SUPPLEMENTARY MATERIAL

1. MATERIALS & METHODS

1.1. Definition of terms

A description of these types of offshore O&G structures can be found in Goodlad, Garden [1]; a summary is presented here.

Fixed platform legs are anchored into the seabed and are constructed usually from steel or concrete. They provide support for the entire structure, encompassing, for example, a drilling rig, production facilities, and crew living quarters.

Conductors are large-diameter pipes positioned at the top of a well. They play essential roles: in isolating loose formations and water sands to prevent them from collapsing into the wellbore, providing structural support for the wellhead and subsequent casing strings, creating a pathway for circulation of drilling fluids to maintain well control, removing cuttings, and protecting against shallow gas pockets and other surface hazards. Typically, conductors are the first casing string installed in a well and are cemented in place to ensure stability and integrity.

Caissons are large, cylindrical structures made from steel or concrete, essential for stability and safety of offshore O&G operations. They act as foundational supports for offshore platforms and other structures, ensuring platforms remain secure and upright in the marine environment. Caissons protect equipment below the waterline, particularly in harsh conditions like those in the North Sea. Typically, they are installed by drilling into the seabed and filling the structure with concrete to create a solid base. They are versatile and used in various environments, including deep waters and areas with soft seabeds, as in the case of this study.

Wellhead Platform Units (WHPUs) are typically unmanned platforms that house the wellheads and associated equipment necessary for extracting O&G from subsea wells. Designed for autonomous operation, WHPUs feature remote monitoring and control systems to manage the production process. Commonly used in shallow water fields, they are connected to a central-processing facility *via* subsea pipelines. The primary functions of WHPUs include, providing a stable structure for wellheads and associated equipment, managing the flow of hydrocarbons from wells to processing facilities, incorporating mechanisms to prevent blowouts and other

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hazardous events, and enabling remote monitoring and control to mswinimise the need for human presence on the platform. WHPUs are essential for efficient and safe offshore O&G production, particularly in fields where manned platforms are not feasible.

Bundles generally refers to a group of functional components assembled before further processing. These components can include hoses, tubes, electric cables, and optical fibre cables. Bundles are often utilised in subsea operations to simplify the installation and management of multiple pipelines and umbilicals, which are then terminated in towheads where manifolds are housed.

A towhead manifold is a network of pipes and valves designed to regulate the flow of fluids from various sources. Typically integrated into a subsea pipeline bundle, it is positioned at the end of the bundle, referred to as the towhead. This manifold facilitates the distribution and collection of fluids, such as oil, gas, and water, from multiple wells to a central processing facility. It features connection points for flowlines and umbilicals, which are crucial for the operation and maintenance of subsea production systems.

1.2. Video screening & selection

To prevent duplicating effort, one analyst commenced viewing footage from the top of the folders (viewed in Microsoft Windows Explorer), and another started at the bottom.

Initial analysis focussed primarily on footage from a depth range of 0-55 m to estimate taxa found in the shallower areas of the platform, which are of key interest for decommissioning strategies. Completed survey sections were marked iteratively on a shared electronic schematic platform to inform analysis of progress, avoid overlap or bias, and ultimately ensure adequate coverage (**Figure S1**).

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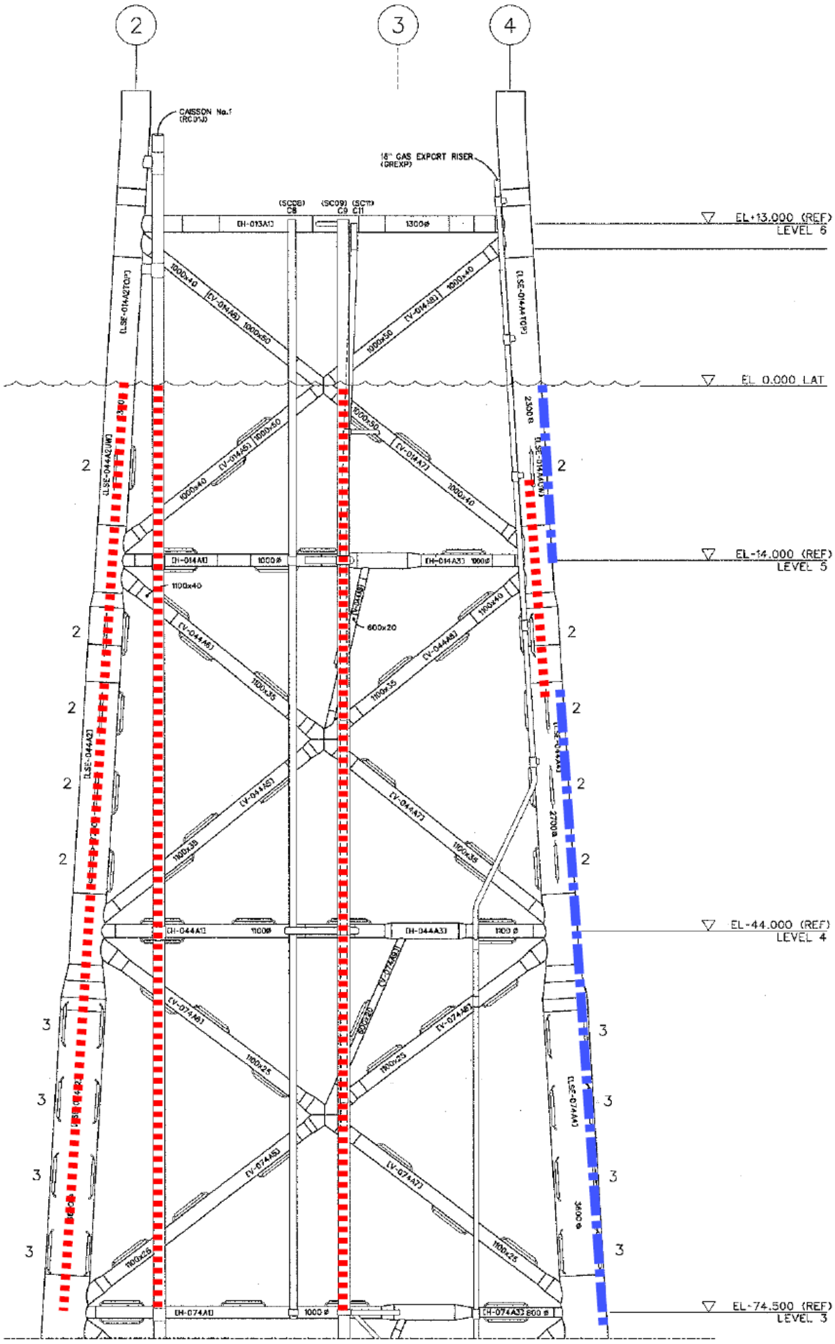

Figure S1: Legs and caissons surveyed on one section of the platform. Different coloured/textured lines in red and blue represent effort by different analysts.

1.3. Video-quality assessment criteria

For videos that passed screening, a further quality-assessment-scoring method adapted from McLean, Gates [2] was applied to selected footage, scoring them on a scale of zero or one based on extent of scientific usability (**Table S1**). Videos scored as ‘unusable’ (score of ‘0’) were not analysed.

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Score	Descriptor	Reason(s)
0	Unusable	ROV focussed on a specific task on small section of structure only No clear imagery of structure Blurry images or poor visibility
1	Usable	Most ROV video imagery can be used to assess fish/habitat associations with the structure Mostly clear and in-focused imagery Appropriate lighting

Table S1: Scoring extent of scientific usability (score 0 or 1) of ROV imagery of a structure with reasons. *Source*: modified from McLean, Gates [2].

Videos scored as 'usable' (score of '1'), were further scored on their species-identification feasibility for both motile species, such as fish and invertebrates (**Table S2**), and habitat assessment of benthic species, such as sessile invertebrates, and plants/algae (**Table S3**), on a score 0–4, as described in McLean, Gates [2].

Score	Descriptor	Evaluation	Data metric(s)
0	Unusable	None	N/A
1	Very poor	Motile species identifiable to family/genus level only	- Estimated family richness
2	Poor	Motile species identified to family/genus level, approx. 25% identified to species	- Estimated family richness - Estimated species richness
3	Average	Motile species identified to	- Estimated species richness

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		family/genus level, *ca.* 50% identified to species, estimated abundances for some species	- Estimated abundance
4	Good	Nearly all motile species (at least 75%) identified to species level (species richness), abundances and feeding information	- Species richness - Abundance - Diversity - Feeding

Table S2: Scoring ROV video according to resolution of data on motile species assemblages that can be obtained. *Source*: modified from McLean, Gates [2].

Score	Descriptor	Evaluation	Data metric(s)
0	Unusable	None	N/A
1	Very poor	Presence of habitat (broad-level classification)	- Estimated broad-level classification
2	Poor	Broad classification of habitats (with some uncertainty), and percent cover	- Estimated broad-level classification - Estimated % cover
3	Average	Broad classification, 20% sessile species-level IDs and broad percent cover	- Broad-level classification - Broad % cover

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4	Good	Detailed classification, 50% sessile species-level IDs and percent cover	- Estimated species richness* - % cover

Table S3: Scoring ROV video according to resolution of sessile species data on habitats that can be obtained. *Note: it is often not possible to identify all marine growth forming sessile species from imagery – this would require laboratory analysis. *Source*: modified from McLean, Gates [2].

1.4. Video analysis

Following scoring, two marine scientists with good taxonomical knowledge of North Sea taxa analysed footage visually, establishing formal assessment protocols to avoid observer bias. Metadata (*e.g.* time, depth, duration, file path, and name, *etc.*) and results (*e.g.* species present) were entered into a shared Excel spreadsheet (Microsoft Office, 365 Business), with one row representing each video. Videos were analysed in 5-minute sections [as per 3, 4]. Every observed individual was identified to lowest taxonomic level – for more details see **Section 2.4** in the main text.

Most videos were cropped during collection by the ROV video-recording software (software unknown at the time of this report) at five-minute (or five minutes and one second) durations; however, some videos of towhead, bundles, and WHPUs were up to 15 minutes. Videos exceeding five minutes and one second were analysed in five-minute sections. Consequently, these longer videos represented two to three rows in the data frame.

