ASSESS Oil platform field campaign 2022 with Heerema Marine Contractors

Cruise report 31 May – 04 June 2022

Author(s): Joop W.P. Coolen[1]; Bruno Ibanez-Erquiaga[2]

Wageningen University &
Research report C065/22

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CONTRACTORS

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1: Wageningen University & Research

2: DTU Aqua

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Contents

1 Introduction

1.1 Background

The artificial hard substrate on oil and gas platforms creates artificial reefs, which provide habitat for multiple organisms (also known as fouling organisms or marine growth), increasing local biodiversity and potentially altering the wider marine environment. Fouling organisms influence the marine environment from its basis by consuming primary producers (algae) from the water, excreting organic matter which is accumulated on the seabed around the platform, to higher trophic levels by attracting fish species that feed on them. Over the last years the biodiversity of fouling organisms on platforms has been thoroughly investigated, but their functions remain understudied. To successfully restore, protect and strengthen marine ecosystems, it is essential to investigate their functioning, e.g. food webs. Hence, investigating the biodiversity and food web properties of fouling communities on platforms would provide us with crucial information on how fouling organisms function and subsequently how they can affect the ecosystem.

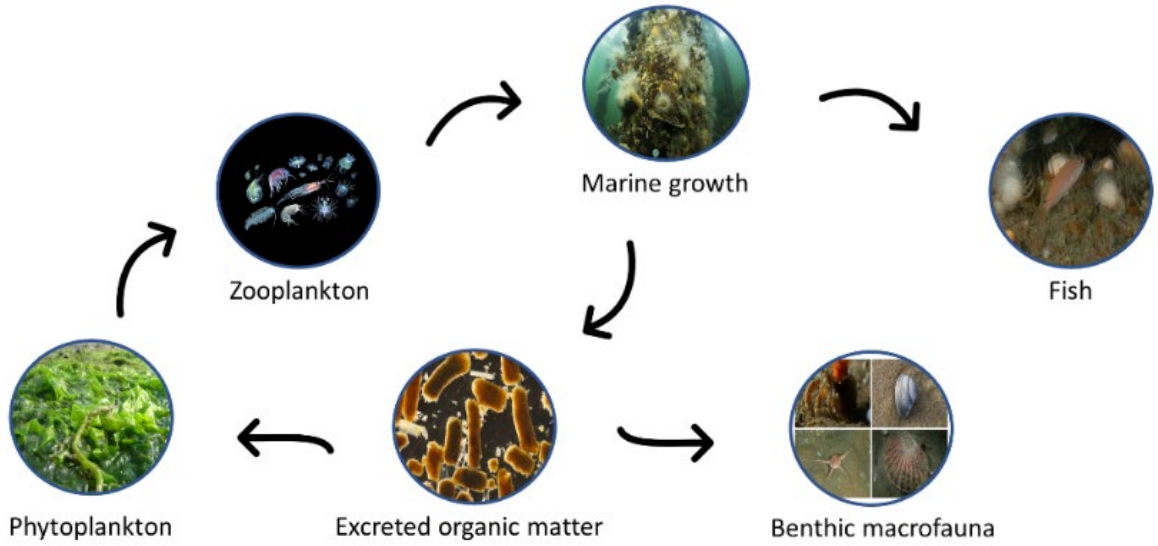

Figure 1: Schematic overview of the food web structure on artificial hard substrates (image source O. Bos).

1.2 Study aim

The study reported here was carried out as part of the projects 'Artificial Structures and the functioning of the North Sea EcoSyStem' (ASSESS) led by Wageningen Marine Research and 'BioRigs: studying the influence of oil and gas platform foundations on commercial fish species' led by DTU Aqua. The aim of this study was to investigate the ecological value of an old offshore structure. During its life the structure has served as habitat for fouling organisms. This indicates that, by now, it sustains a stable fouling community and food web. To investigate the food web properties on and around the structure, we aimed to collect samples from the marine growth on the platform, the surrounding seabed, the water column and larger species such as fish and crabs in the surroundings. This was done at different depths along the structure, aiming to compare stable isotope data from similar species from different depths, to investigate different feeding behaviour between depths. Furthermore, stomach content was collected from fish near the platform and video surveys were conducted to quantify fish abundance.

2 Material & methods

All times in this report are in CET, water depths in meter sea water (msw) and temperatures in degrees centigrade (°C).

2.1 Study location

The study site was a >40 year old offshore platform located in the central northern North Sea, north east of Shetland near the Norwegian border (Figure 2). Local water depth was ca. 150 meters.

