Beatrice Offshore Windfarm Post-Construction Monitoring Year 2 (2021): Turbine Foundation Marine Ecology Survey Report

SSE Renewables and Beatrice Offshore Windfarm Ltd (BOWL) Ltd

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Ashleigh Kitchiner, Dr Marc Hubble

Client:	**Beatrice Offshore Windfarm Ltd**
Address:	**Inveralmond House**
	200 Dunkeld Road
	Perth
	PH1 3AQ
Project reference:	**P00006764b**
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Project Director:	**Gillian Sutherland**
Project Manager:	**Marc Hubble**

APEM Ltd
Riverview
A17 Embankment Business Park
Heaton Mersey
Stockport
SK4 3GN

Tel: 0161 442 8938
Fax: 0161 432 6083

Registered in England No. 02530851

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Executive Summary

As part of a post-construction sampling programme to partially discharge Condition 27 of the Beatrice OWF Section 36 consent, APEM Ltd was commissioned by Beatrice Offshore Windfarm Ltd (BOWL) to undertake an underwater video survey of foundation jacket legs and surrounding seabed at the Beatrice Offshore Wind farm (OWF) site in June 2021. The survey was designed to gather qualitative data for community composition of biofouling on the turbine jacket legs and epibiota on the surrounding seabed. This survey was conducted alongside a benthic grab survey within the OWF site and the results of that survey are reported in APEM (2022).

A Remotely Operated Vehicle (ROV) recording High Definition (HD) video and fitted with GoPros recording Ultra High Definition (UHD) video streams (2.7K) was deployed at four turbine foundation locations (turbines C04, F06, H08 and K07). These turbine locations were selected based on a number of criteria including location within the OWF site and proximity to a benthic grab station. Each turbine foundation consisted of four jacket legs and associated cross-bracing. The face of each jacket leg was inspected from the water surface to the jacket leg base which ranged from 38-45 m depth, with still images obtained every 5 m. The ROV was also used to survey the seabed adjacent to the turbine legs for a distance of approximately 50 m.

There was extensive biofouling on all turbine jacket legs with signs of zonation and successional development. A range of species had colonised the available substrate which was consistent with the colonisation of turbine foundations at other windfarms (e.g. EMU 2008, Whomersley & Picken 2003, Bouma & Lengkeek 2009, Leonhard & Pedersen 2006). It was noted that blue mussel *Mytilus edulis,* which often colonises hard structures in the marine environment (e.g. Leonhard & Pedersen 2006, Joschko *et al*. 2008, Bouma & Lengkeek 2009, Coolen *et al*. 2015) was recorded at two of the turbine foundations in low numbers during this second Beatrice OWF monitoring survey. Blue mussels were not recorded during the 2020 survey.

Consistent with the colonisation of other turbines in the southern and wider North Sea area, biofouling communities were found to occupy distinct zones dominated by one or two key species and the depth zones in which taxa were recorded were typical of colonisation of other natural and artificial hard substrata (e.g. EMU 2008, Whomersley & Picken 2003, Bouma & Lengkeek 2009, Leonhard & Pedersen 2006). Across all turbine foundations the plumose anemone *M. senile* was the most abundant species accounting for the majority of the total biofouling cover and this species occupied the central and lower sections of the jacket legs, with keel worm *Spirobranchus* sp. tending to dominate the deepest sections near the jacket leg base. The upper 0-5 m of all turbine foundations were dominated by algal turf, kelp and a range of epiphytic species. Biomass from fouling species typically followed a bell curve distribution with depth, with algal dominated biomass at the surface, highest epifaunal biomass at mid depths and lowest biomass at the base. The zoned pattern of biomass distribution was found across all turbines and is considered likely to remain consistent into the future except for some small-scale variation, unless blue mussels become more established in the first 0-10 m of the structures.

De Mesel *et al*. (2013) found that zonation and community composition differed little after the first two years of colonisation and that communities would typically contain the same limited number of species but with some species in high abundances. In contrast, Leonhard & Pedersen (2006) indicated a climax community on introduced hard structures may not be expected until 5-6 years after hard substrate deployment. In general, at the Beatrice OWF site the broad patterns of colonisation and zonation on the jacket legs observed in 2020 (APEM 2021) were apparent in 2021 and further monitoring will elucidate how stable the communities recorded on the jacket legs are over time.

At the base and in the immediate vicinity of the jacket legs, mobile species such as the hermit crab *Pagurus bernhardus*, flatfish, the common sea urchin *Echinus esculentus* and common starfish *Asteria rubens* were recorded which would suggest the availability of food in the immediate vicinity of the turbine legs (e.g., pseudofaeces and detritus) although no biological material was recorded on the seabed. Material may be rapidly consumed by organisms or relocated due to tidal currents and further monitoring will be required to clarify if biological material builds up over time. Survey of transects running out 50 m from the turbines indicated the sediment was predominantly Sublittoral coarse sediment (EUNIS code A5.1) with the exception of some Sublittoral mixed sediments (EUNIS code A5.4) at Turbine F06.

A number of fish species were recorded during the survey, most of which were small pelagic fish and flatfish which could not be identified to species level. Abundance of small newly settled fish was high at all depths along the jacket legs and adults were abundant around the base of the jacket legs and surrounding seabed. Of those recorded to species level haddock *Melanogrammus aeglefinus* is listed as vulnerable on the IUCN Red List (IUCN 2022) with other species recorded being of 'Least Concern' (IUCN 2022). In terms of other taxa the common sea urchin *Echinus esculentus* is considered 'Near Threatened' on the IUCN Red List (IUCN 2022). No conspicuous NNS were recorded from the ROV or GoPro footage.

The findings of this study indicate that the Beatrice OWF supports a wide diversity of life along its entire depth, with distinct zonation of marine communities. This can provide food and refuge to considerable populations of sessile and motile invertebrates and fish. Based on the results of the survey there was limited evidence for effects of fouling communities on the epibenthic community composition in the immediate vicinity of the turbines, other than the presence of some mobile species. In general terms the range of species recorded and patterns of zonation were similar for the 2020 and 2021 surveys and further monitoring to be undertaken as part of the post-construction monitoring programme will provide additional information relating to how the turbine jacket legs are colonised over time, and help clarify if the organisms on the jacket legs are influencing sediment and habitat type in the vicinity of the turbines.

1. Project Overview

1.1 Scope of Work

1.1.1 Project background

This report presents the results of a Year 2 post-construction ecological survey undertaken by APEM Ltd at turbine foundations at the Beatrice Offshore Wind Farm (OWF) site utilising underwater video/stills. The survey was conducted to partially discharge Condition 27 of the Beatrice OWF Section 36 consent which states that the Project Environmental Monitoring Programme (PEMP) must cover, but not be limited to:

"Pre-construction, construction (if considered appropriate by the Scottish Ministers) and post-construction monitoring surveys as relevant in terms of the Environmental Statement and any subsequent surveys for….[6] benthic communities; and [7] (Seabed scour and) local sediment deposition."

The work forms part of the benthic monitoring strategy for the Beatrice OWF. The wider Year 2 survey included use of a benthic grab to determine sediment type and invertebrate communities within the OWF site (results of the survey are provided in APEM 2022). Methods for the underwater video survey broadly followed those set out in the Benthic Post-Construction Monitoring Strategy (RPS/BOWL 2015), refined following meetings with the Moray Firth Regional Advisory Group (MFRAG) and subsequent email correspondence.

1.1.2 Survey objectives

The objective of the survey was to utilise underwater video/stills to provide a visual inspection of the jacket legs of selected turbine foundations and collect data relating to the range of species colonising the jacket legs and taxon abundance. In addition, a visual inspection of the seabed in the vicinity of these structures was conducted to determine if any debris from the jacket legs was evident on the seabed and to enable an assessment of potential wider effects of biofouling of the jacket legs on the surrounding soft sediments.

The monitoring was designed to address the following question:

- How do the fouling communities associated with the introduction of hard substrate (i.e. foundations) change in the long term and what, if any, visible effects have occurred on the epibenthic community composition on the seabed in the immediate vicinity?

It should be noted that the original wording of this question included consideration of scour protection, however, as scour protection was not installed the question no longer addresses this.

1.1.3 Survey Design

The Beatrice Offshore Windfarm site is located south-west of Wick on the edge of the 12 nm limit in the Northern Moray Firth (Figure 1).

Visual inspection surveys were carried out on the four jacket legs at each of the four turbine foundation locations selected to fulfil the following criteria:

- Locations were within the MoeVen biotope as mapped during the previous survey;
- Two locations were near the border of the wind farm, and two were near the centre, to provide good spatial coverage;
- Locations were close to one of the grab sample stations within the OWF site.

The turbines foundations surveyed are the same as those surveyed in 2020 (APEM 2021) and locations of the turbine foundations surveyed including the seabed transects are indicated in Figure 1. Co-ordinates for the turbines and the start and end point of transects are provided in Appendix 1 .

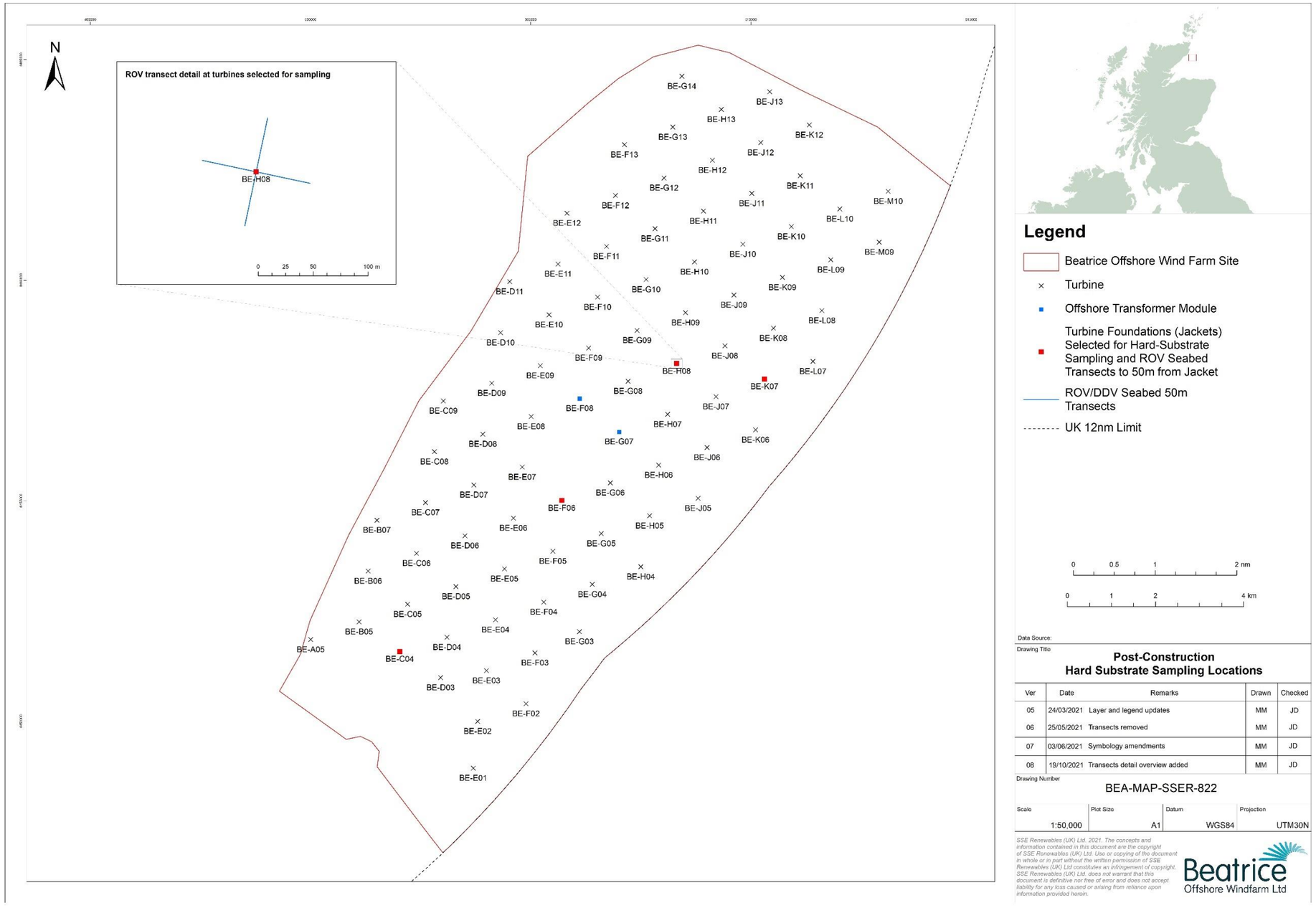


Figure 1. Locations of the four sampled turbine foundations (jackets) and associated seabed transects.

2. Methodology

2.1 Survey Vessel and Permissions

The turbine foundation survey was undertaken using the Moray First Marine vessel 'Waterfall' (Figure 2), mobilising from Montrose. The Waterfall is a 16 m Aluminium Catamaran workboat rated to 60 miles offshore under MCA Category II classification.

The Waterfall has been audited by the International Marine Contractors Association (IMCA) and was audited by Beatrice Offshore Windfarm Ltd (BOWL) for this project.

All survey permissions were obtained by BOWL prior to the survey commencing.

Figure 2. MFM vessel Waterfall used during the turbine foundation survey

2.2 Underwater video/stills acquisition

The survey was conducted on the 18th and 19th June 2021.

Due to the manoeuvrability required, a Remotely Operated Vehicle (ROV) (Figure 3) was used to survey the turbine foundations and immediate surrounding area of seabed (out to approximately 50 m). The approach followed JNCC methodology and guidance produced as part of the Mapping European Seabed Habitats project (MESH) (Coggan *et al*. 2007, JNCC 2018).

The ROV used was an Outland 2500 with a tilting mechanism and LED lighting system providing high resolution outputs and good colour in low light conditions. The ROV recorded High Definition (HD) 1080 dp video, and when descending the turbine foundation, the movement of the ROV was halted at five metre depth intervals along the foundation to enable

freeze frame images to be captured. The typical depth of turbine foundation from the sea surface to the seabed is known to be 35-45 m.

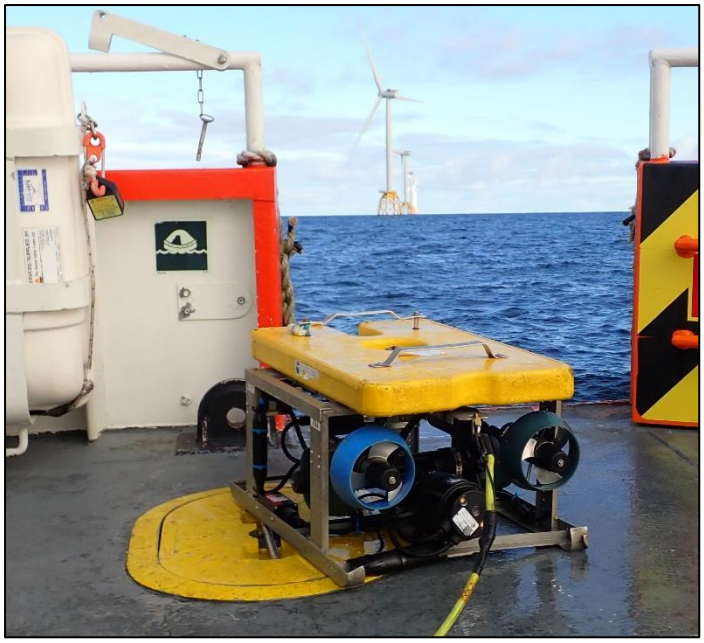


Figure 3. Outland 2500 ROV on deck at BOWL

An additional 2.7K video stream was also captured by fitting a GoPro in a waterproof housing to the ROV via a specific mount.

The ROV seabed transect was run to 50 m away from the foundation in the following directions

- east-southeast and west-northwest (perpendicular to the prevailing current).
- north-northeast and south-southwest (in the direction of the prevailing current).

Current roses taken from pre-construction monitoring were reviewed to determine the direction of the prevailing currents at the site (see Figure 4, taken from ABPmer 2015).

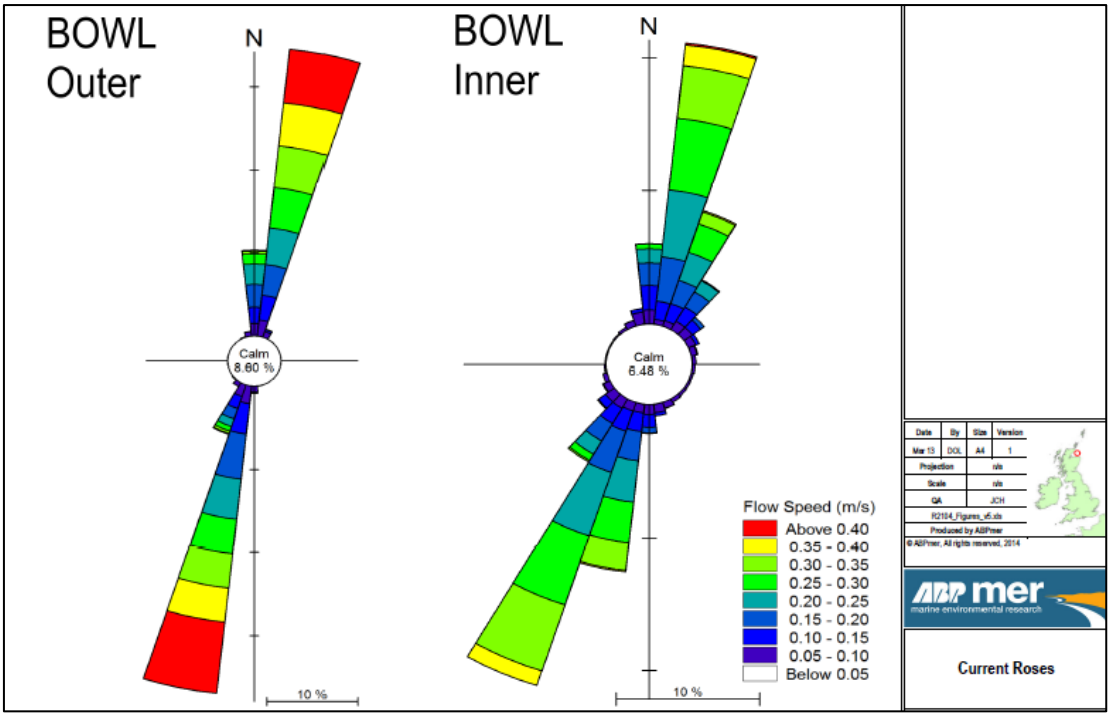


Figure 4. Current roses for BOWL outer and inner.

2.3.1 Survey of turbine foundations and seabed habitat in the immediate vicinity of the turbine foundations

The monitoring strategy for the turbine foundations was developed based on a comprehensive review of monitoring requirements undertaken by RPS Energy in 2015, on behalf of BOWL in consultation with various stakeholders. The strategy was updated through discussion with MFRAG in advance of the 2020 and 2021 surveys.

The ROV video was recorded continuously and monitored on-board the vessel, with adjustments made to the ROV system as required to maintain image quality. *In situ* assessment of the live footage was conducted by an experienced marine ecologist to record species/habitats. The following data were collected at each of the four turbine locations:

- Video footage from sea surface (including the splash zone) to the seabed for the jacket legs of each turbine foundation.
- Stills images (video freeze frames) were captured from the 1080p HD video signal at five metre intervals along the turbine foundation and/or at notable changes in species composition. Stills capture was conducted separately to the video so it did not interfere with the recording of the video stream.
- 2.7K UHD video from an additional 2 x GoPro Cameras.