1.5. Taxonomic identification

During the footage-review process, a customised, interactive species-Identification (ID) guide was created in Microsoft PowerPoint (Microsoft Office 365, Windows 11). This was used as a tool for analysts to review, and to justify selection of, identified species. Before entry into the ID guide, any newly observed species, or uncertain identifications, were passed via a taxonomy expert for confirmation and if possible, identified to species level.

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Peer reviewed websites utilised for identification included: www.fishbase.org, www.habitas.org.uk, www.sealifebase.ca, http://species-identification.org, www.marinespecies.org, www.marlin.ac.uk, and only occasionally (as a final cross check, but never relied upon) https://species.wikimedia.org.

1.6. Still-image analysis

PhotoQuad v1.4 [5] was used for analysis of still images.

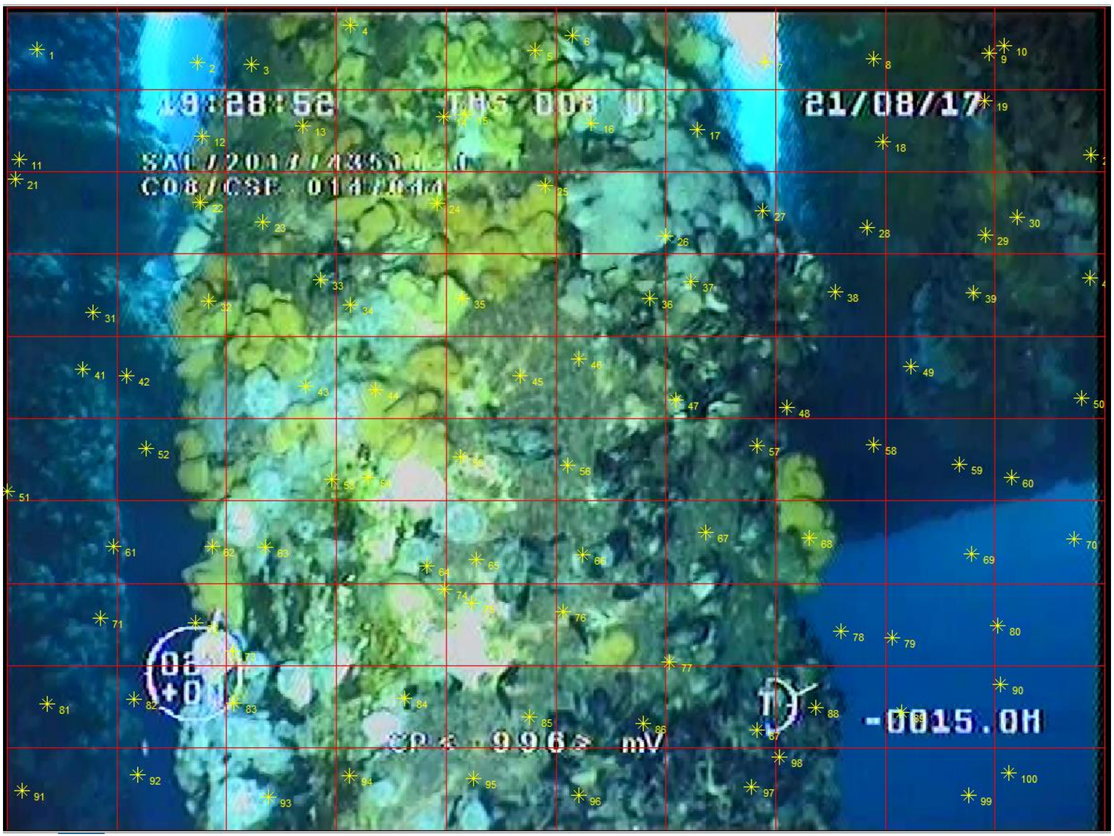

Figure S2: Example image of ROV footage showing stratification grid (red lines) and random-stratified points (yellow stars) that were used to analyse percentage cover for sessile species. *Source*: Ocean Science Consulting Ltd.

Data were grouped by depth band as per Guerin, Jensen [6] and Guerin [7], in which depth bands were at 5-m intervals near the surface (due to greater variation by depth in shallow compared to deep water), increasing to 10-m intervals past 20 m depth and 20-m intervals past 80 m depth (**Figure S3**).

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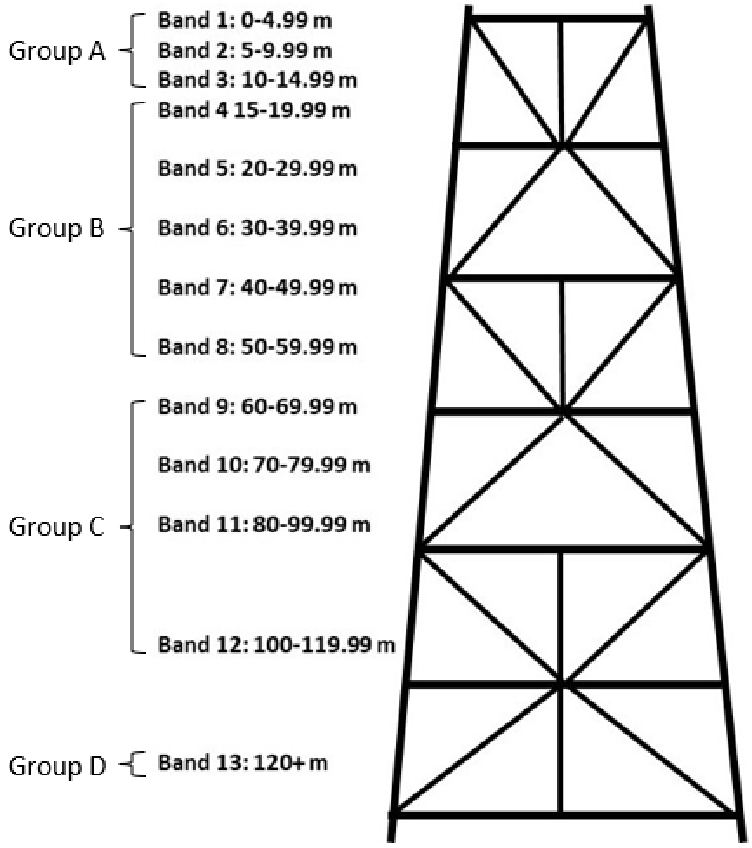

Figure S3: Example of depth bands used for analysis. *Source*: modified from Guerin [7].

2. RESULTS

Analysis of each hour of video footage took approximately ten work hours. Analysis of each still took approximately 20–30 minutes, depending on complexity.

At least ten stills per depth band were analysed (horizontal line in **Figure S4**), with exception of band 1 (0–5 m), as no species were found to be present in four of these. The peak in stills analysed at >120 m (depth band 13) was due to additional seabed structures analysed, and peaks in bands 3 (10–15 m) and 7 (40–50 m) were based on how ROV surveys were performed, with vertical transects of structures starting at 14, 44, 74 or 107 m depths.

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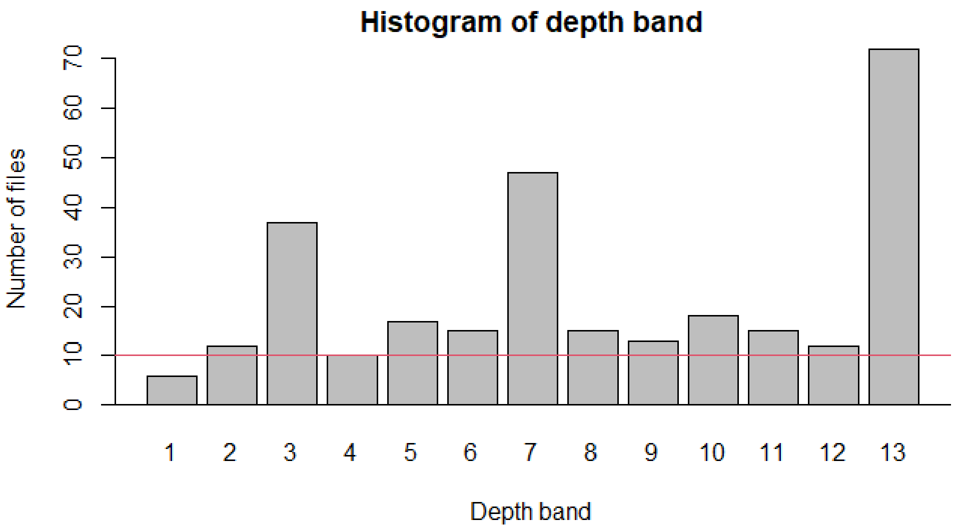

Figure S4: Number of analysed ROV video footage across depth bands (0–13). Bars indicate number of analysed stills per depth band with a horizontal line illustrating that a minimum of ten stills were analysed for all except band 1.

2.1. Data quality

The most common quality score for motile species was one (very poor), followed by two (poor), and the most common score for sessile species was four (good) followed by two (**Table S4**). For motile species, video quality was generally best deeper, with videos in depth band 11 and 13 having the highest quality (**Table S5**). This is likely related to most fish being observed in deeper areas. For sessile species, videos in the middle depths had the highest quality (**Table S5**).

Quality score	Number of videos with score for motile species	Number of videos with score for sessile species
0	16	3
1	50	19
2	34	33
3	17	28
4	11	45

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Table S4: Number of videos for motile and sessile species assigned to each quality score. *Source*: Ocean Science Consulting Ltd.

Depth band	Motile species (mean ± SD)	Sessile species (mean ± SD)
1	0.50 ± 0.71	2.50 ±0.71
2	1.33 ± 0.56	3.00 ± 1.00
3	1.42 ± 0.77	2.89 ± 0.88
4	1.00 ± 1.41	4.00 ± 0.00
5	1.08 ± 1.04	3.46 ± 0.78
6	1.67 ± 0.71	3.22 ± 0.97
7	0.93 ± 0.70	3.47 ± 0.74
8	1.50 ± 1.18	3.80 ± 0.42
9	1.17 ± 0.75	2.17 ± 0.41
10	1.00 ± 0.00	3.00 ± 1.41
11	1.89 ± 1.36	1.78 ± 1.30
12	1.29 ± 0.76	1.57 ± 0.79
13	2.77 ± 0.99	2.00 ± 1.18

Table S5: Mean ± Standard Deviation (SD) of video footage quality score in each depth band. *Source*: Ocean Science Consulting Ltd.