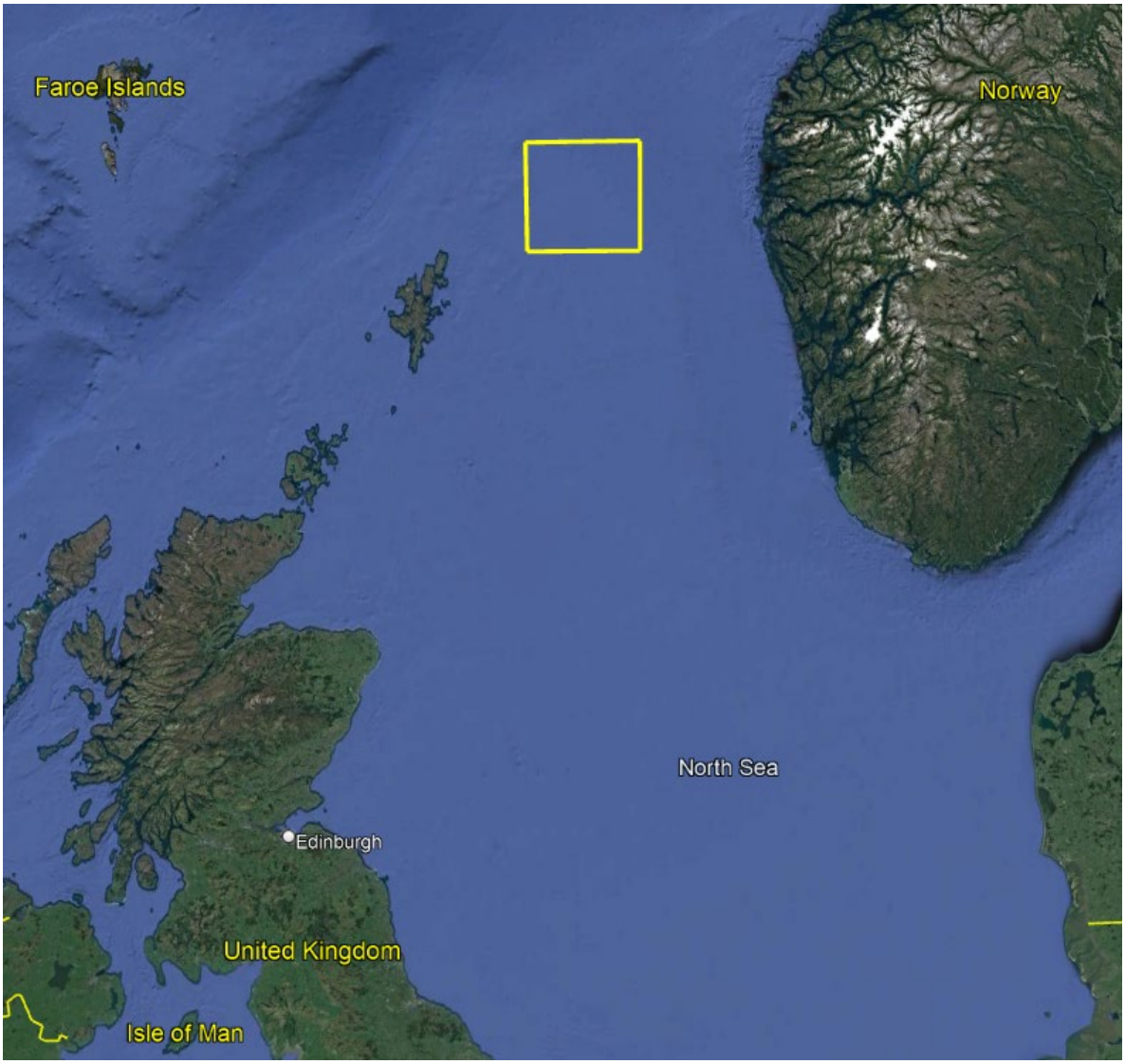

Figure 2: study location (yellow box)

2.2 Vessel & Equipment

The research was carried out during a platform removal campaign carried out by Heerema Marine Contractors using the Semi-Submersible Crane Vessel Sleipnir. During the platform removal carried out by the vessel, WMR and DTU Aqua scientists worked together with the ROV and deck crew to collect video images and acquire samples from the seabed, the marine growth on the structure,

zooplankton from the water column and large mobile species using fish cages. The work was carried out using two work class ROVs, operated by Oceaneering. A Millennium 200 ROV placed the cages and carried out video surveys, while a Millennium 215 ROV was used to collect samples. The zooplankton samples were collected using a WP2 net lowered to 10 meters above the seabed using one of the vessels cranes.

2.3 List of participants

The study was carried out by the following scientists:

Name	Institute	Role
Joop Coolen	WUR	PI, science leader
Bruno Ibanez-Erquiaga	DTU Aqua	PhD student

The scientists were supported by the following persons:

Name	Organisation	Role
Jeroen Kriek	HMC	HMC Project Engineer
Ewout Bastian	HMC	HMC Project Manager
Rienk Krol	HMC	Liason HMC - WUR

Furthermore a long list of ROV crew, deck crew, riggers and others supported the scientist team during the project.

2.4 Detailed method description as applied

2.4.1 Lab container setup

HMC provided a 20ft shipping container to be used as lab facility by the science team (Figures 3-5). Close to the container, fresh water from the utility water supply and seawater from the fire water system could be obtained. The container was supplied with lights and 230V electricity. Next to the container, there was a water drain, that allowed water to be drained from the lab. The container was placed near the large starboard side crane, in close proximity of the 215 ROV container.

Figure 3: container setup at start of the campaign.

Figure 4: container setup during seabed sample processing.

Figure 5: container setup during fish sample processing (left) and position on deck (right), orange container visible on far lower left between yellow and white containers. Background left image: starboard side heavy lift crane.

2.5 Fish cages

Samples of fish near the seabed and on the structure as well as large mobile invertebrates (i.e. lobsters, crabs, star fish) were caught using fish cages (fykes) baited with frozen mackerel. Six sets of cages were deployed, each consisting three different cages of different size and mesh size, to catch different species and different life stages of these species. Three cages were placed on the seafloor at random positions in the proximity of the subsea foundation structure, one was placed on the subsea foundation structure at a depth of -119 meters and two cages were attached to the structure at -40 and -76 meters.

Each cage set was composed of:

1. A large cage sized 100 x 100 x 100 cm, of which the top and 4 sides were mounted with a flexible net of a mesh size of 2x2 cm and with two entrance holes, one on the front and one on the back side of the cage (Figure 6). The bottom of the cage was mounted with a steel mesh of 2x2 cm mesh size. Cages could be maneuvered on deck with a pallet truck. The cages had ROV handles on each corner and a lifting eye on the top centre. The weight of 1 cage was approximately 30 kg.

Figure 6: Large cage as built.

