

GREENLINK MARINE ENVIRONMENTAL STATEMENT- WALES

APPENDIX J

Environmental Survey Report

P1975_R4484_RevF1
June 2019

Greenlink Interconnector
- connecting the power markets
in Ireland and Great Britain



Greenlink
INTERCONNECTOR



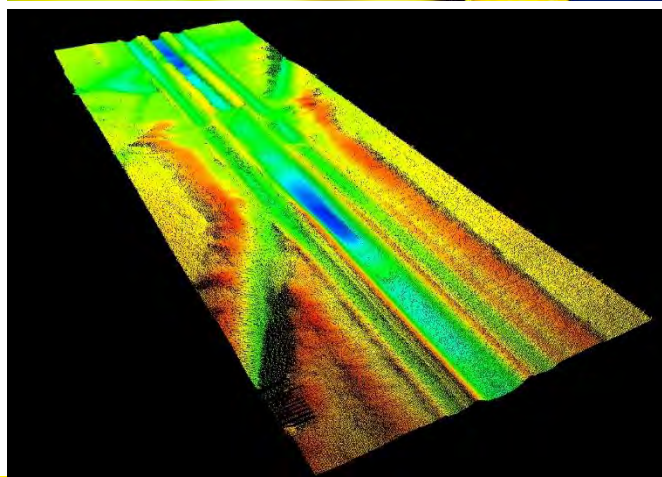
ENVIRONMENTAL SURVEY REPORT

102953-GRL-MMT-SUR-REP-ENVIRORE
REVISION A | ISSUE FOR USE
JUNE 2019



GREENLINK INTERCONNECTOR BENTHIC SURVEY

IRISH SEA
SEPTEMBER-MARCH 2019



EXECUTIVE SUMMARY

MMT was contracted by Greenlink Interconnector to conduct a geophysical, geotechnical and benthic survey for a proposed high voltage direct current submarine power interconnector between Pembrokeshire, Wales, UK and County Wexford, Ireland. This report presents the results of the environmental survey, encompassing habitat classifications, protected habitats and species as well as chemical and particle size analyses. The results are divided by country into two sections: UK and Ireland. Results are presented for the Final Route, as well as surveyed route options A and E wherever they deviate from the Final Route. The survey corridor was 500 m wide and divided into six survey blocks covering nearshore and offshore areas.

Environmental data acquisition comprised of sediment sampling, photography, and video recording to gather data on existing habitats and species present on the seabed; the survey data was used to ground truth the predictive habitat mapping. The survey was performed using Drop Down Video system a Day Grab, and a Hamon Grab for grab sampling, all deployed from the MMT survey vessels M/V Franklin as well as the M/V Olyptic Challenger.

A total of 38 photo transects, each between 130 m and 500 m long, and 38 grab sample locations were selected for sampling. At each of the 38 grab sample locations, three samples were collected. Two of the samples at each grab sample location were collected for faunal analysis and the third sample for chemical and particle size analysis.

Geophysical data was acquired to determine water depths, surficial geology, seabed features, shallow geology, and object detection. Instruments used during the geophysical survey were multibeam echo sounder, side scan sonar, sub-bottom profiler, and magnetometer. The geophysical results combined with the environmental data was used as the basis for the EUNIS habitat classification, assessments of potential areas and species of conservation and charts.

The benthic sampling survey started on the 30th of September 2018 and was completed on the 1st of January 2019.

A total of 33 habitats were identified within the survey corridor, 12 of which were observed in the Irish section and 25 observed in the UK section. Three potential Annex I habitats, 1160 Large shallow inlets and bays, 1110 Sandbanks which are slightly covered by sea water all the time and 1170 Reefs, with its three subtypes "Bedrock Reef", "Stony Reef", and "Biogenic Reef" were identified within the corridor. Bedrock Reefs were mainly found near the landfalls, and on route alternative A.

REVISION HISTORY

REVISION	DATE	STATUS	CHECK	APPROVAL	CLIENT APPROVAL
A	2019-06-24	Issue for Use	ID	MG	
02	2019-03-22	Issue for Client Review	MB, ID	MG	
01	2019-03-21	Issue for Internal Review	AJ, ID	ID	

REVISION LOG

DATE	SECTION	CHANGE
2019-06-10	All Sections	Amended as per client comments in document "102953-GRL-MMT-SUR-REP-ENVIRORE-02_AF&KAG"
2019-06-10	All Sections	The final route was referenced as primary and final route within this report. This was amended to final route throughout the report and images.

DOCUMENT CONTROL

RESPONSIBILITY	POSITION	NAME
Content	Marine Biologist	Malin Tivefålh
Content	Marine Biologist	Felicia Ulltin
Content	Senior Marine Biologist	Svante Martinsson
Content	Marine Biologist	Rikard Karlsson
Content, Check	Environmental Supervisor	Andrea Johansson
Content, Check	Environmental Supervisor	Iris Duranovic
Check, Approval	Project Report Coordinator	Maria Blom
Approval	Project Manager	Martin Godfrey

TABLE OF CONTENTS

1 	INTRODUCTION	11
1.1	PROJECT INFORMATION	11
1.2	SURVEY INFORMATION	13
1.3	SURVEY OBJECTIVES	13
1.4	PURPOSE OF DOCUMENT	13
1.5	REFERENCE DOCUMENTS	14
2 	SURVEY PARAMETERS	15
2.1	GEODETIC DATUM AND GRID COORDINATE SYSTEM	15
2.2	VERTICAL DATUM	15
2.3	TIME DATUM	16
2.4	KP PROTOCOL	16
3 	METHODOLOGY	19
3.1	FIELD METHODS	19
3.1.1	SURVEY DESIGN	19
3.1.2	PHOTO AND VIDEO SAMPLING	20
3.1.3	FAUNAL GRAB SAMPLING AND SAMPLE PRESERVATION	20
3.1.4	PARTICLE SIZE ANALYSIS AND CHEMICAL SAMPLING	21
3.2	LABORATORY METHODS	21
3.2.1	PARTICLE SIZE ANALYSIS	21
3.2.2	CHEMICAL ANALYSIS	22
3.2.3	BIOLOGICAL ANALYSIS	23
3.3	DATA ANALYSIS	23
3.3.1	VISUAL DATA ANALYSES	23
3.3.2	PARTICLE SIZE DISTRIBUTION	23
3.3.3	CHEMICAL ANALYSIS	24
3.3.4	MULTIVARIATE STATISTICAL ANALYSES	24
3.4	HABITAT CLASSIFICATION	25
3.5	PROTECTED HABITATS AND SPECIES ASSESSMENTS	25
4 	RESULTS	28
4.1	SUMMARY OF IDENTIFIED HABITATS	28
5 	UNITED KINGDOM	34
5.1	DETAILED AREA DESCRIPTIONS	49
5.1.1	FINAL ROUTE	49
5.1.2	ROUTE A	60
5.1.3	ALTERNATIVE E	62
5.2	SEDIMENT PARTICLE SIZE DISTRIBUTION	65
5.2.1	MULTIVARIATE ANALYSES FOR SEDIMENT	66
5.3	CHEMICAL ANALYSES	67
5.3.1	METALS	68
5.3.2	ORGANICS AND MOISTURE	70
5.3.3	PAH	70

5.4	MULTIVARIATE ANALYSIS OF GRAB SAMPLES	73
5.5	POTENTIAL AREAS AND SPECIES OF CONSERVATION.....	75
5.5.1	FINAL ROUTE.....	84
5.5.2	ROUTE A	94
5.5.3	ALTERNATIVE E	100
5.5.4	PROTECTED AREAS.....	104
6 	IRELAND	106
6.1	DETAILED AREA DESCRIPTIONS.....	112
6.1.1	FINAL ROUTE.....	112
6.1.2	ALTERNATIVE E	119
6.2	SEDIMENT PARTICLE SIZE DISTRIBUTION	119
6.2.1	MULTIVARIATE ANALYSES FOR SEDIMENT.....	121
6.3	CHEMICAL ANALYSES.....	122
6.3.1	METALS	122
6.3.2	ORGANICS AND MOISTURE	125
6.3.3	PAH	125
6.4	MULTIVARIATE ANALYSIS OF GRAB SAMPLES	128
6.5	POTENTIAL AREAS AND SPECIES OF CONSERVATION.....	132
6.5.1	FINAL ROUTE.....	133
6.5.2	ALTERNATIVE E	133
6.5.3	HOOK HEAD SAC	134
7 	DISCUSSION	135
8 	RESERVATIONS AND RECOMMENDATIONS	137
9 	REFERENCES.....	138

APPENDICES

APPENDIX A 	SAMPLE POSITION LIST
APPENDIX B 	GRAB FIELD PROTOCOLS
APPENDIX C 	TRANSECT FIELD PROTOCOLS
APPENDIX D 	GRAB ID PROTOCOLS
APPENDIX E 	TRANSECT ID PROTOCOLS
APPENDIX F 	PARTICLE SIZE ANALYSIS RESULTS
APPENDIX G 	CHEMICAL ANALYSIS
APPENDIX H 	CTD DATA

LIST OF FIGURES

Figure 1 Overview of survey area.....	12
Figure 2 Initial route options.....	17
Figure 3 Final route (Greenlink_WGS84_UTM30N_09112018_RPL_Rev0) and reported route alternatives.....	18
Figure 4 Example of EUNIS Hierarchy.....	25
Figure 5 Overview of sampling and transect locations in the UK EEZ.....	34
Figure 6 Overview of UK EEZ KP 0 to KP 5.....	49
Figure 7 Example image DDV_T09_005.....	50
Figure 8 Example image DDV_T08_009.....	50
Figure 9 Example image DDV_T07_008.....	50
Figure 10 Example image DDV_T06_012.....	50
Figure 11 Overview of UK EEZ KP 5 to KP 9.....	51
Figure 12 Overview of UK EEZ KP 9 to KP 12.....	52
Figure 13 Overview of UK EEZ KP 12 to KP 18.....	53
Figure 14 Overview of UK EEZ KP 18 to KP 22.....	54
Figure 15 Overview of UK EEZ KP 22 to KP 28.....	55
Figure 16 Overview of UK EEZ KP 28 to KP 37.....	56
Figure 17 Overview of UK EEZ KP 36 to KP 45.....	57
Figure 18 Overview of UK EEZ KP 44 to KP 53.....	58
Figure 19 Overview of UK EEZ KP 51 to KP 60.....	59
Figure 20 Overview of UK EEZ KP 58 to KP 75.....	60
Figure 21 Overview of Alternative E in UK EEZ KP 13 to KP 25.....	62
Figure 22 Overview of Alternative E in UK EEZ KP 25 to KP 37.....	63
Figure 23 Bar chart displaying sediment fraction distribution across all grab sample sites.....	65
Figure 24 SIMPROF dendrogram based on sediment composition for each grab sample site.....	67
Figure 25 PCA plot of sediment data for each grab sample site, groups based on SIMPROF.....	67
Figure 26 Arsenic (As) concentrations (µg/g dry weight) in sediment across grab sample sites together with threshold values for CCME ISQG.....	69
Figure 27 SIMPROF dendrogram based on faunal composition for each grab sample site and replicate.....	73
Figure 28 nMDS plot on faunal composition for each grab sample site and replicate, groups based on SIMPROF.....	74
Figure 29 SIMPROF dendrogram based on faunal composition with EUNIS habitat classification overlay for each grab sample site and replicate.....	75
Figure 30 Overview of Annex I areas in UK EEZ between KP 1 and KP 7.5.....	76
Figure 31 Overview of Annex I areas in UK EEZ between KP 7 and KP 13.....	77
Figure 32 Overview of Annex I areas in UK EEZ between KP 14 and KP 18.....	78
Figure 33 Overview of Annex I areas in UK EEZ between KP 16 and KP 21.....	79
Figure 34 Overview of Annex I areas in UK EEZ between KP 20 and KP 25.....	80
Figure 35 Overview of Annex I areas in UK EEZ route Route A between KP 38 and KP 47.....	81
Figure 36 Overview of Annex I areas in UK EEZ route Alternative E between KP 15 and KP 22.....	82
Figure 37 Overview of Annex I areas in UK EEZ route Alternative E between KP 24 and KP 32.....	83
Figure 38 Image T06_014 of Annex I (1170) – Bedrock reefs with the habitat A4.138 – Molgula manhattensis with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock.....	86
Figure 39 Image RR_T03_001 of Annex I (1170) – Medium Grade Stony Reef with the habitat A5.141 – Pomatoceros triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.....	87
Figure 40 Image S25_003 of Annex I (1170) – Low Grade Biogenic reef with the habitat A5.611 – Sabellaria spinulosa on stable circalittoral mixed sediment.....	89
Figure 41 Image S24_001 of the habitat A5.611 – Sabellaria spinulosa on stable circalittoral mixed sediment.....	90
Figure 42 Image S20_005 of Annex I (1170) – Low Grade Biogenic reef with the habitat A5.611 – Sabellaria spinulosa on stable circalittoral mixed sediment.....	91