2.2. Taxa recorded

Still images of each species can be seen Figure S5,Figure S5: Still images of identified taxa Figure S6, and Figure S7. Most of these stills were recorded in August, and not November footage, though some were only recorded in November. These included two fish, cod (*Gadus morhua*, (Figure S6o), and a labrid (Figure S7c), turf Bryozoa (Figure S6e), and one Northern Henricia starfish (*Henricia sanguinolenta*, Figure S6h).

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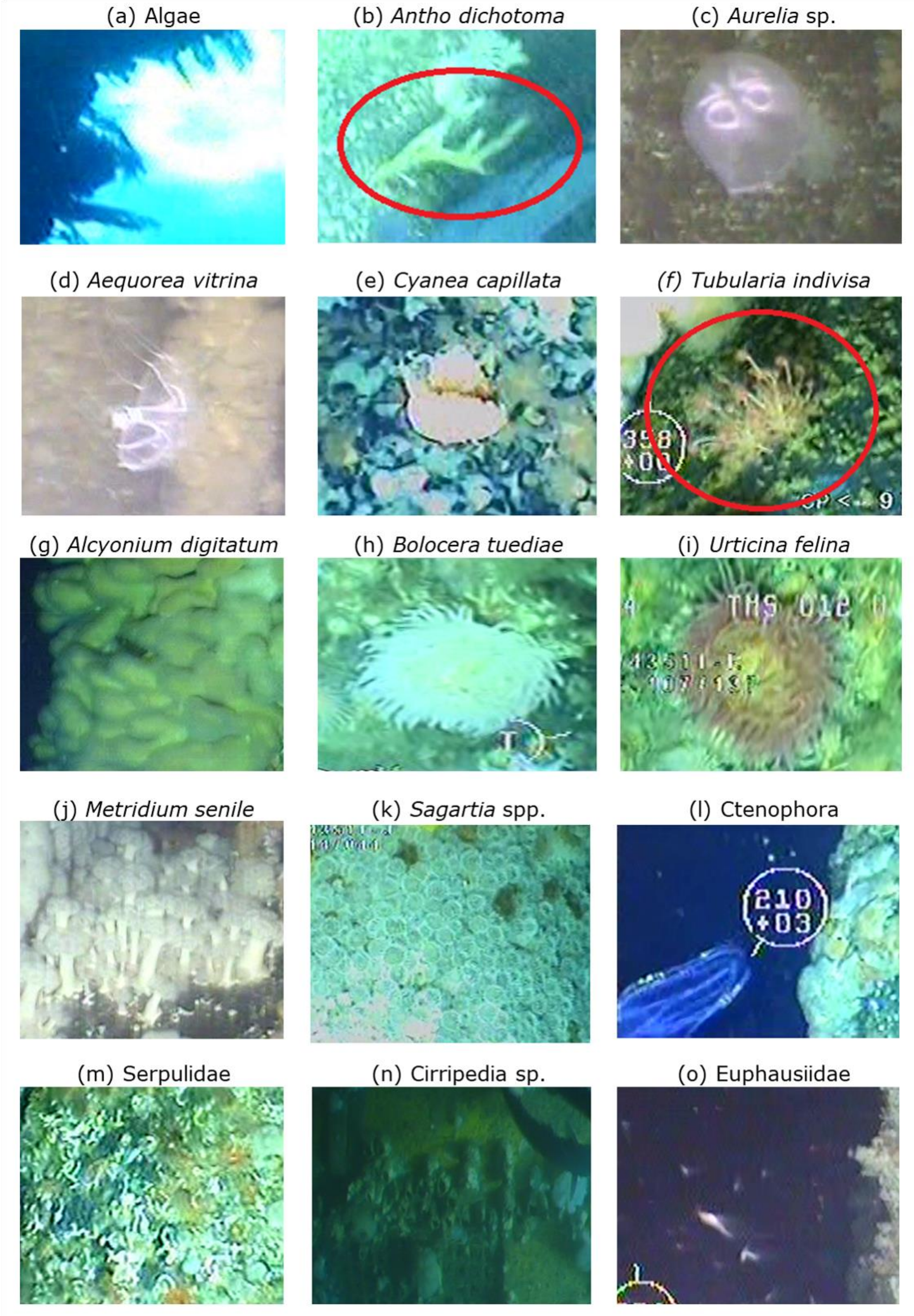

Figure S5: Still images of identified taxa

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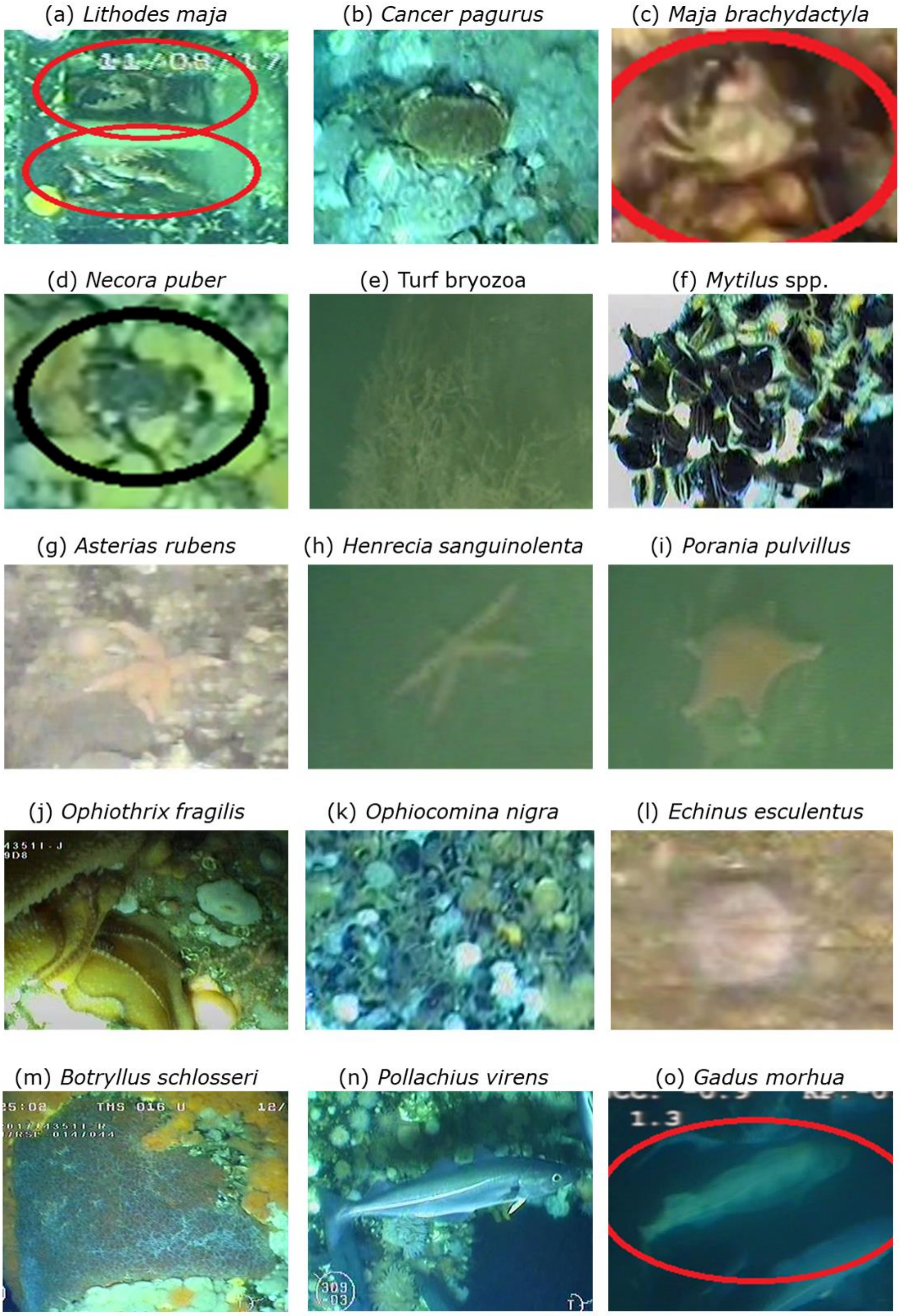

Figure S6: Still images of identified taxa

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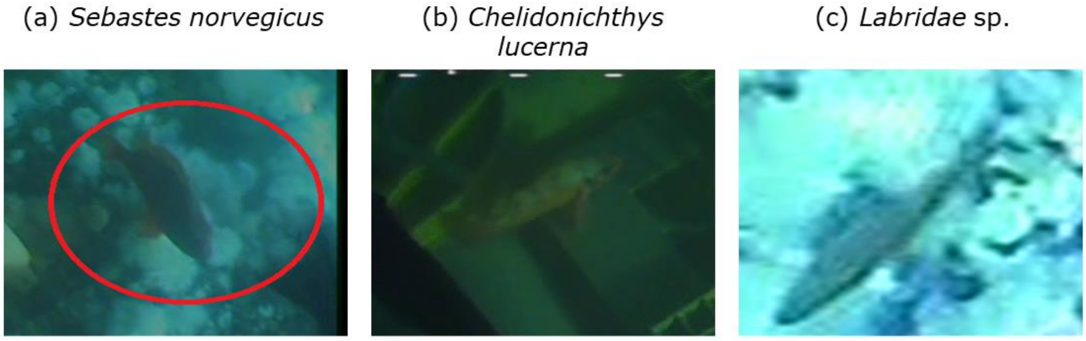

Figure S7: Still images of identified taxa.

Kingdom: Archaeplastida (*sensu lato* kingdom Plantae)

Unidentified algae

Figure S5a. Morphometrics: not derived from a collected specimen. Unknown if red algae (Rhodophyta), green algae (Chlorophyta) or brown algae (Phaeophyceae). Individuals in the ROV footage occurred at a depth range of 0–30 m.