2. On the inside of the large cage, two small size cages (70x20x20 cm), one with a mesh size of 0.5x0.5 cm and one with a mesh of 1x1 cm were mounted using tie wraps, aiming to catch very small mobile species (Figure 7). These cages remained inside the large cages during deployment.

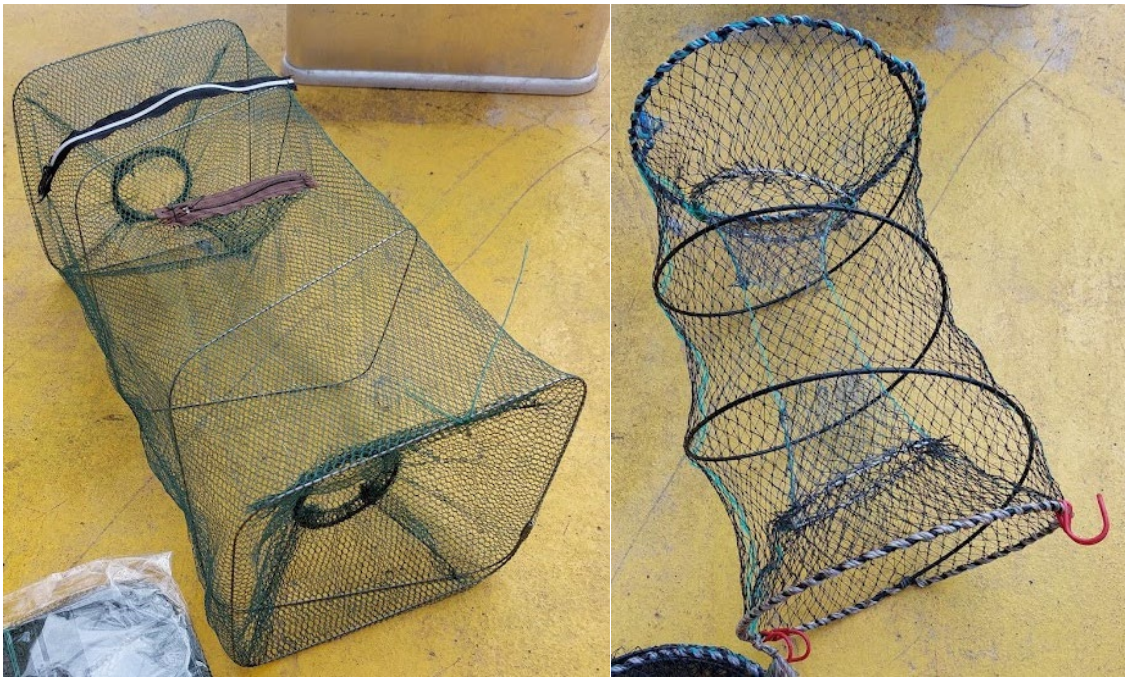

Figure 7: Small fykes that were mounted inside the large cage, left: 5x5 mm mesh size, right: 10x10 mm mesh size.

3. A niskin bottle was mounted on the side of each cage (see section on water samples).

During preparations, the ROV crew added rope with monkey fists to the handle bars and central eye on top of each cage, for easier manipulation by the ROV (Figure 8). The cages that were to be mounted on the structure at -40 and -76 meters depth, were mounted with an additional rope with hook that could be used to suspend the cage from a horizontal beam. This was fixed in place by cable ties that would break once the ROV pulled the hook, to release the hook and rope from the cage. The cages were baited with mackerel, which was suspended centrally in the large cage in a washing net, and placed without fixation in the smaller cages. Two complete mackerel cut in pieces of ~5 cm length were used per cage set.