2.3.2 Survey of seabed habitat extending from turbine foundations

As indicated above, surveys were run in a north-northeast, south-southwest, east-southeast, and west-northwest direction extending from each turbine location for a distance of approximately 50 m.

The video was recorded along the total specified length and direction at each transect, with still images taken at approximately 30 second intervals or where there was a change in habitat type. The video was monitored on-board the vessel, with adjustments made to the camera system as required to maintain image quality. *In situ* assessment of the live footage was conducted by APEM's survey lead to note changes in habitat type.

For the ROV surveys a survey log was completed daily, detailing each drop of the underwater video equipment, with the following information recorded per deployment:

- Transect number
- Date
- Start time (24-hour format);
- Water depth;
- Tidal state;
- Sea surface conditions;
- Weather conditions;
- Start and end positions;
- Seabed substrate;
- Any conspicuous fauna;
- Presence/absence of Annex I habitats

2.3 Laboratory analysis of video and stills

Detailed laboratory analysis of digital stills and video footage was conducted utilising supplementary notes recorded in the field, positional data, captured images and videos. Still images and video taken along each transect were analysed by viewing in real-time or slower, with key habitat changes and species recorded utilising overlayed positional data to georeference the data. For the transects along the turbine foundations the location of any species or habitat changes were indicated in relation to changes in depth.

All taxa were identified to the lowest possible taxonomic level using relevant taxonomic keys and photographic guides. Taxa were counted semi-quantitatively using the SACFOR scale of abundance (Appendix 2 Hiscock, 1996): Super-abundant (S), Abundant (A), Common (C), Frequent (F), Occasional (O), Rare (R) and Present (P). The abundance ratings for each taxon were then assigned for each 5 m depth band along a jacket leg.

On the turbine foundations the taxonomic abundance data and substrate information for each image and video was noted using 5 m depth bands to subdivide each jacket leg. As no EUNIS habitats are currently designated for artificial substrates, SACFOR data (Appendix 2 Hiscock, 1996) were used to define vertical zonation where possible.

The taxonomic abundance data and substrate information for the ROV transect along the seabed was used to assign a EUNIS habitat type (EEA 2020[1]).

[1] EEA (European Environment Agency). 2020. EUNIS habitat descriptions. Available online [accessed 08 December 2020].

2.4 Non-Native Species

In addition to the standard video sampling protocol for the post-construction monitoring marine growth survey, it was suggested by the MFRAG steering group that an additional sampling approach should be conducted for non-native species (NNS). Consequently, the additional UHD 2.7k video footage was collected to supplement the ROV footage, as indicated above. It was anticipated that this would allow for easier identification of conspicuous NNS (if present) during the lab-based video analyses. During the survey and the subsequent lab-based video analysis, the onboard ecologist looked for the NNS indicated in Table 1 as well as any other NNS. These NNS have been recorded in Scottish waters and are considered to be potentially present at the OWF site (Table 1; Nall *et al*. 2015). Note: this list is not considered exhaustive and was kept under review.

Table 1. Scottish non-native species that could inhabit the OWF (Nall et al. 2015)

Species
Undaria pinnatifida
Codium. fragile subsp. tomentosoides
Caprella mutica
Styela clava
Austrominius modestus
Corella eumyota
Tricellaria inopinata
Botrylloides violaceus
Schizoporella japonica
Dasysiphonia japonicac
Bugulina simplex
Bonnemaisonia hamifera
Heterosiphonia japonica
Didemnum vexillum

2.5 Additional observations recorded

2.6.1 Fish

Any fish that were observed were identified (if possible) and noted in the results.

2.6.2 Marine growth imagery for volume estimation by 3D photogrammetry

At the request of MSS and SAMS, a second GoPro camera was mounted onto the survey ROV, to enable the collection of imagery suitable for subsequent 3D photogrammetry analysis (by MSS / SAMS).

3. Results

3.1 Turbine foundations

Specific information is provided in Section 3.3 onwards for each turbine foundation (set of four jacket legs) surveyed. Results are provided separately for each jacket leg and in this report the four jacket legs at each turbine foundation surveyed are termed North, East, South and West respectively, corresponding to the cardinal point to which they are most closely aligned.

Still images were reviewed at 5 m intervals down the jacket leg and data are provided for each of these depth intervals in Appendix 3 . When describing the communities present, however, these 5 m depth intervals tended to fall within wider 'zones' of communities and the depth range of these zones has been described in the results section for each jacket leg. Biological zones were determined by considering the SACFOR information and the presence/absence of key species. In general terms, with increased depth down the jacket leg there was a shallow algae-dominated zone, a transition zone between an algae-dominated and cnidarian-dominated zone, a cnidarian dominated zone and a zone dominated by keel worms *Spirobranchus* sp. Biomass generally peaked at the mid-depths.

No conspicuous NNS were recorded on the jacket legs during the survey.

Fish were often common/abundant and taxa recorded were Actinopterygii *(*small fish that could not be identified to a lower taxonomic level), wrasse (Labridae), flatfish (Pleuronectiformes), haddock *Melanogrammus aeglefinus*, saithe *Pollachius virens* and common dragonet *Callionymus lyra*.

Broad findings for each zone are indicated below although there was some variation across jacket legs.

3.1.1 0 - 5 m

This depth band covered the splash zone +0.5 m / -0.5 m and the first 5 m. Mean spring tidal range at this site is *ca*. 0.5 m, which can influence species in the shallowest depth band as they experience periods of desiccation. This depth band was typically dominated by the superabundant kelp taxa *Laminaria* sp. and *Alaria esculenta* and the brown alga *Desmarestia* sp. was abundant. Below 1 m, red algal species were present and could not be identified beyond the grouping of red algal turf (Rhodophyta turf) based on the video/stills. In addition to algae, several epiphytic species such as bryozoans and hydroids were recorded. At increasing depth the plumose anemone *M. senile* was often present and within deeper zones this species increased in abundance and started to replace most other taxa. Small fish (Actinopterygii) were seen around the jacket leg along with blue mussel *Mytilus edulis* and barnacles (Balanoidea).

3.1.2 5 - 10 m

This band usually delineated a transition between the algae-dominated upper leg and the cnidarian-dominated zone on the mid-leg. *M. senile* was dominant in this band and was recorded as superabundant throughout. This zone typically consisted of a mix of *Laminaria*

sp. and a red algal turf. Common starfish *A. rubens* and small fish (Actinopterygii) were occasionally seen within this band.

3.1.3 10 - 25 m

This band was dominated by the large superabundant plumose anemone *M. senile*, *Spirobranchus* sp. were abundant and light bulb sea squirt *Clavelina lepadiformis*, dead man's fingers *Alyconium digitatum* and *Asterias rubens* were recorded as rare to occasional. Anemones (*Sargartia* sp.) were present and recorded as frequent. Many of the species were relatively slow growing and typically had higher biomass than within the other zonation bands. It is anticipated that a range of more cryptic and epiphytic species would be present in between the more visible species.

3.1.4 25 - 40 m

The lower sections of the legs were dominated by the superabundant keel worm *Spirobranchus* sp. The taxa *M. senile, A. digitatum* and *C. lepadiformis* were all common and recorded until approximately 1 m off the seabed. *A. rubens* and common sea urchin *E. esculentus* were both occasional to rare. Small fish (Actinopterygii), flatfish (Pleuronectiformes), haddock *Melanogrammus aeglefinus* and a single individual of a wrasse (Labridae) were seen around the jacket legs.

3.1.5 Seabed

At the base of almost all of the jacket legs and the surrounding seabed, flatfish (Pleuronectiformes), small Actinopterygii and hermit crab *Pagurus bernhardus* were present suggesting the presence of a potential food source. Common starfish *A. rubens* were also observed at the base of the jacket leg which suggests an availability of food for these taxa, although none was conspicuous on the video footage. There was no evidence of accumulated biological material visible at or around the base (within 50 m of the base), although some shell debris was seen.

3.2 Habitats on the transects extending from the turbine foundations

Two benthic habitats were recorded extending further from the turbines (recorded across a distance of approximately 50 m):

- Sublittoral coarse sediment (EUNIS A5.1); and
- Sublittoral mixed sediments (EUNIS A5.4).

Sediment was categorised as Sublittoral coarse sediment (EUNIS code A5.1) at 13 of the 16 transects. Sublittoral mixed sediments (EUNIS code A5.4) dominated two transects, both at Turbine F06. On one of the transects both habitat types were recorded (FO6 west). It was not possible to determine habitat beyond EUNIS level 3 (i.e., A5.1 or A5.4) due to the lack of conspicuous species present and the fact that higher level allocations are based on the invertebrate communities present beneath the sediment surface.

No conspicuous NNS were recorded within habitats along the transects.

Definitions of Sublittoral coarse sediment and Sublittoral mixed sediments are provided below.

3.2.1 Sublittoral coarse sediment (EUNIS A5.1)

This habitat is characterised by coarse sediments including coarse sand, gravel, pebbles, shingle, and cobbles which are often unstable due to tidal currents and/or wave action. These habitats are generally found on the open coast or in tide-swept channels of marine inlets. They typically have a low silt content and lack a significant seaweed component. They are characterised by a robust fauna including venerid bivalves (EEA 2020).

3.2.2 Sublittoral mixed sediments (EUNIS A5.4)

These habitats encompass a range of sediments including heterogeneous muddy gravelly sands and also mosaics of cobbles and pebbles embedded in or lying upon sand, gravel or mud. Another 'form' of mixed sediment includes mosaic habitats such as superficial waves or ribbons of sand on a gravel bed (observed frequently in this form during this survey) or areas of lag deposits with cobbles/pebbles embedded in sand or mud. These habitats are less well defined and may overlap into other habitat or biological subtypes. These habitats may support a wide range of infauna and epibiota including polychaetes, bivalves, echinoderms, anemones, hydroids and bryozoans (EEA 2020).

3.3 Turbine C04

The nearest benthic grab station to this turbine was Station 5 at which all three replicate samples were allocated the biotope '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (SS.SSa.CFiSa.EpusOborApri; A5.251), (see APEM 2022 for details).

3.3.1 C04 North

3.3.1.1 C04 North: Turbine jacket leg assessment

0 - 5 m

The upper section of the jacket leg was colonised by superabundant *Laminaria* sp. and *A. esculenta* along with abundant *Desmarestia* sp. Rhodophyta and Phaeophyta turf were common and hydrozoa/bryozoa turf was frequent. From about 3.5m depth, *M. senile* increased in abundance and started to replace most other taxa. Small Actinopterygii were seen around the jacket leg.

5 - 10 m

This section of the jacket leg was dominated by *M. senile* which was recorded as superabundant. Common starfish *A. rubens* was recorded as common and *Spirobranchus* sp. as occasional. Macroalgae was still present in this section and *Desmarestia* sp. was recorded as occasional. The red seaweed sea beech *Delesseria sanguinea* was recorded as rare and Rhodophyta turf, Phaeophyta turf and hydrozoa/bryozoa turf were frequent. Small Actinopterygii were seen around the jacket leg.

10 - 25 m

This band was dominated by *M. senile* which was superabundant throughout. *Sagartia elegans* was also present in the 20-25 m section and recorded as frequent. *Spirobranchus* sp. was occasional to frequent and *A. rubens* was common. The sea squirt *Diplosoma listerianum* was recorded as rare in the 15-20 m and 20-25 m sections. Small Actinopterygii and comb jellies Ctenophora were seen around the jacket leg

25 - 38 m

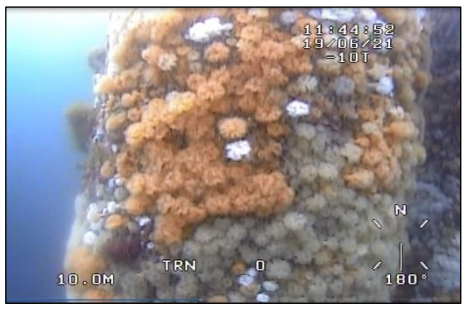
In this band *M. senile* decreased from abundant to common and *Spirobranchus* sp. increased to abundant. Athecate hydrozoans were recorded as occasional in the 30-38 m section. *A. rubens* and *E. esculentus* were recorded as common. Small Actinopterygii, Pleuronectiformes, *M. aeglefinus* and a single individual of a wrasse (Labridae) were seen around the jacket leg.

Seabed

On the sediment at the base of the jacket leg, *A. rubens* was recorded as common. Abundant Pleuronectiformes and small Actinopterygii were also seen, along with common *M. aeglefinus.* There was no evidence of accumulating biological material visible at or around the base, although some shell debris was present.

0m

5m



10m

15m

20m

25m

30m

35m

38m

seabed

Figure 5. Photos taken at 5 m depth bands at C04N.

3.3.1.2 C04 North: Benthic habitat around turbine

Heading in a north-northeasterly direction for approximately 50 m, the substrate at C04N was Sublittoral coarse sediment (EUNIS A5.1; Figure 6) including sand, shell and gravel. The only conspicuous fauna identified on the transect were *A. rubens, P. bernhardus, M. aeglefinus* and Pleuronectiformes.

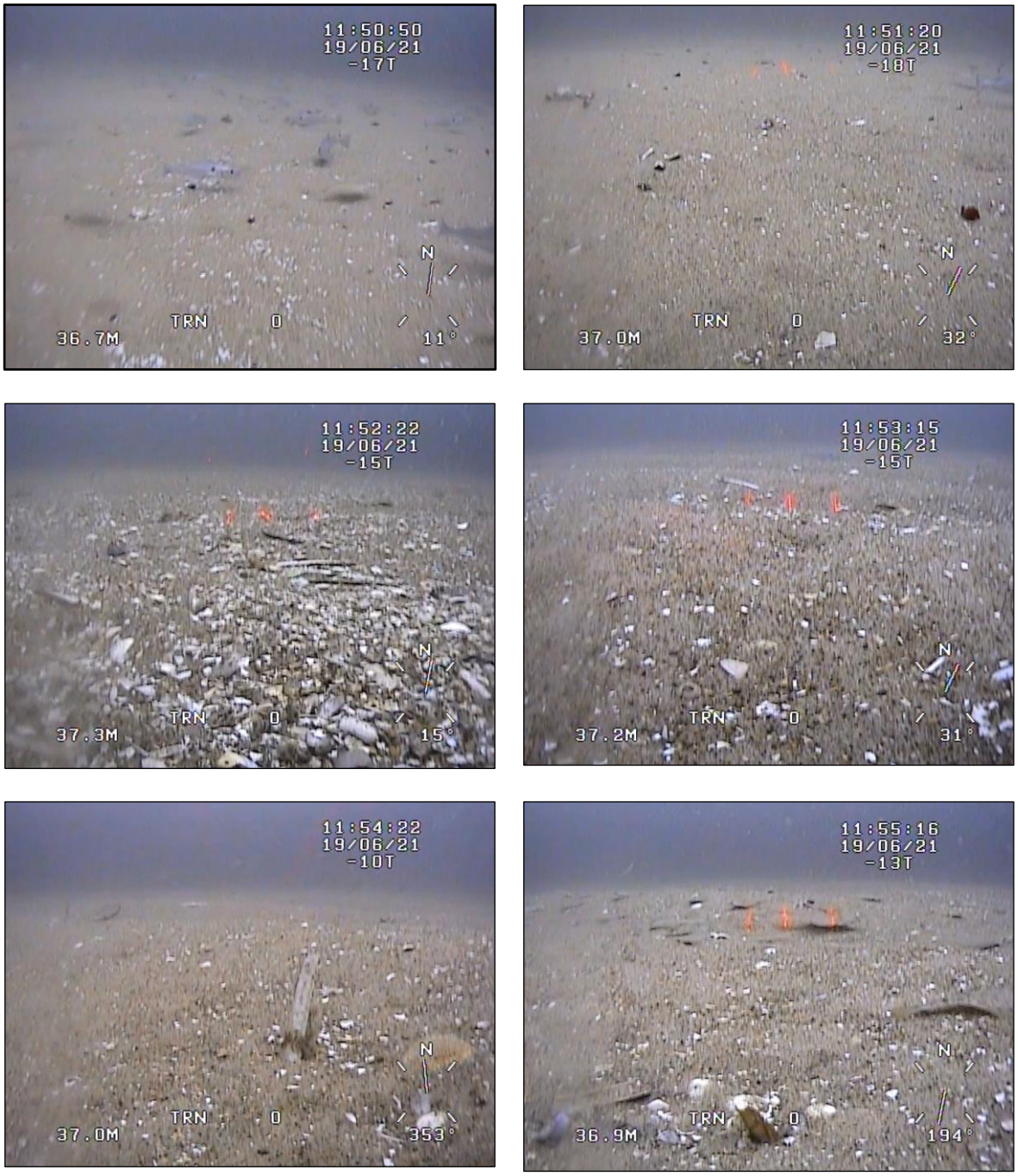


Figure 6. Representative seabed images taken at C04N (all EUNIS A5.1)

3.3.2 C04 East

3.3.2.1 C04 East: Turbine jacket leg assessment

0 - 5 m

The upper section of the jacket leg was colonised by superabundant *Laminaria* sp. and *A. esculenta* along with abundant *Desmarestia* sp. Rhodophyta and Phaeophyta turf were frequent and hydrozoa/bryozoa turf was occasional. From approximately 3 m, *M. senile* was abundant and started to replace most other taxa. Small Actinopterygii were seen around the jacket leg.

5 - 10 m

M. senile was the dominant taxon in this band and was recorded as superabundant, covering almost the entire surface area of the jacket leg. Rhodophyta, Phaeophyta and hydrozoa/bryozoa turf were occasional and *Desmarestia* sp. was recorded as rare, only occurring in the area around 5 m depth. Small Actinopterygii were seen around the jacket leg.

10 - 25 m

This band was dominated by *M. senile* which was superabundant throughout. *Spirobranchus* sp. increased from rare to frequent as depth increased. *A. rubens* was recorded as common. Small Actinopterygii, Ctenophora and moon jellyfish *Aurelia aurita* were seen around the jacket leg.

25 - 38 m

Spirobranchus sp. numbers increased with depth from abundant to superabundant, whilst *M. senile* decreased from abundant to frequent. *A. rubens* was recorded as abundant and *E. esculentus* as common. *A. digitatum* was rare and athecate hydrozoans were occasional. Small Actinopterygii and a single individual of a saithe *Pollachius virens* were visible around the jacket leg.

Seabed

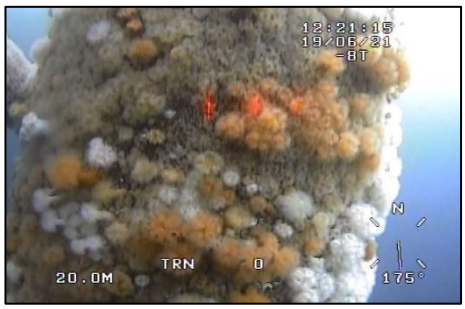
On the seabed at the jacket base, Pleuronectiformes were recorded as common and *A. rubens* as frequent.

0m

5m

10m

15m



20m

25m

30m

35m

38m

seabed

Figure 7. Representative images taken at 5m depth intervals at C04E

3.3.2.2 C04 East: Benthic habitat around turbine

Heading in an east-southeasterly direction for approximately 50 m, the substrate at C04E was Sublittoral coarse sediment (EUNIS A5.1; Figure 8), including sand, shell and gravel. The only conspicuous fauna identified on the transect were *A. rubens* and Pleuronectiformes.