Order: POECILOSCLERIDA

Family: MICROCIONIDAE (*et ut* CLATHRIIDAE)

Antho dichotoma (Esper, 1794)

Common sponge

Figure S5b. Morphometrics: not derived from a collected specimen; however, based on visual identification from ROV video footage and stills, confidence in species-level identification was reasonably high, although a sample would be required to differentiate this species from other clathriid sponges, such as *A. involvens* (Schmidt, 1864), which can be orange-red and sheet-like [8] or the apparently little-known *A. erecta* (Ferrer-Hernandez, 1922) described in Kramp [9]; Costello, Emblow [10]; Van Soest [11] and Bisby, Roskov [12]. *A. dichotoma* is a thinly and dichotomously branched sponge with a finely *hispid* surface through protruding

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spicules. Branches reach 0.5 cm in diameter and total height is 30 cm [13]. Axially strengthened, thus difficult to break, general consistency firm, barely compressible, no apparent oscules [13]. An axial and extra-axial skeleton are developed: extra-axial skeleton consists of ectosomal subtylostyles in bouquets and long single styles erect on the axial reticulation and protruding far beyond the surface. Colour yellowish with reddish tinges [13]. Individuals in the ROV footage occurred at a depth range of 60–144 m.

Order: SEMAEOSTOMEAE

Family: ULMARIDAE

Aurelia sp. (Linnæus, 1758)

Moon jelly

Figure S5c. Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, confidence in taxonomic identification to genus-level is high, and the species is potentially *Aurelia aurita*; however, there can be confusion in taxonomy because all species in the genus are closely related, and it is difficult to identify *Aurelia medusae* without genetic sampling. Identification to genus level was determined using various sources [e.g. 8, 14]. The following information applies to the species *A. aurita*, which has a maximum diameter of 40–50 cm being more typical [8] – with height ranging from 10–12.5 cm. Plane bell, comprising very many tentacles courts with the periphery [15]. Four oral arms and four sexual organs of annular form or in the horseshoe shape very many radiate channels [15]. *A. aurita* is translucent, with slightly pink reflections, blue or purple. Sexual organs are more clearly coloured red or pink [15]. Throughout this study, *A. aurita* were observed in August and November 2017. Individuals in the ROV footage occurred at a depth range of 13–145 m.

Order LEPTOTHECATA

Family AEQUOREIDAE

Aequorea vitrina (Gosse, 1853)

Jellyfish

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Figure S5d. Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, at least genus (and probably species-level) identification was possible. Taxonomic sources for *A. vitrina* taken from text and citations and detailed species descriptions provided in http://species-identification.org or descriptions taken mostly from Russell [16]; Kramp [9]; Russell [17], Schuchert [18]. *A. vitrina* adults have a maximum diameter of 17 cm, the umbrella is saucer shaped, thick in centre, gradually thinning towards margin with the stomach about half width of disc. Radial canals 60–100; gonads extending along almost their entire length. Tentacles more than three times as numerous as radial canals, with a few small marginal bulbs. Tentacle bulbs elongate, slightly laterally compressed, with excretory *papillae*. *Statocysts* usually one to two, between successive radial canals, each with two to four concretions and *A. vitrina* normally appears violet-blue fluorescent. Individuals in the ROV footage occurred at a depth of 100 m.

Order SEMAEOSTOMEAE

Family CYANEIDAE

Cyanea capillata (Linnæus, 1758)

Lions' mane jellyfish

Figure S5e. Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, a very high confidence level in species-level identification was possible. Taxonomic sources for *C. capillata* taken from text and citations and detailed species descriptions provided in http://species-identification.org or descriptions taken mostly from Russell [16]; Russell and Sea [19], and various other sources [8, 14]. *C. capillata* umbrella saucer-shaped with uniformly thick jelly thinning suddenly at bases of marginal *lappets*; exumbrella with central surface smooth, without prominent *nematocyst* clusters. Margin with eight deep *adradial* tentacular clefts, and four perradial and four interradial rhopalar clefts less deep; marginal lappets sloping asymmetrically outwards from the tentacular clefts towards the rhopalar clefts. Marginal tentacles hollow, arranged in up to four complete serial rows, arising from subumbrella surface at a distance from umbrella margin; tentacles in adradial groups of 70–150 or more. Stomach without interradial gastric septa; with many gastric filaments arranged in four interradial groups on subumbrellar wall where central stomach cavity passes into gastrovascular sinus. Gastrovascular sinus divided into sixteen pouches by an equal number of radial septa extending from near the

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proximal border of *coronal* muscle to distal margin of umbrella, merging into fused areas of marginal lappets; pouches branched, terminal ramifications without *anastomoses*. Subumbrellar with radial and circular muscles. Coronal and radial muscle folds with pit-like intrusions from gastrovascular sinus; 13–15 coronal folds between radial septa. The four oral arms arise from a ring of thickened subumbrellar mesogloea surrounding the base of the *manubrium*; each arm as long as the umbrella radius and thins out to form membranous lips on either side of a median furrow. Adjacent oral arms connected by a membranous, much-folded curtain about half the length of the arms. The four interradial, much-folded gonads hang freely down from the subumbrellar surface. Umbrella usually 300–500 mm, up to 2,000 mm in diameter. Colour usually yellowish brown with dark red manubrium (manubrium darkens with age), sometimes paler or almost colourless (*C. capillata habitus*), which was also observed in footage at a depth range of 0–20 m. Viewed from above, the darker pigmentation of stomach and gastrovascular pouches shows up strongly with a clear pattern due to the weakly pigmented radial and 'false' septa. Individuals in the ROV footage were observed in the months of August and occurred at a depth of 95 m. Although outside normal depth range, the clarity of the image is such that identification is possible of this distinct species.

Order: ANTHOATHECATA

Family: TUBULARIIDAE

Tubularia indivisa (Linnæus, 1758)

Oaten pipes hydroid

Figure S5f. Morphometrics: not derived from a collected specimen; however, based on prior experience with this species on offshore jack-up installations and visual identification from ROV stills, a very high confidence level in species identification was possible. Taxonomic sources for *T. indivisa* taken from text and citations and detailed species descriptions provided in https://species.nbnatlas.org/species or descriptions taken mostly from Edwards [20]; Bay-Nouailhat [21] and Picton [22], and from various other references [e.g. 8, 14]. *T. indivisa* is a large hydroid with solitary conical or flask-shaped and richly-coloured polyps, with various shades of pink to red, found on dull yellow unbranched stems that reach 10–15 cm in height with a diameter of 1.5 cm [18]. Oral and aboral tentacles roughly similar in number and stems sometimes fused [8]. Polyps resemble flowers, having 40 oral tentacles surrounded by about 20–30 paler but larger aboral tentacle in two

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concentric rings, with the outer rings being paler and longer than the inner ring. At the centre is a pale pink *gonotheca*. Individuals observed in this study frequented depths of 10–130 m.

Order: ANTHOATHECATA

Family: ALCYONACEA

Alcyonium digitatum (Linnæus, 1758)

Dead man's fingers

Figure S5g. Morphometrics: not derived from a collected specimen; however, based on prior experience with this common and easily recognisable species on offshore jack-up installations, and from visual identification from ROV stills and video footage, a very high confidence in species-level identification was possible, as nothing else resembles *A. digitatum* in the North Sea. Taxonomic sources for *A. digitatum* taken from text and citations and detailed species descriptions provided in www.marlin.ac.uk, and references therein, and various other sources [e.g. 8, 14]. Mature colonies form thick erect fleshy lobes of irregular shape, typically of stout, finger-like lobes that usually exceed 20 mm in diameter. Young, developing colonies form encrustations about 5–10 mm thick. Height and breadth of colonies up to 200 mm. Polyps *monomorphic*, secondary polyps arising from solenia within the coenenchyme. *Sclerites* abundant in surface layer of coenenchyme, forming a crust. Anthocodia translucent white. Cross sections of fingers have few cavities, usually less than 12. White, yellow, orange or brownish in colour, sometimes appearing reddish or brownish during periods of inactivity when polyps are withdrawn into the colony (seasonally), owing to development of a film of epizoota. Individuals in the ROV footage occurred in all months, and at depth ranges of 5–141 m.

Order: ACTINIARIA

Suborder: NYNANTHEAE

Infraorder: THENARIA

Family: ACTINIIDAE

Bolocera tuediae (Linnæus, 1758)

Deeplet anemone

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Figure S5h. Morphometrics: not derived from a collected specimen; however, based on visual identification from ROV stills and behavioural observations from video footage, a high confidence in species-level identification was possible, as there are no other species of anemone resembling *B. tuediae* in the North Sea. Taxonomic sources for *B. tuediae* taken from text and citations and detailed species descriptions provided in http://species-identification.org and in www.marlin.ac.uk, and various other sources [e.g. 8, 14, 23]. One of the largest of the North Sea anemones, up to 30 cm across the base, which is lightly adherent. Column cylindrical, variable in height, sometimes taller than wide but often kept short and hidden by the tentacles; smooth and soft in texture, never with verrucae or acrorhagi, occasionally with a slight rim at the top, suggestive of a parapet, in some states of contraction. Disc wide. Tentacles stout, long and graceful in full extension, not readily retracted; arranged hexamerously, up to about 200. In most states of contraction, tentacles are longitudinally fluted and at the base of each is a slight circular constriction indicating the position of the basal sphincter muscle. The reason for the tentacles being deciduous is unknown, nevertheless they are readily shed on occasion and isolated tentacles remain alive for many days, although they cannot regenerate into new anemones as occurs in some species with deciduous tentacles. Colouration fairly uniform usually pink or whitish, but sometimes orange or buff. Disc and tentacles slightly translucent, with sometimes vague indications of a dark pattern around the tentacle bases. Individuals in the ROV footage occurred in the months of August and November at a depth of 60–144 m.