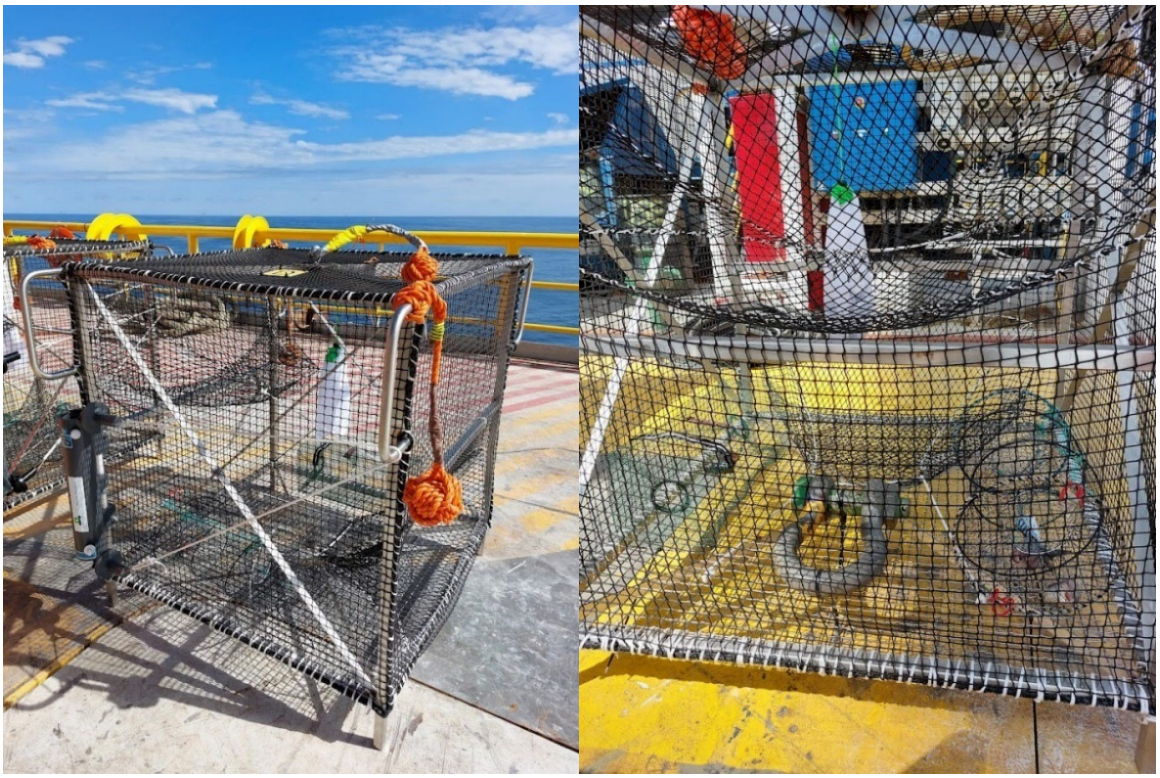

Figure 8: Cage set complete, with monkey fist ropes (orange) visible on left image, shackle weight visible on the bottom of the cage visible in right image. Washing net containing mackerel visible in both images (white net with green top).

Figure 9: Subsea basket as used for cage deployment and recovery, while empty (left) and filled with 6 cage sets (right).

Figure 10: The subsea basket is deployed using the port side heavy lift crane.

The cages were designed to be deployed and recovered using the debris basket for the ROV (Figures 9-10). After placement, the 6 cages remained in their position undisturbed between 30 and 33 hours (table 1).

Table 1: Cage placement metadata. Note: Cage recovery time is time of placement in subsea basket by ROV. Subsea basket was recovered to deck at 07:00 on 2 June 2022

Cage	Deployment date	Deployment time	Recovery date	Recovery time	Depth (m)	Remarks
A	31-5-2022	18:30	2-6-2022	3:15	40	NA
B	31-5-2022	18:55	2-6-2022	3:42	76	NA
C	31-5-2022	19:20	2-6-2022	3:28	119	NA
D	31-5-2022	20:00	2-6-2022	2:10	151	NA
E	31-5-2022	19:30	2-6-2022	2:18	151	NA
F	31-5-2022	19:45	2-6-2022	1:50	151	Ling caught in cage within 1 hour after placement

After recovery (Figure 11), the catch was processed. The majority of the cages had performed well, and large fish as well as crabs and shrimps were caught in most of the cages (Figure 12). The -40 m cage remained empty.

Figure 11: The ROV manipulator arms ready to recover cage A from the -40 m location.

Figure 12: Example of catch of fish in one of the cages.

All fish were processed by weighing, measuring, identifying and photographing them with sample number (Figures 13-14). A tissue sample was then collected and stored in -20ºC, then the stomach was removed and also stored in -20ºC.

Figure 13: Specimen of Tusk (Brosme brosme) during length measurements (length: 86 cm, weight 7 kg).

Figure 14: Specimen of Ling (Molva molva) during length measurements (length: 145 cm, weight 16.5 kg).

2.6 Marine growth samples

Marine growth samples were collected at 30, 45, 60, 75, 90, 105 and 135 meters depth. Sampling depths <30 meters was not possible due to safety restrictions for the ROV. Samples were scraped from the structure using a Marine Growth Sample tool (Vortex Subsea Solutions; Figure 15), which was designed to deposit scraped marine growth in sample bags (Figure 17), while isolating different samples from each other in separate sample bags. This was essential since the aim of the study was to compare stable isotope data from similar species from different depths, to investigate different feeding behaviour between depths. However, the mechanism used to change nets between samples, in combination with a narrowing of the sample tube at multiple points between scraping tool and entry into the nets, very often caused internal blockage of the tube by large calcareous specimens, resulting in accumulation of all following samples in the sampling tube. This resulted in mixed samples from all depths collected in the tube, with no indication on which part originated from which depth. After trying different settings and ROV connections, the team decided to remove the net changing system from the sequence, place the sampling net directly on the ejection point of the dredge vortex pipe, and collect 1 large individual sample per ROV deployment (Figure 16-17). Even when the pipe blocked, collection of that sample at 1 depth now continued, to assure enough material was collected from each depth in a single ROV deployment. This worked well, and samples with a volume of 2-4 litres were collected from each depth.