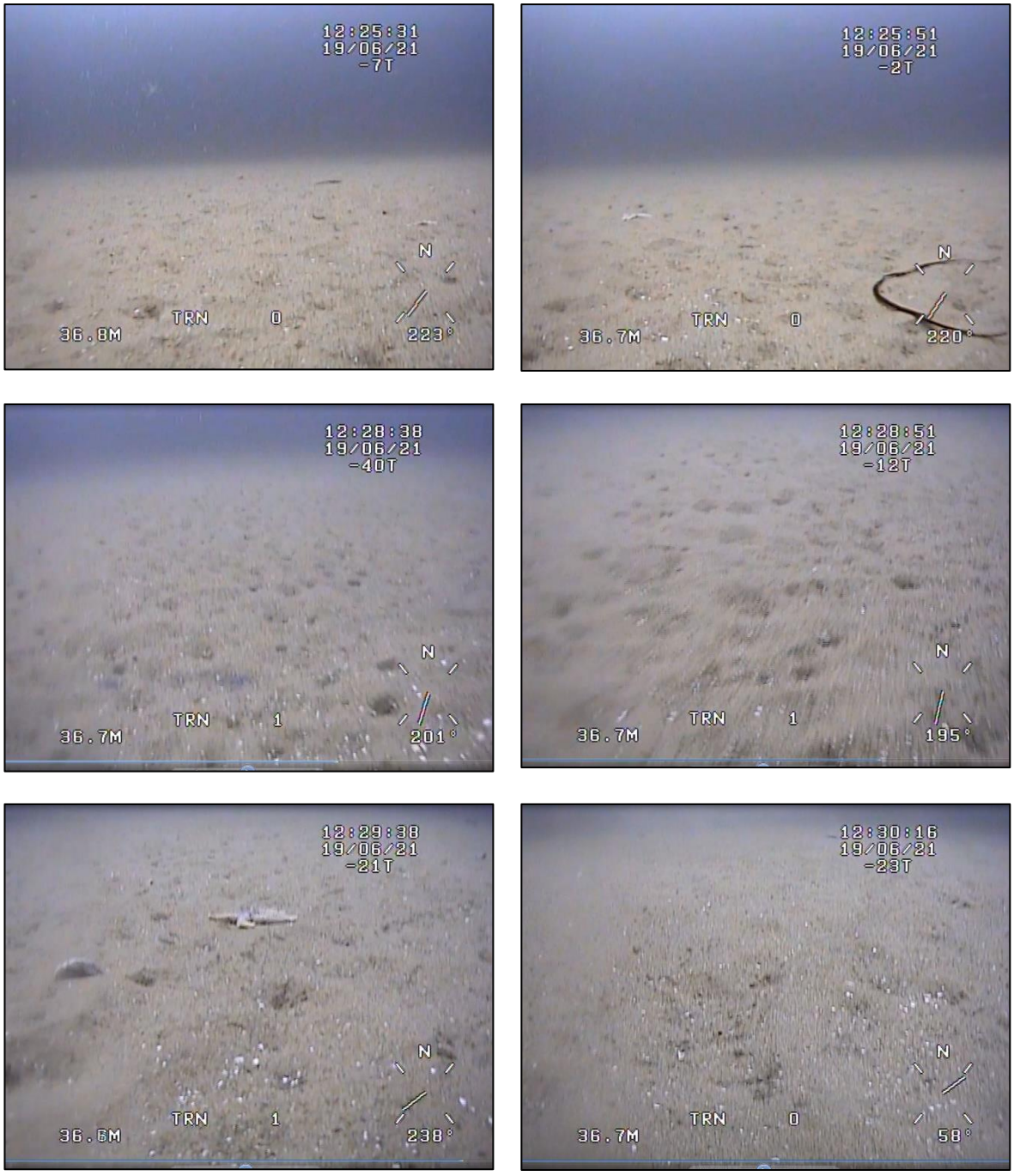


Figure 8. Representative seabed images taken at CO4E (all EUNIS A5.1)

3.3.3 C04 South

3.3.3.1 C04 South: Turbine jacket leg assessment

0 - 5 m

The upper section of C04S was dominated by superabundant *Laminaria* sp. and *A. esculenta*. There was also abundant *Desmarestia* sp., abundant Rhodophyta turf and common Phaeophyta turf. Small Actinopterygii, visible around the jacket leg, were frequent and edible crab *Cancer pagurus* was occasional.

5 - 10 m

The upper 2.5 m of this section was dominated by an algal turf consisting of abundant Rhodophyta and *Desmarestia* sp. with occasional *A. esculenta* and *Laminaria* sp. Below this there was high coverage of *M. senile* and the algal turf coverage became more sporadic. Occasional *A. rubens* and hydrozoa/bryozoa turf were also seen. Small Actinopterygii were visible around the jacket leg.

10 - 25 m

This section was dominated by superabundant *M. senile* with frequent Phaeophyta turf and occasional Rhodophyta turf in the first 5 m. Below 15 m there was increasing coverage of *Spirobranchus* sp. tubes which were recorded as frequent. *A. rubens* was common to occasional and hydrozoa/bryozoa turf increased from occasional to frequent. Colonial ascidians and *D. listerianum* were both recorded as rare. Small Actinopterygii and a ctenophore were visible around the jacket leg.

25 - 38 m

The lower sections of C04S were dominated by abundant *M. senile* and common *Spirobranchus* sp. tubes. Hydrozoa/bryozoa turf increased from frequent to common between these depths. The light-bulb sea squirt *C. lepadifomis* was recorded as common and large colonies were seen around 35 m. *A. rubens* was recorded as common and below 30 m the common sea urchin *E. esculentus* was recorded as frequent. The bryozoan hornwrack *Flustra foliacea* was also present and recorded as rare. Small Actinopterygii were seen in high numbers around the jacket leg and Pleuronectiformes and *M. aeglefinus* were common. Extensive biofouling was evident in this band (90-100%) and consisted of small, low biomass taxa.

Seabed

M. senile, *Spirobranchus* sp. and hydrozoa/bryozoa turf were common at the jacket base. Also recorded as common were *A. rubens, E. esculentus* and the common sun star *Crossaster papposus*, while the soft coral *A. digitatum* was rare. Pleuronectiformes and *Melanogrammus aeglefinus* were recorded as abundant. The seven-armed starfish, *Luidia ciliaris,* was common on the seabed surrounding the jacket base. There was no evidence of material falling onto the seabed from the jacket, but some shell debris was present around the jacket base.

0 m

5 m

10 m

15 m

20 m

25 m

30 m

35m

38m

seabed

Figure 9. Representative images taken at 5m depth intervals at C04S

3.3.3.2 C04 South: Benthic habitat around turbine

Heading in a south-southwesterly direction for approximately 50 m, the substrate at C04S was Sublittoral coarse sediment (EUNIS A5.1; Figure 10), including sand, shell, and gravel. The only conspicuous fauna identified on the transect were frequent *A. rubens* and common Pleuronectiformes and *M. aeglefinus*.

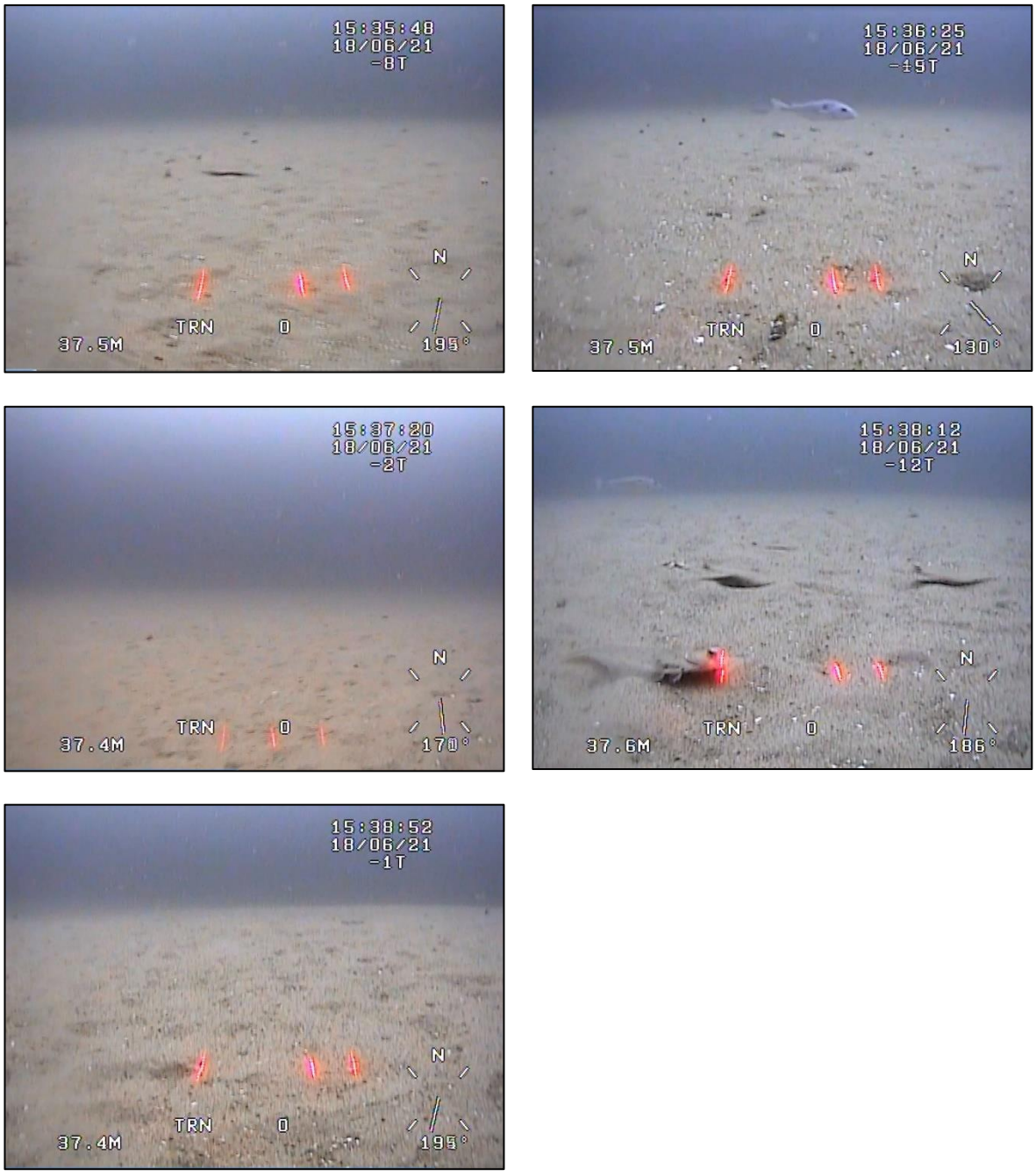


Figure 10. Representative seabed images taken at CO4S (all EUNIS A5.1)

3.3.4 C04 West

3.3.4.1 C04 West: Turbine jacket leg assessment

0 - 5 m

The upper sections of C04W were colonised by superabundant *Laminaria* sp., *A. esculenta* and abundant *Desmarestia* sp. Rhodophyta turf was common and the red seaweed *D. sanguinea* was occasional. From approximately 4 m, *M. senile* could be seen colonising sections where macroalgae was absent. Small Actinopterygii were seen around the jacket leg.

5 - 10 m

Consistent with the other legs, the 5-10 m zone was a transition zone between the upper kelp zone and the middle *M. senile* dominated zone. *Desmarestia* sp., Rhodophyta turf and Phaeophyta turf were recorded as common and *M. senile* was abundant. *A. rubens* and *C. pagurus* were common and the ascidian *D. listerianum* was rare. Small Actinopterygii were seen around the jacket leg.

10 - 25 m

This section was dominated by superabundant *M. senile* and frequent to common *Spirobranchus* sp.. *A. rubens* and *E. esculentus* were common and the sea squirt *D. listerianum* and colonial ascidians were rare. Hydrozoa/bryozoa turf was recorded as occasional at 20-25 m depth. Small Actinopterygii were seen around the jacket leg.

25 - 38 m

The lower section of C04W transitioned from a *M. senile* dominated zone to one where *Spirobranchus* sp. became the main biofouling taxa and was superabundant. Hydrozoa/bryozoa turf was recorded as occasional and *A. rubens* was common. Colonies of the light-bulb ascidian *C. lepadiformis* and the soft coral *A. digitatum* were recorded as occasional at a depth of 35 m. Small Actinopterygii were abundant around the jacket leg.

Seabed

At the jacket base, *A. rubens* and Pleuronectiformes were abundant and *M. aeglefinus* was common. There was little visible evidence of material falling onto the seabed from the jacket, although some shell debris was present.

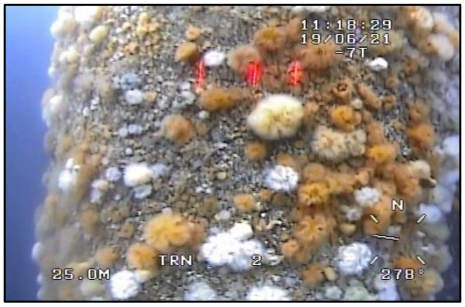
0m

5m

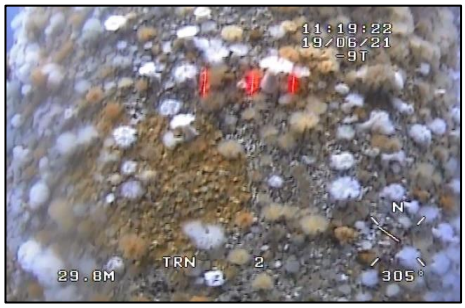
10m

15m

20m



25m



30m

35m

38m

seabed

Figure 11. Representative images taken at 5m depth intervals at C04W

3.3.4.2 C04 West: Benthic habitat around turbine

Heading in a west-northwesterly direction for approximately 50 m, the substrate at C04W was Sublittoral coarse sediment (EUNIS A5.1; Figure 12) including sand, shell and gravel. *A. rubens* and Portunidae (with attached *A. digitatum)* were recorded as frequent during the transect and small flatfish (Pleuronectiformes) were common.

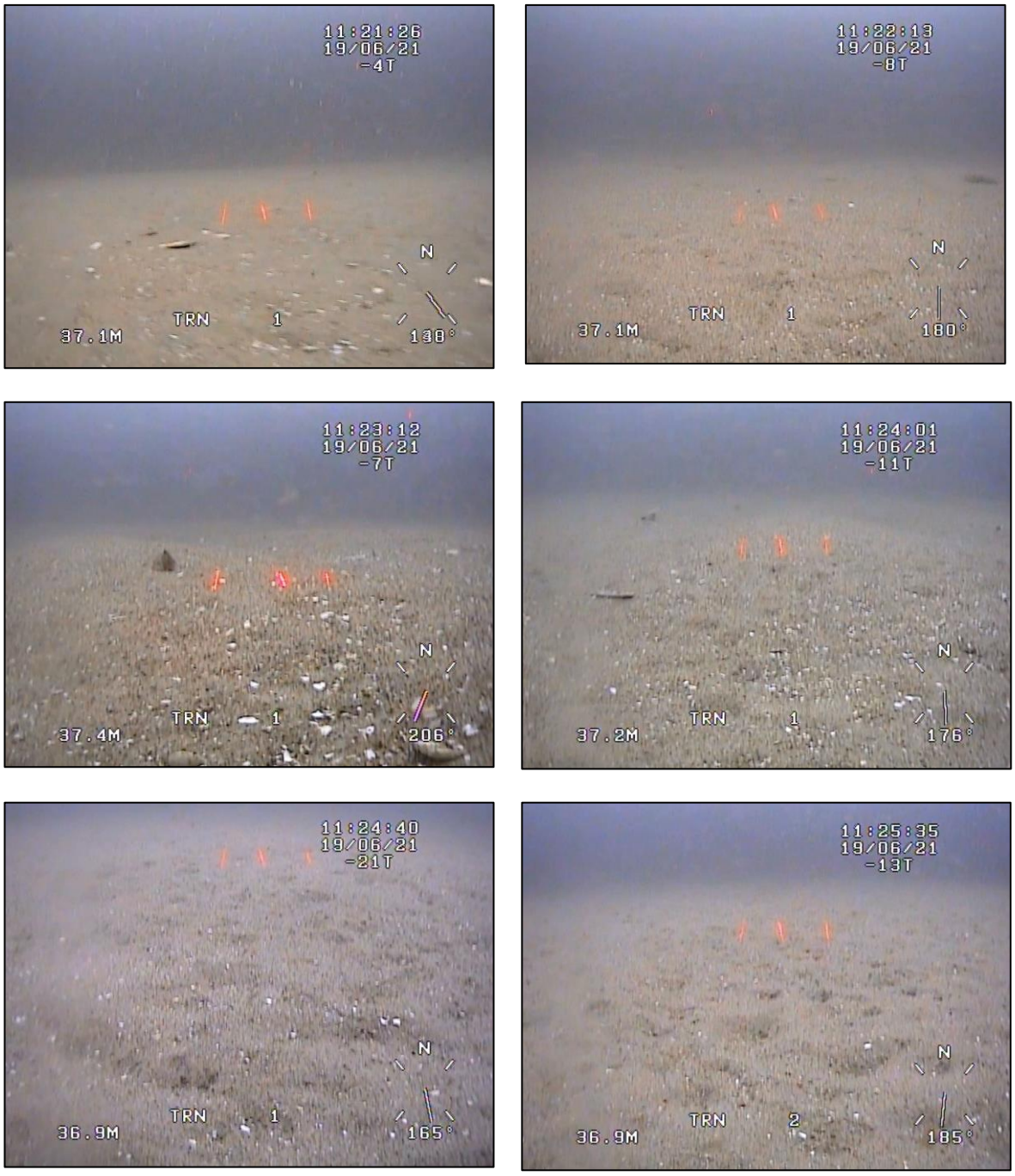


Figure 12. Representative seabed images taken at CO4W (all EUNIS A5.1)

3.4 Turbine F06

The nearest benthic grab station to this turbine was Station 9 at which all three replicate samples were allocated the biotope '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (SS.SSa.CFiSa.EpusOborApri; A5.251), (see APEM 2022 for details).

3.4.1 F06 North

3.4.1.1 F06 North: Turbine jacket leg assessment

0 - 5 m

The splash zone was sparsely populated with areas of uncolonised yellow high-visibility paint. Within the first metre of this section there were barnacles (Balanoidea) and lots of kelp (*Laminaria* sp. *and A. esculenta)*. Below 1 m this gave way to *Rhodophyta* turf, *Desmarestia* sp. and *D. sanguinea.* In the lower sections *M. senile* was recorded as occasional.

5 - 10 m

Biofouling in this band was extensive (90-100%) with a mixture of high and low biomass taxa. Within this zone *M. senile* was superabundant, *A. rubens* was rare, Rhodophyta turf and *Laminaria* sp. were frequent.

10 - 25 m

This zone was heavily biofouled by the large superabundant plumose anemone *M. senile*. In addition, *A. digitatum* became increasingly more common with depth and *A. rubens* was also present. From approximately 17 m the keel worm *Spirobranchus* sp. increased in abundance from common to superabundant.

25 - 41 m

The lower sections of F06N were almost entirely covered in superabundant *Spirobranchus* sp.. Common starfish *A. rubens* were present to about 30 m depth along with occasional common sea urchins *E. esculenta. M. senile* was still present until approximately 2-3 m off the seabed. *A. digitatum* was also recorded as frequent.

Seabed

The presence of occasional Pleuronectiformes (small flatfish), *A. rubens* and *E. esculentus* would suggest an availability of food on sediment at the base of the jacket although no material was visible.

