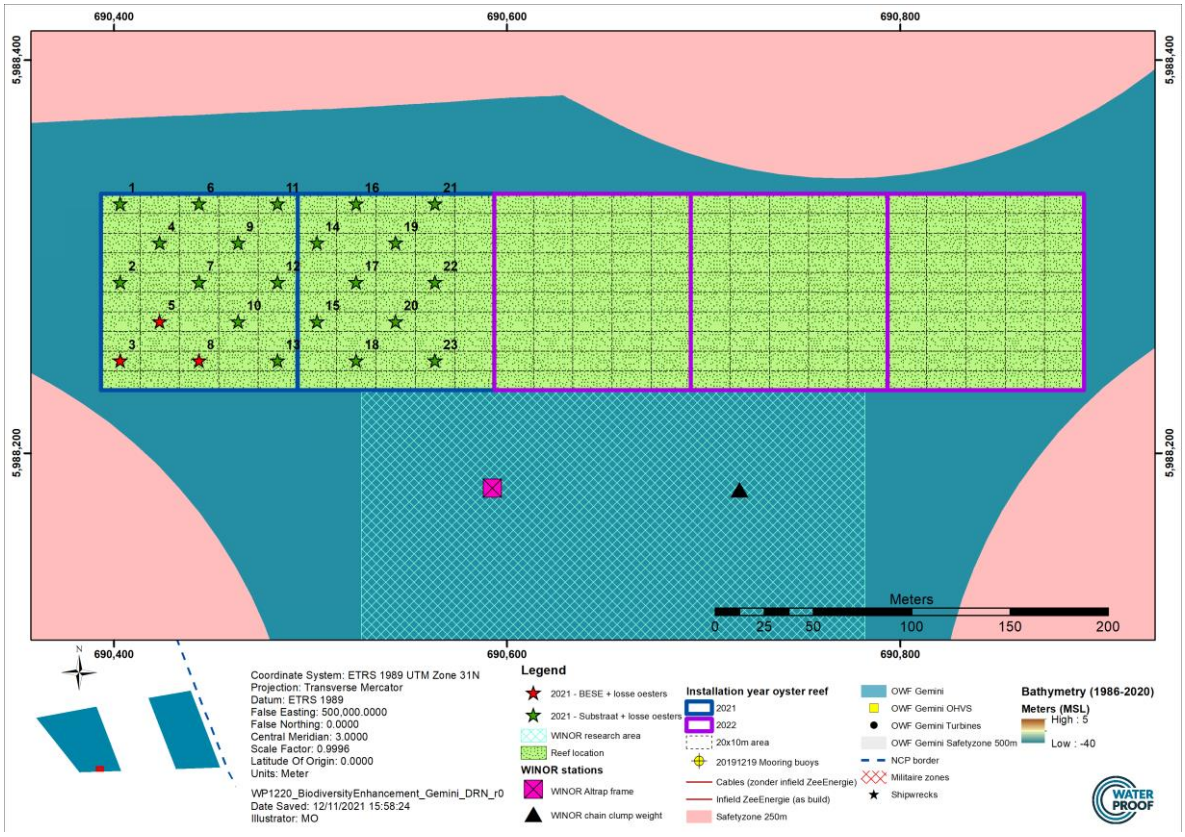

Figure 3.3 Deployment locations frame and substrate with oysters.

A photo impression of the works is given below (Figure 3.4 to Figure 3.11). Figure 3.12 shows the verification of the reef by means dropcam monitoring by Bureau Waardenburg. Clearly visible is the deployed substrated and adult oysters on top of the substrate.

Figure 3.4 Drop cam monitoring prior to deployment

Figure 3.5 Big bag with adult oysters on top of substrate.

Figure 3.6 Deployment of substrate: bag successfully emptied on the seafloor.

Figure 3.7 Deployment of substrate with adult oysters on top.