Figure 43 Raw image T05_013 of Annex I (1170) – Medium Graded Biogenic Reef on the habitat A4.2212 – <i>Sabellaria spinulosa</i> didemnid and small ascidians on tide-swept moderately wave-exposed circalittoral rock.	93
Figure 44 Annex I (1170) – Bedrock Reef at A_T05_009.	95
Figure 45 Image A_T01_008 of <i>S. spinulosa</i> encrusted circalittoral rock.	97
Figure 46 Image A_T07_010 of <i>S. spinulosa</i> on the habitat A4.21 – Echinoderms and crustose communities on circalittoral rock on Annex I (1170) – Bedrock reefs.	98
Figure 47 Image A_T09_001 of <i>S. spinulosa</i> on the habitat A4.13 – Mixed faunal turf communities on circalittoral rock, on Annex I (1170) – Bedrock reefs.	99
Figure 48 Image A_T02_008 of <i>M. edulis</i> on the habitat A4.13 – Mixed faunal turf communities on circalittoral rock, on Annex I (1170) – Bedrock reefs.	100
Figure 49 Image E_T04_004 of the habitat A4.132 – <i>Corynactis viridis</i> and a mixed turf of crisiids, <i>Bugula</i> , <i>Scrupocellaria</i> , and <i>Cellaria</i> on moderately tide-swept exposed circalittoral rock, on Annex I (1170) – Medium Grade Stony Reefs.	102
Figure 50 Image E_T03_009 of <i>S. spinulosa</i> on the habitat A5.611 – <i>Sabellaria spinulosa</i> on stable circalittoral mixed sediment.	104
Figure 51 Overview of sampling and transect locations in the Irish EEZ.	106
Figure 52 Overview of Irish EEZ KP 74 to KP 91.	112
Figure 53 Overview of Irish EEZ KP 90 to KP 106.	113
Figure 54 Overview of Irish EEZ KP 105 to KP 120.	114
Figure 55 Overview of Irish EEZ KP 120 to KP 135.	115
Figure 56 Overview of Irish EEZ KP 131 to KP 150.	116
Figure 57 Overview of Irish EEZ KP 105 to KP 159.	118
Figure 58 Bar chart displaying sediment fraction distribution across all grab sample sites.	120
Figure 59 SIMPROF dendrogram based on sediment composition for each grab sample site.	121
Figure 60 PCA plot of sediment data for each grab sample site, groups based on SIMPROF.	122
Figure 61 Arsenic (As) concentrations (µg/g dry weight) in sediment across sample sites together with threshold values for CCME ISQG.	124
Figure 62 SIMPROF dendrogram based on faunal composition for each grab sample site and replicate.	128
Figure 63 nMDS plot on faunal composition for each grab sample site and replicate, groups based on SIMPROF.	129
Figure 64 SIMPROF dendrogram based on faunal composition with EUNIS habitat classification overlay for each grab sample site and replicate.	131
Figure 65 Overview of Annex I areas in Irish EEZ between KP 149 and KP 159.	132
Figure 66 Image T02_001 of Annex I (1170) – Bedrock Reefs with the habitat A3.11 – Kelp with cushion fauna and/or foliose red seaweeds.	134

LIST OF TABLES

Table 1 Project details.	11
Table 2 Reference documents.	14
Table 3 Geodetic Parameters.	15
Table 4 Projection parameters.	15
Table 5 Vertical reference parameters.	15
Table 6 Route deviations from Final Route.	16
Table 7 Reconnaissance survey lengths.	19
Table 8 British standard Methods of test for soils for civil engineering purposes (2010) PSA intervals.	21
Table 9 Hydrocarbon analysis minimum limits of detection.	22
Table 10 Metal analysis minimum limits of detection.	22
Table 11 Organics analysis and minimum limits of detection.	23
Table 12 Proposed chart for <i>Sabellaria spinulosa</i> reef identification (Gubbay, 2007).	26
Table 13 Guidelines used to categorise 'reefiness' for stony reefs (Irving, 2009).	27
Table 14 Habitat description.	28
Table 15 Number of sample sites in the UK EEZ.	34

Table 16 List of proposed transects along Final Route in UK waters.	35
Table 17 List of proposed transects along route alternative A in UK waters.	36
Table 18 List of proposed transects along route alternative E in UK waters.	39
Table 19 List of proposed transects along reconnaissance re-route option in UK waters.	42
Table 20 Sample locations for grab samples performed.	43
Table 21 Summary of sediment distribution across all grab sample sites in the Wales area.	65
Table 22 Summary of metal concentrations (µg/g dry weight) in sediment across grab sample sites together with threshold values.	68
Table 23 Summary of organics and moisture concentrations in sediment across grab sample sites.	70
Table 24 Summary of PAH concentrations (µg/Kg dry weight) across grab sample sites.	71
Table 25 Characteristics of groups identified by SIMPROF analysis on abundance of non-colonial fauna.	74
Table 26 Annex I habitats identified within the survey corridor.	84
Table 27 Reef assessment for assessed stony reef in RR_T01.	86
Table 28 Reef assessment for assessed stony reef in RR_T02.	86
Table 29 Reef assessment for assessed stony reef in RR_T03.	87
Table 30 Reef assessment for assessed stony reef in RR_T04.	87
Table 31 Reef assessment for assessed stony reef in RR_T05.	87
Table 32 Summary of <i>S. spinulosa</i> quantities at sample locations where it occurred (Final Route, UK).	88
Table 33 Assessment of <i>S. spinulosa</i> at sample location S25 (Gubbay, 2007).	89
Table 34 Assessment of <i>S. spinulosa</i> at sample location S20 (Gubbay, 2007).	91
Table 35 Average coverage and standard deviation of <i>S. spinulosa</i> in transects where it occurred in ascending KP (Final Route, UK).	92
Table 36 Assessment of <i>S. spinulosa</i> at transect T05 (Gubbay, 2007).	93
Table 37 Annex I habitats identified within the survey corridor.	94
Table 38 Reef assessment for assessed stony reef in A_T02.	95
Table 39 Reef assessment for assessed stony reef in A_T06.	96
Table 40 Average coverage and standard deviation of <i>S. spinulosa</i> in transects where it occurred (Route A, UK).	96
Table 41 Annex I habitats identified within the survey corridor.	100
Table 42 Reef assessment for assessed stony reef in E_T04 and E_T05.	102
Table 43 Reef assessment for assessed stony reef in E_T10.	103
Table 44 Average coverage and standard deviation of <i>S. spinulosa</i> in transects where it occurred (Alternative E, UK).	103
Table 45 Number of sample sites.	106
Table 46 List of proposed transects along Final Route in Ireland waters.	107
Table 47 List of proposed sampling sites performed in Irish waters.	107
Table 48 Summary of sediment distribution across all grab sample sites for Ireland.	120
Table 49 Summary of metal concentrations (µg/g dry weight) in sediment across grab sample sites together with threshold values.	123
Table 50 Summary of organics and moisture concentrations in sediment across grab sample sites.	125
Table 51 Summary of PAH concentrations (µg/Kg dry weight) across grab sample sites.	126
Table 52 Characteristics of groups identified by SIMPROF analysis on abundance of non-colonial fauna.	130
Table 53 Annex I habitats or species of special interest identified within the survey corridor.	133

ABBREVIATIONS AND DEFINITIONS

APEM	APEM Limited
BAC	Background Assessment Concentration
BAP	Biodiversity Action Plan
BC	Background Concentration
CCME	Canadian Council of Ministers of the Environment
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
DDV	Drop Down Video
DPR	Daily Progress Report
EAC	Environmental Assessment Criteria
EC	European Commission
EEZ	Exclusive Economic Zone
EQS	Environmental Quality Standards
ERL	Effect range-low
EUNIS	European Union Nature Identification System
GIS	Geographic Information System
HD	High definition
HVDC	High voltage direct current
ICP-MS	Inductively Coupled Plasma-mass Spectrometry
ISQG	Interim Sediment Quality Guidelines
JNCC	Joint Nature Conservation Committee
JUV	Juvenile
KP	Kilometre Post
LAT	Lowest Astronomical Tide
LED	Light-Emitting Diode
LOI	Loss On Ignition
MBES	Multibeam Echo Sounder
MDS	Multi-Dimensional Scaling
MMT	MMT Sweden AB
MPA	Marine Protected Areas
MSL	Mean Sea Level
NMBAQC	National Marine Biological Analytical Quality Control Scheme
NRW	Natural Resources Wales
ODMH	Ordnance Datum Malin Head
ODN	Ordnance Datum Newlyn
OSGM15	Ordnance Survey Geoid Model 15
OSPAR	OSPAR Oslo and Paris Conventions for the protection of the East Atlantic marine environment of the North-East Atlantic
PAH	Polycyclic Aromatic Hydrocarbon
PCA	Principal Component Analysis
PEL	Probable Effects Levels
PPS	Pulse Per Second
PRIMER	Plymouth Routines in Multivariate Ecological Research
PSA	Particle Size Analysis
PSD	Particle Size Distribution
ROG	Recommended Operational Guidelines
RPL	Route Position List
SAC	Special Areas of Conservation
SBP	Sub-Bottom Profiler
SIMPROF	Similarity Profile Analysis
SPA	Special Protected Area
SSS	Side Scan Sonar
TOC	Total Organic Content
UK	United Kingdom
UKAS	United Kingdom Accreditation Service
USBL	Ultra-Short Base Line
UTC	Coordinated Universal Time
UXO	Unexploded Ordnance
VC	Vibrocore
VORF	Vertical Offshore Reference Frame

1 | INTRODUCTION

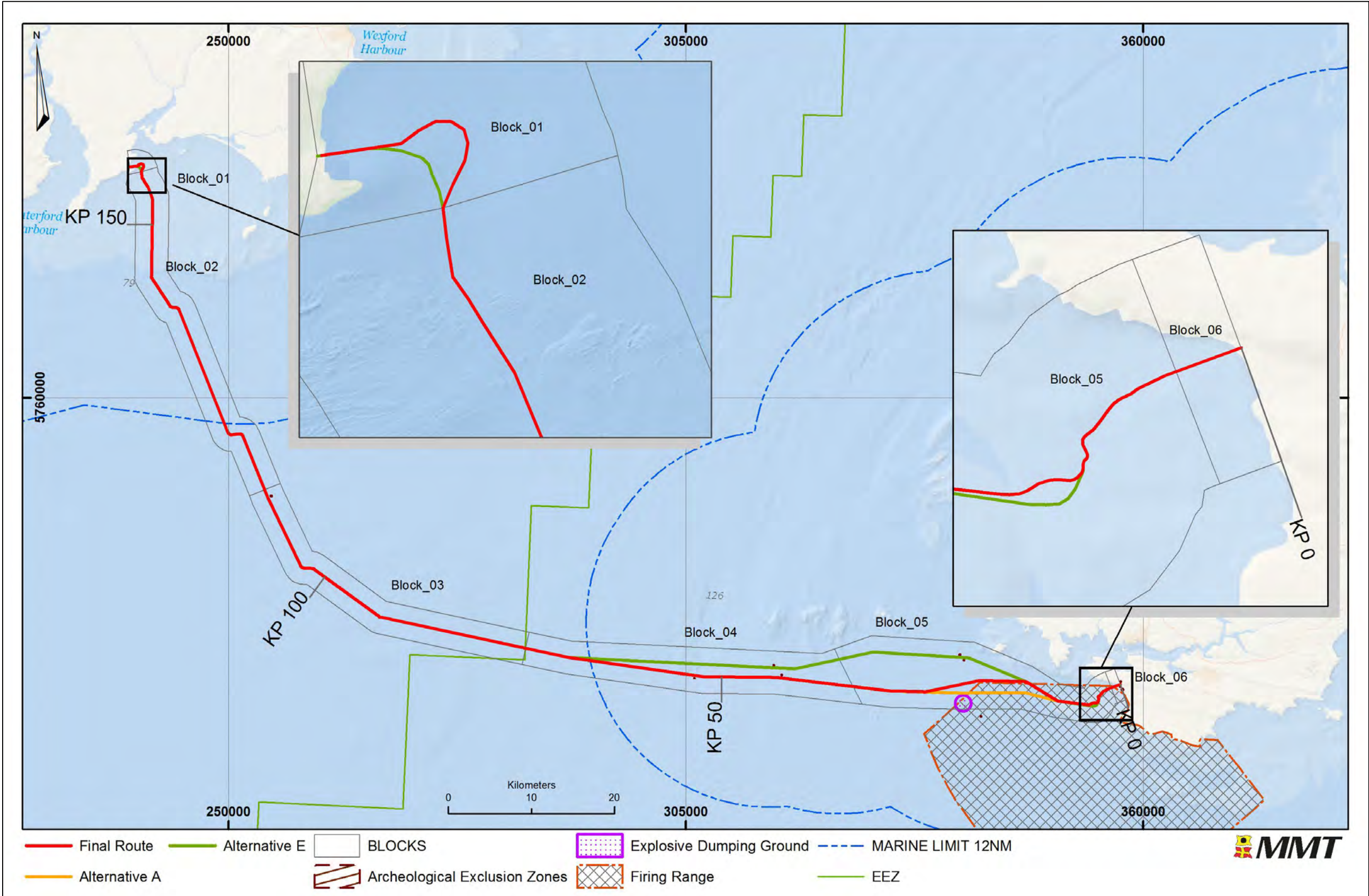
1.1 | PROJECT INFORMATION

Greenlink Interconnector Limited' proposes to develop a high voltage direct current (HVDC) submarine power interconnector, which will allow transfer of power between the high voltage grid systems of the United Kingdom (UK) and the Republic of Ireland. Greenlink will connect to the United Kingdom (UK) National Grid system at Pembroke substation in Pembrokeshire, United Kingdom and to the Irish network at Great Island substation in County Wexford, Ireland. Figure 1 presents an overview of the survey area and Final Route (Greenlink_WGS84_UTM30N_09112018_RPL_Rev0).

Project details are presented in Table 1.

Table 1 Project details.

CLIENT:	Greenlink Interconnector Limited
PROJECT:	Greenlink Interconnector
MMT SWEDEN AB (MMT) PROJECT NUMBER:	102953
SURVEY TYPE:	Geophysical, Geotechnical, Environmental, Topographic, UXO, ROV infrastructure crossing, land seismic
AREA:	Irish Sea
SURVEY PERIOD:	September 2018 – March 2019
SURVEY VESSELS:	M/V Edda Fonn, M/V Franklin, M/V Seabeam, M/V Olympic Challenger, M/V Sandpiper, Onshore Topography, Onshore Refraction Survey
MMT PROJECT MANAGER:	Martin Godfrey
CLIENT PROJECT MANAGER:	Stephane Theurich



1.2 | SURVEY INFORMATION

The objective of the Greenlink Marine survey was to acquire all appropriate data for the conformation of a preferred route for the high voltage direct current (HVDC) cable, undertaking detailed mapping of shallow geology, seabed features and baseline environmental mapping along the entire route corridor and subsequently provide all geotechnical design data for the whole offshore and nearshore route with conformation of detail seabed character along the final offshore design route. Additionally, an unexploded ordnance (UXO) survey was performed to ensure route viability within the Castlemartin Firing Range area.