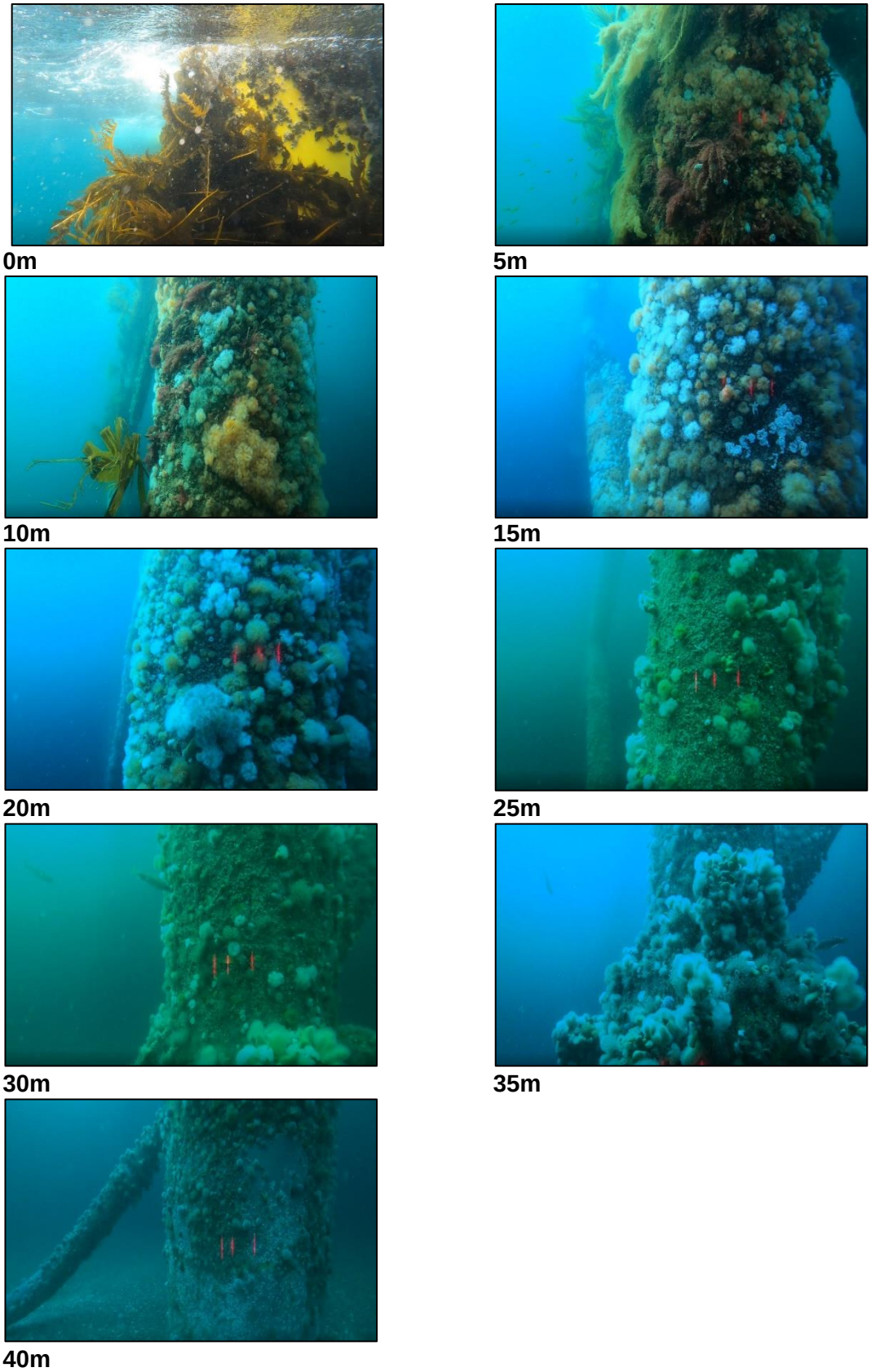


Figure 13. Representative images taken at 5m depth intervals at F06N

3.4.1.2 F06 North: Benthic habitat around turbine

Heading in a north-northeasterly direction for approximately 50 m, the substrate at F06N was classified as Sublittoral mixed sediments (EUNIS A5.4; Figure 14) with frequent *E. esculentus*, rare *A. rubens* and common *M. aeglefinus* and Pleuronectiformes.

Figure 14. Representative seabed images taken at F06N (all EUNIS A5.4)

3.4.2 F06 East

3.4.2.1 F06 East: Turbine jacket leg assessment

0 - 5 m

The splash zone was sparsely populated with areas of uncolonised yellow high-visibility paint. The top section of this zone was populated with abundant Balanoidea, and common limpet *Patella vulgata* and blue mussels *Mytilus edulis* were rare. Below this there was a band of kelp species (*Laminaria* sp. and *A. esculenta*) which gave way to algal species (*Desmarestia* sp., *D. sanguinea and Rhodophyta* turf).

5 - 10 m

The upper section of this band was dominated by algal species and these became sparser with depth and gave way to extensive biofouling (90-100%) containing a mixture of large and small taxa. Within this zone *M. senile* was abundant, *A. digitatum* was common, *A. rubens* was occasional and *C. pagurus* was rare. The lower end of this section had increasing numbers of the keel worm (*Spirobranchus* sp.).

10 - 25 m

This zone was heavily biofouled by large cnidarians such as superabundant to common *M. senile* and occasional *A. rubens*. From approximately 17 m *Spirobranchus* sp. became increasingly more common as depth increased (transitioning from common to superabundant).

25 - 40 m

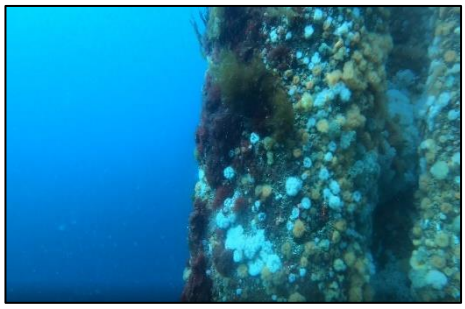
As with all other legs, the lower sections were almost entirely covered in superabundant *Spirobranchus* sp.. Common to occasional *M. senile* were also found until approximately 2-3 m off the seabed. Frequent *E. esculentus* (juvenile) and occasional *A. rubens* were also present down to the base of the jacket leg. At 35-36 m there was a band of *A. digitatum* with fish species seen swimming around the jacket edge.

Seabed

The presence of occasional *P. bernhardus*, *E. esculentus* (juvenile) and common *A. rubens* at the base of the jacket leg suggests an availability of food for these taxa although no biological debris was visible on the video footage. Abundant Pleuronectiformes and common *A. rubens* were also recorded around the base.

0m

5m



10m

15m

20m

25m

30m

35m

40m

Figure 15. Representative images taken at 5m depth intervals at F06E

3.4.2.2 F06 East: Benthic habitat around turbine

Heading in an east-southeasterly direction for approximately 50 m, the transect started in Sublittoral mixed sediments (EUNIS A5.4; Figure 16) with large amounts of shell and common *E. esculentus*, occasional *P. bernhardus* and rare *A. rubens*. To the side of the transect there was a visible area of Sublittoral coarse sediment (EUNIS A5.1; see Figure 16D) with no distinguishable conspicuous fauna identified.

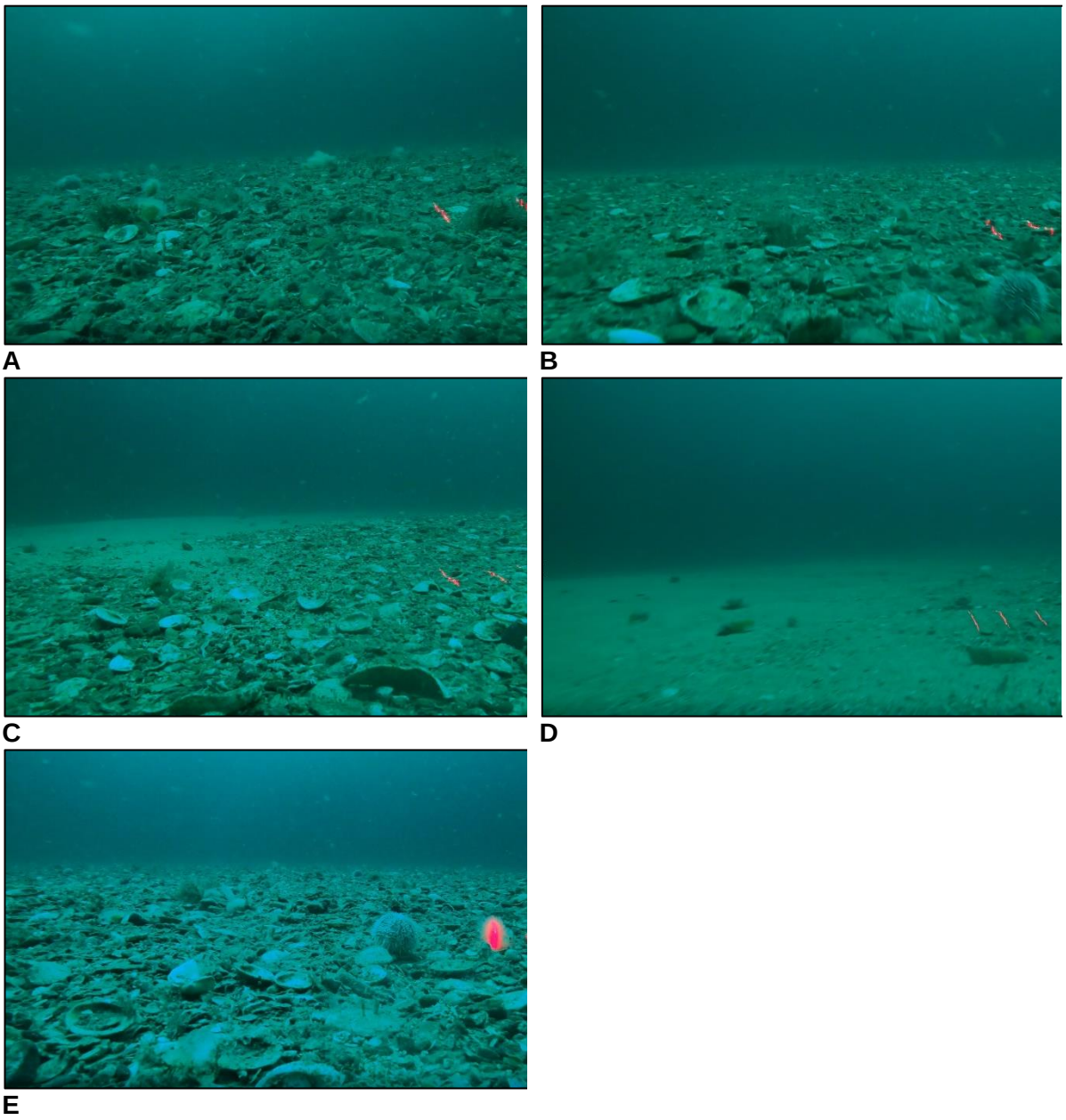


Figure 16. Representative seabed images taken at F06E (all EUNIS A5.4 except D, EUNIS A5.1)

3.4.3 F06 South

3.4.3.1 F06 South: Turbine jacket leg assessment

0 - 5 m

As with other legs on the F06 turbine, the splash zone was sparsely populated with areas of unpopulated yellow high-visibility paint, although Balanoidea were present in low numbers. The remainder of this section was densely populated with the kelps *Laminaria* sp. and *A. esculenta* and at the lower part of this section was densely populated with *Rhodophyta* turf, *Desmarestia* sp. and *D. sanguinea*.

5 - 10 m

As with other legs on turbine F06 this transitional zone included most of the taxa found lower on the leg along with kelp species. Biofouling in this band was extensive (90-100%) with superabundant *M. senile*. Algal taxa became increasingly rare with depth.

10 - 25 m

This zone was heavily biofouled with *M. senile*, *Spirobranchus* sp. and *A. digitatum*. Occasional *A. rubens and E. esculentus* were also present.

25 - 40 m

As with all other legs, the lower sections were almost entirely covered in superabundant *Spirobranchus* sp. The taxa *M. senile and A. digitatum* were present but both were rare near the base. *A. rubens and E. esculentus* were also present, increasing to common at the base.

Seabed

At the jacket base the presence of *A. rubens* and *E. esculentus* would suggest a potential availability of food although no biological material was visible. A single common dragonet *C. lyra* was also present at the jacket base.

0m

5m

10m

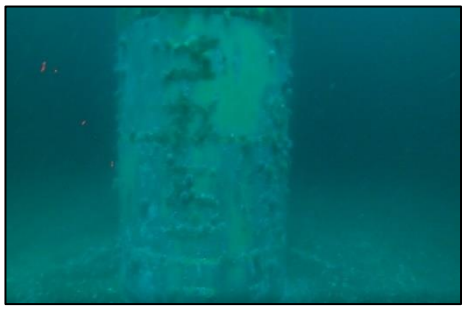
15m

20m

25m

30m

35m



40m

Figure 17. Representative images taken at 5m depth intervals at F06S

3.4.3.2 F06 South: Benthic habitat around turbine

Heading in a south-southwesterly direction for approximately 50 m, the transect consisted of Sublittoral mixed sediments (EUNIS A5.4; Figure 18) with large amounts of shell, rare Pleuronectiformes and occasional *A. digitatum* and *E. esculentus.*

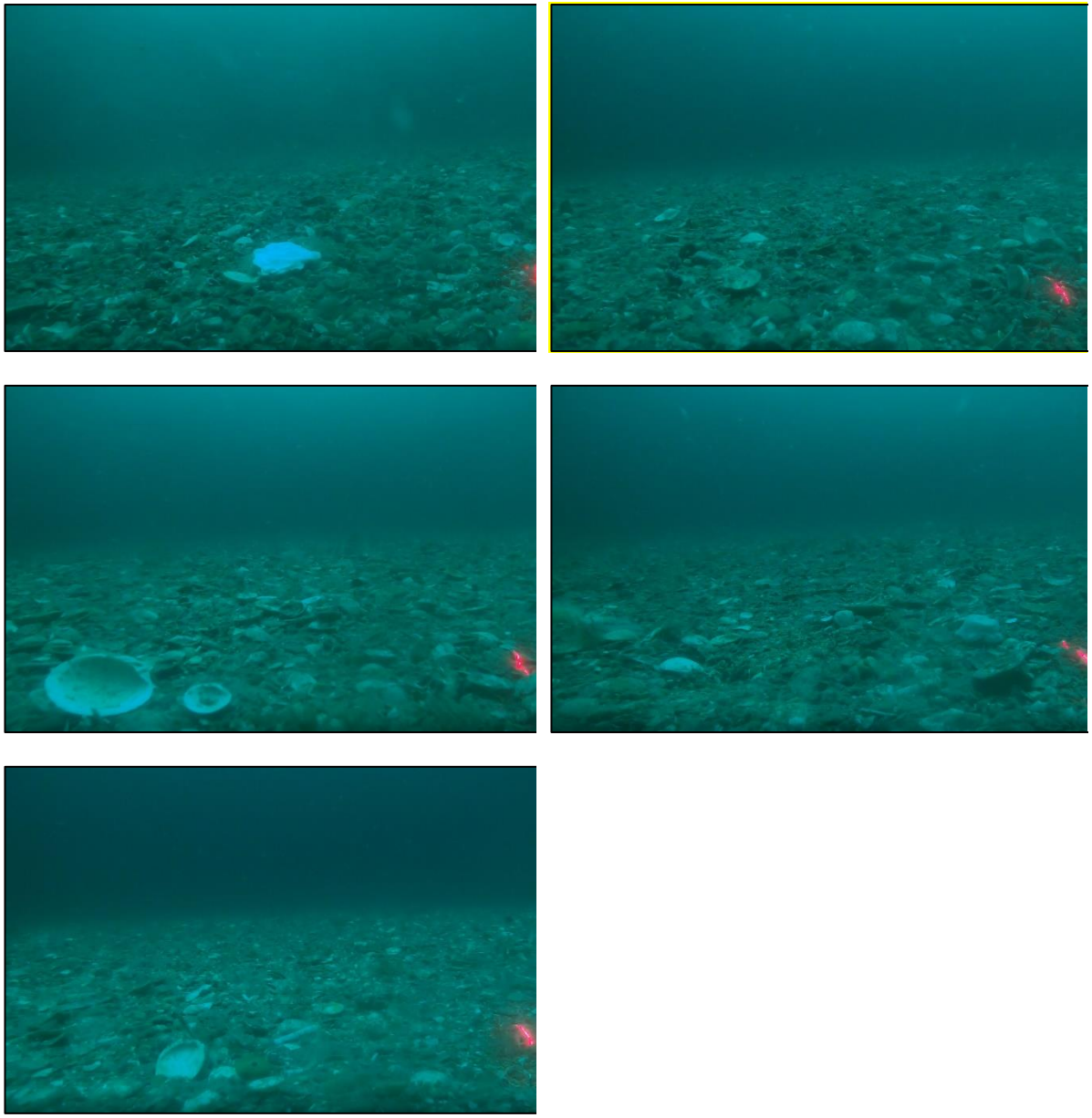


Figure 18. Representative seabed images taken at F06S (all EUNIS A5.4)

3.4.4 F06 West

3.4.4.1 F06 West: Turbine jacket leg assessment

0 - 5 m

The splash zone had small areas of unpopulated yellow high-visibility paint and Balanoidea, *M. edulis* and *P. vulgata* were present on the upper section before algal taxa became increasingly dominant. The lower section of this band had occasional *M. senile* and small *Actinopterygii* could be seen swimming around the jacket.

5 - 10 m

This transition zone was consistent with other jacket legs with extensive biofouling (90-100%) with a mixture of superabundant *M. senile* and occasional *A. digitatum*. Small fish could be seen swimming around the jacket edge.

10 - 25 m

This zone was heavily biofouled with superabundant *M. senile*, occasional to abundant *Spirobranchus* sp. and abundant *A. digitatum*. Common starfish *A. rubens* were rare.

25 - 41 m

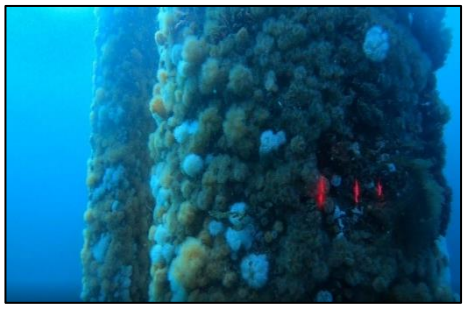
The lower sections of F06W were almost entirely covered in superabundant *Spirobranchus* sp.. Abundant to occasional *M. senile* and *A. digitatum* were recorded until approximately 1 m off the seabed. *E. esculentus* was recorded as common and *A. rubens* was occasional throughout the zone.

Seabed

The presence of common *E. esculentus* and occasional A. rubens at the base of the jacket leg suggests an availability of food for these taxa, although none was conspicuous on the video footage.

0m

5m



10m

15m

20m

25m

30m

35m

41m

Figure 19. Representative images taken at 5m depth intervals at F06W

3.4.4.2 F06 West: Benthic habitat around turbine

Heading in a west-northwesterly direction for approximately 50 m, the transect started in Sublittoral mixed sediments (EUNIS A5.4; Figure 20) with occasional *A. digitatum*, and Pleuronectiformes, common *E. esculentus* and Frequent *P. bernhardus*. The rest of the transect was Sublittoral coarse sediment (EUNIS A5.1; see Figures 20D, E, and F) with no conspicuous fauna recorded.