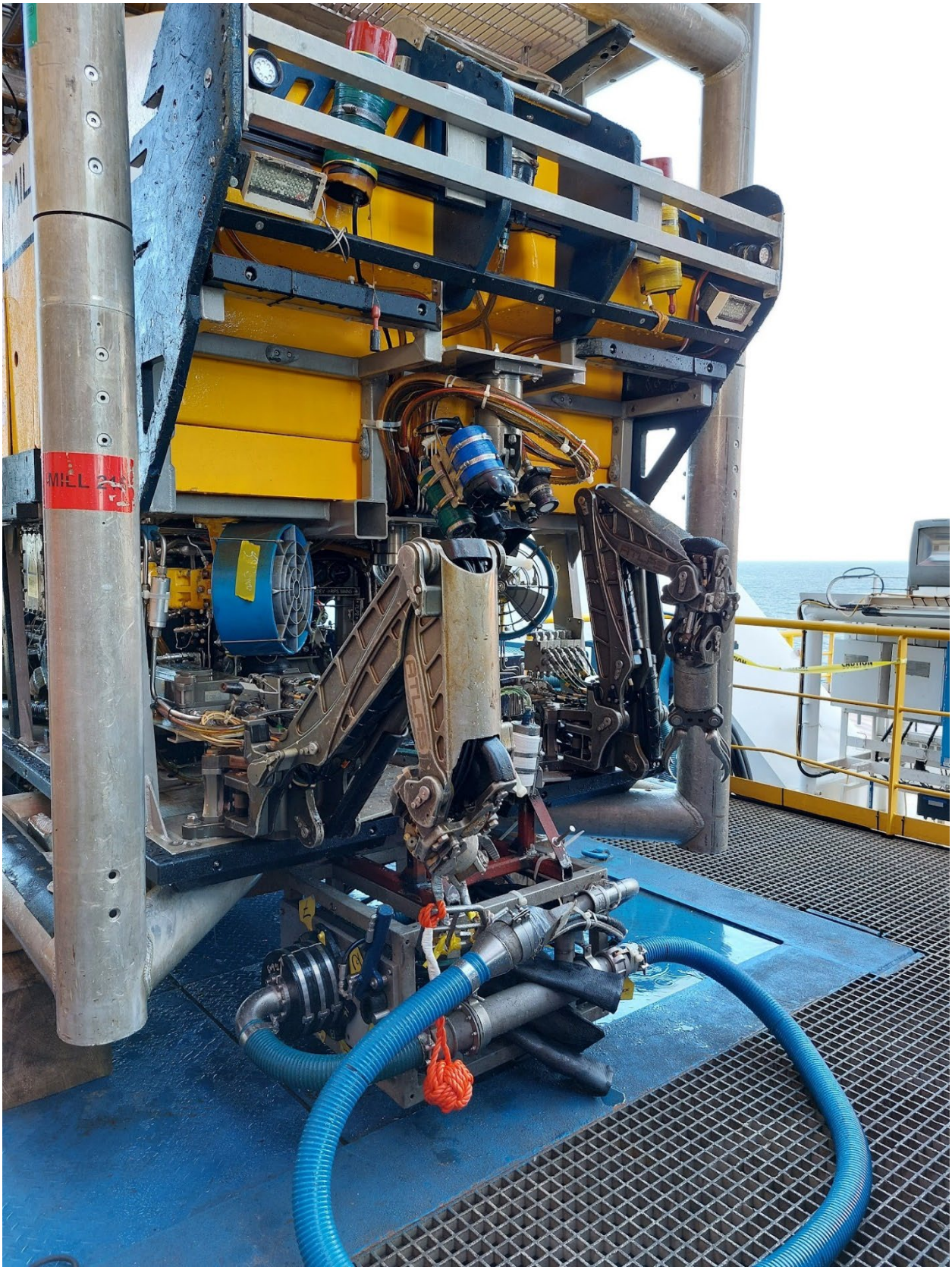

Figure 15: Vortex Marine Growth Sampler (bottom part with blue hose) as initially installed on the Millennium 215 ROV.

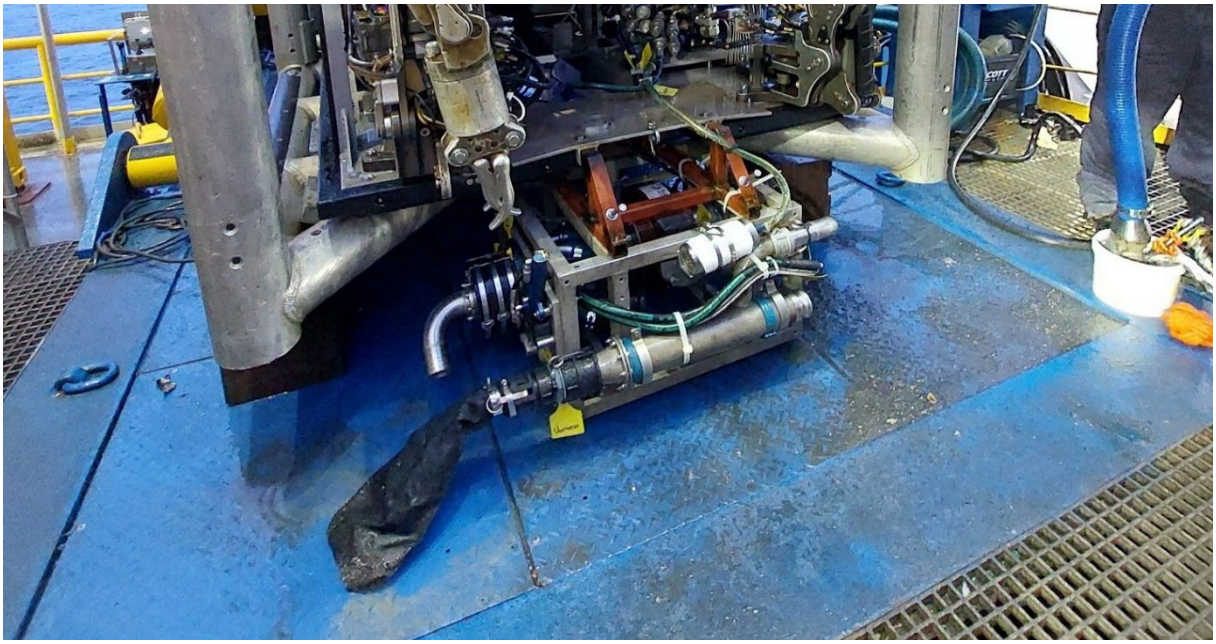

Figure 16: Marine Growth sampler setup after connecting a sampling net directly to the ejection tube of the dredge (lower left of image). Note the sampling tube was temporarily removed during photographing to deposit a sample in a bucket.

Figure 17: Vortex Marine growth sampler nets as provided, with ~1 mm meshed inner net (left) and external ~2 mm meshed external protective net with camlock connector (right).

Since the cold-water coral (*Lophelia pertusa*, current name: *Desmophyllum pertusum*) was expected to be present and sampled, the necessary licences (CITES) for export of specimens from the UK and import in the Netherlands were in place. Lophelia was indeed present and a total of 50 grams was collected and processed (Figure 18).