The Greenlink marine survey scope of work comprised:

- Onshore/intertidal topographic survey
- Geophysical/hydrographic nearshore and offshore data acquisition
- Geotechnical investigations along the proposed route with vibrocoring (VC) and cone penetration testing (CPT)
- Environmental sampling and imagery
- Infrastructure crossing survey with remotely operated vehicle (ROV)
- UXO survey
- Geotechnical boreholes to inform horizontal directional drilling
- Onshore reflection and refraction survey

1.3 | SURVEY OBJECTIVES

The aim of the environmental part of the survey was to provide an environmental benthic survey to determine the presence of reef habitats prior to the establishment of a route. Seabed sampling was to be undertaken for physico-chemical analysis (sediment grain size and a suite of chemical determinants) and biological analysis (benthic infauna), in order to determine the occurrence and distribution of species/habitats within the survey corridor.

1.4 | PURPOSE OF DOCUMENT

The purpose of the report is to present the environmental results from the Greenlink Marine Survey. This report together with Geographic Information System (GIS) database presents the results from the environmental survey.

Areas of special interest along the route corridor and within sites are presented in this report as well as in habitat charts presented in a GIS database. All existing MMT data from the survey corridor is correlated to the environmental survey data to strengthen the accuracy of the interpretations.

Separate reports are issued for the geophysical scope, geotechnical scope, UXO scope, as well as infrastructure crossing scope. A full list of reports is given in Table 2. It is recommended to read this report in conjunction with the Environmental Field Report, Geophysical report and the Operations Report for a wider understanding of the conditions along the cable routes.

1.5 | REFERENCE DOCUMENTS

The reference documents for the project are presented in Table 2.

Table 2 Reference documents.

DOCUMENT NUMBER	TITLE	AUTHOR
102953-GRL-MMT-QAC-PRO-PMQAPLAN	Project Manual and Quality Assurance Plan	MMT
102953-GRL-MMT-QAC-PRO-ENVIRO	Environmental Sampling and Reporting Specification	MMT
102953-GRL-MMT-HSE-PRO-HIRA	Hazard Identification & Risk Assessment: Geophysical	MMT
102953-GRL-MMT-HSE-PRO-HSEFRANK	HSE Plan Franklin	MMT
102953-GRL-MMT-HSE-PRO-HSESEAON	HSE Plan Seabeam and Onshore	MMT
102953-GRL-MMT-QAC-PRO-CADGIS	CAD and GIS Specification	MMT
102953-GRL-MMT-SCH-PRO-SCHEDULE	Time schedule	MMT
102953-GRL-MMT-MAC-REP-FRANKLIN	Mobilisation and Calibration Report - Franklin	MMT
102953-GRL-MMT-MAC-REP-SEABEAM	Mobilisation and Calibration Report – Seabeam	MMT
102953-GRL-MMT-SUR-REP-OPERATRE	Operations Report	MMT
102953-GRL-MMT-SUR-REP-GEOPHYRE	Geophysical Report	MMT
102953-GRL-MMT-SUR-REP-UXOREP	UXO Report	MMT
102953-GRL-MMT-SUR-REP-GEOTECHRE	Geotechnical Report	MMT
102953-GRL-MMT-SUR-REP-CABLECRE	Cable Crossing Report	MMT
102953-GRL-MMT-SUR-REP-ENVIRORE	Environmental Report	MMT
102953-GRL-MMT-SUR-REP-ENVFROFF	Environmental Field Report	MMT
102953-GRL-MMT-SUR-REP-INTEGRRE	Integrated Report	MMT
P1975_ExhibitB_ScopeofWork	Scope of work	GRL
P1975_ExhibitC_TechnicalSpecifications	Technical Specifications	GRL
P1975_ExhibitG_Greenlink UXO DBS	UXO Desktop Study	GRL
P1975 Greenlink Clarification	Clarifications	GRL
P1975 Greenlink Addendum_Rev0	Clarifications	GRL

2 | SURVEY PARAMETERS

2.1 | GEODETIC DATUM AND GRID COORDINATE SYSTEM

The geodetic and projection reference parameters used during the survey are presented in Table 3 and Table 4.

Table 3 Geodetic Parameters.

GEODETIC PARAMETERS	
Datum	World Geodetic System 1984 (6326)
Ellipsoid	World Geodetic System 1984 (7030)
Spheroid	WGS84
Semi Major Axis	6378137.000 m
Semi Minor Axis	6356752.31414035610 m
Inverse Flattening (1/f)	298.25722210100002
Unit	International metre

Table 4 Projection parameters.

PROJECTION PARAMETERS	
Projection	UTM Zone 30N (EPSG 16030)
Longitude at Central Meridian	003°00'00.0" W
Latitude of Origin	00°00'00.0" N
False Northing	0 m
Scale Factor (Central Meridian)	0.9996
Units	Metres
Time Datum	Coordinated universal time (UTC)

2.2 | VERTICAL DATUM

The vertical reference parameters used during the survey are presented in Table 5.

Table 5 Vertical reference parameters.

VERTICAL REFERENCE PARAMETERS	
Vertical reference (offshore)	DTU10 Lowest Astronomical Tide (LAT)
Height model (offshore)	Vertical Offshore Reference Frame (VORF)
Height model (nearshore)	Ordnance Survey Geoid Model 15 (OSGM15)
Vertical reference (nearshore UK)	Ordnance Datum Newlyn (ODN) Mean Sea Level (MSL)
Vertical reference (nearshore IRL)	Ordnance Datum Malin Head (ODMH) Mean Sea Level (MSL)

2.3 | TIME DATUM

Coordinated universal time (UTC) is used on all survey systems on board the vessel. The synchronisation of the vessel's onboard system is governed by the pulse per second (PPS) issued by the primary positioning system. All displays, overlays and logbooks are annotated in UTC as well as the Daily Progress Report (DPR) that is referred to UTC.

2.4 | KP PROTOCOL

Four routes were considered during the preparation and survey phase of the project, see Figure 2, namely Route A which was the base route starting with KP 0 at the landfall in Freshwater West, UK and with an increasing KP towards the landfall in Baginbun, Ireland.

In addition to Route A, Alternative E also starts at the landfall in Freshwater West, UK and increasing in KP towards the landfall in Baginbun, Ireland. The difference between Route A and Alternative E is visible in Figure 2 where Alternative E runs north of Route A.

Option C deviates from Route A (as well as Alternative E) where it turns south to an alternative landing point in Boyce's Bay, Ireland. Option C was never surveyed and no results are therefore present in this report.

Option D deviates from Route A (as well as Alternative E) and runs further north of Route A before it joins Route A towards the landing point at Baginbun, Ireland.

The Final Route, Greenlink_WGS84_UTM30N_09112018_RPL_Rev0, is presented in Figure 3 showing the Final Route starting at Freshwater West, UK with KP 0 and increasing towards the landfall in Baginbun, Ireland. The Final Route, is a mixture of Route A, Alternative E and Option D as well as re-routing conducted during survey.

The parts surveyed which does not coincide with the Final Route are the following:

Table 6 Route deviations from Final Route.

DEVIATION	START/END ROUTE	KP	COMMENTS
Route A deviation 1	Start KP (Final Route)	3.653057	
	Start KP (Route A)	3.646765	
	End KP (Final Route)	25.38879	The Final Route and the Route A runs perpendicular (max 0.12 m distance between the two routes) to each other from this point until KP 29.622 (Final Route KP). For reporting purposes this deviation is not presented after KP 29.622
	End KP (Route A)	24.9087	
Alternative E deviation 1	Start KP (Final Route)	13.17312	
	Start KP (Alternative E)	13.37349	
	End KP (Final Route)	68.60038	
	End KP (Alternative E)	69.22904	
Route A deviation 2	Start KP (Final Route)	156.667	

DEVIATION	START/END ROUTE	KP	COMMENTS
	Start KP (Route A)	156.187	
	End KP (Final Route)	158.7594	
	End KP (Route A)	157.4134	

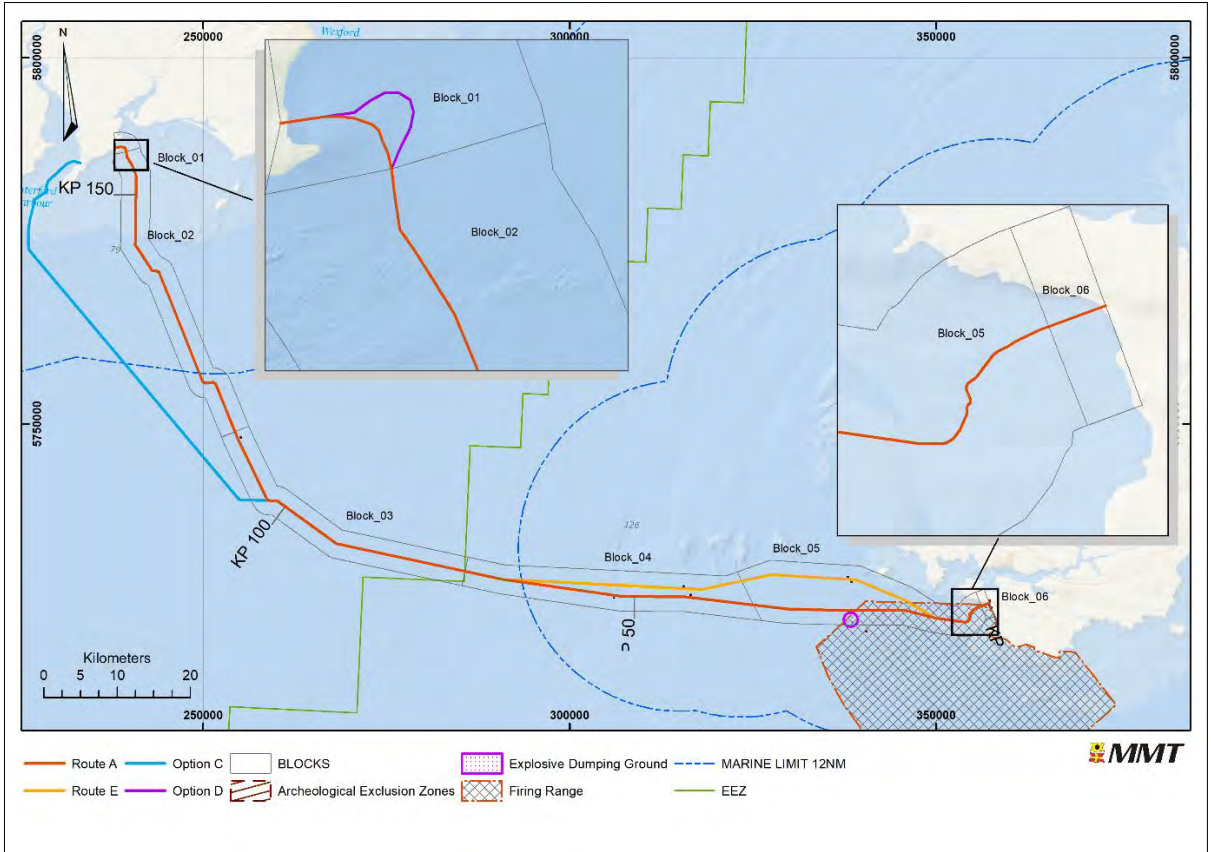


Figure 2 Initial route options.

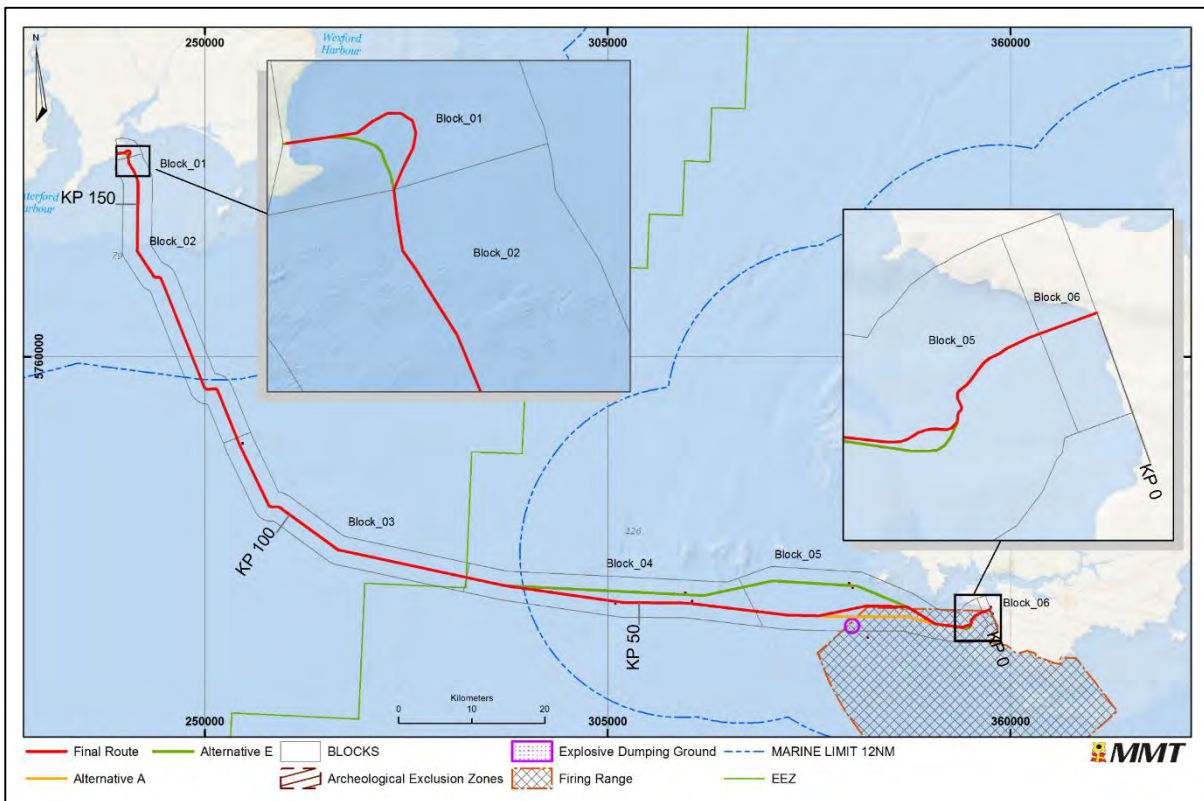


Figure 3 Final route (Greenlink_WGS84_UTM30N_09112018_RPL_Rev0) and reported route alternatives.