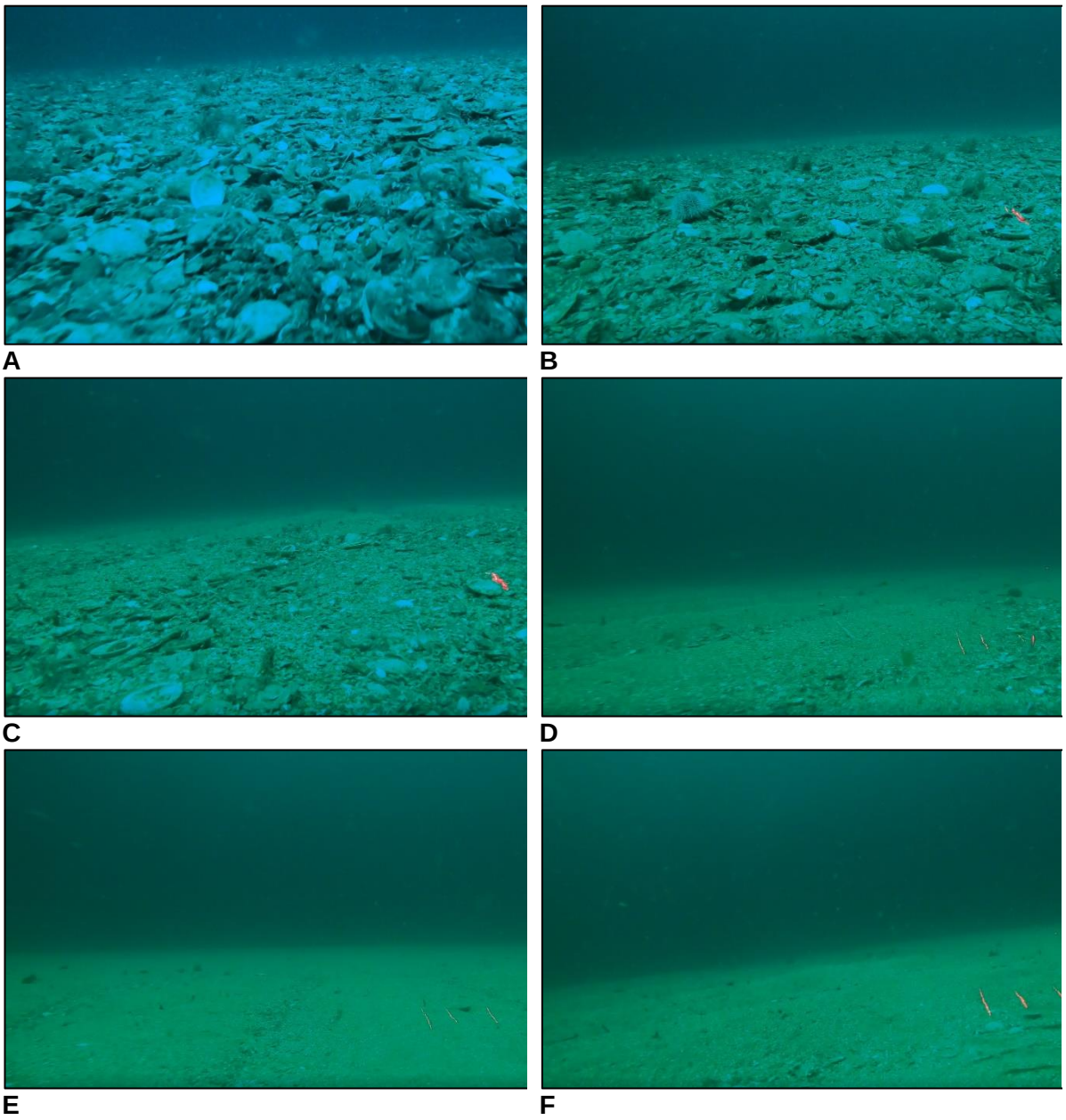


Figure 20. Representative seabed images taken at F06W (all EUNIS A5.4 except D, E, F, EUNIS A5.1)

3.5 Turbine H08

The nearest benthic grab station to this turbine was Station 1 at which all three replicate samples were allocated the biotope '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (SS.SSa.CFiSa.EpusOborApri; A5.251), (see APEM 2022 for details).

3.5.1 H08 North

3.5.1.1 H08 North: Turbine jacket leg assessment

0 - 5 m

The upper section had areas of uncolonised yellow high-visibility paint visible with barnacles Balanoidea, limpets *P. vulgata* and blue mussels *M. edulis* attached. The section below this was predominantly dominated by algal taxa including kelp *Laminaria* sp. and *A. esculenta*, red algal Rhodophyta turf, *D. sanguinea* and *Desmarestia* sp. The lowest part of this section was colonised by the plumose anemone *M. senile*.

5 - 10 m

Transitioning into the deeper bands, algal species were present to approximately 8 m depth. The lower part of this section was dominated by the abundant plumose anemone *M. senile.* Rare *A. rubens* were also present

10 - 25 m

This section contained heavy biofouling mainly attributed to *M. senile*, however, slower-growing taxa like dead man's fingers *A. digitatum* became increasingly common with depth. The keel worm *Spirobranchus* sp. was also frequent throughout the lower part of this band.

25 - 42 m

As with each of the other turbines sampled, *Spirobranchus* sp. was superabundant in this band and was the dominant taxon with almost 100% cover in some places. *M. senile* and *A. digitatum* became increasingly rare, however between 38 – 40 m they became abundant again. Below 40 m the jacket was dominated by *Spirobranchus* sp. and common sea urchin *E. esculentus* and a sun star *C. papposus* were recorded.

Seabed

At the jacket base, Pleuronectiformes were common and wrasse (Labridae) were frequent suggesting the presence of food sources but no biological debris was visible in the underwater footage.

0m

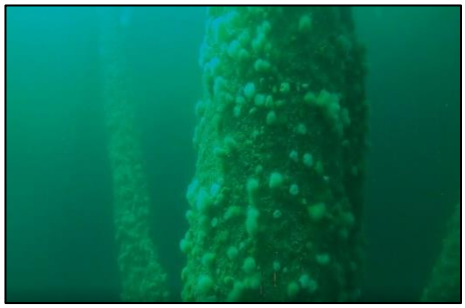
5m

10m

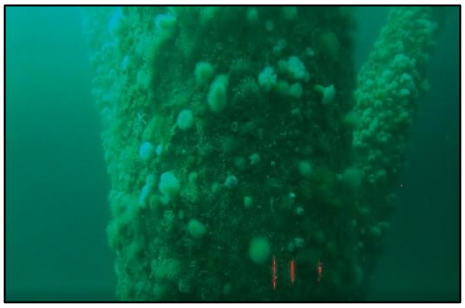
15m

20m

25m



30m



35m

Jacket base

Figure 21. Representative images taken at 5 m depth intervals at H08N

3.5.1.2 H08 North: Benthic habitat around turbine

Heading in a north-northeasterly direction for approximately 50 m, the whole of the transect was Sublittoral coarse sediment (EUNIS A5.1; Figure 22). Pleuronectiformes and *M. aeglefinus* were abundant, there were occasional hermit crabs *P. bernhardus* and common sea urchins *E. esculenta* as well as rare dead man's fingers *A. digitatum,* common starfish *A. rubens* and anemones *M. senile*.

Figure 22. Representative seabed images taken at H08N (all EUNIS A5.1)

3.5.2 H08 East

3.5.2.1 H08 East: Turbine jacket leg assessment

0 - 5 m

In the upper splash zone, small areas of uncolonised yellow high-visibility paint were visible. This section was heavily covered with different algae including superabundant kelp *Laminaria* sp. and *A. esculenta* as well as *D. sanguinea* and Rhodophyta turf.

5 – 10 m

Transitioning into deeper bands the algal taxa become less abundant and were replaced predominantly by the plumose anemone. *M. senile* and *bryozoa/ hydrozoa* turf. *Spirobranchus* sp. was occasional and *A. rubens* was rare.

10 – 25 m

A high proportion of the biofouling in this zone was attributable to *M. senile*, however, slower-growing taxa like *A. digitatum* were common. The keel worm *Spirobranchus* sp. became more abundant with depth. *A. rubens* was rare in this band.

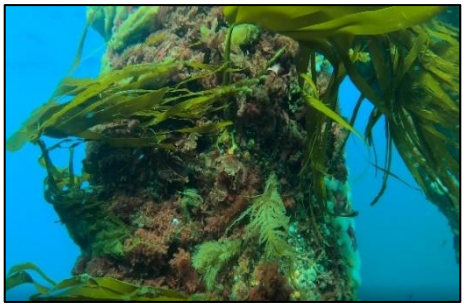
25 – 44 m

Spirobranchus sp. was superabundant in this band and the dominant taxon resulting in almost 100% cover in some places. In addition, *M. senile, A. digitatum, E. esculentus* and *C. papposus* were all present.

Seabed

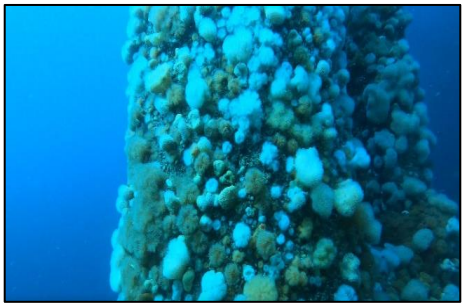
The taxa *E. esculentus,* Pleuronectiformes *and M. aeglefinus* were recorded at the base of the turbine suggesting food resources were readily available although there was no evidence of biofouling being present on the seabed.

0m



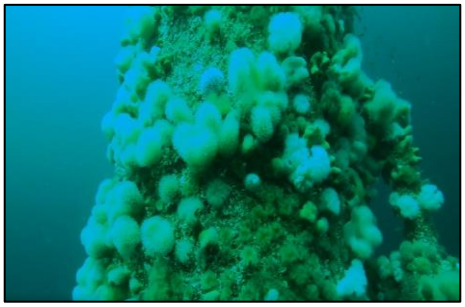
5m

10m



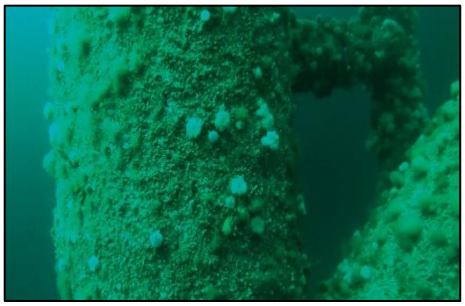
15m

20m



25m

30m



35m

40m

Figure 23. Representative images taken at 5m depth intervals at H08E

3.5.2.2 H08 East: Benthic composition around turbine

Heading in an east-southeasterly direction for approximately 50 m, the area directly below the turbine jacket contained large shell fragments, however, overall the transect was recorded as Sublittoral coarse sediment (EUNIS A5.1; Figure 24). Pleuronectiformes were common and there were occasional hermit crabs *P. bernhardus* and rare starfish *A. rubens*

Figure 24. Representative seabed images taken at H08E (all EUNIS A5.1)

3.5.3 H08 South

3.5.3.1 H08 South: Turbine jacket leg assessment

0 - 5 m

The upper splash zone was well colonised and biota present was consistent with other jacket legs with *Laminaria* sp., *A. esculenta* and *D. sanguinea* being abundant to superabundant. Balanoidea were common and small Actinopterygii could be seen swimming around the jacket leg.

5 – 10 m

Algal taxa still present within this band were abundant *Laminaria* sp. and *A. esculenta* as well as common *D. sanguinea* and *Rhodophyta* turf. At the lower end of the section the plumose anemone *M. senile* was occasional.

10 – 25 m

The band was dominated by large, high biomass individuals such as *M. senile*, *A. digitatum*, *A. rubens*, and *E. esculentus.* Keel worms *Spirobranchus* sp. were also increasingly abundant

25 – 44 m

Keel worms *Spirobranchus* sp. was the dominant taxon within this band and they were superabundant throughout. In addition, *M. senile* was occasional to superabundant, while *A. digitatum* and *C. lepadiformis* were both common to abundant.

Seabed

At the jacket base Pleuronectiformes, *E. esculentus* and *M. aeglefinus* were all occasional and *A. rubens* was rare but there was no evidence of accumulating biological material on the video footage.

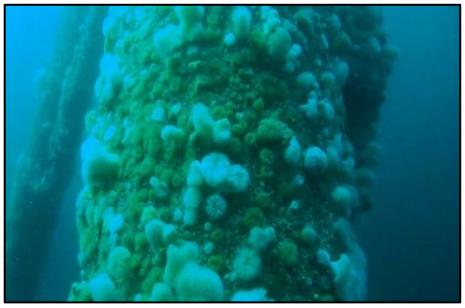
0m

5m

10m

15m

20m



25m

30m

35m

40m

Figure 25. Representative images taken at 5m depth intervals at H08S

3.5.3.2 H08 South: Benthic composition around turbine

Heading in a south-southwesterly direction for approximately 50 m, the transect was recorded as Sublittoral coarse sediment (EUNIS A5.1; Figure 26) with *P. bernhardus* and red whelk *Neptunea antiqua* recorded as rare, *E. esculentus* was recorded as occasional and Pleuronectiformes and *M. aeglefinus* were abundant.

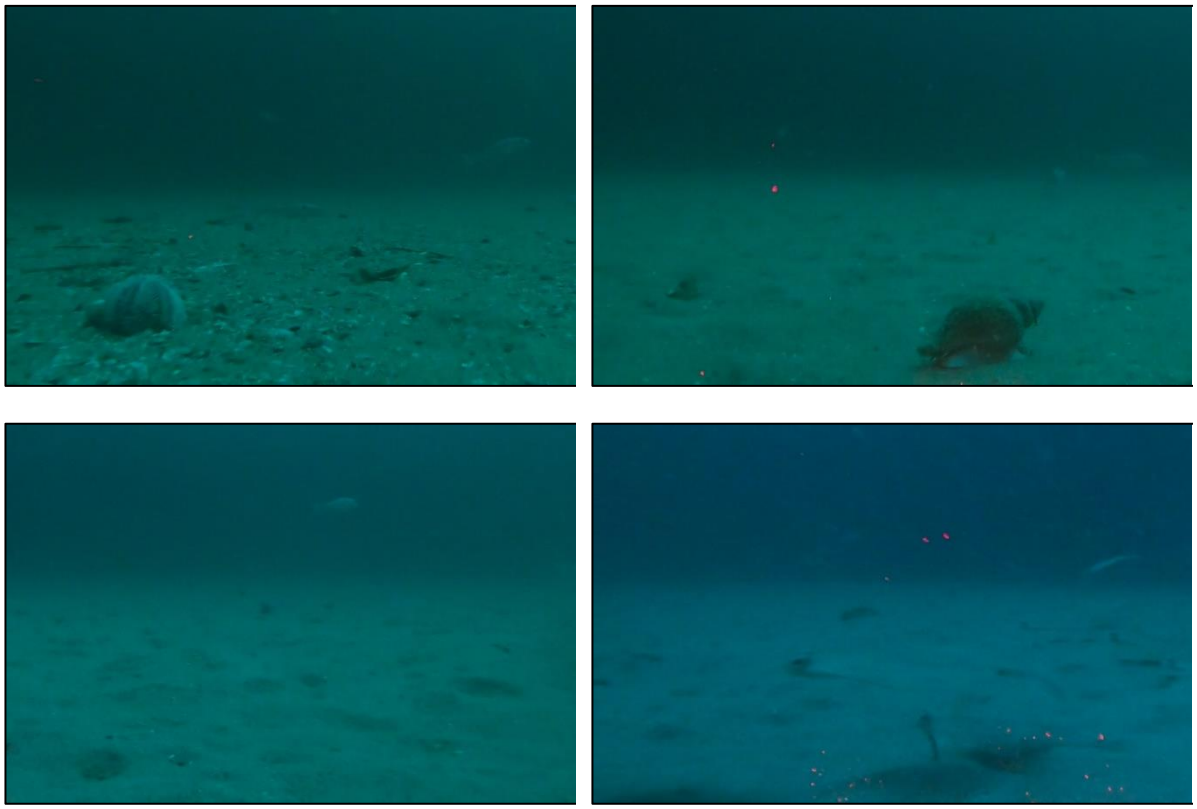


Figure 26. Representative seabed images taken at H08S (all EUNIS A5.1)

3.5.4 H08 West

3.5.4.1 H08 West: Turbine jacket leg assessment

0 - 5 m

The upper splash zone had areas of uncolonised foundation where yellow high-visibility paint was visible. Below 0.5 m algae were abundant, with *Laminaria* sp. and *A. esculenta* being superabundant, while Rhodophyta turf and *D. sanguinea* were common. At the lower section of this band *M. senile* was abundant.

5 - 10 m

Biofouling in this band was dominated by *M. senil*e which was superabundant. The sea squirt *C. lepadiformis* and *Spirobranchus* sp. were occasional. The algal species found in the shallower bands were still present but became increasingly less common with depth.

10 - 25 m

This section was dominated by *M. senile, Spirobranchus* sp. and *A. digitatum* with occasional *E. esculentus* and *C. lepadiformis*.

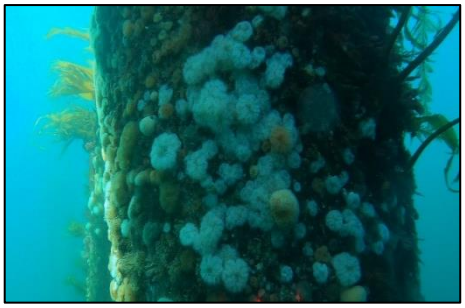
25 - 44 m

Spirobranchus sp. became the dominant taxon below 25 m where it was superabundant. *A. digitatum* was abundant to common, *E. esculentus* and *A. rubens* were both occasional to rare and *M. senile* was abundant.

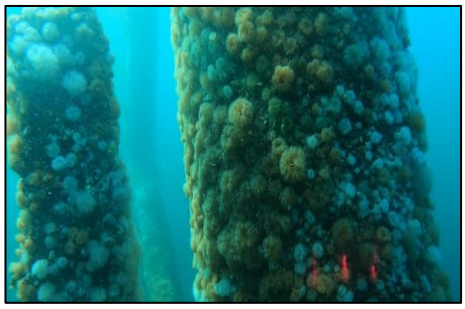
Seabed

At the jacket base *E. esculentus, A. rubens* and flatfish (Pleuronectiformes) were occasional. There was no evidence of accumulated biological material on the video footage.

0m

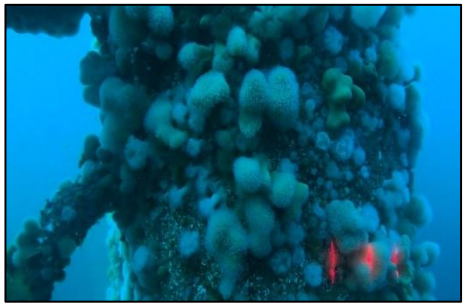


5m

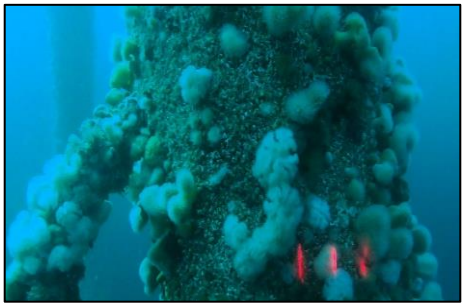


10m

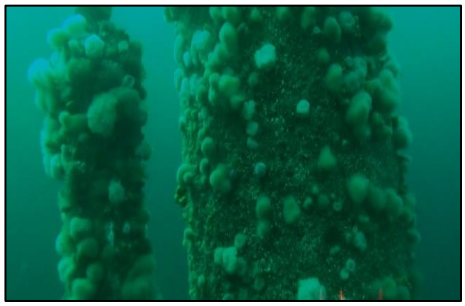
15m



20m



25m



30m

35m

Jacket base (43m)

Figure 27. Representative images taken at 5m depth intervals at H08W

3.5.4.2 H08 West: Benthic composition around turbine

Heading in a west-northwesterly direction for approximately 50 m, the substrate was Sublittoral coarse sediment (EUNIS A5.1; Figure 28). Hermit crab *P. bernhardus* and *M. aeglefinus* were rare and flatfish (Pleuronectiformes) were occasional.