After collection by ROV, the samples were deposited in buckets and kept in a cool location before processing. Then each sample was sorted in species or higher level of taxonomic groups, and for each species between 5 and 25 individuals were collected (when possible), stored in vials and frozen in -20°C.

Figure 18: Examples of species collected from the foundation by the marine growth sampler, from top left to bottom right: Hard coral Lophelia pertusa (current name: Desmophyllum pertusum); Horse mussel Modiolus modiolus; Spider crab Hyas spp.; individual hard coral Desmophyllum dianthus; Brittle star Ophiuroidea and Squat lobster Galathea spp..

2.7 Seabed samples

Seabed samples were collected using the same (final) setup of the Vortex dredge pump with single sampling net. At increasing distance from the platform foundation, sediment samples were suctioned in a sampling net (but now containing only the coarse outer protective net, mesh size estimated at 2*2 mm). Samples were taken at 1, 5, 15, 25, 50, 75, 100 m distance from the foundation. Between samples the ROV was recovered, the nets replaced with an empty net and the ROV deployed again. After collection, the samples were kept in buckets waiting to be processed, outside on deck. With air temperatures ranging from 8-10°C this was deemed acceptable for a maximum of 24 hours. Samples needed to be stored as the shortened project time line and efficient sample taking by the ROV crew,

caused a back log of the sample processing. Finally, all samples were processed within 1 day after acquisition (Figure 19).

Figure 19: Examples of species collected from the seabed by the marine growth sampler, from top left to bottom right: as of yet unidentified tube worms in translucent tubes; bivalves; soft tube worms; polychaeta spp.

2.8 Plankton samples

Plankton samples from the water column, were taken with a 57 cm diameter WP-2 zooplankton net (Figure 20), mesh size 200 µm. The net was lowered with the large port side crane (Figure 21), to a water depth of 130 meters. Then it was lifted at a speed of 0.25 meters per second and returned to deck. The sample was then deposited in a bucket, the net rinsed with sea water from the fire water pump and then the net was redeployed, for a total of 3 samples.
The collected zooplankton was then sieved on 3 stacked sieves with mesh size 500, 212 and 100 µm. The fraction remaining in each sieve was stored in a separate container. Since the 100 µm mesh sieve did not contain any visible plankton at that time, no samples were taken of any of these fractions.

Figure 20: The WP-2 net on deck, ready to be deployed.

Figure 21: The WP-2 net attached to the crane hook, being lifted from deck to be lowered in the water.

2.9 Water samples

Water samples were collected using Niskin bottles placed on each cage (Figure 22). The Niskins were altered by removing the original triggering mechanism and attaching the lids on both sides of the bottle to a rope that fed through the ROV manipulator handle on the opposite corner of the cage. The bottles remained in this open position during the deployment time of the cages. Shortly before the ROV team started removing cages from the structure and seabed, the ropes were cut on all niskins, triggering the lids to close, capturing the water from the depth the cage was lowered at (Figure 23).

Then the cages were recovered and the niskins emptied in separate jerrycans (Figure 24).
During manoeuvring on deck, one of the ropes of a niskin was trapped under the forklift wheels, triggering the lids to open. This sample, which originated from cage C at 119 m water depth, was lost. All other samples were successfully collected.
The water from each sample from the platform was divided in three replicates. On the seabed three smaller sized niskins were present and there were filtered completely, 1 sample per niskin. Each sample was filtered first on a 212 µm mesh size sieve and then and filtered on a Whatman glass fibre filter.

Figure 22: Niskin as placed on a cage, with lids in open position, white rope holding them both open.

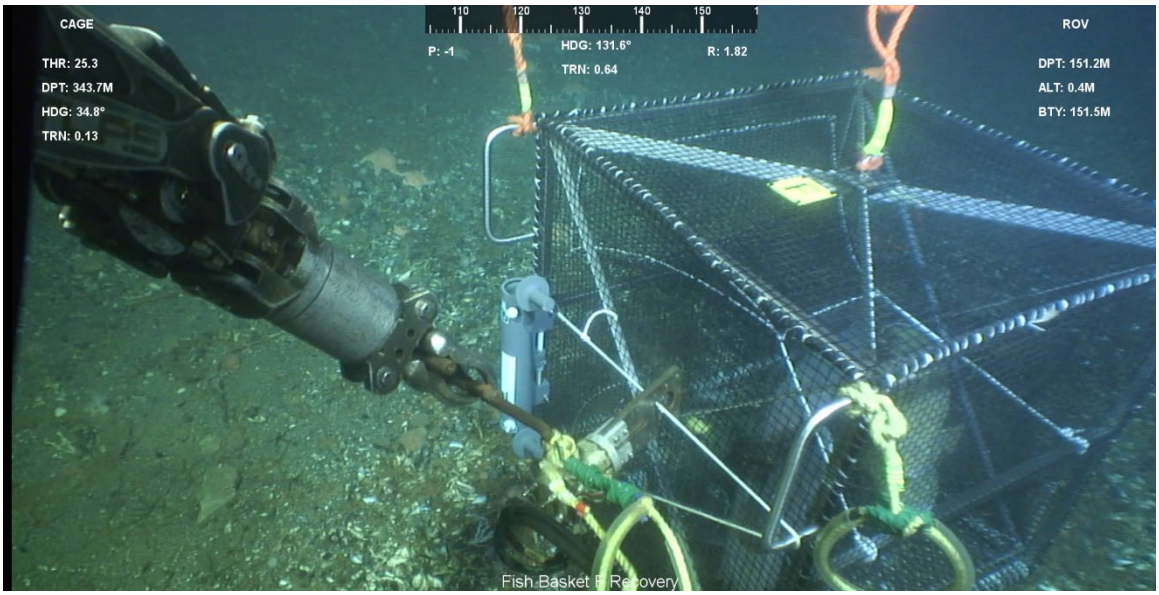

Figure 23: ROV rope cutting tool ready to cut the niskin rope at the end of a deployment.