Order: ACTINIARIA

Suborder: NYNANTHEAE

Infraorder: THENARIA

Family: ACTINIIDAE

Urticina felina (Linnæus, 1761)

Dahlia anemone

Figure S5bi. Morphometrics: not derived from a collected specimen. Based on visual identification from ROV stills and behavioural observations from video footage, species-level identification as *U. felina* has been assumed, based on taxonomic sources, detailed species descriptions, and text and citations provided in http://species-identification.org and in www.marlin.ac.uk, and various other sources [e.g. 8, 14, 23]; however,

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taxonomy and relationships of *U. felina* are currently in debate, and a comprehensive review by Jackson and Hiscock [24] has determined that there are anemones of very similar appearance and apparent reproductive biology to *U. felina* occurring on the north-west (Pacific) coast of North America. Diameter of base up to 120 mm in shore-dwelling specimens, often larger in examples from deep water offshore; base is broad and firmly adherent, and damaged easily if removed forcibly [25]. Column usually shorter than wide, with well-marked parapet and a deep *fosse*. Verrucae always present, variable in size but generally well-developed, largest in the middle of the column and extending onto the parapet where individuals tend to form longitudinal rows. Columns strongly adhesive and in shore-dwelling specimens, often have numerous particles of gravel and other debris stuck to them; a contracted anemone having the appearance of a rounded mound of gravel. Disc not normally wider than the parapet. Tentacles stout, short, occasionally moderate in fullest extension, their decamerous arrangement determined easily, up to 160. Colouration highly variable and spectacularly diverse, a common form being as follows: column red, irregularly blotched with green, grey verrucae; disc pale blue-grey shading to red around the mouth, with prominent pattern of broad red lines amongst the tentacle bases; tentacles greyish, banded with dull red and white. Colour range endless: white, yellow, orange, red, blue, grey, purple and brown are all common, occurring in various combinations or, less frequently, plain. Distinctive and typical pattern of red lines on the disc is usually present but differs in detail: often lines enclosing the primary tentacles are bordered with white behind the tentacles, sometimes coalesced to form a broad red area amongst the tentacle bases, sometimes the whole disc is plain red. Tentacles are usually banded but may be plain; another common form is red all over except for grey verrucae and plain white tentacles. Individuals in the ROV footage occurred in the months of August and November and at depths of 40–143 m.

Order: ACTINIARIA

Suborder: ACONTIARIA

Family: METRIDIIDAE

Metridium senile (Linnæus, 1761)

Plumose anemone

Figure S5j. Morphometrics: not derived from a collected specimen. Based on visual identification from ROV stills and behavioural observations from video footage, sub species-level identification as *M. senile* var. *dianthus* has been assumed to an extremely high confidence level, based on taxonomic sources, detailed

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species descriptions, and text and citations provided in http://species-identification.org and in www.marlin.ac.uk (the latter of which incorrectly classify this species as *Metridium dianthus*), and various other sources [e.g. 8, 14, 23]. Fautin [26] recognised both *Metridium senile* and *M. dianthus* as valid synonyms but noted that the use of the names has varied over time. This anemone is a common and well-known species occurring in a large variety of forms which differ considerably in general appearance. Two distinct varieties are recognised in British waters: *M. senile* var. *dianthus* and *M. senile* var. *pallidus*, although these are probably only extremes of a long series connected by numerous intermediate forms. Consequently, it is highly likely that *M. senile* var. *pallidus* has been confused with the elegant anemone, *Sargartia elegans* in other studies of this nature. Base wider than the column, moderately or firmly adherent, its outline often ragged due to *basal laceration*. Column divided into a smooth *scapus* and a relatively long *capitulum*, with a parapet and fosse; in full expansion the parapet often forms a *salient*, collar-like ring. Inconspicuous cinclides present on the scapus; *acontia* emitted reluctantly. Disc reasonably wide, with prominent protruding lips around the mouth. Tentacles highly variable in length, relatively long in small specimens, and often very numerous – several thousand may be present in a large individual. Catch-tentacles are rare in British specimens. Colouration plain, with no pattern on the disc but often one or two opaque white bars are present on the basal part of each tentacle; disc and tentacles otherwise translucent. Commonest colours are white or orange, but brown, grey or occasionally red or yellow varieties occur. Bi-coloured specimens, e.g. brown column, white disc and tentacles, are not uncommon.

M. senile var. *dianthus* is the well-known large plumose form. Scapus smooth, pillar-like in extension, terminating above in a broad collar-like parapet; capitulum long and flaring out toward the disc. Disc in older, not necessarily large specimens deeply waved or folded, often tending to form lobes. Tentacles relatively short and slender, those of the inner cycles larger than the rest; very numerous – up to several thousand – an imparting a densely fluffy appearance to the expanded anemone. Colouration as above, sometimes lacking the white bars on the tentacles. Large specimens (size being relative, since scale was not available on footage) often attain 300 mm in height, with a basal diameter and tentacle span of 150 mm or more.

M. senile var. *pallidus* is a small form not exceeding about 25 mm across the base. Column not usually very tall, its regions clearly defined. Disc flattish or slightly undulating, never deeply waved or lobed. Tentacles long and slender, not usually more than about 200. Colouration as above; usually very translucent, with prominent white bars on the tentacles; occasionally with greyish radial lines on the disc, amongst the tentacle

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bases. This variety, which changes in detail in different localities, appears to be a genuine dwarf race which becomes sexually mature at a small size [27].

The two varieties described above are linked by a series of forms of intermediate size and structure which may exhibit characters of either variety. A common form frequent on the shore has a tall column and a slightly waved disc, occasionally forming lobes, and up to about 500 tentacles of moderate length. Such specimens are probably stunted forms of *M. senile* var. *dianthus*, their growth being inhibited by the littoral environment, but young anemones developing from basal lacerations often bear a close resemblance to pallidus. Individuals in the ROV footage occurred in the months of August and November and at a depth of 5–144 m.

Order: ACTINIARIA
Suborder: ACONTIARIA
Family: SAGARTIIDAE
Sagartia elegans (Dalyell, 1848)
Elegant anemone

Figure S5k. Morphometrics: not derived from a collected specimen. Based on visual identification from ROV stills and behavioural observations from video footage, species-level identification as *S. elegans* (and potentially other variates) has been assumed to an extremely high confidence level. *S. elegans* var. *miniata* is the most widespread variety, while *S. elegans* var. *aurantiaca* is considered rare, reported only from South Wales and Devon. *S. elegans* is found rarely in muddy or sandy substrata, where *S. troglodytes* and *Cereus pedunculatus* are more common. Identification based on taxonomic sources, detailed species descriptions, and text and citations provided in http://species-identification.org and in www.marlin.ac.uk and various other sources [e.g. 8, 14, 23]. Diameter of base up to 30 mm, span of tentacles to 40 mm. Occasionally much larger individuals may be encountered; these are usually hexamerous and may be specimens that have never reproduced asexually. Base wider than the column, closely adherent and difficult to detach from the substratum without tearing; its outline is usually ragged due to basal laceration. Column moderately tall in expansion, flaring out trumpet-like toward the disc. Suckers usually prominent, largest on the distal part of the column and fading away proximally; only exceptionally do they have gravel or other debris stuck to them. Cinclides barely visible as dark dots, are present on the upper part of the column and just above the limbus;

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acontia are emitted from them freely. Tentacles moderate or long, usually irregularly arranged but occasionally hexamerous, up to about 200. Column variable in colour: red, orange, brown, whitish or pale grey green. The suckers form pale whitish spots, usually prominent but sometimes indistinct on specimens with pale columns. The general colour is palest on the proximal part, which often bears paler longitudinal stripes, becoming richer and darker distally. Five colour varieties are recognised, based on colouration of the disc and tentacles; these are usually distinct, but intermediary forms are not uncommon:

- *S. elegans* var. *miniata*: ground colour of disc variable, often variegated – orange, red, grey, brown, cream, etc. – typically shading to orange around the margin. Always with a well-marked dark pattern, but often varying in detail. Tentacles similar to disc, usually banded and sometimes with a pair of dark longitudinal lines;
- *S. elegans* var. *rosea*: disc variably coloured, plain, or patterned as in *S. elegans* var. *miniata*; tentacles pink, rose-red or magenta;
- *S. elegans* var. *aurantiaca*: disc usually greyish, sometimes with traces of the typical pattern; tentacles dull orange. This variety resembles a common variety of *S. troglodytes* and care should be taken not to confuse the two.
- *S. elegans* var. *venusta*: disc plain orange, varying from pale and translucent to a rich, opaque colour; tentacles white; and,
- *S. elegans* var. *nivea*: disc and tentacles plain white, usually translucent.

Individuals in the ROV footage occurred in the month of August and at depths of 15–142 m.

It must be noted that the nomenclature of *Sagartia elegans*, first described in 1848 by Dalyell, has recently come under scrutiny. Fautin [26] lists an inventory of all taxa within the orders Actiniaria and Corallimorphari (correct as of 2010). In this, the type species was removed from the genus *Sagartia*, based on the International Code of Zoological Nomenclature, meaning all species therein should be assigned to a new genus. Subsequently, however, Sanamyan and Sanamyan [28] criticised this approach, arguing that the Code was not correctly interpreted. Instead, they suggested a change in nomenclature of *Sagartia* to *Cylista* Wright, 1859. We acknowledge this disparity and refer to the species throughout the present manuscript using the name *Sagartia elegans* rather than *Cylista elegans*, to remain consistent with prior literature and avoid confusion for readers familiar with *Sagartia*.

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Phylum CTENOPHORA Eschscholtz, 1829

Order UNKNOWN

Family UNKNOWN

Unidentified Ctenophoran

Comb jelly

Figure S5l. Morphometrics: not derived from a collected specimen. Unidentified ctenophorans observed in six videos, and not in stills. Image quality was insufficient to identify to order level, but according to Hayward and Ryland [8], shape, colouration and presence of combs identified the six occurrences as definite ctenophoran and depths of 16 – 143 m.

Order: CANALIPALPATA

Suborder: SABELLIDA

Family: SERPULIDAE

Unidentified tube worm

Figure S5m. Morphometrics: not derived from a collected specimen. Serpulidae were identified primarily from white casings on hard substrates (often as epizooites on Mytilus spp.); no evidence of living worms was detected. Based on visual identification from ROV stills and behavioural observations from video footage, identification to subclass level was certain. Identification was determined using various sources [e.g. 8, 14]. Image quality was insufficient to identify any individuals to taxonomic level lower than family. Serpulidae spp. have a short front region with a much longer rear one and typically have 100 segments. The front region is draped with a cloak-like membrane, and they have a crown of feathery tentacles (usually 30–40 in two groups), but the tube is a hard, calcareous material that is secreted by the worm. Identifying features are the tube and operculum which is a modification seen in most members of the family. Total length of the tube attached to a solid object. Individuals in the ROV footage were observed in the month of August at depths of 0–144 m.