Figure 28. Representative seabed images taken at H08W (all EUNIS A5.1)

3.6 Turbine K07

The nearest benthic grab station to this turbine was Station 2 at which all three replicate samples were allocated the biotope '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (SS.SSa.CFiSa.EpusOborApri; A5.251), (see APEM 2022 for details).

3.6.1 K07 North

3.6.1.1 K07 North: Turbine jacket leg assessment

0 - 5 m

The upper section of the jacket leg was colonised by superabundant *Laminaria* sp and *A. esculenta* along with abundant *Desmarestia* sp. The plumose anemone *M. senile* was present at a much shallower depth compared to other turbines and after the first 1 m section *M. senile* was abundant (this observation was similar across other legs at K07 and was consistent with the findings of the 2020 survey (APEM 2021)). Rhodophyta and Phaeophyta turf were recorded as occasional and *A. rubens* was common. A single individual of a Portunidae crab was recorded at 4 m depth. Small Actinopterygii were seen around the jacket leg.

5 - 10 m

Within this transition zone algal taxa were occasional to frequent in the upper zone. The plumose anemone *M. senile* was superabundant and small Actinopterygii were seen around the jacket leg.

10 - 25 m

This band was dominated by superabundant *M. senile*, the lower section of this band had occasional *A. digitatum*, common keel worm *Spirobranchus sp.* and occasional to common *A. rubens*. Haddock *M. aeglefinus* were present around the jacket leg.

25 - 45 m

Descending the leg, *Spirobranchus* sp. was superabundant and became the dominant taxon. *M. senile* was still present along with *A. digitatum*, *E. esculentus*, *A. rubens* and *C. lepadiformis*.

Seabed

At the base of the leg Pleuronectiformes, *P. bernhardus and M. aeglefinus* were recorded. There was, however, no evidence of accumulated biological material on the seabed.

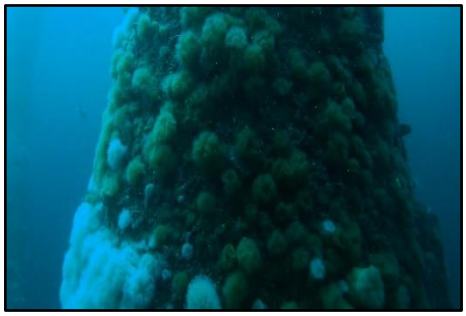
5m

10m

15m

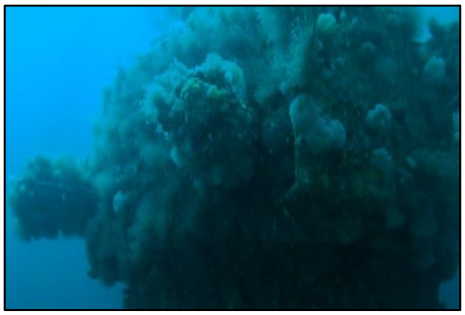
20m

25m



30m

35m



40m

Jacket base

Figure 29. Representative images taken at 5m depth intervals at K07N

3.6.1.2 K07 North: Benthic composition around turbine

Heading in a north-northeasterly direction for approximately 50 m, the substrate was recorded as Sublittoral coarse sediment (EUNIS A5.1; Figure 30). Species present were *A. rubens, P. bernhardus,* Pleuronectiformes *and M. aeglefinus.*

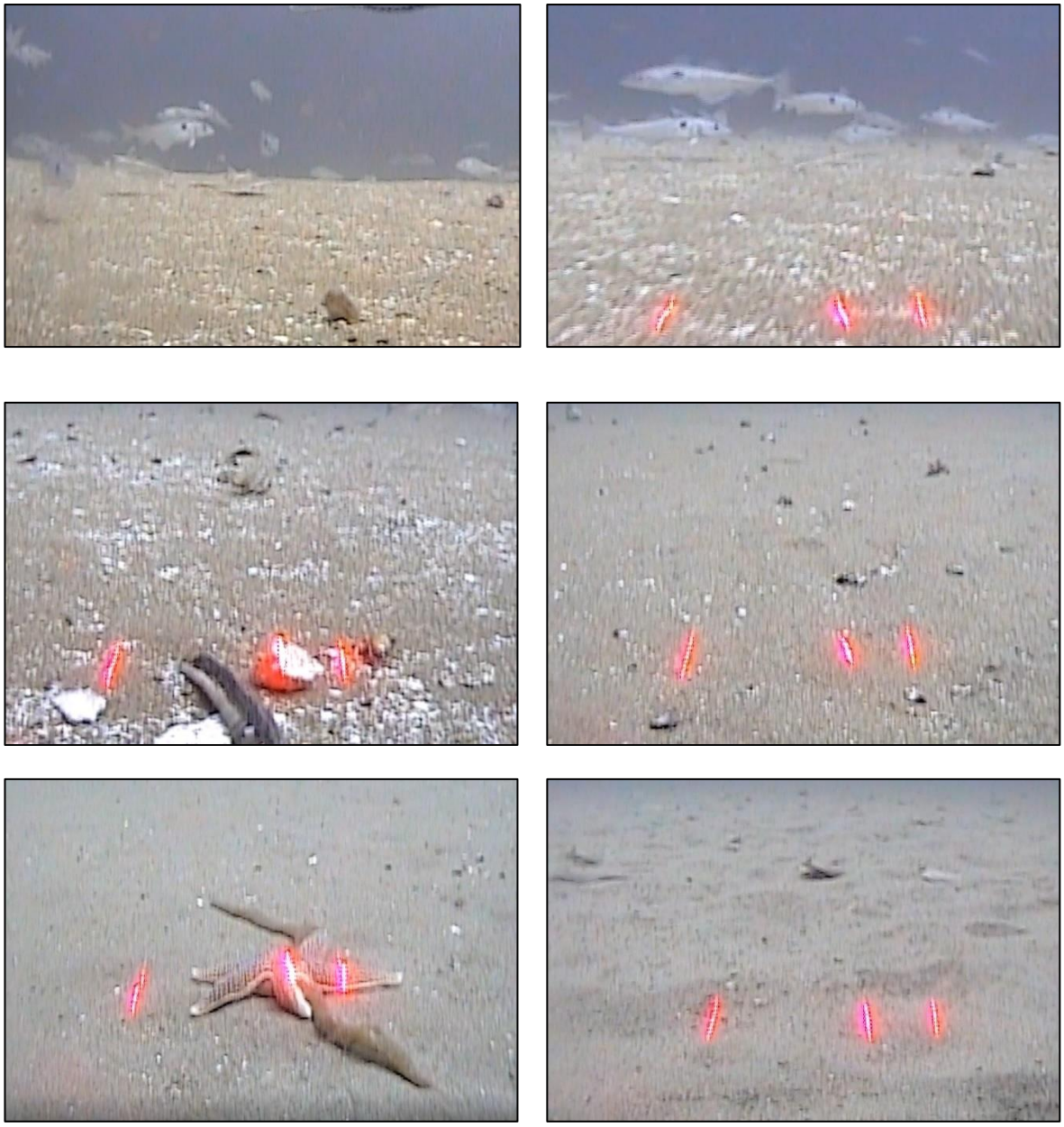


Figure 30. Representative seabed images taken at K07N ((all EUNIS A5.1))

3.6.2 K07 East

3.6.2.1 K07 East: Turbine jacket leg assessment

0 - 5 m

There was no visible area of high-visibility paint on this jacket leg. The upper section was dominated by algal taxa (superabundant kelp *Laminaria* sp. and *A. esculenta*, occasional *Desmarestia* sp. and *D. sanguinea* as well as Rhodophyta and Phaeophyta turf). The plumose anemone *M. senile* was abundant from approximately 3 m depth. Small Actinopterygii could be seen swimming around the edge of the jacket leg.

5 - 10 m

In this transition zone algal taxa were present, but this section was dominated by superabundant *M. senile*, small *Actinopterygii* could still be seen swimming around the edge of the jacket leg.

10 - 25 m

This depth band was dominated by larger, high biomass taxa. *M. senile* was superabundant, *A. rubens* and *A. digitatum* were occasional, *E. esculentus* was rare and the keel worm *Spirobranchus* sp. became increasingly more abundant with depth.

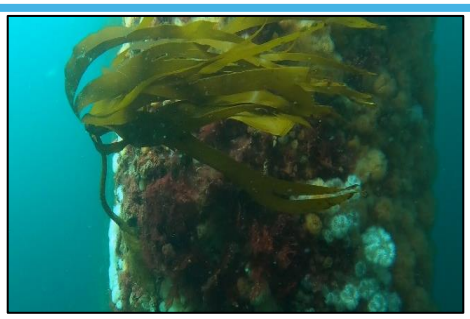
25 - 40 m

Transitioning deeper down the leg, *Spirobranchus* sp. became dominant and was superabundant. *A. digitatum* and the light bulb sea squirt *C. lepadiformis* were occasional, and *A. rubens* and *E. esculentus* were present along with the edible crab *Cancer pagurus* and a common dragonet *C. lyra*.

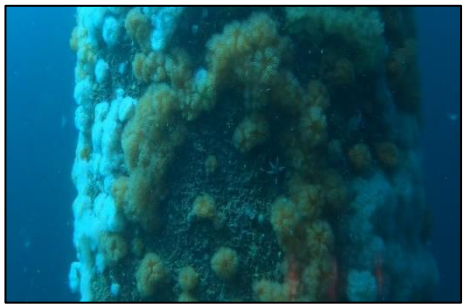
Seabed

At the jacket base Pleuronectiformes, Labridae and *A. rubens* were present but there was no evidence of accumulated biological material.

5m

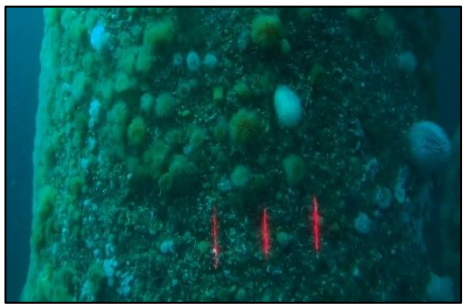


10m



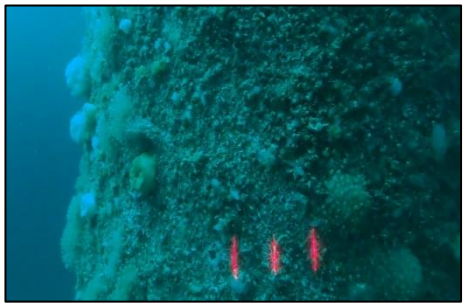
15m

20m



25m

30m



35m

40m

Jacket base (43m)

Figure 31. Representative images taken at 5m depth intervals at K07E

3.6.2.2 K07 East: Benthic composition around turbine

Heading in an east-southeasterly direction for approximately 50 m, the substrate was Sublittoral coarse sediment (EUNIS A5.1; Figure 32) and *A. rubens* was recorded as occasional and flatfish (Pleuronectiformes) were common.

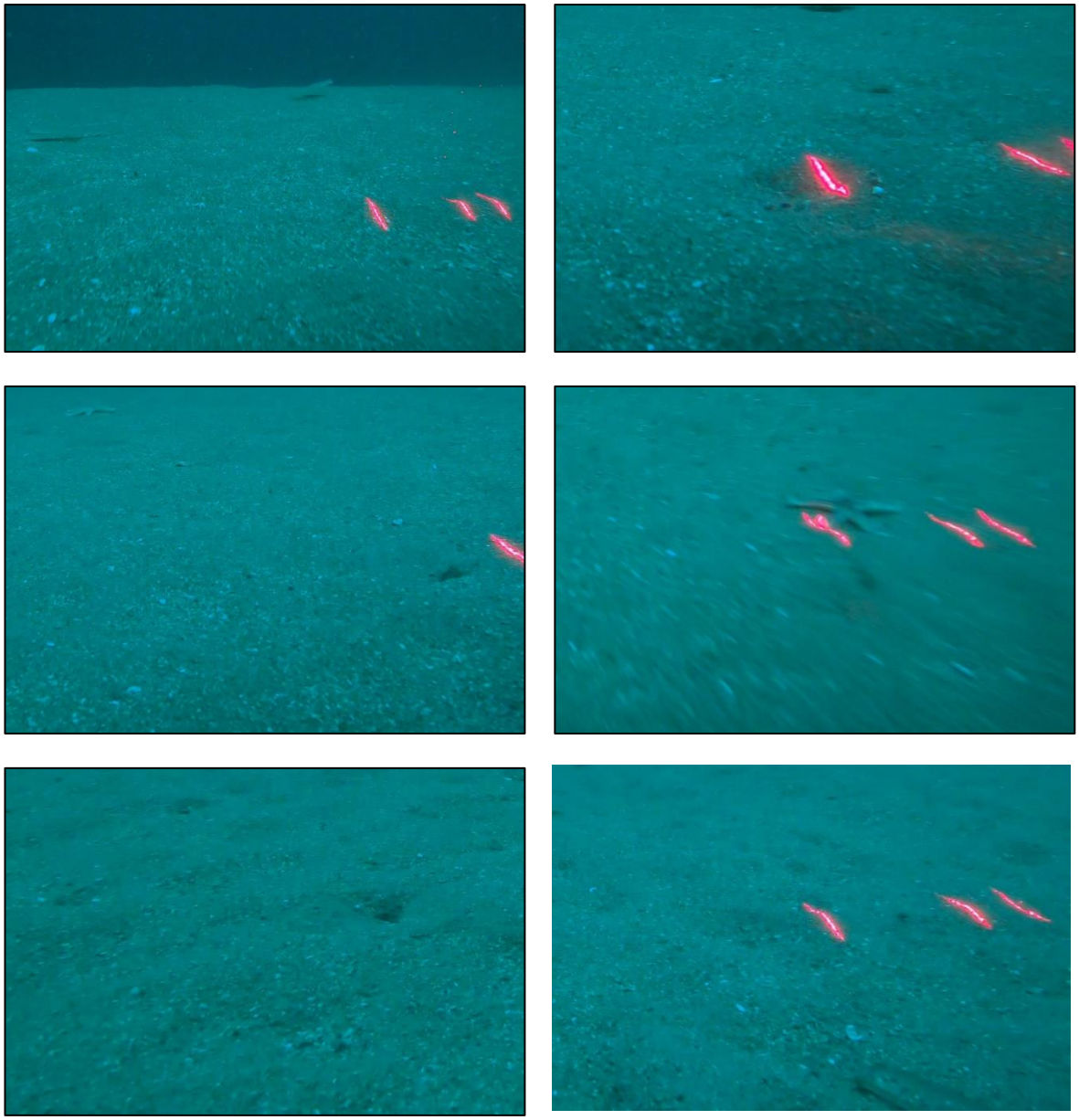


Figure 32. Representative seabed images taken at K07E (all EUNIS A5.1)

3.6.3 K07 South

3.6.3.1 K07 South: Turbine jacket leg assessment

0 - 5 m

Small patches of uncolonised yellow high-visibility paint were visible at the very top of this section. The rest was dominated by kelp *Laminaria* sp. and *A. esculenta* and other algal taxa *D. sanguinea, Desmarestia* sp. and Phaeophyta and Rhodophyta turf. At the bottom of this section *M. senile* was occasional. Small fish (*Actinopterygii*) were seen swimming around the jacket leg.

5 - 10 m

This band was a transition area between the shallower algae-dominated zone and the slightly deeper *M. senile* dominated zone. *A. rubens* was rare and small *Actinopterygii* were seen swimming around the jacket leg.

10 - 25 m

This band was dominated by superabundant *M. senile* and *Spirobranchus* sp.. Also present were occasional *A. rubens* and *C. lepadiformis* and rare *A. digitatum* and *E. esculentus*.

25 - 45 m

This section was heavily bio-fouled with *Spirobranchus* sp., *M. senile, A. digitatum* and *C. lepadiformis*. Common starfish *A. rubens* were rare and common sea urchin *E. esculentus* were occasional.

Seabed

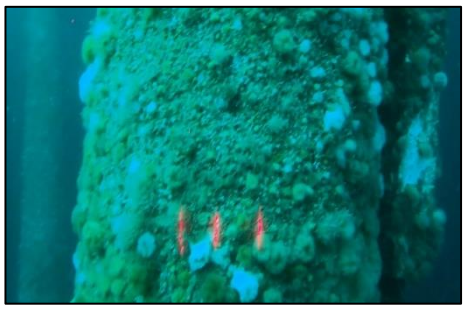
P. bernhardus and Pleuronectiformes were present at the base of the jacket although no biological material was evident on the seabed.

5m

10m

15m

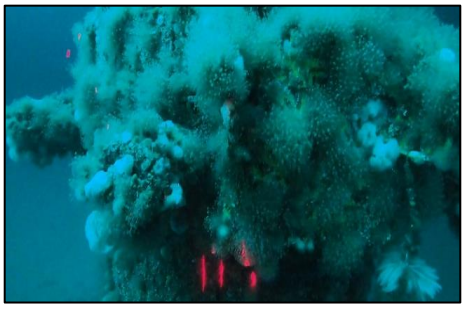
20m



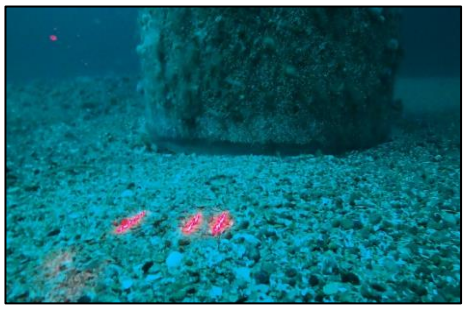
25m

30m

35m



40m



Jacket base (45m)

Figure 33. Representative images taken at 5m depth intervals at K07S

3.6.3.2 K07 South: Benthic composition around turbine

Heading in a south-southwesterly direction for approximately 50 m, the substrate was Sublittoral coarse sediment (EUNIS A5.1; Figure 34). Common starfish *A. rubens* and red whelk *Neptunea antiqua* were recorded as rare, there were occasional *E. esculentus* and *P. bernhardus* while Pleuronectiformes and *M. aeglefinus* were common.