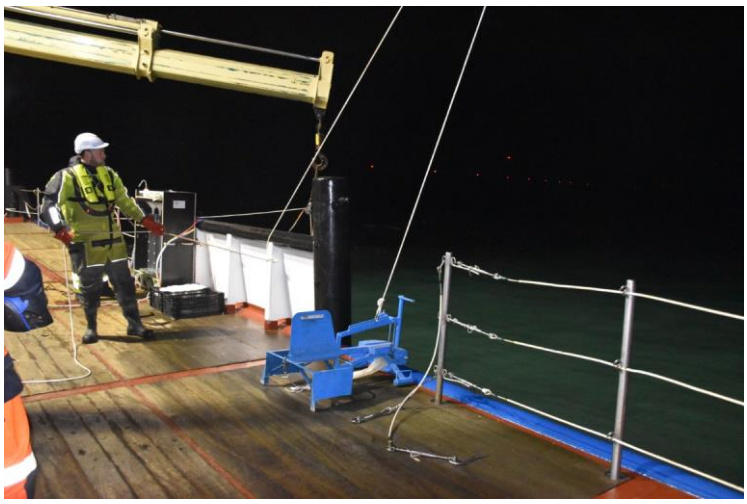

Figure 3.8 Measurement fish deployment.

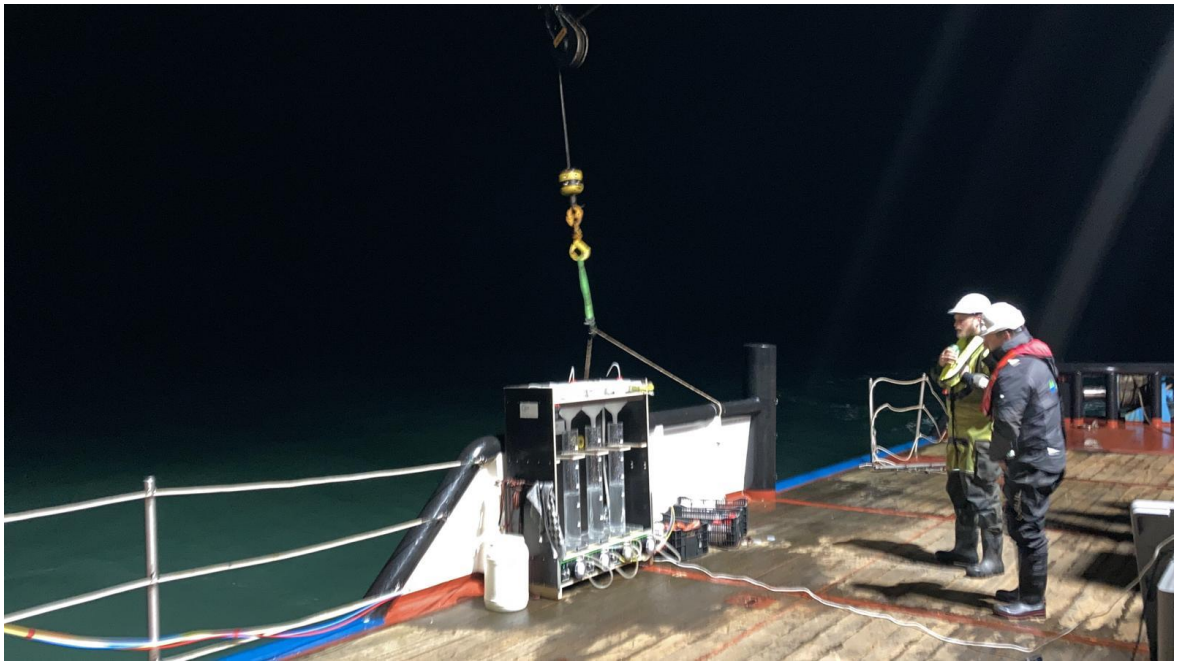

Figure 3.9 Measurement fish water sampling.