3 | METHODOLOGY

The benthic survey was performed using grab samplers and a video and still camera system. Sample sites were selected using the information provided from the geophysical survey data and in accordance with the requirements from the Client.

A biologist on board during the geophysical survey planned the benthic survey based on the geophysical data and preliminary geological interpretations, ensuring that the different habitats interpreted from the SSS and MBES were ground truthed.

Sample sites were documented by video and still photography and by grab sampling. Where grab sampling was not possible due to hard seabed or coarse substrates, only video/still photo was used for sampling.

The method used correlates the geophysical information from MBES and SSS with information on substrate through Particle Size Analysis (PSA) and quantitative taxonomic analysis of the infauna. These survey and analytical methods provides a comprehensive view of present conditions.

3.1 | FIELD METHODS

3.1.1 | SURVEY DESIGN

The final number and location of environmental sample sites were decided on board the vessel based on depth variation, sediment, and habitat changes, as delineated during the acoustic survey, to provide benthic data of all habitats interpreted across the survey route. Grab sampling was planned at 38 sites, distributed among Ireland and Wales. Stills were acquired to connect the epifaunal and infaunal assemblage. In addition, 38 transects were also planned.

An offshore Reconnaissance survey was conducted in order to determine the presence of reef habitats prior to the establishment of a route (Table 7). The Reconnaissance survey covered the full 500 m corridor with MBES, SSS, SBP and DDV. Photo and video transects were planned in areas where indications of reef structures were present in the geophysical data, i.e. areas of bedrock or boulders and areas with a divergent seabed structure. The collected data from the reconnaissance survey was sent immediately ashore, after acquisition, for review by Natural Resource Wales (NRW) that provided a stand-alone assessment of the reefs along the different route alternatives and options.

Table 7 Reconnaissance survey lengths.

RECONNAISSANCE SURVEY SECTIONS	LENGTH (km)
Route A rev 1	24.84
Alternative E rev 0	27.62

Transects were required throughout the corridor within the reconnaissance survey areas. The location of the transects were selected based on the preliminary geophysical interpretations. The SeaSpyder DDV was used for transects over potential sensitive habitats/reef formations.

Two additional survey lines were added perpendicular to Route A and Alternative E in order to ascertain a broader knowledge about the surface conditions in-between the two route alternatives. The final survey route was routed between the original Route A and Alternative E. This resulted in an additional benthic Reconnaissance survey.

3.1.2 | PHOTO AND VIDEO SAMPLING

A SeaSpyder system from STR was used for image acquisition at each grab sampling site prior to grab sampling and along photo transects.

This system used a Canon EOS 100D Digital Still Camera (18 megapixels) with dedicated strobe and an integrated video system capable of performing full HD recordings. Lighting for video was provided by a set of four LED lamps, each with adjustable intensity. Scaling was provided by a set of four laser units which produced a 20 x 20 cm pattern of dots on the seabed.

Prior to sampling, the stills of the seabed, acquired at each grab sample site, were reviewed by experienced marine biologists on board to confirm the presence/absence of any potentially sensitive habitats or features of conservation importance.

The stills were analysed to identify species and density. The different European Union Nature Identification System (EUNIS) habitat criteria were compared to the results of the stills analysis. Particular attention was paid to habitats above the elevated seabed level, together with their spatial extent, percentage biogenic cover and patchiness, as these are key criteria for evaluating areas of conservation importance and reef structures (Irving, 2009; Gubbay, 2007).

A log was maintained of the stills acquired, along each transect, for the habitat assessment and at each grab sample site and photo transect. The field notes are detailed in Appendix B| and Appendix C|. As a minimum, this included the drop number, start and end position, duration, and a summary of the sediment type and main species observed. A list of the stills, including their position, along with a clear indication of those taken at random for future assessment, and those taken to show particular features of interest, was also maintained.

3.1.3 | FAUNAL GRAB SAMPLING AND SAMPLE PRESERVATION

Three grab samples were retrieved at each benthic grab sampling site. One grab sample was used for particle size and chemical analysis and two for infaunal analysis.

Two types of grab samplers (Day grab, and Hamon grab) were available during the benthic sampling. The Day grab was used for finer sediments and Hamon grab for coarser sediments.

The planned grab sample site positions were used as targets to guide the vessel as close as possible to each proposed sample site. The actual position of each sample was recorded each time the grab landed on the seabed using an attached ultra-short base line (USBL). This was conducted by taking a manual fix in QINSy.

A minimum obtained sediment depth of five cm (seven cm in fine sediments) was considered to be an acceptable sample. The accepted minimum sample volume for the Hamon grab was seven litres. If the first attempt was not acceptable, up to three additional attempts were made. The type of grab sampler was also changed to the other to maximise the probability of sampling success. If none of the four samples was acceptable, the attempt with the largest retrieved sample volume was saved with a note highlighting the volume in the field log. Samples that were not accepted were not included in any statistical analyses.

A field log of sample positions including time, sediment type, and water depth was kept for later reference. All samples were photo documented in-situ. Approved samples were carefully sieved using seawater in a 5 mm mesh sieve over a 1 mm mesh sieve using gentle hose pressure. Faunal samples were preserved on-board in 80 % ethanol directly after the sieving was completed. The 5 mm and 1 mm fractions were kept in separate jars, that were labelled with a unique label containing grab sample site ID and replicate number. For further information regarding sample volume and number of attempts, see Appendix B|.

3.1.4 | PARTICLE SIZE ANALYSIS AND CHEMICAL SAMPLING

Sediment was sampled for PSA and chemical analyses at each benthic grab sample site. The PSA and chemical samples were sampled from a separate sample than the infaunal samples, normally from one of the two samples retrieved from the second drop with the grab sampler.

Samples for metals, polycyclic aromatic hydrocarbons (PAH) and organics (Loss of Ignition (LOI) and total organic content (TOC)) were sampled from an undisturbed surface. The sediments were collected with a plastic spoon for metals, and metal spoon for hydrocarbons and organics. This was to ensure minimal contamination risk. The grab sampler was cleaned between samples and sample sites.

The sediment for PSA was sampled by taking a representative sample (one litre) from the sample bucket using a big plastic spoon.

For the chemical analysis of hydrocarbon, organics and nutrients samples, 125 ml tin jars were used. One litre plastic containers were used for the metal samples. The difference in containers ensured that there was no outside contamination to the samples.

The sample containers were labelled with a unique sample site ID. All samples were stored frozen or refrigerated according to the analysing laboratory recommendations, before and during shipment for analysis.

Replicate samples for all the analyses were collected and stored as back-up samples (not analysed).

3.2 | LABORATORY METHODS

3.2.1 | PARTICLE SIZE ANALYSIS

The PSA was conducted by a UK based company "In Situ Site Investigation". Sediment from each sample site was analysed to detail the different particle fraction components. This was achieved using a combination of sieving and sedimentation. Up to one litres of sediment from each sample location was analysed to detail the different particle fraction components.

In line with the (British Standard, 2010), wet sieving was applied in essentially cohesion-less sediments while dry sieving was only used for sediments that did not contain significant amounts of silt and clay, i.e. almost entirely granular sand and/or gravel.

To analyse the finer fractions such as silt and clay (<0.063 mm), the sedimentation by the hydrometer method was applied. This analysis is carried out when a certain percentage of material passing through the 0.063 mm wet/dry sieve is reached. This is usually 10 or 15 % due to the fact that, at this level, the ratio of silt and/or clay can have a substantial effect on the physical or engineering properties of a soil.

The particle sizes are grouped into the five large textural groups for descriptions purposes. The samples are described according to Table 8.

Table 8 British standard Methods of test for soils for civil engineering purposes (2010) PSA intervals.

CLASSIFICATION	PARTICLE SIZE INTERVALS (DIAMETER mm)	GROUPED CLASSIFICATION
Boulder	>75	Boulders/cobbles
Cobble	75-63	
Coarse Gravel	63-20	Gravel
Medium Gravel	20-6.3	

CLASSIFICATION	PARTICLE SIZE INTERVALS (DIAMETER mm)	GROUPED CLASSIFICATION
Fine Gravel	6.3-2	
Coarse Sand	2-0.6	Sand
Medium Sand	0.6-0.2	
Fine Sand	0.2-0.063	
Coarse Silt	0.063-0.02	
Medium Silt	0.02-0.0063	Silt
Fine Silt	0.0063-0.002	
Clay	<0.002	Clay

3.2.2 | CHEMICAL ANALYSIS

The different compounds that were analysed along with detection limits are stated in Table 9, Table 10 and Table 11. The analyses included concentration analysis of metals, hydrocarbons (PAH) and organics (LOI and TOC). Detailed chemical results are presented in Appendix G, with a brief summary presented below.

PAHs were analysed using Gas chromatography–mass spectrometry (GC-MS).

Table 9 Hydrocarbon analysis minimum limits of detection.

HYDROCARBONS	DETECTION LIMITS ($\mu\text{g Kg}^{-1}$)	METHOD OF ANALYSIS
PAHs: 2 to 6 ring aromatics by GC-MS*	1	Documented in-house method using DTI specification by GC-MS, PAHSED

* indicate United Kingdom Accreditation Service (UKAS) accreditation (16 USEPA + Dibenzthiophene & Benzo(e)pyrene only)

All metals were analysed using the following method: Hydrofluoric acid and boric acid extraction followed by Inductively Coupled Plasma-mass Spectrometry (ICP-MS).

Table 10 Metal analysis minimum limits of detection.

METALS	DETECTION LIMITS ($\mu\text{g.g}^{-1}$)	Method of analysis
Hg	0.01	Hydrofluoric acid and boric acid extraction followed by ICP-MS
Cd	0.1	Hydrofluoric acid and boric acid extraction followed by ICP-MS
Cr, Ni, Sn*	0.5	Hydrofluoric acid and boric acid extraction followed by ICP-MS
As*	1	Hydrofluoric acid and boric acid extraction followed by ICP-MS
Cu*, Pb*	2	Hydrofluoric acid and boric acid extraction followed by ICP-MS

* indicate United Kingdom Accreditation Service (UKAS) accreditation.

LOI was analysed by heating a ground sample at 450°C for 4 hours and the lost mass was calculated.

TOC was analysed by adding sulphurous acid to an air-dried ground sample. The sample was then dried at 100°C and analysed using Eltra induction furnace fitted with an NDRI cell.

Table 11 Organics analysis and minimum limits of detection.

ORGANICS	DETECTION LIMITS	METHOD OF ANALYSIS
LOI	0.2 %	Documented method using furnace combustion, LOI%(MM)
TOC	0.02 %	Documented method with carbonate removal and sulphurous acid/combustion at 800°C/NDIR, WSLM59

3.2.3 | BIOLOGICAL ANALYSIS

The infaunal analysis was conducted by the UK based company APEM. Analysis was conducted in accordance with NMBAQC scheme (Worsfold & Hall, 2010) and at least 10 % of the samples were randomly quality controlled.

The infaunal samples were sorted from sediment residue, and the fauna was identified to the most detailed level possible, mainly species, counted and weighted. When the species could not be identified, the specimen was grouped into the nearest identifiable taxon of a higher rank, i.e. genus, or family, or order etc. If the species remained unknown but clearly separated from any other found specimen within the same genus, it was assigned a "Type" denomination, i.e. Type A or Type B. Juveniles were marked with the qualifier "juvenile", and later excluded from further statistical analyses. For a detailed list of grab fauna identification results, see Appendix D].

3.3 | DATA ANALYSIS

3.3.1 | VISUAL DATA ANALYSES

The stills were analysed to identify species and species densities, including seabed substrate. The video recordings were used to aid in the assessment of features and extent of habitats. Particular attention was paid to the elevation of habitats above ambient seabed level, together with their spatial extent, percentage biogenic cover and patchiness, as these are key criteria for evaluating areas of conservation importance and reef structures (Gubbay, 2007) (Irving, 2009).

Quantitative methods were used for the identification of biota in grab samples and still photographs, with all the data presented as individuals per square metre and percentage cover of colonial species. Stills were analysed in AutoCAD Map 3D 2016, where visual epibenthic fauna was counted and results summarised in a log, containing scientific name, position, date, time, and stills ID.

3.3.2 | PARTICLE SIZE DISTRIBUTION

Sediment particle size distribution statistics for each sample were calculated from the raw data by the Insitu laboratory. The distribution curves of sediment composition along with uniformity coefficient and Coefficient of Curvature is provided in Appendix F].

3.3.3 | CHEMICAL ANALYSIS

Environmental Quality Standards (EQS) for metals and hydrocarbons in sediments are not yet developed for UK waters.

Assessment criteria developed by the Canadian Council of Ministers of the Environment (CCME) together with the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) guideline action levels for disposal of dredged material have been considered common practice to use in the UK.

The OSPAR Environmental Assessment Criteria (EAC) have also been used as guidelines for metal and PAH concentrations, when applicable, within this report.

The Canadian sediment quality guidelines include two values as assessment criteria, the Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL). The ISQG are threshold levels which are set to protect all aquatic life during an indefinite period of exposure, and for values above PEL adverse effects are expected to occur frequently (Environment, 1995) (Environment, 2001). For concentrations between the ISQG and PEL adverse effects occur occasionally.