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Class: CRUSTACEA

Infraclass: CIRRIPEDIA

Unidentified barnacle

Figure S5n. Morphometrics: not derived from a collected specimen. Based on visual identification from ROV stills and behavioural observations from video footage, identification to subclass level was certain. Image quality was insufficient to identify any individuals to taxonomic level lower than subclass. These features included: being sessile, slight opening, presence of a *carapace* and absence of legs. According to www.marinespecies.org, identification of one species of barnacle may have been a possibility: Superorder Thoracica, Order Sessilia, Suborder Balanomorpha, Superfamily Balanoidea, Family Archaeobalanidae, Subfamily Archaeobalaninae (yes…this does eventually end somewhere): *Chirona hameri* (Ascanius, 1767) – formally classified as *Balanus hameri* [8], which is suggested based on colouration, distribution, strata preferences, and depth, but this not a certain identification. Individuals in the ROV footage were seen throughout August and November at depths of 15–144 m with more numerous aggregations being observed in deeper areas.

Class: MALACOSTRACA

Order: EUPHAUSIACEA

Euphasiidae sp.

Unidentified free-swimming shrimp

Figure S5o. Morphometrics: not derived from a collected specimen. Based on visual identification and behavioural observations from ROV video footage, identification to class level was certain; however, identification of free-swimming shrimps is notoriously hard, especially with poor image quality. Individuals observed were often attracted to the ROV light, biasing any accurate assessment of depth preferences, which were 10-144 m Moreover, there were mixed assemblages of fish larvae and free-swimming shrimp, further hindering any level of positive identification.

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Order: DECAPODA

Suborder: PLEOCYEMATA

Infraorder: ANOMURA

Family: LITHODIDAE

Lithodes maja (Linnæus, 1758)

King crab

Figure S6a. Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, and the length of pincers, *Lithodes maja* is likely. Observed individuals had large spines on their legs and carapaces, differentiating them from *Maja brachydactyla*, which are also characterised by shorter pincers. Taxonomic sources for *L. maja* taken from text and citations and detailed species descriptions provided in http://species-identification.org and in www.marlin.ac.uk, and various other sources. A large crab with a well-calcified carapace with a width up to 12 cm [29]. Carapace is almost circular with a well-defined rim of irregular spines scattered on the back and legs [29]. Right *chela* larger than left and fifth *pereopods* small and hidden, often orange-brownish colour [29]. Individuals in ROV footage occurred at depths, of 138 m and 143 m, with only two sightings recorded of three individuals.

Order: DECAPODA

Family: CANCRIDAE

Cancer pagurus (Linnæus, 1758)

Edible crab

Figure S6b Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, species-level identification was certain. *C. pagaurus* can reach 25 cm width, and has a wide, oblong carapace with distinct fronto-lateral markings, 10 rounded lobes and large black-tipped pincers [30]. The last dactyl of walking legs ends in spine-like tips and is reddish-brown in colour [30]. Individuals in ROV footage occurred at depths, of 12–44 m.

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Order: DECAPODA

Family: PORTUNIDAE

Maja brachydactyla (Linnæus, 1767)

Common spider crab

Figure S6c Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, species-level identification was probable, but note that the taxonomy of this species is under debate. From a morphological perspective, this crab has recently been proposed as a distinct species, *M. brachydactyla*, although for commercial purposes it is still considered the same species as its Mediterranean congener, *Maja squinado* (Andrés et al., 2007; Sotelo et al., 2008). *M. brachydactyla* is also not listed on http://species-identification.org, which instead provides insights into the plethora introduced species from Japan. Consequently, taxonomic sources for *M. brachydactyla* taken from text and citations in www.marlin.ac.uk. *M. brachydactyla* can reach 20 cm with a circular to oval carapace that is strongly convex, both transversely and longitudinally; dorsal surface with many short and acute spines; frontal region produced as a stout, short, bifid rostrum each half conspicuously diverging outward or almost parallel; chelipeds equal and along with second to fifth pairs of pereiopods, moderately stout, segments with *spinules*; brownish-red in colour [31]. Two sightings occurred in the ROV footage at depths of 67 and 104 m.

Order: DECAPODA

Family: PORTUNIDAE

Necora puber (Linnæus, 1767)

Velvet crab

Figure S6d Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage species-level identification was probable, with a reasonable level of confidence. *N. puber* can have a carapace width of up to 10 cm with short hairs [29]. Carapace dorsal is flattened and pubescent; frontal margin with up to ten narrow unequal teeth, middle two

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often larger; antero-lateral margin with five sharp; forward-pointing teeth and the chelipeds equal, strong, pubescent; reddish-brown colour [29]. One individual in the ROV footage occurred at a depth of 15 m.

Phylum: BRYOZOA (Ehrenberg, 1831)

Phylum: CNIDARIA

Subphylum: MEDUSOZOA

Bryozoa/hydrozoa turf biotope

Figure S6e. Morphometrics: not derived from any collected specimens. Biotope listed commonly in www.marlin.ac.uk. Found mostly below 120 m in ROV footage.

Class: BIVALVIA

Subclass: PTEROMORPHIA

Order: MYTILOIDA

Family: MYTILIDAE

Mytilus sp.

Blue mussel

Figure S6f. Morphometrics: not derived from any collected specimens. In terms of taxonomy, the blue mussel (*Mytilus* spp.) is the most common genus in the North Sea and comprises a complex of species with a high degree of hybridisation (Mathiesen et al., 2017), making it highly difficult to reliably identify. Most reports cite Mytilus edulis as the observed species, but without genetic and morphometric verification, this may be inaccurate (Lucas et al., 2002; Wilson et al., 2018): According to http://species-identification.org, within the genus *Mytilus*, there are 30 species (including seven varieties) in the North Sea; consequently, identification of species observed in the footage occurred to genus level only.

1. M. abbreviatus (synonym for M. galloprovincialis);
2. M. barbatus (synonym for Modiolus barbatus);

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3. M. curtus (synonym for Modiolus modiolus);
4. M. decussatus (synonym for Crenella decussata);
5. M. dilatatus (synonym for M. galloprovincialis);
6. M. discors (synonym for Musculus discors and Modiolarca subpicta);
7. M. discrepans (synonym for Musculus discors);
8. M. flavus (synonym for M. galloprovincialis);
9. M. galloprovincialis
10. M. galloprovincialis var. eduliformis (synonym for M. galloprovincialis);
11. M. galloprovincialis var. falcata (synonym for M. galloprovincialis);
12. M. galloprovincialis var. frequens (synonym for M. galloprovincialis);
13. M. galloprovincialis var. herculean (synonym for M. galloprovincialis);
14. M. galloprovincialis var. latissimi (synonym for M. galloprovincialis);
15. M. galloprovincialis var. trepida (synonym for M. galloprovincialis);
16. M. galloprovincialis var. uncinate (synonym for M. galloprovincialis);
17. M. gibbsianus (synonym for Modiolus barbatus);
18. M. glocinus (synonym for M. galloprovincialis);
19. M. hesperianus (synonym for M. galloprovincialis);
20. M. marmoratus (synonym for Modiolarca subpicta);
21. M. modiolus (synonym for Modiolus modiolus);
22. M. pelecinus (synonym for Mytilus galloprovincialis);
23. M. petasunculinus (synonym for Mytilus galloprovincialis);
24. M. praecisus (synonym for Hiatella arctica);
25. M. retusus var. acrocyrta (synonym for M. galloprovincialis);
26. M. sagittatus (synonym for M. galloprovincialis);
27. M. succineus (synonym for M. galloprovincialis);
28. M. trigonus (synonym for M. galloprovincialis);
29. M. umbilicatus (synonym for M. modiolus); and,
30. M. zonarius (synonym for M. galloprovincialis).

Individuals in the ROV footage occurred during the month of August at a depth 0–50 m.

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Order FORCIPULATIDA

Family ASTERIIDAE

Asterias rubens (Linnæus, 1758)

Common starfish

Figure S6g. Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV stills and video footage, species-level identification was possible. *A. rubens* may grow up to 52 cm in diameter, but commonly 10–30 cm with small disc and five arms. The body wall is flexible with numerous groups of papulae in soft areas [32]. Major spines on the upper surface often in one or more longitudinal rows, sometimes surrounded by bundles of straight and crossed pedicellariae [32]. Ventro-lateral spines just outside adambulacrals, in oblique rows, with straight pedicellariae on lower surface in ambulacral grooves and attached to furrow spines [32]. *A. rubens* is variable in colour, though usually orange, pale brown or violet and is found on a variety of substrata that include coarse and shelly gravel and rock. Individuals in the ROV footage occurred in the month of August at a depth 14–140 m with it being more frequent at increased depth.

Order SPINULOSIDA

Family ECHINASTERIDAE

Henricia sanguinolenta (Linnæus, 1758)

Figure S6h. Morphometrics: not derived from a collected specimen. *H. sanguinolenta* is very similar *to H. oculata* (Laakmann et al., 2016), and possible misidentification has led to little understanding of *H. sanguinolenta*. The two species are only truly distinguishable through genetic analysis [33], but differ in depth and distribution. Based on visual identification and behavioural observations from ROV stills and video footage, species-level identification was therefore possible with a reasonable level of confidence, based on its depth preference of >100 m, whereas *H. oculata* has a depth range of 0–50 m. *H. sanguinolenta* grows to a diameter of 7–12 cm and has five arms which taper evenly to the tips, no marginal plates, two tube foot rows, and no pedicellaria [34]. There are fine *spinelets* with 3–6 glassy points on its dorsal surface, the sides of its arms are curved smoothly, with no clear distinction between dorsal and ventral surface, and each has a narrow

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ambulacral groove which contains the tube feet [34]. *H. sanguinolenta* is variable in colour but often seen as the rich red morph [34]. Individuals in the ROV footage occurred during the month of November at a depth of 144 m.

Order PHANEROZONIA

Family PORANIIDAE

Porania pulvillus (Müller, 1788)

Cushion star

Figure S6i. Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, species-level identification was possible to a reasonable confidence level, based on numerous sources, such as http://species-identification.org (but is not listed on www.marlin.ac.uk); however, this species can be confused with *P. gibbosa*, which is smaller in size, and often green. *P. pulvillus* has a large convex disc with five short wide arms reaching up to 11–12 cm in diameter, the lower marginal plates have 3–5 fairly strong spines, forming a distinct fringe along the edge of the body [34]. *P. pulvillus* are bright red or pale yellow colour with a white underside [34]. Individuals in the ROV footage occurred in the month of November at a depth of 130 m.