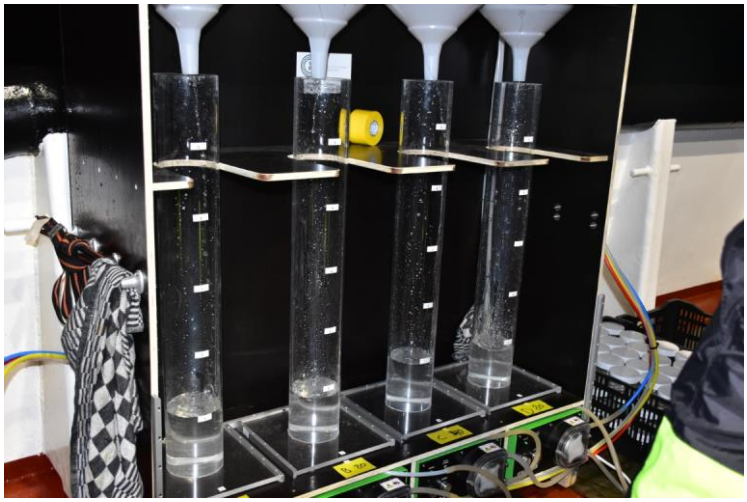

Figure 3.10 Measurement fish water sampling.

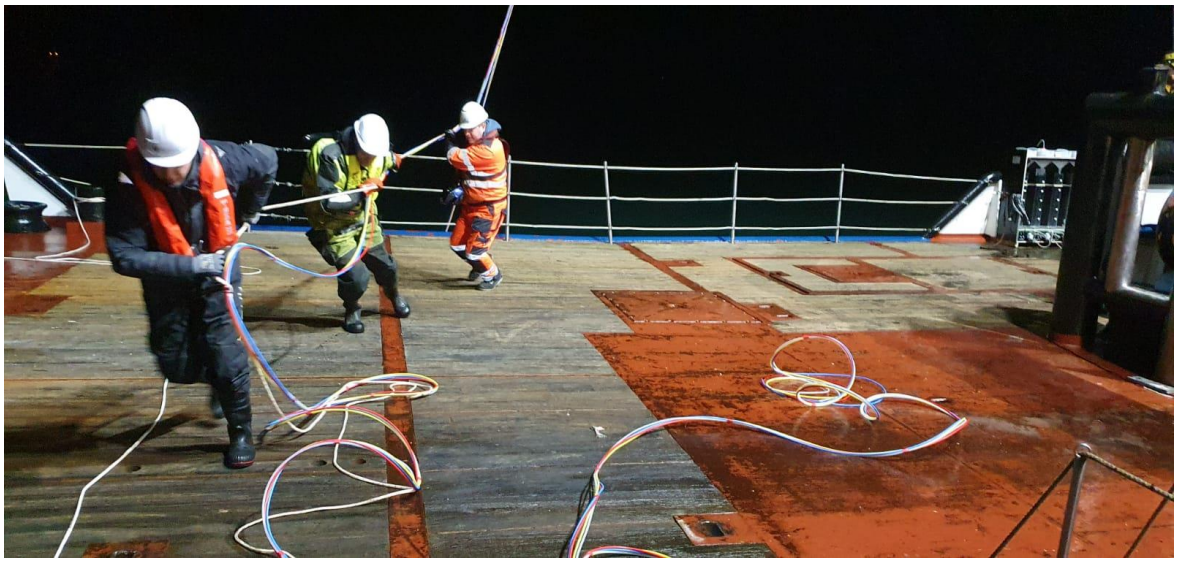

Figure 3.11 Measurement fish retrieval.

Figure 3.12 Drop cam verification by Bureau Waardenburg, showing the substrate with adult oysters on the seafloor.

APPENDIX 1: DAILY PROGRESS (FIELD) REPORTS

DAILY PROGRESS REPORT

GENERAL

PROJECT NUMBER	WP1220
PROJECT NAME	GIMINI Biodiversity Enhancement
DATE	15/11/2021
LOCATION	Offshore, North Sea, GIMINI
SURVEYORS	Daniel Nieuwendijk - WaterProof bv
	Joost Bergsma - Bureau Waardenburg
	Dirk Spruijt - Bureau Waardenburg
VESSEL	Zwerver III