Figure 24: Left: Water is removed from the closed niskin by draining in to a jerry can, right: water filtration set-up in lab container.

2.10 Fish transects

Video footage was recorded using the attached cameras on the ROVs mil200 and mil215. The video recordings encompassed three different sampling techniques for estimating fish relative abundance and species richness. Initially, horizontal transects (HTs) were performed starting 100m away from the closest leg and towards the platform at an average speed of 0.5 m/s. The initial point was <5m above the seabed and each transect was repeated every 10m depth all the way to 40m deep (i.e., 150, 140, 130, 120, 110, 100, 90, 80, 70, 60, 50, 40m). Shallower transects were not possible due to technical constrains of ROV operation and to minimize any risk of collisions. HTs were carried out during day and night for allowing to explore changes in fish behaviour associated to photoperiod. Then, timed stationary counts (SC) followed, and consisted of fixing a camera pane for 10 minutes to record any fish presence (Figure 25). The SC was performed <7m away from the closest structure (i.e., leg of the platform) and at four depth levels: bottom (on the seabed, ca. 150m deep), on top of the platform base (ca. 120m deep), midwater (80m deep), and 'surface' (40m deep). Finally, vertical transects (VT) were carried out next (<5m away) to a leg of the platform. VT consisted on a transect from 40m deep to the seabed (ca. 150m deep) at a constant speed of 0.5 m/s with the camera aiming at the leg. A total of 5 day and 2 night HT were completed. Additionally, 5 bottom, 3 on the base, 4 midwater, and 4 surface SC were recorded. VT accounted for 3 replicates at the end of the survey timeframe. All sampling was adapted to Sleipnir activities and positioning. Therefore, the replicas of each sampling did not seek to be fixed in each direction of the platform, but rather adopted a semi-randomized distribution.

Figure 25. Fixed pane of the camera attached to the ROV recording fish presence and activity at the seabed.

3 Verbal account of the activities

Pre cruise activities
All needed materials were transported from Vlissingen to the Sleipnir before the work started, using a HMC mobilisation barge. The science team travelled from the Netherlands to Norway by van, to allow transport of frozen samples on the way back. The van was parked at the AF Environmental Base in Vats, Norway, were the Sleipnir would arrive at the end of the campaign, to deposit the removed platform. The team was transferred to Stavanger awaiting boarding of the Sleipnir the next day.

Day 1 – 30 May 2022. The science team was transferred to the Sleipnir by a crew transfer vessel from the Mekjarvik kai in Stavanger, Norway. Once familiarised with the vessel and safety procedures, the materials were unpacked and made ready to start the research the next day. The ROV team had already mounted the ROV scrape sample system on the ROV and made sure it was operational. During the evening, the vessel started sailing towards the study area.

Day 2 - 31 May 2022. During transit before arrival at the study site, materials were prepared further. The ROV team together with deck personnel supported the science team to prepare the cages for ROV handling, and placing them in the subsea basket. Furthermore, the WP2 net was prepared to be deployed. The Sleipnir arrived at the platform at approximately 15:00, when DP trials started outside the 500 meter zone. During the trials, one of the heavy lift 10.000 tonne cranes was used to deploy the WP2 net, south of the platform. Once the trials were ready, the vessel approached the platform and the subsea basket containing 6 cage sets was deployed using a heavy lift crane, and placed on the seabed near the platform subsea foundation structure. The ROVs worked together to remove each cage from the basket and place them on and around the platform. Then the 215 ROV started scrape sampling the legs and subsea foundation structure and the 200 ROV started video transects. This work continued for the remainder of the day, into the next day.

Day 3 - 1 June 2022. The video transects and sampling had continued throughout the night. Meanwhile the fish cages had been observed to already contain some fish. The scrape sampling continued until approximately midnight 1-2 June, after which the sampling of the seabed started. Due to technical problems with the Vortex Marine Growth Sample Tool, there were significant delays in the sampling time. Finally, the ROV team decided to only utilise the Vertex dredge in combination with a single sampling net, which worked well, although the ROV had to return to deck after each sampling to change nets, taking an average of about 1 hour per sample. By doing this, the 7 scrape samples from the legs and subsea foundation structure were collected in approximately 9 hours. At approximately 15:30 the ROV started sampling the seabed, using the same tool as for the scrape samples, but without the small inner net, using only the black protective net on the dredge, since the inside nets started to fall apart, possibly as a result of the powerful blast of the sediment deposited in the nets by the dredge. The seabed sampling continued until midnight, when the ROV 215 started working on cage recovery.
During the scrape sample acquisition, part of the samples were processed directly by sorting through the catch, collecting the needed individuals, storing and registering them. Processing a single sample took between 2 and 3 hours, allowing for 4 samples to be processed in full during this day.

Day 4 - 2 June 2022. The ROV 215 started cutting the niskin lines on all cages, around 01:00, after which each cage was collected and placed in the subsea basket. At 07:00 the basket with all the cages was lifted back on deck. Then the scientists collected the water in the niskins and processed the samples, before starting on the fish. All fish were weighed, the length measured, species identified after which a tissue sample was taken from under the skin inside the dorsal muscle behind the fish head. Also, the stomach of each fish was removed and stored in the freezer at -20^{0}C. Processing all 30 fish from 5 cages (the -41 m cage was empty), took approximately 7 hours. Although intending to collect more sample types as additional supporting data, the team decided this was not feasible in the time available to them. After the fish samples had been processed, the left over 3 scrape samples

from day 3 were processed, but in a quicker manner, combining more species in a single stored sample, to allow processing of all 3 samples in ~4 hours, as it was expected that the deck would become off-limits sometime during the evening as the HMC team prepared a heavy lift to be carried out during the night. Meanwhile the ROV team collected a number of larger invertebrate specimens using the ROVs manipulator arms.
Approximately 50 hours after the Sleipnir arrived at the study location, the sample campaign was finished.