Order OPHIURIDA

Family OPHIOTRICHIDAE

Ophiothrix fragilis (Abildgaard, 1789 in Müller, 1789)

Common brittle star

Figure S6j. Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV stills and video footage, and on numerous descriptions and references in http://species-identification.org and www.marlin.ac.uk, identification to a higher taxonomic level was possible. *O. fragilis* disc grows to 1 cm with five arms which reach 5 cm, the central disc has five rays of spines forming from a spiny centre, between these are five pairs of triangular plates [32]. Arms are quite

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distinct from the disc and are covered with overlapping scales with each arm having seven spines [32]. *O. fragilis* dorsal arm plates are naked and have a longitudinal-keel spines. *O. fragilis* are variable in colouration, ranging from violet, purple or red to yellowish or pale grey. Individuals in the ROV footage occurred at a depth range 0–140 m with greater aggregations occurring 0–60 m. Maturity of observed individuals cannot be confirmed due to quality of footage.

Order: OPHIURAE

Family: OPHIOCOMIDAE

Ophiocomina nigra (Abildgaard, 1789 in Müller, 1789)

Black brittle star

Figure S6k. Morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, and on numerous descriptions and references in http://species-identification.org and www.marlin.ac.uk, species-level identification to a high level was possible. *O. nigra* disc grows to 2 cm with five arms which can reach 10 cm. 5–7 long slender arm spines and a pair of tentacle scales [35]. *O. nigra* are variable in colouration, uniform dark brown or black but pale or white specimens [36]. Individuals in the ROV footage occurred in months August and November at a depth range 0–50 m.

Order: CAMARODONTA

Family: ECHINIDAE

Echinus esculentus (Linnæus, 1758)

Common sea urchin

Figure S6l. Morphometrics: not derived from a collected specimen; however, based on visual identification from ROV video footage, and on numerous descriptions and references in http://species-identification.org and www.marlin.ac.uk, species-level identification to a reasonable level of confidence was possible. This is

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because of potential confusion with *E. acutus* (more oval shaped) and *E. elegans*. *E. esculentus* can reach 17.6 cm and are rounded and radially symmetrical, slightly flattened but overall globular; each ambulacral plate with three pairs of pores; globiferous pedicellariae with one lateral tooth below terminal tooth; primary and secondary spines and *bosses* are similar in size, except in small specimens; buccal spines bear short, club shaped spines and often reddish in colour [32]. Individuals in the ROV footage occurred during the month of August at depths, of 45–120 m.

Subphylum: TUNICATA

Class: ASCIDIACEA

Order: PLEUROGONA

Suborder: STOLIDOBRANCHIA

Family: STYELIDAE

Botryllus schlosseri (Pallas, 1766)

Star ascidian

Figure S6m. Morphometrics: not derived from a collected specimen. Taxonomic sources for *B. schlosseri* taken from text and citations and detailed species descriptions provided in http://species-identification.org and in www.marlin.ac.uk, and various other sources. Based on visual identification from ROV stills and from video footage, taxonomic identification to species level at medium level of confidence. This is because this species can only be distinguished from *Botrylloides* sp. By, *inter alia*, pattern of zooid growth. *B. schlosseri* zooids emanate in a star-shaped pattern from a central point, and there are typically fewer zooids per cluster (five to eight in *B. schlosseri* and 10 or more in *Botrylloides* sp.). Colour is highly variable, typically purple, but colours also range from orange, blue and grey. Specimens in the footage were purple. Individuals in the ROV footage occurred in the month of August at depths of 15–130 m, with most observed at 15–40 m.

Order: GADIFORMES

Family: GADIDAE

Pollachius virens (Linnæus, 1758)

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Saithe

Figure S6n. Meristics and morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV stills, video footage, text and citations and detailed species descriptions provided in http://species-identification.org and in www.marlin.ac.uk, and from various keys and guides [14, 37, e.g. 38], species-level identification was certain. Adults grow up to 130 cm with a small chin (The jaws are equal in young fish; the lower jaw protrudes slightly in adults), *barbel* barely visible, no dorsal or anal spines, three dorsal fins, two anal fins, 35–40 gill-rakers and a straight, pale lateral line across the body, with body colour appearing brownish green becoming paler ventrally [39]. Individuals in the ROV footage were observed in the months of August and November at a depth range between 74–140 m, with larger aggregations recorded at between 130–140 m. Foraging was noted in aggregations of *P. virens*.

Order: GADIFORMES

Family: GADIDAE

Gadus morhua (Linnæus, 1758)

Cod

Figure S6o. Meristics and morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV stills and video footage, and citations and detailed species descriptions provided in http://species-identification.org and in www.marlin.ac.uk, and from various keys and guides [14, 37, e.g. 38], species-level identification was certain. *G. morhua* possess no dorsal or anal spines, 44–55 dorsal soft rays, 33–45 anal soft rays, 51–55 vertebrae, with a protruding jaw and chin barbel [39]. Straight, pale lateral line across the body that curves above the pectoral fins with body colour appearing brownish green or grey becoming pale and silvery ventrally [39]. Individuals in ROV footage were observed in the month of November at a depth of 144 m, occurring within *P. virens* aggregations.

Order: SCORPAENIFORMES

Family: SEBASTIDAE

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Sebastes norvegicus (Linnæus, 1758)

Rose fish

Figure S7a. Meristics and morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage and citations and detailed species descriptions provided in http://species-identification.org and in www.marlin.ac.uk, and from various keys and guides [14, 37, e.g. 38], species-level identification was certain for *S. norvegicus*. Dorsal and anal fin, 14–16 dorsal spines, three anal spines, eight anal soft rays, and the membrane of the pectoral fins extend almost to the tips of the rays [40]. Bright red colouration, dusky area behind opercula with lower preopercular spine is directed downward and slightly backward and 55 oblique scale rows below the lateral line [40]. Individuals were observed in ROV footage in the month of November at depths of 139–144 m.

Order: SCORPAENIFORMES

Family: TRIGLIDAE

Chelidonichthys lucerna (Linnæus, 1758)

Tun gurnard

Figure S7b. Meristics and morphometrics: not derived from a collected specimen; however, based on visual identification and behavioural observations from ROV video footage, and citations and detailed species descriptions provided in http://species-identification.org and in www.marlin.ac.uk, and from various keys and guides [14, 37, e.g. 38], species-level identification was certain. Head lacks deep transverse groove, scales small, lateral scales little enlarged and tubular, first dorsal fin not elongated, pectoral fin long to anal fin 2–4, body lacks transverse skin ridges, dull reddish below, white or golden, reddish outer face, inner side bright blue with dark mark, normally reaches 75 cm. Individuals were observed in ROV footage in November at a depth of 144 m.

Order: LABRIFORMES

Family: LABRIDAE

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Labridae sp. (Cuvier, 1815)

Figure S7c. Morphometrics and morphometrics: not derived from a collected specimen; however, based on visual identification from ROV stills and behavioural observations from video footage, and citations and detailed species descriptions provided in http://species-identification.org and in www.marlin.ac.uk, and from various keys and guides [14, 37, e.g. 38], confidence in taxonomic identification to genus-level was high, and the species was potentially *Ctenolabrus rupestris*; however, this is a diverse family of fish. *Labridae* sp. usually have oblong, compressed bodies, prominent lips on a protrusible mouth; teeth conical, but molar-like teeth in pharynx; first dorsal fin, caudal fin truncate to rounded. Individuals were observed in ROV footage in August at a depth of 13 m (one individual) and the remaining four individuals at 143–144 m.

2.3. Species richness & diversity

S and *H'* are presented for sessile and motile species at each depth band in **Table S6.**

Depth (m)	Depth bands	Sessile species		Motile species	
		S	H'	S	H'
0–5	1	5	1.064	-	-
5–10	2	7	1.375	1	0.000
10–15	3	7	1.268	2	0.011
15–20	4	7	1.397	1	0.000
20–30	5	7	1.254	1	0.000
30–40	6	4	1.045	1	0.000
40–50	7	6	1.020	1	0.000
50–60	8	5	1.121	1	0.000
60–70	9	5	0.542	1	0.000
70–80	10	5	0.621	2	0.693
80–100	11	6	0.321	2	0.670
100–120	12	9	1.213	2	0.598
>120	13	9	1.293	6	0.517

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Table S6: Species richness (*S*) and diversity (*H'*) for sessile and motile species at each depth band (1–13) and water depths (0 to >120 m). Values are calculated from percentage cover, scaled to include only species present, taken from still ROV images. No motile species were observed at 0–5 m.

3. DISCUSSSION

3.1. Industry data vs. scientific data

Prior to expanding on relevance of results in this study, it is important to clarify the nature of non-scientific, short-term, 'snapshot' GVI/CVI ROV industrial data, and their caveats in scientific-research studies, many of which were applicable to the present study.

The availability of data is opportunistic, due largely to the sensitive nature of industrial studies. Data are often provided to scientists with little in the way of metadata or information on the type/configuration of ROV used. For example, in dedicated scientific ROV studies, such as those carried out in Australia, industry works directly together with Government agencies, and pilots are often in direct liaison with scientists in real time *e.g.*, it is especially important to know ROV specifications, because cameras (and the ports they are contained in), have different degrees of optical distortion (*e.g.,* refraction error) that are accounted for in dedicated ecological studies. In addition, metadata for each ROV dive should be made available and includes such metrics, as height above the bottom, tilt and yaw, whether scaling lasers were available, and distance from subject for every video frame grab or still taken. This laconic level of information is typical of North Sea, *post hoc*, industry studies, where direct liaison with third-party ROV operators is either not possible nor allowed.

At the time of analysis, the criteria used to assess quality of the videos used (**Tables S1-3**) was based on biological attributes of the communities under study. In a dedicated survey, a recent study evaluated quality was based on whether images are orthogonal in nature by assessing, and most importantly, whether the image is oblique or perpendicular in nature, in focus and has adequate illumination with a usable scale [41]. Geometric distortion is the most common error in ROV-based imagery, especially imagery that was not taken with a pre-planned, ecological, survey in mind. Knowing size of each image is very important whether conducting a plot, or plotless, survey. This study did not use orthorectified images for quantitative analyses,

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and moving forward, this is a very important consideration that ought to be incorporated into industry studies if possible.