The CEFAS Action Levels are used as a part of assessing the contamination status in dredged material, where material below Action Level 1 (AL1) generally indicates that contaminant levels are of no concern, while contaminant levels above Action Level 2 (AL2) generally are considered unsuitable for disposal in the sea (MMO, 2015).

The OSPAR EACs are under development and OSPAR uses “Effect range-low” (ERL) values for sediment assessment of metals and PAHs, where EACs are not available. The ERL value indicates a concentration below which adverse effects on organisms are rarely observed (OSPAR, 2011). Background Concentration (BC) is the concentration of a contaminant found at a pristine site and considered not to be affected by anthropogenic sources. The Background Assessment Concentration (BAC) is a value for testing whether the concentrations [sediments; water; biota] at a site are at or close to background concentrations (OSPAR, 2011).

3.3.4 | MULTIVARIATE STATISTICAL ANALYSES

Multivariate analysis was undertaken using the Plymouth Routines in Multivariate Ecological Research (PRIMER) v7.0 statistical package (Clarke K. &, 2015). The statistical analyses were based on macrofaunal data derived from the taxonomic analyses of two replicates from each sample site. Abundances were expressed as a number of individuals per 0.1 m².

The macrofaunal organisms were separated into non-colonial and sessile colonial fauna. Colonial fauna was not quantified in the laboratory analysis, and was treated separately in the statistical analyses. All colonial fauna was also considered being epifauna. Juvenile (JUV) taxa, eggs and fragments of an animal were excluded from the dataset. Foraminifera's were excluded from the datasets. The faunal composition was linked to physical variables such as depth and sediment composition.

Square root transformation was applied to the non-colonial enumerated fauna before calculating the Bray-Curtis similarity measures. This transformation was made to prevent abundant species from influencing the Bray Curtis similarity index measures, excessively and also to take the rarer species into account (Clarke & Warwick, 2001).

The infaunal laboratory results were compared for faunal composition within and between sampling sites. Site related differences in community structure were examined in a clustering analysis using Euclidean distance and the Bray-Curtis similarity coefficient. This method is common when measuring ecological distance in biological sample data.

Multi-Dimensional Scaling (MDS) analysis was undertaken in conjunction with the cluster analysis. The MDS analysis is based on the same similarity matrix as that of the cluster analysis, and produces a multidimensional ordination of samples. The number of restarts was set to 100 with a minimum stress

of 0.1. The MDS plot visualises the relative (dis)similarities between samples; the closer they are the more similar the species composition between the samples. The degree to which these relations can be satisfactorily represented is expressed as the stress coefficient statistic, low values (<0.1) indicate a good ordination with low probabilities of misleading interpretation. Generally, the higher the stress, the greater the likelihood of non-optimal solutions (Clarke & Warwick, 2001).

A Similarity profiling algorithm (SIMPROF) test was run in conjunction with the cluster analysis, which was used to identify significantly different natural occurring groups among grab samples. The results are presented in the cluster dendrogram as black lines indicating significant statistical differences.

Red lines represent samples that are not statistically different. The SIMPROF is based on taxa, and the abundance of each taxon in each sample, thus different SIMPROF groups may host similar fauna which differ in abundance.

PSA data was analysed in PRIMER, and normalised before included in any statistical analysis. Data for the percentage composition was analysed in a cluster analysis using the Euclidean distance. A Principal Component Analysis (PCA) was undertaken on the sediment data set in order to identify spatial patterns and relationships between variables.

3.4 | HABITAT CLASSIFICATION

All data obtained from the geophysical, geotechnical and environmental survey are combined and correlated. The data are compared to existing background information, in order to ground-truth the survey results and to strengthen the accuracy of the interpretations.

Habitats were classified to the lowest hierarchic level possible and based on interpretations that combine biotope descriptions of species abundance, diversity, depth and seabed features from grab samples, video and photos acquired at each sample site.

The classification of the communities of the different habitat types is based on physical characteristics such as benthic geology, wave exposure, tidal currents, temperature and salinity together with key species present in the area.

The EUNIS classification (European Commission, 2007) is divided into six hierarchic levels (Figure 4). At Level 1, the marine habitats are divided into coastal and terrestrial habitats. At Level 2, the biological zone and presence/absence of rock is a classification criterion, and at Level 3, the softer substrata are divided into different sediment types. Hence, these three levels of classification are based on physical characters. Level 4 gives references to specific taxa, for rocky substrates the major epifauna is used, and for softer substrates the classification relies on both zonation and physical attributes. Further, at Level 5, the classification is based on both the physical and biological characters of the habitats. Classes are defined with both infauna and epifauna on different substrates. At the highest level, 6, the different characterising taxa are associated with differing environmental characteristics of the habitat.

Level 1	⇒ (A) Marine Habitats
Level 2	⇒ (A5) Sublittoral sediment
Level 3	⇒ (A5.5) Sublittoral macrophyte-dominated sediment
Level 4	⇒ (A5.53) Sublittoral seagrass beds
Level 5	⇒ (A5.533) <i>Zostera</i> beds in full salinity infralittoral sediments
Level 6	⇒ (A5.5331) <i>Zostera marina</i> / <i>angustifolia</i> beds on lower shore or infralittoral clean or muddy sand

Figure 4 Example of EUNIS Hierarchy.

3.5 | PROTECTED HABITATS AND SPECIES ASSESSMENTS

For assessment and classification of potential areas and/or species of conservation importance, the following legislations and guidelines have been consulted.

The European Commission (EC) Habitat Directive specifies the European nature conservation policy. Species and habitats of special interest for conservation are specified in the different annexes to the directive. Annex I states the habitats of special conservation interest and Annex II states the species of special conservation interest. Among the habitats specified in Annex I are the "Reefs" (code 1170). Reefs can be of biogenic, e.g. mussel beds or corals, or geogenic origin, e.g. stony areas with epifauna.

The JNCC's lists of UK BAP (Biodiversity Action Plan) was also consulted (Brig, 2008 (Updated Dec 2011)).

The UK BAP species and habitats are defined nationally by the UK. Threatened species and habitats are listed to aid in the survival of species in accordance with the Convention of Biological Diversity (UN, 5 June 1992).

The Marine Protected Area (MPA) network is a term describing areas in the ocean which are protected in part or closed off completely by strict regulations. One example of MPAs is the Special Areas of Conservation (SAC), which are a part of defined in the European Commission (EC) Habitats Directive.

The Oslo and Paris Conventions for the protection of the marine environment of the North-East Atlantic (OSPAR), lists protected species and habitats, as well as sensitive habitats and species in need of protection in the North-East Atlantic. This serves also as a complement to the EC Habitats Directive.

In the Habitat Directive's interpretation manual (EUR 27, 2007) reefs are explained as follows:

"Reefs can be either biogenic concretions or of geogenic origin. They are hard compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions."

The distinction between what is to be considered a "reef" is not yet precise. This is particularly the case in relation to colonies of the tube-building polychaete, *Sabellaria spinulosa* and stony reefs. If for example *S. spinulosa* or horse mussel (*Modiolus modiolus*) is found in an area, it does not automatically make the area a potential Annex I habitat. Therefore, a scoring system based on a series of physical, biological and spatial characteristic reef features is used to assess the degree of "reefiness".

The reefiness is weighted according to the perceived importance of each feature. Furthermore, the reefiness is increased with a score indicating the confidence in the feature score. Threshold ranges proposed, for the reef characteristics elevation, spatial extent and patchiness of *S. spinulosa*, are provided by (Gubbay, 2007) (Table 12) and for stony reefs by (Irving, 2009) (Table 13).

Table 12 Proposed chart for *Sabellaria spinulosa* reef identification (Gubbay, 2007).

CHARACTERISTIC	NOT A REEF	"REEFINESS"		
		LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	<2	2-5	5-10	>10
Extent (m ²)	<25	25 - 10,000	10,000 – 1,000,000	>1,000,000
Patchiness (% cover)	<10	10 - 20	20-30	>30

The general definition of biogenic reefs is made by (Holt, 1998) as;

"Solid, massive structures which are created by accumulations of organisms, usually arising from the seabed or at least clearly forming a substantial, discrete community or habitat which is very different from the surrounding seabed. The structure of the reef may be composed almost entirely of the reef-building organism and its tubes or shells or it may to some degree be composed of sediments, stones and shells bound together by the organism."

Table 13 Guidelines used to categorise 'reefiness' for stony reefs (Irving, 2009).

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	<10 %	10-40 % Matrix supported	40-95 %	>95 % Clast supported
Notes: Diameter of cobbles / boulders being greater than 64 mm. Percentage cover relates to a minimum area of 25 m ² . This 'composition' characteristic also includes 'patchiness'.				
Elevation	Flat Seabed	<0.064 m	0.064 m-5 m	>5 m
Notes: Minimum height (64 mm) relates to minimum size of constituent cobbles. This characteristic could also include 'distinctness' from the surrounding seabed.				
Extent	<25 m ²	>25 m ²		
Biota	Dominated by infaunal species			>80 % of species present composed of epifaunal species.

This scoring system indicates that stony reefs should be elevated by at least 0.064 m and with a composition of at least 10 % stones, covering an area of at least 25 m² and have an associated community of largely epifaunal species.

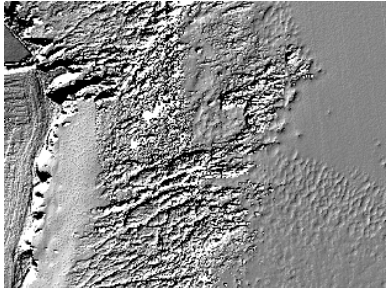
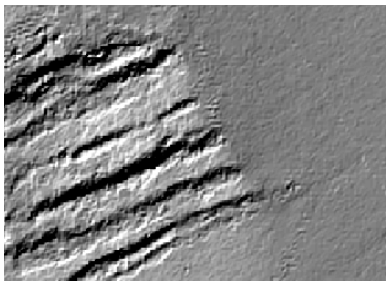
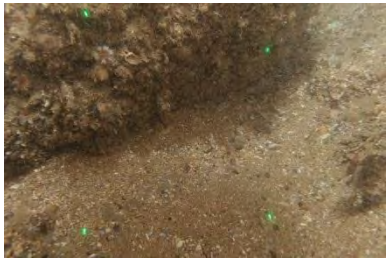
For "Bedrock Reefs" no similar scoring system exists. In areas where the geophysical data cannot provide information on the degree of exposure, on bedrock, these areas will be delineated as "Potential Bedrock Reefs". The qualifying criteria for the classification "Bedrock Reefs" is the presence of bedrock that could support an epifaunal community.

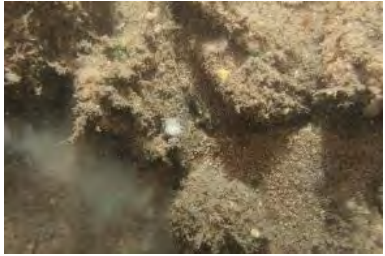
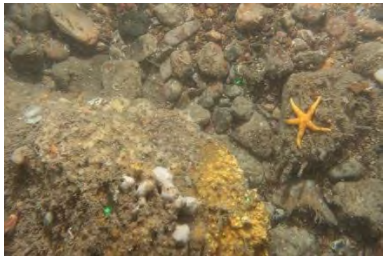
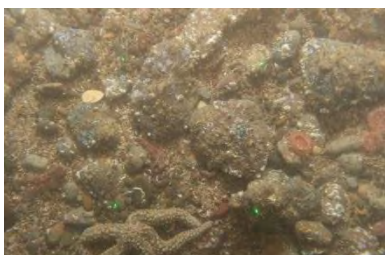
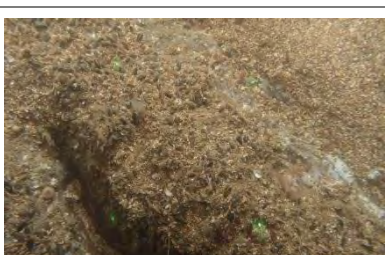
4| RESULTS

4.1| SUMMARY OF IDENTIFIED HABITATS

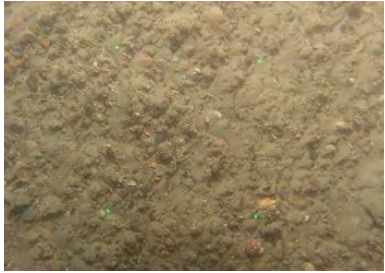
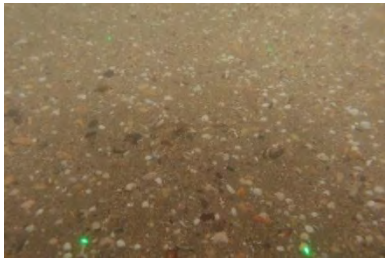
A total of 33 habitats were identified within the survey corridor (Table 14). An overview of the distribution of habitats and sample locations including areas of Annex I habitats within the UK are presented in Figure 6, Figure 11 to Figure 22 and within Ireland in Figure 52 to Figure 57 and Figure 65.

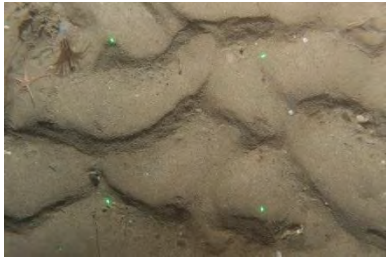
Table 14 Habitat description.