PROVIDED TO

DAILY CHECKS

- Daily check on planning and weather
- Toolbox meeting

GENERAL COMMENTS

PROGRESS SUMMARY

- Mobilisation and sailing to the GIMINI

ACTIVITY

Time (Local)	Activity	Comments
8:30	Mobilisation	
09:00	Loading big bags, frame and tools	
10:00	Ship induction	
11:30	Organizing material	
14:30	Saftey talk	
15:15	Frame and big bag praperations	Checked all the connection
16:30	Departure from Harlingen	

WEATHER

Time (Local)	Wind direction	Windspeeds (Kts)	Sea State	Visibility
06:00	E	8	2 (Smooth)	5 - Haze (2km - 4km)
12:00	E	8	2 (Smooth)	7 - Clear (10km - 20 km)
18:00	E	6	2 (Smooth)	7 - Clear (10km - 20 km)

SHE OBSERVATIONS

Type	Description	Immediate action(s) taken	Reported to QHSE-manager

DAILY PROGRESS REPORT

GENERAL		PROVIDED TO
PROJECT NUMBER	WP1220	
PROJECT NAME	GIMINI Biodiversity Enhancement	
DATE	16/11/2021	
LOCATION	Offshore, North Sea, GIMINI	
SURVEYORS	Daniel Nieuwendijk - WaterProof bv	
	Joost Bergsma - Bureau Waardenburg	
	Dirk Spruijt - Bureau Waardenburg	
VESSEL	Zwerver III	

DAILY CHECKS

Daily check on planning and weather
Toolbox meetings

GENERAL COMMENTS

Sand transport measurements canceled due
to heavy weather

PROGRESS SUMMARY

Water sampling eDNA
Dropcam activities
Deployment measurment frame
Deployment big bags with substrate
Sand transport measurements

ACTIVITY

Time (Local)	Activity	Comments
0:00	Sailing to GIMINI windfarm	
06:00	DP check on board	
07:00	Arrvival at GIMINI	Sailing on DP in the park
07:10	Toolbox meeting sampling and dropcam	
08:00	Watersampling for eDNA & Dropcam	Both activiteis were executed at the same time
10:30	Toolbox meeting deployment frame	
11:00	Preparations and tests frame	
12:15	Deployment frame	
13:00	Toolbox deployment big bags	
13:15	Deployment bigbangs	
18:30	Dropcam the substrate	
19:00	Watersampling eDNA refrence location	
19:30	Tool box sand transport sampling	
20:30	Sandtransport sampling	Canceled early due to high winds and waves
0:00	Prepare the ship for sailing	

WEATHER

Time (Local)	Wind direction	Windspeeds (Kts)	Sea State	Visibility
06:00	E	10	2 (Smooth)	4 - Thin fog (1km - 2km)
12:00	S	15	2 (Smooth)	7 - Clear (10km - 20 km)
18:00	S	15	2 (Smooth)	7 - Clear (10km - 20 km)
0:00	S	28	5 (Rough)	7 - Clear (10km - 20 km)

SHE OBSERVATIONS

Type	Description	Immediate action(s) taken	Reported to QHSE-manager

DAILY PROGRESS REPORT

GENERAL

PROJECT NUMBER	WP1220
PROJECT NAME	GIMINI Biodiversity Enhancement
DATE	16/11/2021
LOCATION	Offshore, North Sea, GIMINI
SURVEYORS	Daniel Nieuwendijk - WaterProof bv
	Joost Bergsma - Bureau Waardenburg
	Dirk Spruijt - Bureau Waardenburg
VESSEL	Zwerver III

PROVIDED TO

DAILY CHECKS

Daily check on planning and weather

GENERAL COMMENTS

ACTIVITY

Time (Local)	Activity	Comments
0:00	Prepaire ship for departure	
0:30	Sailing to port Harlingen	
13:45	Arrival at the harbor	

WEATHER

Time (Local)	Wind direction	Windspeeds (Kts)	Sea State	Visibility
0:00	S	25	5 (Rough)	4 - Thin fog (1km - 2km)
6:00	S	28	5 (Rough)	7 - Clear (10km - 20 km)
12:00	S	22	4 (Moderate)	7 - Clear (10km - 20 km)

PROGRESS SUMMARY

Demobilisation

SHE OBSERVATIONS

Type	Description	Immediate action(s) taken	Reported to QHSE-manager