One of the most important requirements for calculating diversity indices is a method of standardising data by effort of area (see Gotelli and Colwell 2001, Ecol. Lett. 4: 379-391), sampling evenly across depth *etc*.; however, this requires knowledge of the area sampled, which is not available in industry studies of this nature. This means that it is also not possible to know the entire survey area, so that all depths are be sampled equally. Controlling for area in industry studies, is not possible. For example, in an ideal scientific survey, distance between the camera and the substratum should be held more-or-less constant because otherwise different areas (assuming a 2D/flat surface) are being sampled, which introduces biases to estimations of prevalence of species, richness, diversity, proportion of rare species, *etc.* Industry studies like this are obliged to control for time, which does not necessarily control for area surveyed. In a dedicated scientific ROV survey, quantification of similar areas would be performed for calculation of diversity indices which can be very sensitive to rare species (especially Shannon *H'*), and therefore area sampled. One potential way to overcome this would be to adopt a more recent approach, by using ‘coverage’ and ‘Hill diversity’ as better descriptors of biodiversity (see Roswell et al. 2021, Oikos 130: 321-338).

Industry ROV surveys are not conducted in any specific season or time of day, making temporo-spatial studies challenging, and surveys are not conducted in a standardised manner. For example, ‘vertical sweeps’ are not planned transects, which obliges industry workers to sample based on depth bands which is a form of ‘binning’, which is a non-random process, and can disguise important community variation based on depth. Furthermore, use of pre-collected industry data results in primarily unbalanced sampling and shallower areas being sampled at night, which can cause misrepresentation or apparent absence of motile species known to undertake diel vertical migrations in the water column. Fujii and Jamieson (2016) recorded strong diel movements in *P. Virens* at the Miller Platform in the northern central North Sea, and vertical movements of zooplankton have been reported widely (as reviewed by Bandara et al., 2021), with artificial lights of O&G platforms thought to influence movements of species (Barker and Cowan, 2018).

Criteria used to assess the quality of the videos used (**Tables S1-3**) are based on the biological attributes of the communities under study, and this is because commercial ROV data quality is lacking. Some studies specify that video should be evaluated based on whether the images are orthogonal in nature by assessing, most importantly, whether the image is oblique or perpendicular in nature, in focus, and has adequate

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illumination with a usable scale. Geometric distortion is the most common error in ROV-based imagery, especially footage that was not taken with a pre-planned, ecological, survey in mind, as in this study.

Non-AI detection and classification industry studies of this nature are incredibly time consuming, and labour intensive, obliging analysis and description of images using a point-count analysis. While Lesser, Slattery [42] disputes this technique, claiming that there is no power analysis to show that an adequate number of images are collected, and no species area curves to show that for each image there is a sufficient number of points being overlayed to capture the maximum number of species possible for subsequent diversity analyses for study sites, Pawlik [43] refutes Lesser, Slattery [42], suggesting that claims in that paper were factually incorrect, which supports the methods used here. Pawlik [43] goes on to state that Lesser, Slattery [42] misuses the terms ‘orthorectification’ and ‘orthorectified’ and does not provide a method for orthorectification of single-shot photographs of complex substrata, nor does it provide a clear definition of orthogonal when applied to complex benthic substrata. More importantly, the point-intercept method does not require orthorectification to generate abundance estimates that are quantitative and valid.

Detailed discussion of methods is beyond the scope of this paper, but it demonstrates that, while in an ideal world, use of 3D photogrammetry as an approach would overcome many of the issues raised above; however, such methods are impossible for these types of industry data collected by third-party ROV companies.

3.2. Taxa not detected in stills

Only 19 of the 34 taxa recorded were detected in stills. Remaining taxa were therefore not included in analysis of species assemblages. These taxa were relatively rare and are described briefly here.

In terms of jellyfish sightings off offshore anthropogenic structures in general, transport by oil platforms [rigs] being located or relocated at sea provides mechanisms for invasive jellyfish translocations [44] Certainly, the notion of global ocean sprawl as a mechanism for the amplification of jellyfish blooms [45] is a not a new one. Moon jellyfish (*Aurelia* sp.) were observed in 15 videos, at depths of 40–140 m. *Aurelia* sp. are observed typically in high abundances during late Autumn [46], explaining presence in recordings taken in both August and November 2017. The jellyfish *A. vitrina* was also detected in one video, at a depth of 100 m. *A. vitrina* has been documented previously throughout the north eastern Atlantic in pelagic and coastal areas [9], though in limited detail; a thorough literature search revealed that this may be its first documented sighting off an

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offshore hydrocarbon platform. One sighting of a Lion's mane jellyfish (*C. capillata*) was recorded at 95 m. In the British Isles this species is recorded commonly along the east coast of Scotland and England [19, 47, 48]. In the North Sea mature *C. capillata* usually peak in abundance from June to September, though a few large specimens may survive the winter in deep water. *Aurelia* has been recorded previously exhibiting DVMs and is capable of advanced swimming behaviour [49].

There were six sightings of Ctenophora, four of which were single individuals, one contained six individuals, and one contained nine. These ranged in depth between 20–140 m. Images were not clear enough to identify to species level, though the partial still (and brief video footage) of the individual in **Figure S5l** resembles *Bolinopsis infundibulum* which is common in the North Sea. Ctenophores have been seen in ROV GVI imagery off offshore O&G platforms in the North Sea before [50]

Swarms of free-swimming shrimp were observed in 15 videos between 40–130 , which are common throughout the world's oceans, comprising a large proportion of biomass, and an important prey source for many higher-trophic-level species [51]. Analysis of stomach contents of saithe (*P. virens*), from individuals sampled at British Petroleum's North Sea Miller platform, were found to contain a high proportion of euphausiids [52].

King crab, *L. maja*, was detected in two videos; one comprised a single crab, while the second showed two perched on 'shelves' in a clamp, at 140–143 m depth. *L. maja* is documented throughout the north Atlantic and the North Sea with a depth range 10–1,000 m [29].

The edible crab (*C. pagurus*), which is an important commercial fishery species, was reported in six videos, at depths between 15–45 m; five comprised of one individual, and one containing four. *C. pagurus* is documented throughout the east Atlantic and North Sea, with a depth range 0–100 m [30]. *C. pagurus* is an active predator and consumes a variety of benthic organisms [53, 54], one of which was observed in high numbers in this study, *Mytilus* spp. [55]. The species is nocturnal [53, 54], which may explain lower sighting incidences, although the majority of footage at depths <50 m was taken overnight, ROV footage in darkness may have been of lower quality than during daylight, leading to lower occurrence of sightings. The main predator of the species are octopuses, Cephalopoda [56] which were not seen in the footage. Distribution of *C. pagurus* is dependent heavily on oceanographic frontal systems and within the North Sea, the population south of the Dogger Bank was thought originally to be supplemented by northerly populations; however, the

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southern population may be a separate, self-sustaining stock, providing recruitment of mature female crabs to northern areas such as north Norfolk [57]. This is highly important when considering genetic diversity of the species and ensuring there are methods of migration for individuals between populations [58, 59], which this installation may be facilitating.

Two individuals of common spider crab (*M. brachydactyla*) were observed, each in a separate video at 60 and 100 m. *M. brachydactyla* is documented throughout the Atlantic with a depth range 0–80 m [31]. Much work has been compiled on larval growth, chemical and genetic compositions for human use [e.g. 60]; however, there is little information on their ecology or zonation patterns. Again, the present sighting demonstrates the possibility for ROV footage to be utilised in future research, specifically for furthering understanding of rare or obscure species.

There was a single sighting of the commercially important velvet crab (*N. puber*) at 20 m. *N. puber* is documented throughout the east Atlantic and the North Sea with a depth range 0–80 m [29]. *N. puber* have planktotrophic larvae, with tidal flow playing a large part in their dispersal [61].

A single sighting of cushion starfish (*P. pulvillus*) was recorded on the bundle structure, at 144 m depth. *P. pulvillus* is documented throughout the British Isles and the North Sea with a depth range of 10–1,000 m [34] and reproduces by external fertilisation of planktonic larvae. This species has a preference for muddy substrata [34]. Its presence may likely be explained by its encounter of the platform when moving from the surrounding soft substratum whilst searching or its main prey species.

Common sea urchin (*E. esculentus*) was recorded in three videos on the platform structure between 40–130 m and has been observed previously on offshore platforms in the North Sea at depths between 25–45 m [4, 62]. In the North Sea, the species is common in all areas with hard substrates [63-65]. *E. esculentus* is documented throughout the north eastern Atlantic with a depth range of 0–100 m [32]. In terms of ecology, *E. esculentus* has a broad diet and has been observed feeding on Polyzoa [Bryozoa] – specifically encrustations of *Membranipora* – *Laminaria* spp., and algal films such as *Hildenbrandia prototypus* [*rubra*] *nardo*, and Balanidae [66, 67], which explains its presence on the platform. Spawning occurs from April to June, generating pelagic eggs and larvae [66, 68]. During a spawning event, males will spawn first, followed by the release of mature ova from the females [69].

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The commercially, deepwater trawled, long-lived, and gregarious [70] rose fish (*S. norvegicus*) were recorded in three videos, each of a single individual on seabed structures at 140–144 m depth. *S. norvegicus* is well-documented throughout the eastern Atlantic and North Sea with a depth range of 100–1,000 m [40]. This benthic species [71] feeds primarily on pelagic species such as euphausiids during the summer, herring (*Clupea harengus*), in autumn and winter, and capelin (*Mallotus villosus*), herring, euphausiids and ctenophores in spring [72, 73].

Tub gurnard (*C. lucerna*) were featured in one video of the bundle at 143 m depth. *C. lucerna* is a demersal species with a depth range of 20–318 m, occurring in areas with sandy, muddy or gravelly seabed [74]. Spawning season for this species is from November to February with a peak in January [75].

3.3. Species observation form for ROV pilots

ROV operators, please complete the form if you observe any interesting marine organisms or behaviours (marine mammals, fish, octopus, squid, crabs, lobsters, starfish, urchins, or life fixed to structures). If possible, please crop and attach associated video file(s), still snapshot(s), and full ROV specifications. Omit sensitive information, if necessary.

Date: (dd/mm/yyyy)	Start time (UTC)	End time (UTC)	Observation no.
Observer name	Client	Contractor	Vessel/platform/rig
Country	Coordinates (WGS'84)	Location	Depth (m)
Observation description (species, behaviour etc.)			
ROV model	Camera model	Video file name	

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