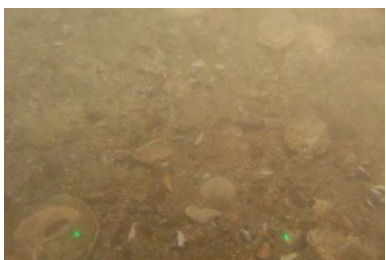
HABITAT IMAGE	HABITAT CLASSIFICATION	HABITAT CODE
	Kelp with cushion fauna and/or foliose red seaweeds	A3.11
	Atlantic and Mediterranean moderate energy infralittoral rock	A3.2
	Atlantic and Mediterranean high energy circalittoral rock	A4.1
	Mixed faunal turf communities on circalittoral rock	A4.13

HABITAT IMAGE	HABITAT CLASSIFICATION	HABITAT CODE
	Mixed turf of bryozoans and erect sponges with <i>Dysidia fragilis</i> and <i>Actinothoe sphyrroeta</i> on tide-swept wave-exposed circalittoral rock	A4.1312
	<i>Corynactis viridis</i> and a mixed turf of crisiids, Bugula, Scrupocellaria, and Cellaria on moderately tide-swept exposed circalittoral rock	A4.132
	<i>Molgula manhattensis</i> with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock	A4.138
	Echinoderms and crustose communities on circalittoral rock	A4.21
	<i>Urticina felina</i> and sand-tolerant fauna on sand-scoured or covered circalittoral rock	A4.213
	<i>Urticina felina</i> and sand-tolerant fauna on sand-scoured or covered circalittoral rock/ <i>Mytilus edulis</i> beds with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rockA4.213/ A4.241	A4.213/ A4.241

HABITAT IMAGE	HABITAT CLASSIFICATION	HABITAT CODE
	<i>Sabellaria spinulosa</i> encrusted circalittoral rock	A4.221
	<i>Sabellaria spinulosa</i> , didemnid and small ascidians on tide-swept moderately wave-exposed circalittoral rock	A4.2212
	<i>Mytilus edulis</i> beds with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rock	A4.241
	Infralittoral coarse sediment	A5.13
	Circalittoral coarse sediment	A5.14
	<i>Pomatoceros triqueter</i> with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	A5.141

HABITAT IMAGE	HABITAT CLASSIFICATION	HABITAT CODE
	<i>Mediomastus fragilis</i> , <i>Lumbrineris</i> spp. and venerid bivalves in circalittoral coarse sand or gravel	A5.142
	<i>Protodorvillea kefersteini</i> and other polychaetes in impoverished circalittoral mixed gravelly sand	A5.143
	Deep circalittoral coarse sediment	A5.15
	Infralittoral fine sand	A5.23
	Infralittoral muddy sand	A5.24
	<i>Fabulina fabula</i> and <i>Magelona mirabilis</i> with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	A5.242

HABITAT IMAGE	HABITAT CLASSIFICATION	HABITAT CODE
	Circalittoral fine sand	A5.25
	<i>Echinocyamus pusillus</i> , <i>Ophelia borealis</i> and <i>Abra prismatica</i> in circalittoral fine sand	A5.251
	<i>Abra prismatica</i> , <i>Bathyporeia elegans</i> and polychaetes in circalittoral fine sand	A5.252
	<i>Abra alba</i> and <i>Nucula nitidosa</i> in circalittoral muddy sand or slightly mixed sediment	A5.261
	Deep circalittoral sand	A5.27
	<i>Owenia fusiformis</i> and <i>Amphiura filiformis</i> in deep circalittoral sand or muddy sand	A5.272

HABITAT IMAGE	HABITAT CLASSIFICATION	HABITAT CODE
	Infralittoral mixed sediments	A5.43
	Circalittoral mixed sediments	A5.44
	Deep circalittoral mixed sediments	A5.45
	Polychaete-rich deep Venus community in offshore mixed sediments	A5.451
	<i>Sabellaria spinulosa</i> on stable circalittoral mixed sediment	A5.611

5 | UNITED KINGDOM

Reported KP for the UK Exclusive Economic Zone (EEZ) Environmental survey are KP 0.325 to KP 73.906. A total of 35 transect (Table 15) were performed within the UK EEZ, distributed among route route A, alternative E, and the route Greenlink_WGS84_UTM30N_09112018_RPL_Rev0 (called “Final route” in this report). Transect T04 to T09 were located within the Final Route corridor in the UK EEZ, along with transect RR_T01 to RR_T07. Transect A_T01 to A_T10 were located within the route A corridor. Transect E_T01 to E_T11 were located within the route alternative E corridor (Figure 5).

Grab sample site S17 to S37 (Table 15) was located within the UK EEZ. All grab sample sites were located within the Final Route corridor (Figure 5). See Appendix A| for a full list of positions of grab sample sites and transects. Field protocols are available in Appendix B| and Appendix C|. Grab identification protocols and Transect identification protocols are found in Appendix D| and Appendix E|.

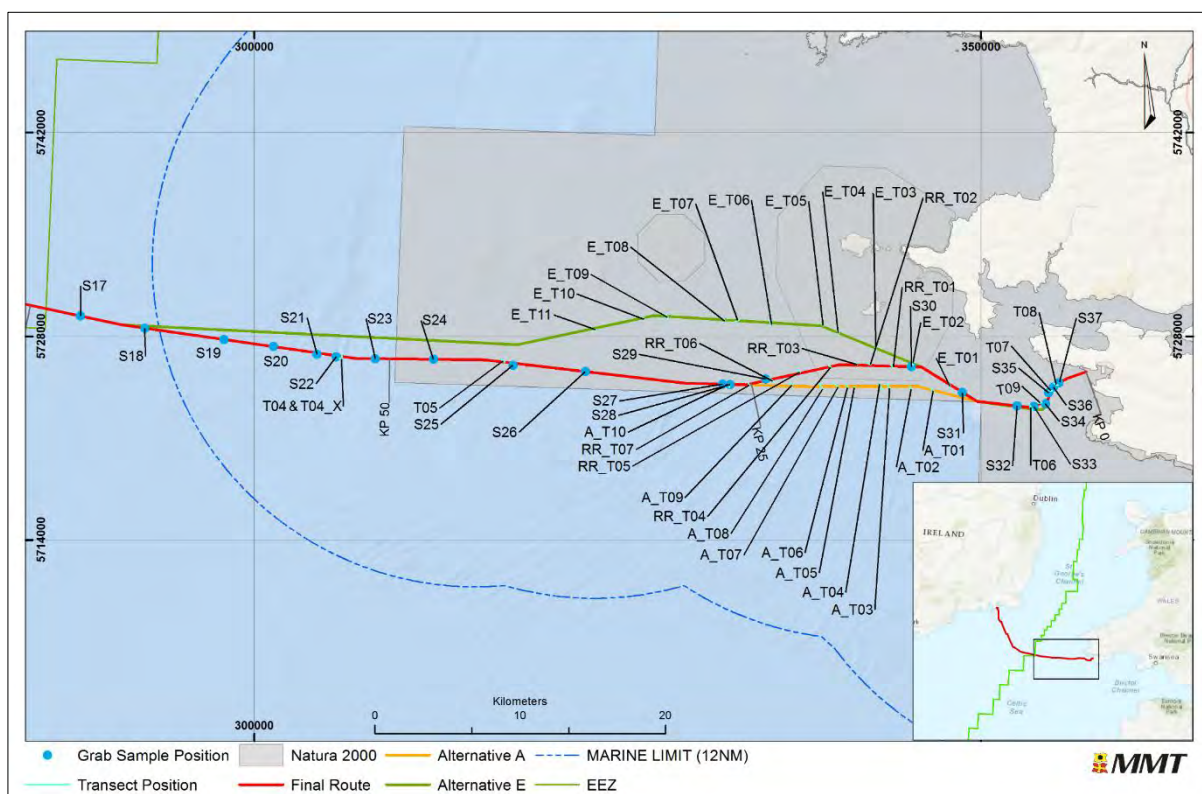


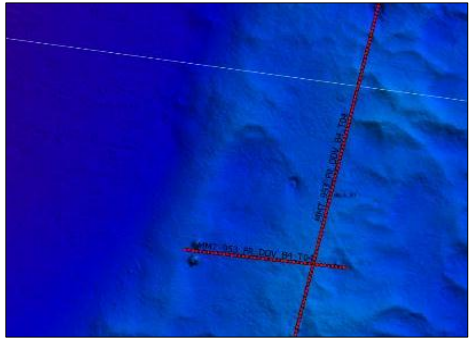
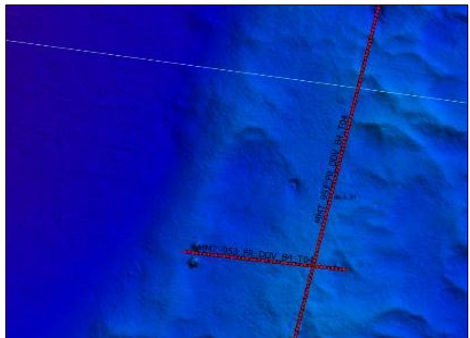
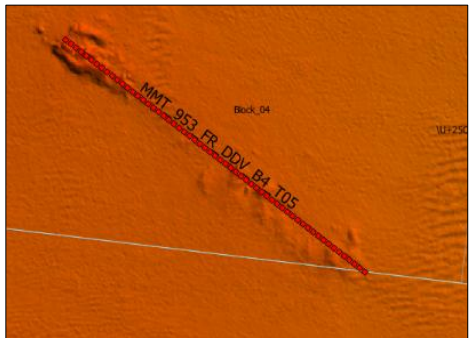
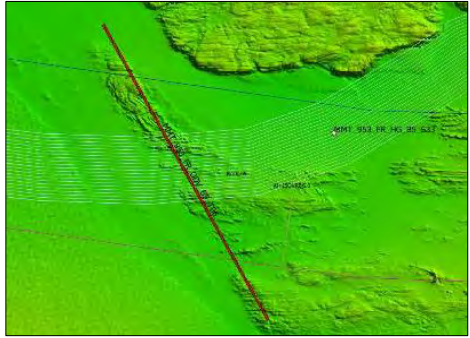
Figure 5 Overview of sampling and transect locations in the UK EEZ.

See Table 15 for the number of sample sites and Table 16 to Table 19 for details regarding planned location coordinates and geophysical features overview.

Table 15 Number of sample sites in the UK EEZ.

NUMBER OF SAMPLE SITES	PHOTO TRANSECT SITES	GRAB SAMPLE SITES	PSA/CHEM SAMPLE SITES
	35	21	21

Table 16 List of proposed transects along Final Route in UK waters.

TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_T04	309033	5726346	308930	5726529	
DDV_T04_X	305879	5726471	306010	5726456	
DDV_T05	317244	5726224	316998	5726411	
DDV_T06	355053	5724748	355286	5724642	

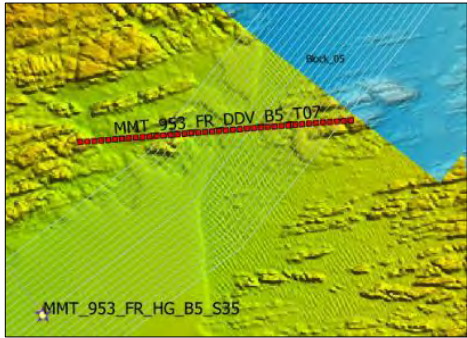
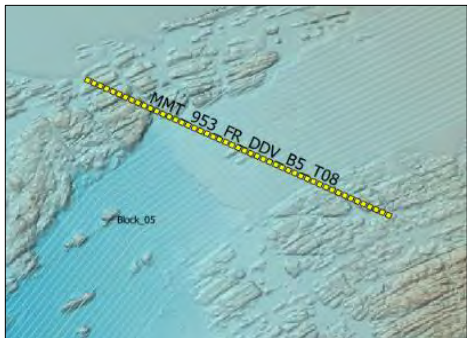
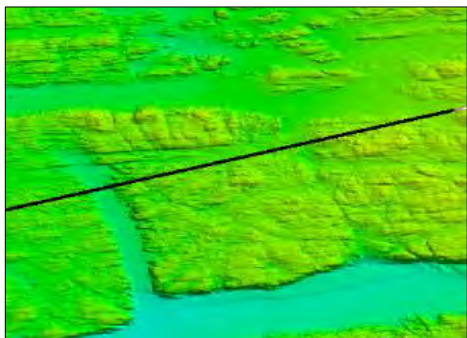
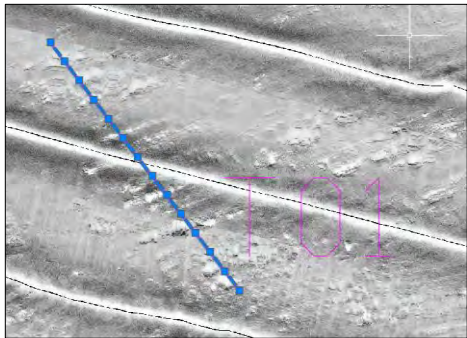
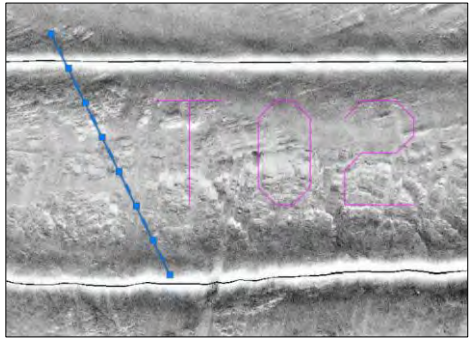
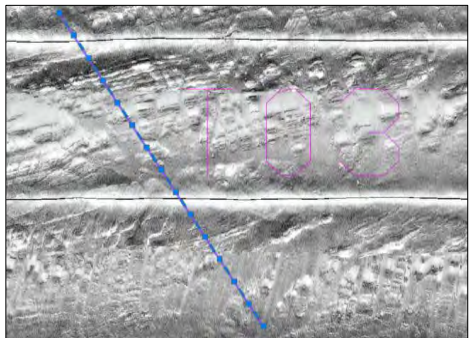
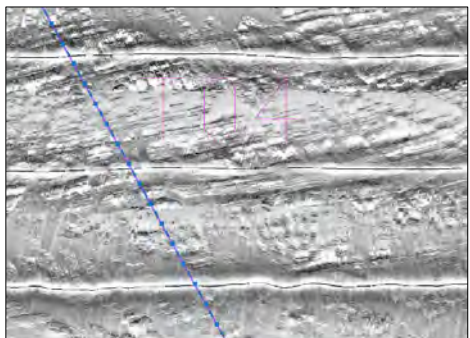
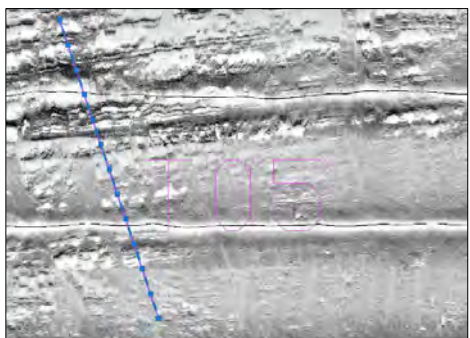
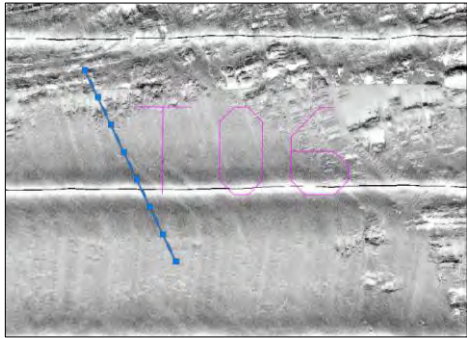
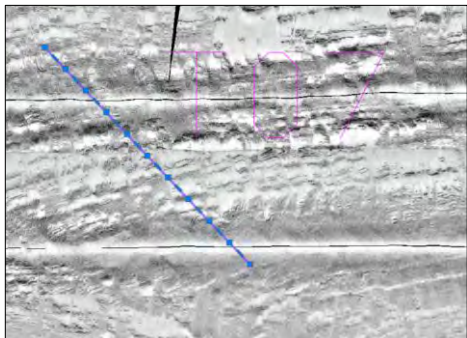
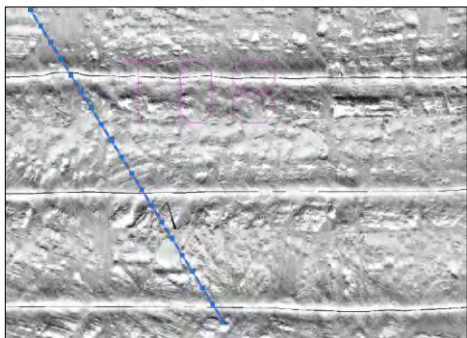
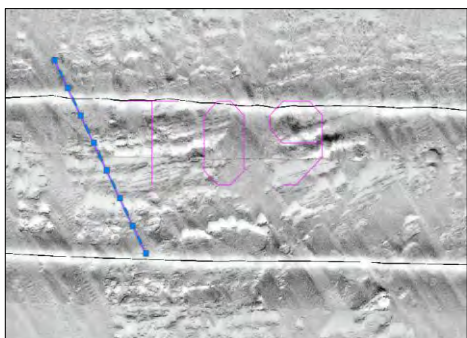
TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_T07	354677	5724250	354886	5724266	
DDV_T08	353304	5723333	353546	5722895	
DDV_T09	354267	5723467	353942	57523410	