Day 5 - 3 June 2022. The Sleipnir had started sailing back to Norway during the night. The remaining 7 seabed samples were processed. All materials were cleaned and sorted. Data registration was finalised on paper. The samples were packed tightly in the freezer and any remaining space was filled with containers of frozen water, meant to buffer the internal temperature of the freezer during transport back.

Day 6 - 4 June 2022. The Sleipnir was still in transit. The team rinsed all materials with fresh water and dried them. Then everything was prepared for transport back home. One pallet was prepared to be lifted off board in Vats to be placed in the van, while 2 pallets were prepared for transport back by HMC barge, together with the cages. The Sleipnir arrived at Vats late evening that day.

Day 7 - 5 June 2022. The freezer pallet was lifted off the Sleipnir around 8:00 and placed in the van by fork lift. Then the team started travelling back, via Sweden to Denmark. There the stomach content samples were remove and stored at DTU Aqua in Copenhagen, and the freezer temporarily stored in the DTU office.

Day 8 - 6 June 2022. The freezer was loaded again and transported back to the WUR office in Den Helder, the Netherlands. Samples were offloaded and placed in the local -20ºC freezer. The materials were still frozen well, the use of large quantities of frozen water in bottles had worked well.

This concluded the field work part of this study.

4 Acknowledgements

This work was carried out as part of the project 'Artificial Structures and the functioning of the North Sea EcoSyStem' (ASSESS) project, funded by TKI Deltatechnology and Heerema Marine Contractors. The design of the cages was inspired by a design of the Royal Netherlands Institute of Sea Research and the cages were built by Piet Wim van Leeuwen (WMR) and Dirk Barends (CVI Texel). The offshore fieldwork was facilitated by Heerema Marine Contractors and their long list of people working at the office and offshore helping us, including Rienk Krol, Jeroen Kriek, Ewout Bastian and many others. The Oceaneering ROV crew was of significant importance for the success of this study.
We are thankful of all these organisations and persons for making this study possible.

5 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2015 certified quality management system. The organisation has been certified since 27 February 2001. The certification was issued by DNV.

Justification

Report C065/22
Project Number: 4312100124

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Dr. Ninon Mavraki
Researcher

Signature: 

Date: 27/10/2022

Approved: Drs. Jakob Asjes
MT member Integration

Signature: 

Date: 27/10/2022

Annex 1 Processing samples for stable isotopes on board

General rules:

1) The ideal number of individuals per species per location (location = sampling net or cage) is > 5. For some rare species this is already a very large number. That does not matter, but make sure that for the non-rare species you have enough individuals (at least 10 per species for large-sized organisms and 20 for smaller ones, like Jassa).
2) For species that have calcareous exoskeletons and you cannot collect only a clean muscle tissue (e.g. amphipods, small crabs, small starfish) account for double the quantity of individuals.
3) Keep all your equipment as clean as possible, clean tweezers with ethanol regularly and definitely when processing samples deriving from different locations.
4) For larger individuals and water filters clean the equipment before every individual/filter.

Small-sized invertebrates from ROV (soft- and hard-substrate related)

- Sort organisms to the lowest possible taxonomic level. It does not matter if you cannot identify the species but try to separate the main taxonomic groups.
- Place small-sized species/organisms, like amphipods, small crabs (e.g. Pisidia longicornis), polychaetes, etc., in vials with filtered-sea water.
- Pool multiple individuals of the same species and location together in one vial (5-10 individuals per species)
- Let small-size organisms to evacuate their guts by leaving them in the vials overnight (ca. 12 h), preferably in a cooled place (fridge of 5°C). Keep the vials without lids and there should be enough oxygen for them to survive.
- Put individuals into sample vials (you can split them in more than one vial if necessary), add a label and put them in the freezer (-20°C) to be moved to the lab.

Large-sized organisms (vertebrates and invertebrates)

- Depending on the type of organism you are treating, you need to extract a different type of tissue.
- All tissues should be placed in a vial, labelled and stored in the freezer (-20°C) to be moved to the lab.

Types of tissue per organism:

Organism	Tissue
Fish	Dorsal muscle
Bivalves	Foot
Decapods	Muscles from cheliped
Echinoderms	Peristomial part (the inner part/"mouth" of urchins and starfish)
Anthozoa	Tentacles or body wall

Water

- Sieve water deriving from one depth through a sieve of 212/200 µm mesh size to get rid of large debris.
- Take a clean GF/F filter and put it on the filtration system.
- Filter 1 L of water through that one filter.
- Fold the filter and put it in a sample vial.
- Label the vial.
- Put the vial in the freezer (-20°C) to be moved to the lab.

Zooplankton

- Collect the zooplankton from the net in a bucket and add some water.
- Take 3 sieves of mesh sizes 500, 212 and 100 µm and put them the one on top of the other having the larger size on top and ending with the smaller one on the bottom.
- Sieve the zooplankton sample through the 3 sieves.
- Extract the zooplankton samples from the sieves using filtered seawater and place them in vials (100-200 ml depending on where the samples fit better).
- Label the vials and store them in the freezer (-20°C) to be moved to the lab.

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With knowledge, independent scientific research and advice, **Wageningen Marine Research** substantially contributes to more sustainable and more careful management, use and protection of natural riches in marine, coastal and freshwater areas.

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