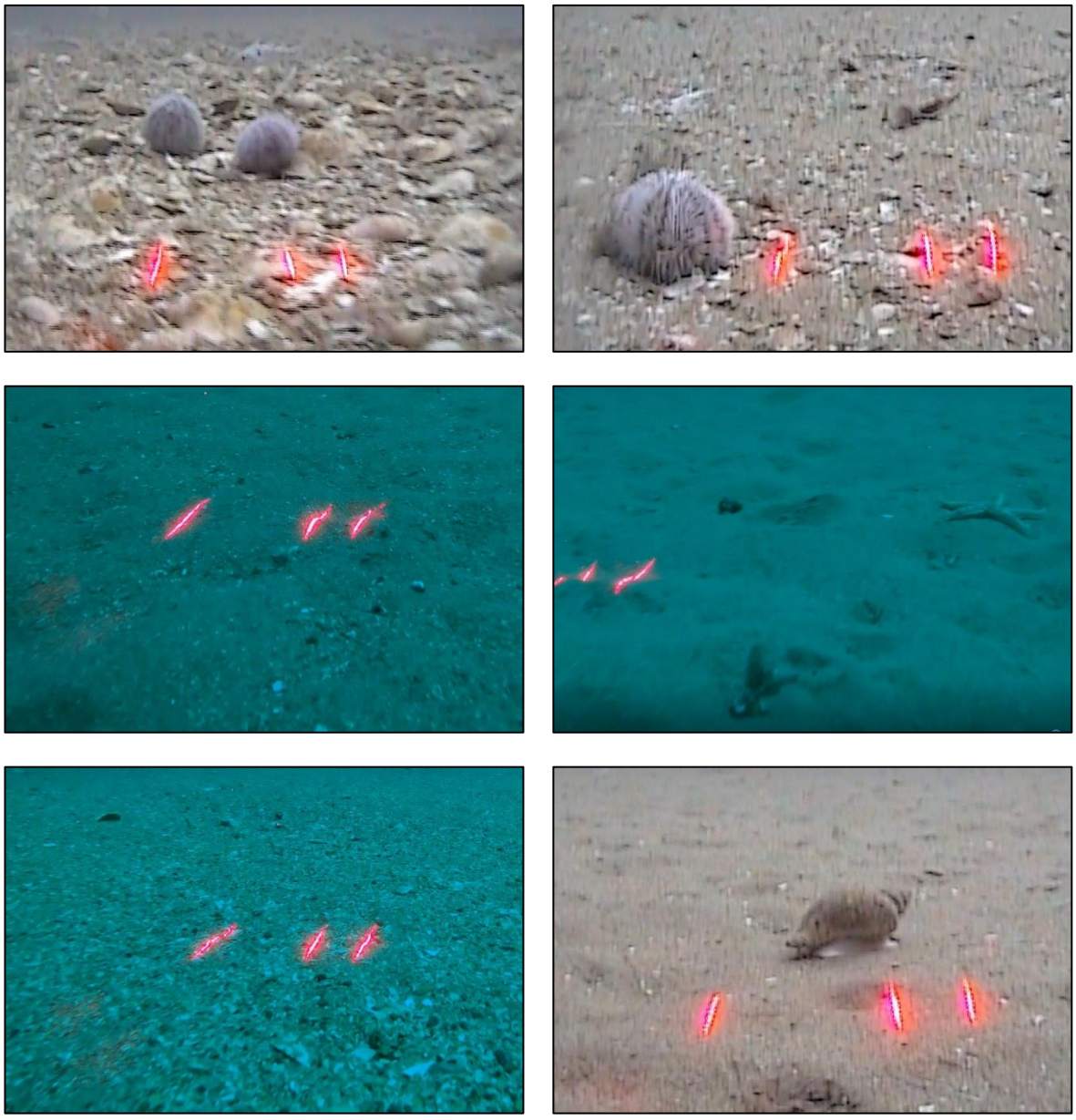


Figure 34. Representative seabed images taken at K07S (all EUNIS A5.1)

3.6.4 K07 West

3.6.4.1 K07 West: Turbine jacket leg assessment

0 - 5 m

There were no patches of uncolonised yellow high-visibility paint visible on this leg. Kelp species *Laminaria* sp. and *A. esculenta* were dominant in the upper part of this section. The plumose anemone *M. senile* was present from 1.5 m and superabundant by 5 m.

5 - 10 m

Algal taxa were rare in this band and *M. senile* was superabundant. Small Actinopterygii could be seen swimming around the edge of the jacket.

10 – 25 m

This band was dominated by the large superabundant cnidarian *M. senile*. *Spirobranchus* sp. were abundant and *C. lepadiformis, A. rubens* and *A. digitatum* were rare to occasional.

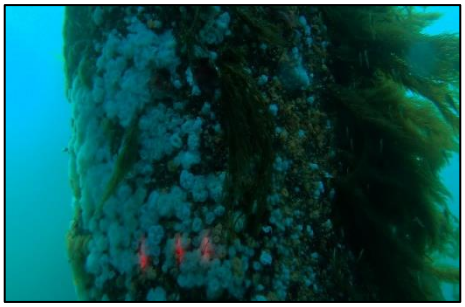
25 – 43 m

As typically found within this depth band on other turbine foundations, the keel worm *Spirobranchus* sp. was superabundant. *M. senile, A. digitatum* and *C. lepadiformis* were all common, *A. rubens* and *E. esculentus* were both occasional to rare.

Seabed

At the jacket base *P. bernhardus, C. papposus* and Labridae were all rare and flatfish (Pleuronectiformes) were frequent.

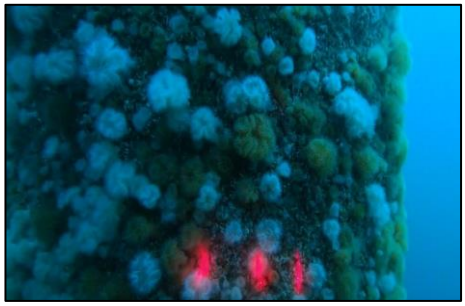
0m



5m

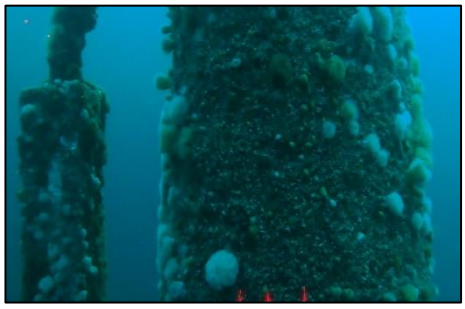
10m

15m



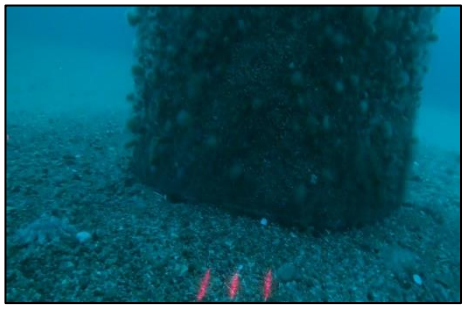
20m

25m



30m

35m



Jacket base (43m)

Figure 35. Representative images taken at 5m depth intervals at K07W

3.6.4.2 K07 West: Benthic composition around turbine

Heading in a west-northwesterly direction for approximately 50 m, the entirety of the K07W transect was Sublittoral coarse sediment (EUNIS A5.1; Figure 36). The conspicuous species present were *A. rubens, E. esculentus and P. bernhardus* which were all rare and flatfish (Pleuronectiformes) and *M. aeglefinus* which were abundant.

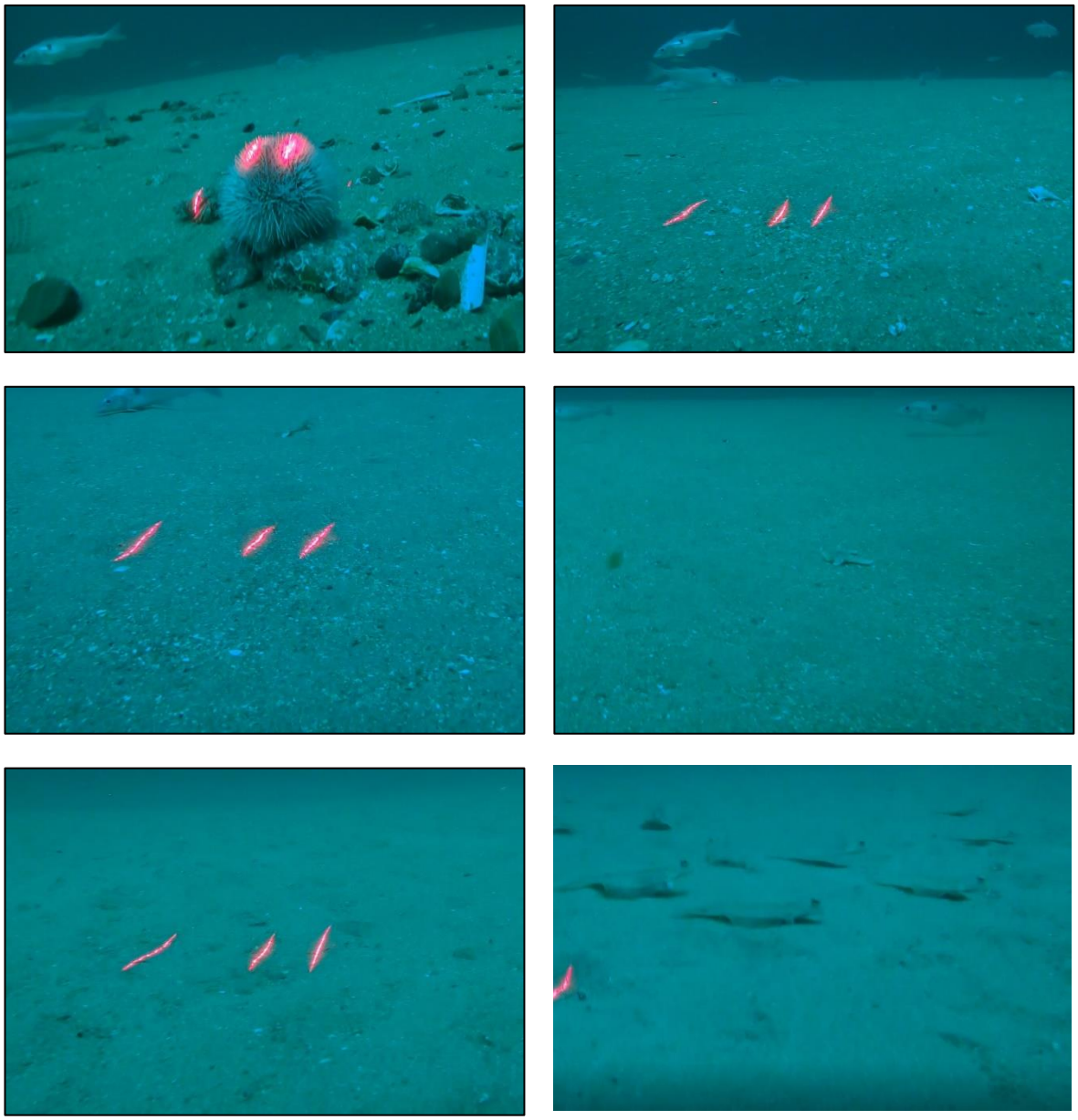


Figure 36. Representative seabed images taken at K07W (all EUNIS A5.1)

3.7 Species of conservation importance

Haddock *M. aeglefinus* is listed as vulnerable on the IUCN Red List (IUCN 2022).

Plaice (which could have been present and recorded as Pleuronectiformes), saithe *P. virens* and common dragonet *C. lyra* are listed as 'Least Concern' (IUCN 2022).

The common sea urchin *E. esculentus* has also been assessed for the IUCN Red List and is considered 'Near Threatened' (IUCN 2022).

3.8 Non-native species

No conspicuous NNS were recorded from the ROV or GoPro footage.

4. Discussion

This survey was undertaken to establish current biological and ecological conditions of fouling assemblages on the jacket legs at the Beatrice OWF. The first post-construction monitoring survey was conducted in 2020 and the results in this report provide the second set of post-construction monitoring data for the examination of colonisation and characterisation of sediment type, habitats and epibiota in the immediate vicinity of these turbines.

4.1 Colonisation of the jacket legs by epibiota

Biofouling was present and extensive on all turbines with signs of zonation and successional development. This is in keeping with the colonisation of other windfarms (e.g. Whomersley & Picken 2003, Leonhard & Pedersen 2006, EMU 2008, Bouma & Lengkeek 2009), with initial opportunistic taxa (r-strategists) gradually being replaced by slightly slower-growing taxa (K-strategists). Reproductive strategies of taxa observed varied considerably from broadcast spawning to budding; however, many species recorded in this study have larval phases which can cover considerable distances.

In common with the colonisation of other turbines in the southern North Sea and wider North Sea area, biofouling communities occupied distinct zones dominated by one or two species, with similar depth zones to those reported for natural and artificial hard substrata (EMU 2008, Whomersley & Picken 2003, Bouma & Lengkeek 2009, Leonhard & Pedersen 2006). Findings were also consistent with depth-related zonation in the community of old gas platforms recorded by Coolen *et al.* (2015), including the presence of blue mussel *M. edulis*. Blue mussels were notably not recorded on the jacket legs during the 2020 monitoring survey, but during the current survey this species was recorded on three of the legs at foundation F06 (rare or occasional and within the 0-5 m zone) and one of the legs at H08 (occasional within the 0-5 m zone).

Other studies at offshore wind farms such as Glufke (2015) have found that *M. edulis* dominated the upper zone 0-10 m after the first year of surveying. Although *M. edulis* was recorded at Beatrice OWF during this secondary monitoring period, it was not present previously and was only found to be rare or occasional and restricted to the 0-5 m zone during the current survey. Considering the pioneering nature of *M. edulis* there is potential for it to be more established during subsequent monitoring, and to be present on more of the turbine jacket legs. This is a filter feeding species and if it becomes established it could result in the accumulation of more pseudofaeces and detritus at the base of the turbines.

De Mesel *et al.* (2013) found that zonation and community composition differed little after the first two years of colonisation and that communities would typically contain the same limited number of species but with some species in high abundances. In contrast, Leonhard & Pedersen (2006) indicated a climax community on introduced hard structures may not be expected within 5-6 years after hard substrate deployment. The turbine jackets at foundations surveyed at Beatrice OWF were installed on the following dates: C04 – 13th December 2017, F06 – 11th September 2017, K07 – 30th December 2017, H08 – 13th September 2017 and further monitoring at Beatrice OWF will elucidate how stable the communities recorded on the jacket legs are over time and how colony structure changes. In general, at the Beatrice OWF

site the broad patterns of colonisation and zonation on the jacket legs observed in 2020 (APEM 2021) were apparent in 2021.

Kerckhof *et al.* (2010) highlighted the importance of timing of the surveys following turbine installation and seasonality of recruitment of different species when comparing the results of monitoring across different years. Kerckhof *et al.* (2010) found different communities in the first year and second year of post-construction monitoring at Thornton Bank in the southern North Sea. This was primarily due to turbines being installed in spring, preventing initial colonisation of species which reproduce early in the year, so these species were absent during the first survey. However, prior to the 2021 monitoring the turbine jackets at the Beatrice OWF were in place for almost four years, therefore seasonality of initial colonisation is not anticipated to have had a notable effect on the communities present in 2021.

The most commonly recorded species on the jackets was the plumose anemone *M. senile* accounting for the majority of the total biofouling cover. *M. senile* is ubiquitous amongst North Sea fouling communities and similar findings have been noted at other North Sea locations with this species often present as a dominant spatial competitor. Hiscock *et al*. (2010) noted that although artificial substrates do often develop towards a climax community consisting of the *M. senile* biotope, they are typically impoverished in comparison to natural equivalent biotopes which typically support a range of epiphytic species.

At the base and in the immediate vicinity of the turbine legs, mobile species such as the hermit crab *P. bernhardus* and the common sea urchin *E. esculentus* were present along with flatfish (Pleuronectiformes) which would suggest availability of food (pseudofaeces and detritus) around the turbine legs. There was no visible evidence, however, of accumulated biological material at or around the base. Material may be rapidly consumed by organisms or relocated due to tidal currents.

A study by Bergström *et al*. (2013) found that OWF construction is unlikely to have detrimental effects on demersal fish populations and may even provide long-term benefits by enhancing local ecosystem services. A number of fish species were present at the Beatrice OWF site including large numbers of unidentified small fish from the surface to the base (Actinopterygyii), with common or abundant haddock and small flatfish nearer the base. This suggests that fish are using the jackets legs as sources of food and shelter. The small fish (Actinopterygyii) were not recorded during the 2020 survey and this is likely due to the fact that the current survey was conducted in June, with juvenile settlement occurring for a number of fish species in spring and early summer, while the 2020 survey was conducted in October. Also it was easier to see these small fish on the UHD footage from the GoPros compared to the HD ROV footage.

No conspicuous NNS were recorded on the jacket legs despite use of UHD video and specific attention to the potential presence of NNS will be given for future monitoring surveys.

4.2 Sediment and habitats around turbine foundations

The analysis of underwater video and stills collected from the 16 transects across the four turbines foundations indicated the presence of two broadscale EUNIS habitats. Sediment was categorised as Sublittoral coarse sediment (EUNIS code A5.1) at 13 of the 16 transects. Sublittoral mixed sediments (EUNIS code A5.4) dominated two transects, both at Turbine F06 (east-southeast and south-southwest), and on one of the transects both habitat types were recorded (FO6 west-northwest).

Based on the results of the survey there was limited evidence for effects of fouling communities on the epibenthic community composition in the immediate vicinity of the turbines, other than the presence of some mobile species. In addition, no NNS were recorded following analysis of the ROV and GoPro footage.

The findings of this study indicate that the Beatrice OWF supports a wide diversity of life along its entire depth, with distinct zonation of marine communities. This can provide food and refuge to considerable populations of sessile and motile invertebrates and fish. In general terms the range of species recorded and patterns of zonation were similar for the 2020 and 2021 surveys. Further monitoring to be undertaken as part of the post-construction monitoring programme will provide additional information relating to how the turbine jacket legs are colonised over time and help clarify if the organisms on the jacket legs are influencing sediment and habitat type in the vicinity of the turbines.

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6. Appendices

Appendix 1 Survey Log

			Start Location		End Location	
Wind Turbine Number	Transect	Length (m)	Longitude (decimal degrees)	Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (decimal degrees)
BE-C04	C04E	117.78	-2° 57.815	58° 12.312	-2° 57.931	58° 12.296
	C04W	66.28	-2° 57.957	58° 12.290	-2° 57.982	58° 12.323
	CO4N	68.40	-2° 57.967	58° 12.320	-2° 57.931	58° 12.351
	CO4S	569.52	-2° 57.815	58° 12.603	-2° 57.931	58° 12.296
BE-F06	F06E	591.82	-2º54.170	58º14.169	-2º53.915	58º 14.169
	F06W	583.58	-2º54.170	58º 14.169	-2º54.426	58º 14.169
	FO6N	578.94	-2º54.170	58º 14.169	-2º54.170	58º 14.303
	FO6S	584.06	-2º54.170	58º 14.169	-2º54.171	58º 13.899
BE-H08	HO8E	245.87	-2° 51.497	58° 15.84	-2° 51.242	58° 15.839
	HO8W	245.41	-2° 51.497	58° 15.84	-2° 51.753	58° 15.84
	HO8N	246.26	-2° 51.497	58° 15.84	-2° 51.497	58° 15.974
	HO8S	496.22	-2° 51.497	58° 15.84	-2° 51.498	58° 15.57
BE-K07	K07E	248.52	-2° 49.459	58° 15.647	-2° 49.203	58° 15.647
	K07W	243.72	-2° 49.459	58° 15.647	-2° 49.714	58° 15.648
	K07N	259.38	-2° 49.459	58° 15.647	-2° 49.458	58° 15.782
	K07S	504.89	-2° 49.459	58° 15.647	-2° 49.460	58° 15.378

Appendix 2 SACFOR scale

S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare, L = Less than rare indicated by extrapolation

SACFOR cover scale			SACFOR counts scale					
Percentage cover	Growth form		Counts (various spatial unit)	Minimum density at 1000 m2	Size of individuals or colonies (cm)			
	Crust/ Meadow	Massive/ Turf			< 1	1–3	3–15	> 15
> 80%	S		> 1 / 0.001 m2 (1 × 1 cm)	10,000,000	S			
40–79%	A	S	1–9 / 0.001 m2	1,000,000	A	S		
20–39%	C	A	1–9 / 0.01 m2 (10 × 10 cm)	100,000	C	A	S	
10–19%	F	C	1–9 / 0.1 m2	10,000	F	C	A	S
5–9%	O	F	1–9 / m2	1000	O	F	C	A
1–5%	R	O	1–9 / 10 m2 (3.16 × 3.16 m)	100	R	O	F	C
< 1%	L	R	1–9 / 100 m2 (10 × 10 m)	10	L	R	O	F
		L	1–9 / 1000 m2 (31.6 × 31.6 m)	1		L	R	O
			< 1 / 1000 m2 (100 × 100 m)	0.1			L	R
			< 1 / 10,000 m2 (1 km2)	0.01				L

Appendix 3 SACFOR results for ROV survey of turbine foundations

Turbine Foundation: C04

C04N (north leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 38	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)									
Species (SACFOR)									
Actinopterygii (small)	F	F	F	F	F	F	S	A	
Alaria esculenta	S								
Asterias rubens		C	C	C	C	C	C	C	C
Athecate hydrozoan							O		
Ctenophora					R				
Delesseria sanguinea		R							
Desmarestia	A	O							
Diplosoma listerianum				R	R				
Echinus esculentus							C		
Hydrozoa/bryozoa turf	F	F	O	O	R	R	R		
Labridae							C		
Laminaria	S								
Melanogrammus aeglefinus							C	C	A
M. senile	C	S	S	S	S	A	C		
Pagurus bernhardus									O
Pleuronectiformes									A
Phaeophyta turf	C	F	O						
Rhodophyta turf	C	F	O	O					
Sagartia elegans					F	F			
Spirobranchus sp.		O	O	F	F	A	A		

C04E (east leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 -38	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)									
Species (SACFOR)									
Actinopterygii (small)	F	F	F	F	F	F	A		
Alaria esculenta	S								
Alcyonium digitatum							R		
Asterias rubens			C	C	C	C	A	C	F
Athecate hydrozoa							O		
Aurelia aurita			C						
Ctenophora				R	R				
Desmarestia	A	O							
Echinus esculentus							C		
Hydrozoa/bryozoa turf	O	O	O						
Laminaria	S								
M. senile	C	S	S	S	S	A	F		
Phaeophyta turf	F	O	O						
Pleuronectiformes								A	C
Pollachius virens							C		
Rhodophyta turf	F	O	O						
Spirobranchus sp.			R	O	F	A	S		

C04S (south leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 38	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)									
Species (SACFOR)									
Actinopterygyii (small)	F	F	F	F	F	C	A	S	
Alaria esculenta	S	O							
Alcyonium digitatum								R	
Asterias rubens		O	O	C	C	C	C	C	F
Cancer pagurus	O								
Clavelina lepadiformis							C		
Colonial ascidiacea					R				
Crossaster papposus								C	
Ctenophora					R				
Delesseria sanguinea		O							
Desmarestia	A	A							
Diplosoma listerianum			R						
Echinus esculentus							F	C	
Flustra folicaea							R		
Hydrozoa/bryozoa turf		O	O	F	F	F	C	C	
Laminaria	S	O							
Luidia ciliaris								C	
Melanogrammus aeglefinus						C	C	A	C
M. senile		S	S	S	S	A	A	C	
Phaeophyta turf	C	C	F						
Pleuronectiformes						C	C	A	C
Rhodophyta turf	A	A	O						
Spirobranchus sp.			F	F	F	C	C	C	

C04W (west leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 38	Jacket base	ROV along seabed
Sublittoral coarse sediment (EUNIS A5.1)									
Species									
Actinopterygii (small)	F	F	O	O	O	F	A		
Alaria esculenta	S								
Alcyonium digitatum							O		R
Asterias rubens		C	C	C	C	C	C	A	F
Cancer pagurus		C							
Clavelina lepadiformis							O		
Colonial ascidiacea					R				
Delesseria sanguinea	O		R						
Desmarestia	A	C	O						
Diplosoma listerianum		R	R	R	R				
Echinus esculentus			C		C		C		
Hydrozoa/bryozoa turf					O	O	O		
Laminaria	S								
Melanogrammus aeglefinus								C	
M. senile	C	A	S	S	S	S	A		
Pagurus bernhardus									
Phaeophyta turf		C							
Pleuronectiformes								A	C
Porifera						R			
Portunidae									F
Rhodophyta turf	C	C	O						
Spirobranchus sp.			O	F	C	C	S		

Turbine Foundation: F06

F06N (north leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 41	Jacket base	ROV along seabed
Seabed habitat: Sublittoral mixed sediments (EUNIS A5.4)										
Species										
Actinopterygii (small)	F	C								
Alaria esculenta	A	O								
Alcyonium digitatum				F	C	C	F	O		
Asterias rubens	R	R	R		O	O	O			R
Balanoidea	A									
Delesseria sanguinea	C	A	O							
Desmarestia	C	A								
Echinus esculentus							O	F	F	F
Hydrozoa/bryozoa turf		F	O	F	F	O	O	F		
Labridae						R	O	F		
Laminaria	A	O								
Melanogrammus aeglefinus						O	R		F	C
M. senile	O	S	S	S	S	F				
Mytilus edulis	R									
Patella vulgata	R									
Phaeophyta turf	O	O								
Pleuronectiformes									O	C
Rhodophyta turf	C	O	O							
Spirobranchus sp.			O	F	C	S	S	S		

F06E (east leg)

Depth (m)	0 - 5	5-10	10-15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	Jacket base	ROV along seabed
Seabed habitat: Sublittoral mixed sediments (EUNIS A5.4)										
Species										
Actinopterygii (small)		C					F	F	O	
Alaria esculenta	A									
Alcyonium digitatum		R		C	C	A	A	C		
Asterias rubens		R	O	F	O	R	R	O	R	R
Balanoidea	A									
Cancer pagurus		R								
Codium spp		R								
Delesseria sanguinea	A	A	O							
Desmarestia	A	A	O	O						
Echinus esculentus				O	O	O	O	C	R	C
Hydrozoa/bryozoa turf			O	O						
Laminaria	S	C								
Melanogrammus aeglefinus								O	O	
M. senile		A	S	A	A	C	O	A		
Mytilus edulis	R									
Pagurus bernhardus									R	O
Patella vulgata	R									
Phaeophyta turf	O	O								
Rhodophyta turf	O	O								
Spirobranchus sp.			A	A	A	S	S	S		

F06S (south leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	Jacket base	ROV along seabed
Seabed habitat: Sublittoral mixed sediments (EUNIS A5.4)										
Species										
Actinopterygii (small)	F	F								
Alaria esculenta	A	O								
Alcyonium digitatum			O	O	F	F	C			O
Asterias rubens			R	O	F	F	O	O	C	
Balanoidea	F		O							
Ctenophora	R									
Delesseria sanguinea	F	A	R							
Desmarestia	C	A								
Echinus esculentus				O	F	O	O	O	C	O
Callionymus lyra									R	
Hydrozoa/bryozoa turf			O	F	C	A	A	O		
Laminaria	S	C								
M. senile		S	S	S	S	O	O			
Phaeophyta turf				O						
Pleuronectiformes										R
Porifera							R			
Rhodophyta turf	F	F	C	O						
Spirobranchus sp.			O	F	A	S	S	A		

F06W (west leg)

Depth (m)	0 - 5	5-10	10-15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 41	Jacket base	ROV along seabed
Seabed habitat: Sublittoral mixed sediments (EUNIS A5.4) and Sublittoral coarse sediments (EUNIS A5.1)										
Species										
Actinopterygii (small)	F	O	O		R					
Alaria esculenta	A	O								
Alcyonium digitatum	R	O	C	A	A	A	A	O		O
Asterias rubens	R		R					F	O	
Balanoidea	A									
Delesseria sanguinea	F	F								
Desmarestia		C								
Echinus esculentus							C	C	C	C
Hydrozoa/bryozoa turf	F	F	F	O	O	O	F	O		
Labridae							R		O	
Laminaria	S	C								
M. senile	O	A	S	S	S	A	O	R		
Mytilus edulis	O									
Pagurus bernhardus										F
Patella vulgata	R									
Pleuronectiformes										O
Porifera							O			
Rhodophyta turf	O	R								
Spirobranchus sp.			O	O	A	A	S	S		

Turbine foundation: H08

H08N (north leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 42	Jacket base	ROV along seabed
Seabed habitat: Sublittoral mixed sediments (EUNIS A5.1)										
Species										
Actinopterygii (small)	F	C	F							
Alaria esculenta	A	F								
Alcyonium digitatum			F	C	A	C	C	C		R
Asterias rubens		R					R			R
Balanoidea	O									
Clavelina lepadiformis								O		
Crossaster papposus								R		
Delesseria sanguinea	O	O								
Desmarestia	F	C								
Echinus esculentus							R	C		O
Hydrozoa/bryozoa turf			O	O	R	F	F			
Labridae								O	F	
Laminaria	A	F								
Melanogrammus aeglefinus							O	O		A
M. senile	F	A	S	S	S	A	F	C		R
Mytilus edulis	O									
Pagurus bernhardus										O
Patella vulgata	R									
Pleuronectiformes									C	A
Rhodophyta turf	F	C	O							
Spirobranchus sp.			R		F	A	A	S		

H08E (east leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 43	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)										
Species										
Actinopterygii (small)	F			O	F					
Alaria esculenta	S	A								
Alcyonium digitatum		O	F	C	A	C	C	A		
Asterias rubens		R	R	R						R
Crossaster papposus								R		
Delesseria sanguinea	A	A								
Desmarestia		A								
Echinus esculentus					O	O	O	O	O	
Hydrozoa/bryozoa turf		O	F	C	C					
Labridae								O		
Laminaria	S	A								
Melanogrammus aeglefinus								R	R	
M. senile	O	A	S	S	A	F	O	A		
Pagurus bernhardus										O
Pleuronectiformes									O	C
Rhodophyta turf	C	F	O							
Spirobranchus sp.		O	O	F	A	S	S	S		

H08S (south leg)

Depth (m)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)										
Species										
Actinopterygii (small)	F	F								
Alaria esculenta	S	A								
Alcyonium digitatum			O	C	A	A	C	A		
Asterias rubens			R	R	R	R			R	
Balanoidea	C									
Delesseria sanguinea	A	A	C							
Desmarestia		C	C							
Clavelina lepadiformis						O	C	A		
Inachidae			R							
Echinus esculentus				O	O	O		O	O	O
Hydrozoa/bryozoa turf		O	C	C	C	C	C			
Labridae								R		
Laminaria	S	A								
Melanogrammus aeglefinus							R	R	O	A
M. senile		O	A	S	A	C	O	S		
Neptunea antiqua										R
Pagurus bernhardus										R
Pleuronectiformes									O	A
Rhodophyta turf		C	C							
Spirobranchus sp.				F	C	A	S	S		

H08W (west leg)

Depth (m)	0 - 5	5-10	10-15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 43	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)										
Species										
*Actinopterygii (*small*)*	F		F	F	F					
Alaria esculenta	S	F								
Alcyonium digitatum			O	F	C	A	A	C		
Asterias rubens			R	R	R			R	O	
Balanoidea										
Clavelina lepadiformis		O		O	O	O	O	F		
Delesseria sanguinea	C									
Desmarestia										
Echinus esculentus				O	O	O	O	R	O	
Hydrozoa/bryozoa turf		O	F	F	F	F	F	O		
Labridae										
Laminaria	S	O								
Melanogrammus aeglefinus										R
M. senile	A	A	S	A	A	A	C	A		
Pagurus bernhardus										R
Patella vulgata										
Pleuronectiformes									O	O
Rhodophyta turf	C	F								
Spirobranchus sp.		O	F	C	A	S	S	A		

Turbine foundation: K07

K07N (north leg)

Depth (m)	0 - 5	5-10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 – 40	35 - 43	Jacket base	ROV along seabed
Seabed habitat : Sublittoral coarse sediment (EUNIS A5.1)											
Species											
Actinopterygii (small)	F	F	F								
Alaria esculenta	S	O									
Alcyonium digitatum					O	F	F	F	C		
Asterias rubens	C		C	O	C	C	C	F	C		O
Clavelina lepadiformis						O	R	F	F		
Desmarestia	A	C									
Echinus esculentus					O			O	O		
Laminaria	S	O									
Melanogrammus aeglefinus				R	C	F	O	O	O	C	A
M. senile	A	S	S	S	S	A	A	O	F		
Pagurus bernhardus										R	C
Phaeophyta turf	O	O									
Pleuronectiformes										O	A
Portunidae	C										
Rhodophyta turf	O	O									
Spirobranchus sp.				C	A	S	*S*	*S*	*S*		

K07E (east leg)

Depth (m)	0 - 5	5-10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 – 40	40 - 43	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)											
Species											
Actinopterygii (small)	F	F									
Callionymus lyra								R			
Alaria esculenta	S	C									
Alcyonium digitatum					O	O	O	R	R		
Asterias rubens			R	R	O	O	C	F		O	O
Hydrozoa/bryozoa turf			O	O	O	O					
Cancer pagurus								R			
Clavelina lepapdiformes							O	C	C		
Delesseria sanguinea	O	F									
Desmarestia	O	C									
Echinus esculentus					R	O	O	O	O		
Labridae										R	
Laminaria	S	C	R								
M. senile	A	S	S	S	S	C	C	O	F		
Phaeophyta turf	O	O									
Pleuronectiformes										O	C
Rhodophyta turf	C	C	O								
Spirobranchus sp.			O	F	C	S	*S*	*S*	*S*		

KO7S (south leg)

Depth (m)	0 - 5	5-10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 – 40	40 - 45	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)											
Species											
Actinopterygii (small)	F	F	F								
Alaria esculenta	S	O									
Alcyonium digitatum					R	O	O	C	F		
Asterias rubens		R	O	O	O	O			R		R
Balanoidea	A										
Bryozoa/ Hydrozoa turf		R	O	O	O						
Clavelina lepadiformis			O	O	O	F	O	C	C		
Delesseria sanguinea	C	A	O								
Desmarestia	C	A	O								
Echinus esculentus				R				O	F	F	O
Labridae									R		
Laminaria	S	O									
Melanogrammus aeglefinus								R		C	C
M. senile	O	A	S	A	A	A	C	O	C		
Neptunea antiqua											R
Pagurus bernhardus										R	O
Phaeophyta turf	O	O	O								
Pleuronectiformes										C	C
Rhodophyta turf	C	F	O								
Spirobranchus sp.			C	A	S	S	*S*	*S*	*S*		

KO7W (west leg)

Depth (m)	0 - 5	5-10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 – 40	40 - 43	Jacket base	ROV along seabed
Seabed habitat: Sublittoral coarse sediment (EUNIS A5.1)											
Species											
Actinopterygii (small)	F	F		F		O					
Alaria esculenta	A	R									
Alcyonium digitatum					O	O	R	C	A		
Asterias rubens				R	R	R		R			R
Hydrozoa/bryozoa turf			R	O							
Clavelina lepadiformis		R			R		R	C			
Crossaster papposus										R	
Delesseria sanguinea	O										
Desmarestia	C	F									
Echinus esculentus							R	R	O		R
Labridae									R	R	
Laminaria	A										
Melanogrammus aeglefinus								R		O	A
M. senile	A	S	S	S	S	S	A	C	F		
Pagurus bernhardus										R	R
Phaeophyta turf	O	O									
Pleuronectiformes										F	A
Rhodophyta turf	C	F	R								
Spirobranchus sp.			O	F	C	S	S	S	S		

Appendix 4 Transect SACFOR abundance data

Sol = Start of line; Eol = End of line (Lat Long in degrees decimal minutes)

Turbine Foundation: C04

CO4N (north)

	Sol		Eol	
	58 12.320	02 57.967	58 12.351	02 57.931
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Asterias rubens	C			
Melanogrammus aeglefinus	A			
Pagurus bernhardus	O			
Pleuronectiformes	A			

CO4E (east)

	Sol		Eol	
	58 12.312	02 57.878	58 12.323	02 57.880
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Asterias rubens	F			
Pleuronectiformes	C			

CO4S (south)

	Sol		Eol	
	58 12.603	02 57.815	58 12.296	02 57.931
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Asterias rubens	F			
Melanogrammus aeglefinus	C			
Pleuronectiformes	C			

CO4W (west)

	Sol		Eol	
	58 12.290	02 57.957	58 12.323	002 57.982
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Alcyonium digitatum	R			
Asterias rubens	F			
Pleuronectiformes	C			
Portunidae	F			

Turbine Foundation: F06

F06N (north)

	Sol		Eol	
	58º14.169	-2º54.170	58º14.303	-2º54.170
Species	**Sublittoral coarse sediment (EUNIS A5.4)**			
Echinus esculentus	F			
Asterias rubens	R			
Melanogrammus aeglefinus	C			
Pleuronectiformes	C			

FO6E (east)

	Sol		Eol	
	58º14.169	-2º54.170	58º14.169	-2º53.915
Species	**Sublittoral mixed sediments (EUNIS A5.4)**			
Asterias rubens	R			
Echinus esculentus	C			
Pagurus bernhardus	O			

FO6S (south)

	Sol		Eol	
	58°14.169	-2°54.170	58°13.899	-2°54.171
Species	**Sublittoral mixed sediments (EUNIS A5.4)**			
Alcyonium digitatum	O			
Echinus esculentus	O			
Pleuronectiformes	R			

F06W (west)

	Sol		Eol	
	58°14.169	-2°54.170	58°14.169	-2°54.426
Species	**Sublittoral mixed sediments (EUNIS A5.4)**		**Sublittoral coarse sediment (EUNIS A5.1)**	
Alcyonium digitatum	O			
Echinus esculentus	C			
Pagurus bernhardus	F			
Pleuronectiformes	O		R	

Turbine Foundation: H08

H08N (north)

	Sol		Eol	
	58° 15.84	-2° 51.497	58° 15.974	-2° 51.497
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Alcyonium digitatum	R			
Asterias rubens	R			
Echinus esculentus	O			
Melanogrammus aeglefinus	A			
M. senile	R			
Pagurus bernhardus	O			
Pleuronectiformes	A			

H08E (east)

	Sol		Eol	
	58° 15.84	-2° 51.497	58° 15.839	-2° 51.242
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Asterias rubens	R			
Pagurus bernhardus	O			
Pleuronectiformes	C			

H08S (south)

	Sol		Eol	
	58° 15.84	-2° 51.497	58° 15.57	-2° 51.498
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Echinus esculentus	O			
Melanogrammus aeglefinus	A			
Pleuronectiformes	A			
Pagurus bernhardus	R			
Neptunea antiqua	R			

H08W (west)

	Sol		Eol	
	58° 15.84	-2° 51.497	58° 15.84	-2° 51.753
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Pagurus bernhardus	R			
Pleuronectiformes	O			
Melanogrammus aeglefinus	R			

Turbine Foundation: K07

K07N (north)

	Sol		Eol	
	58° 15.647	-2° 49.459	58° 15.782	-2° 49.458
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Asterias rubens	O			
Pagurus bernhardus	C			
Pleuronectiformes	A			
Melanogrammus aeglefinus	A			

K07E (east)

	Sol		Eol	
	58° 15.647	-2° 49.459	58° 15.647	-2° 49.203
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Asterias rubens	O			
Pleuronectiformes	C			

K07S (south)

	Sol		Eol	
	58° 15.647	-2° 49.459	58° 15.378	-2° 49.460
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Asterias rubens	R			
Echinus esculentus	O			
Melanogrammus aeglefinus	C			
Pagurus bernhardus	O			
Pleuronectiformes	C			
Neptunea antiqua	R			

K07W (west)

	Sol		Eol	
	58° 15.647	-2° 49.459	58° 15.648	-2° 49.714
Species	**Sublittoral coarse sediment (EUNIS A5.1)**			
Asterias rubens	R			
Echinus esculentus	R			
Melanogrammus aeglefinus	A			
Pagurus bernhardus	R			
Pleuronectiformes	A			