Table 17 List of proposed transects along route alternative A in UK waters.

TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_A_T01	346571	5724421	346770	5724161	

TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_A_T02	345098	5724571	345195	5724379	
DDV_A_T03	343723	5724429	343535	5724727	
DDV_A_T04	343221	5724332	342985	5724767	
DDV_A_T05	341273	5724483	341150	5724800	

TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_A_T06	340823	5724477	340730	5724672	
DDV_A_T07	340187	5724510	339965	5724748	
DDV_A_T08	339112	5724378	338857	5724800	
DDV_A_T09	337003	5724573	336896	5724772	

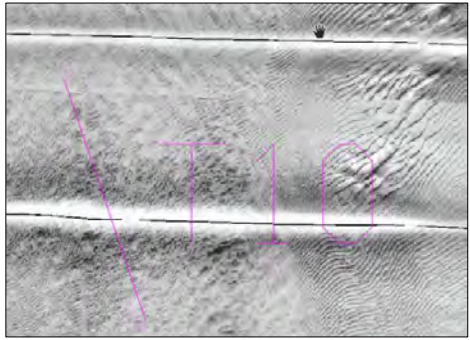
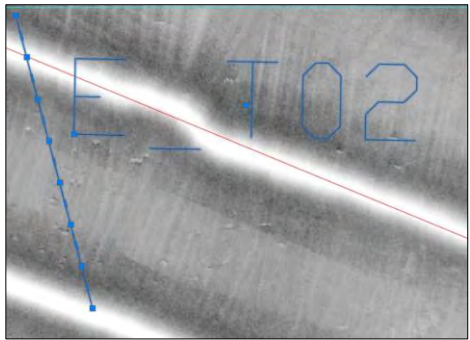
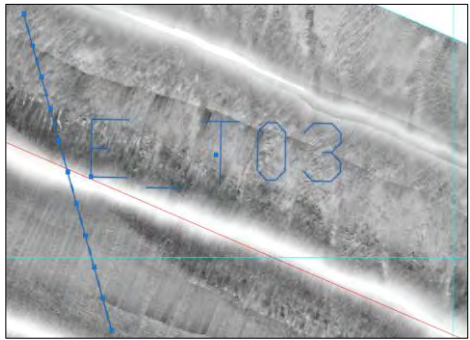
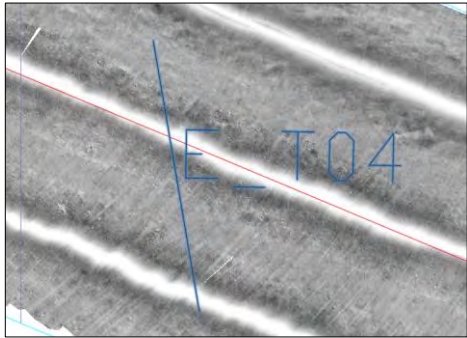
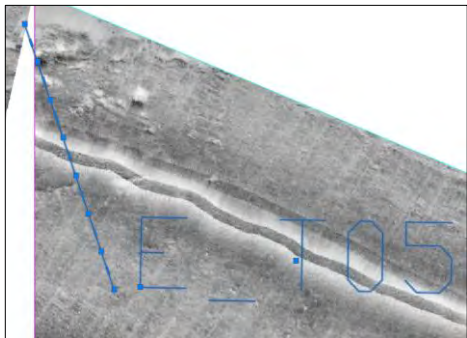
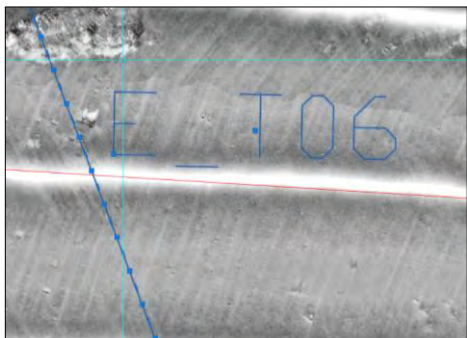
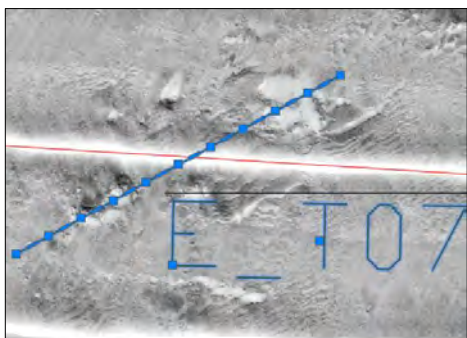
TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_A_T10	332698	5724465	332624	5724672	

Table 18 List of proposed transects along route alternative E in UK waters.

TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_E_T01	347790	5724769	347857	5724568	
DDV_E_T02	345270	5726234	345324	5726030	
DDV_E_T03	342716	5727313	342794	5727024	

TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_E_T04	340137	5728366	340176	5728146	
DDV_E_T05	339134	5728741	339066	5728946	
DDV_E_T06	335576	5728779	335463	5729068	
DDV_E_T07	333376	5729132	333101	5728995	

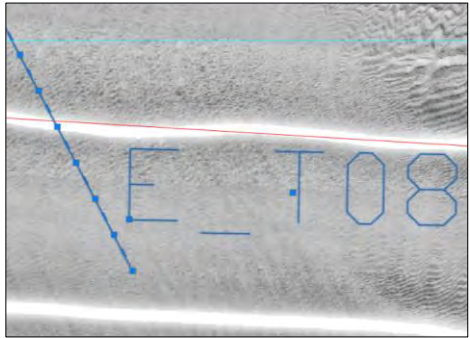
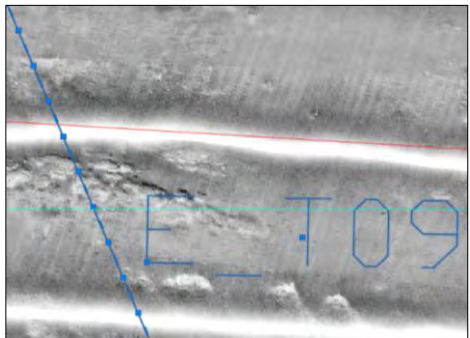
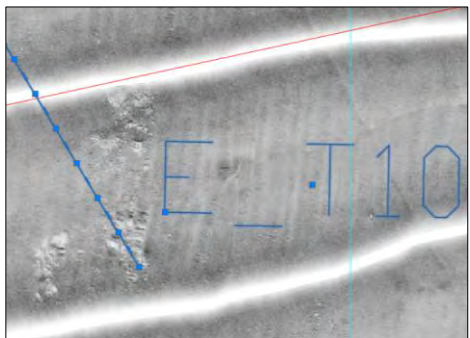
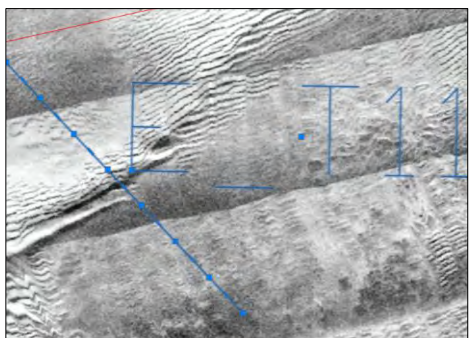
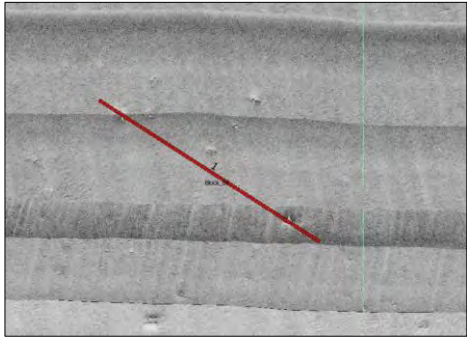
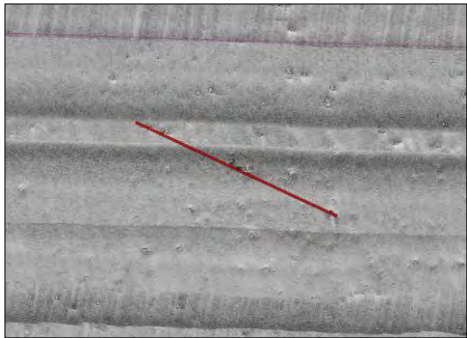
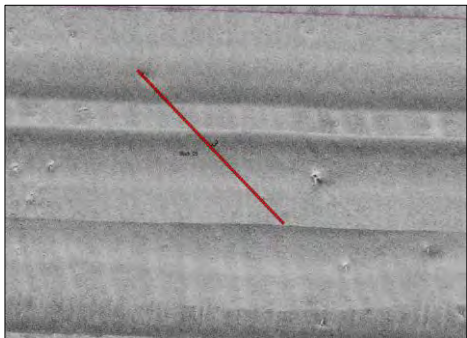
TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_E_T08	332397	5729022	332301	5729216	
DDV_E_T09	328465	5729210	328347	5729494	
DDV_E_T10	326821	5729159	326710	5729341	
DDV_E_T11	323546	5728380	323398	5728534	

Table 19 List of proposed transects along reconnaissance re-route option in UK waters.

TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_RR_T01	343793	5725999	343966	5725880	
DDV_RR_T02	342149	5726144	342408	5726045	
DDV_RR_T03	341334	5726200	341489	5726058	
DDV_RR_T04	339533	5725982	339664	5725859	

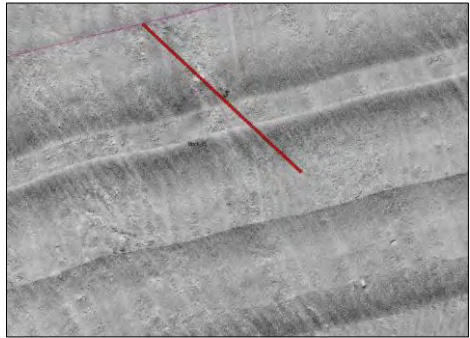
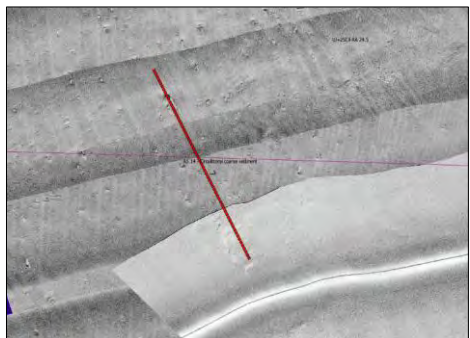
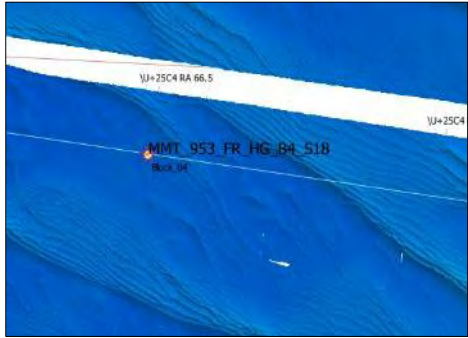
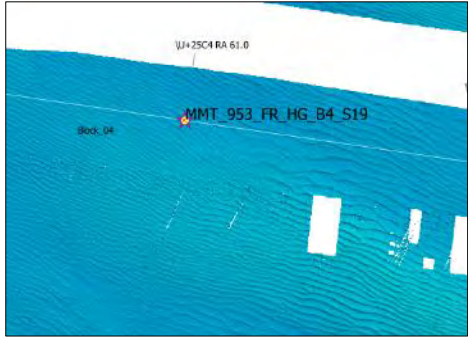
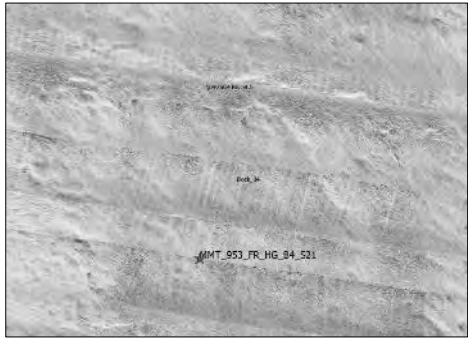
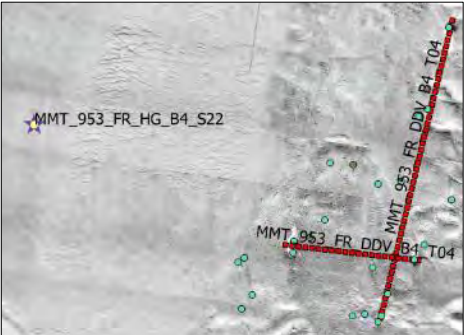
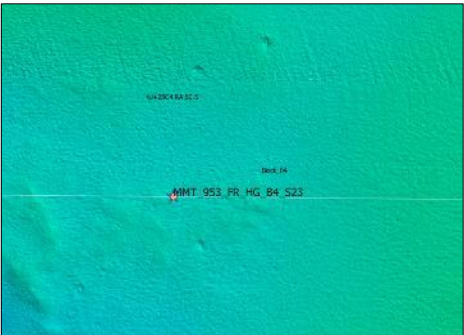
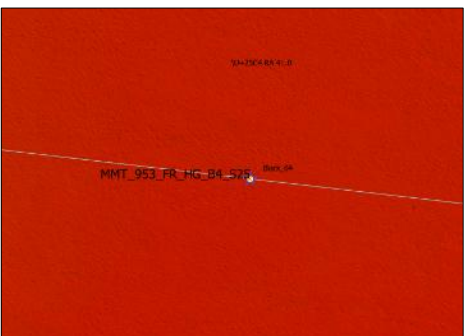
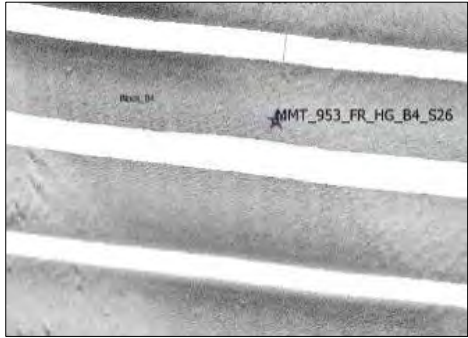
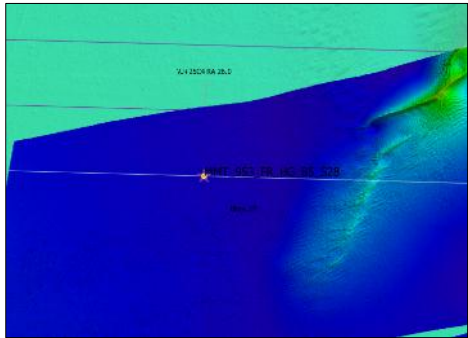
TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_RR_T05	337382	5725670	337545	5725537	
DDV_RR_T06	335397	5725147	335777	5724822	
DDV_RR_T07	334013	5724735	334117	5724552	

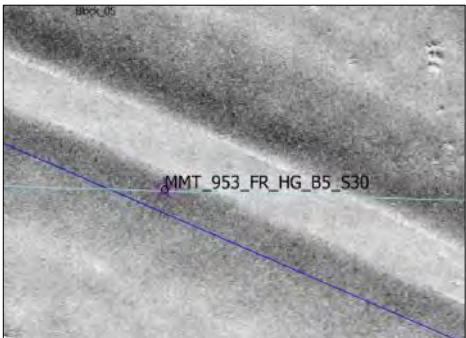
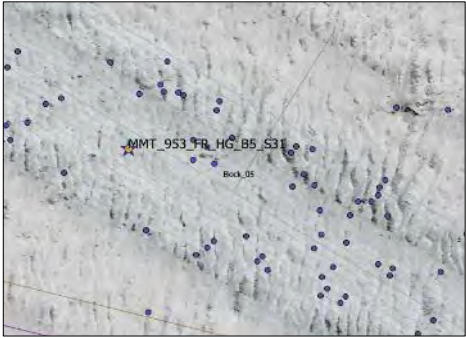
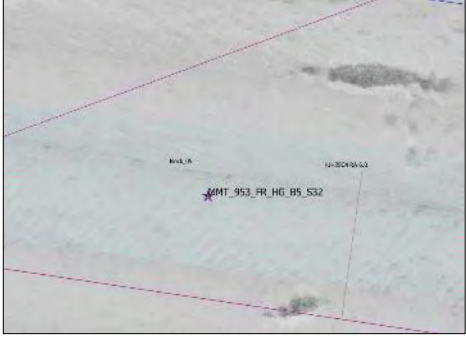
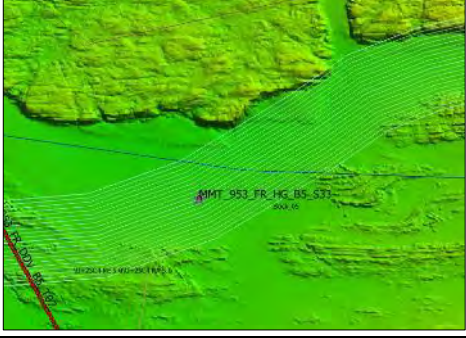
Table 20 Sample locations for grab samples performed.

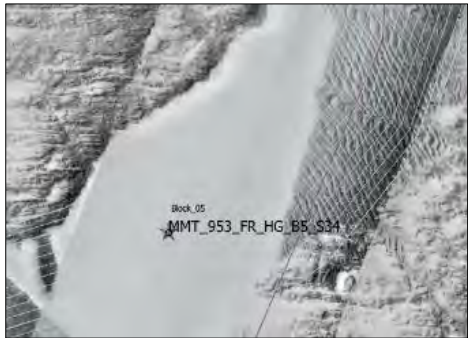
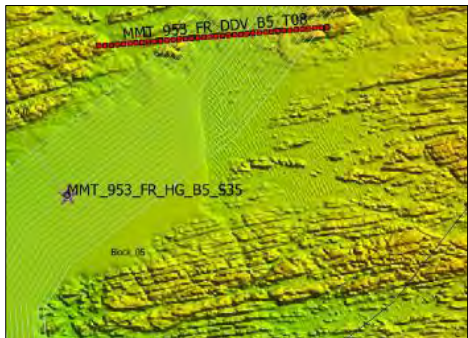
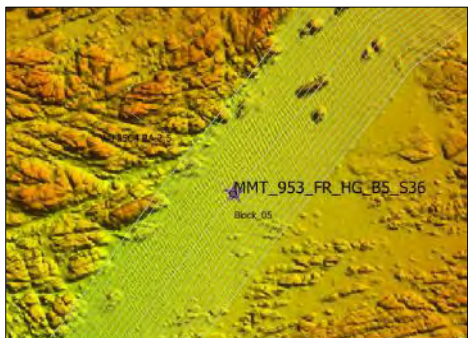
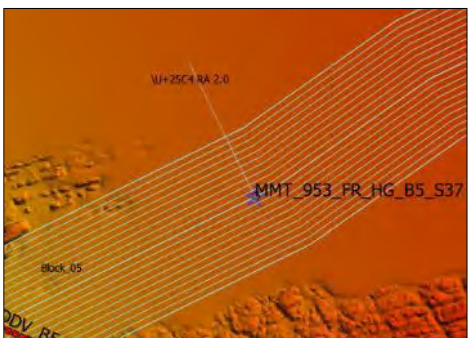
SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S17	288063	5729393	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S18	292478	5728547	
S19	297925	5727770	
S20	301337	5727291	
S21	304333	5726746	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S22	305639	5726586	
S23	308332	5726461	
S24	312332	5726422	
S25	317818	5726156	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S26	322784	5725573	
S27	332228	5724709	
S28	332737	5724687	
S29	335201	5725050	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S30	345214	5725894	
S31	348712	5724137	
S32	352742	5723209	
S33	353644	5723174	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S34	354471	5723403	
S35	354649	5724119	
S36	354980	5724488	
S37	355368	572789	

5.1 | DETAILED AREA DESCRIPTIONS

The KP referenced within this section are based on the Final Route unless otherwise stated and measured from features crossing the Route Position List (RPL).

5.1.1 | FINAL ROUTE

The shallow areas from KP 0.332 to KP 12.851 are located within the SAC area Pembrokeshire Marine/ Sir Benfro Forol (Site code UK0013116), which extends to KP 49.592.

The seabed is initially dominated by fine sediments closest to shore and classified as A5.24 - Infralittoral muddy sand, KP 0.332 to KP 0.463, followed by A5.13 - Infralittoral coarse sediment, from KP 0.463 to KP 0.636 (Figure 6).

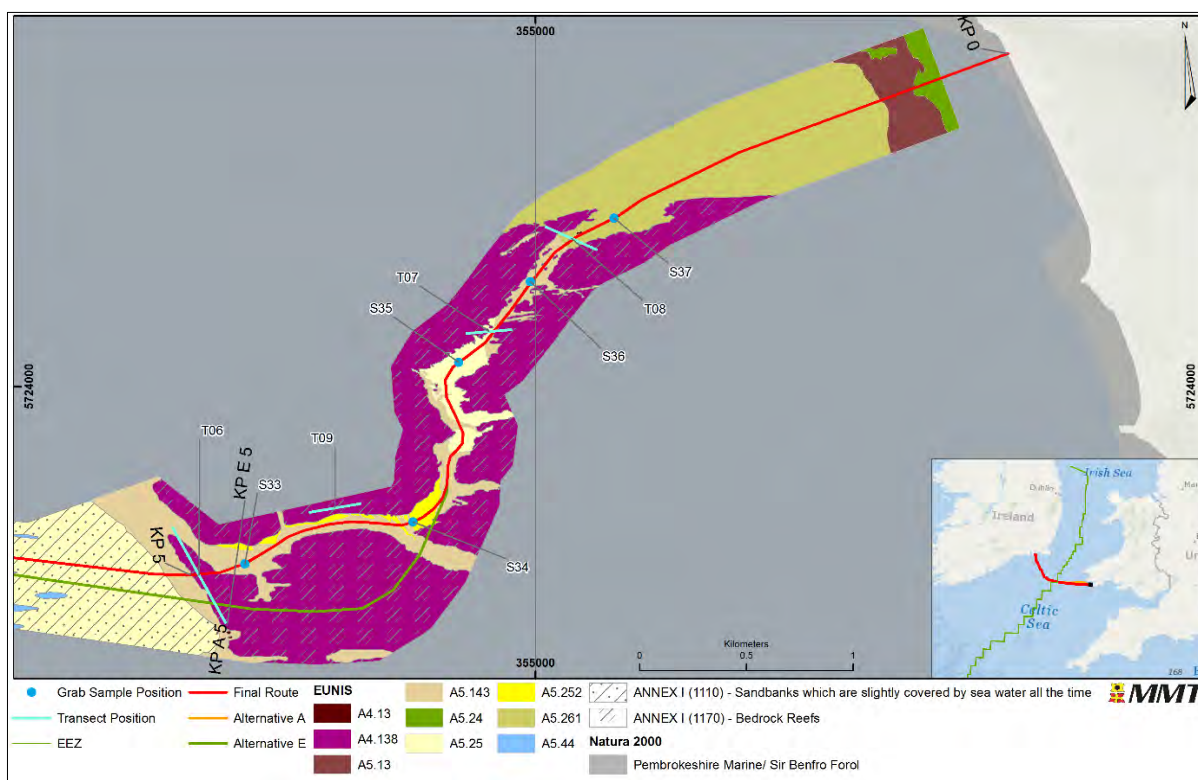


Figure 6 Overview of UK EEZ KP 0 to KP 5.

Habitat A5.261 - *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment was classified between KP 0.463 to KP 2.267 throughout the corridor. The infauna at grab sample site S37, approximate KP 2.006, comprised predominantly of molluscs *A. alba*, *N. nitidosa*, *Fabulina fabula* as well as polychaetes *Magelona filiformis* and *Spiophanes bombyx*.

From approximate KP 2.027 and KP 4.998, the final route extends along a channel of finer sediments surrounded by sedimentary bedrock classified as A4.138 - *Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock and is further assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009).

Transects DDV_T06 to DDV_T09 (Figure 7 to Figure 10) were located in turbid waters on various sections of the bedrock feature A4.138.

The analysed imagery showed similar composition with high diversity and colonisation by ascidians *Dendrodoa grossularia*, *Polycarpa sp.* and sand covered ascidians interpreted to be *M. manhattensis*.

Other taxa identified present were poriferans, *Tubularia* sp., *Caryophyllia smithii*, hydrozoans and bryozoans.

A few small outcrops are interpreted to cross the final route between KP 2.211 and KP 2.412, KP 2.783 with a larger section between KP 4.874 to KP 4.997 (DDV_T06).



Figure 7 Example image DDV_T09_005.



Figure 8 Example image DDV_T08_009.
(KP 2.220)



Figure 9 Example image DDV_T07_008.
(KP 2.797)



Figure 10 Example image DDV_T06_012.
(KP 4.874 to KP 4.997)

The seabed substrate in the channel between KP 2.027 and KP 4.998 was generally dominated by finer sediment fractions with areas of gravelly sands.

An initial section from KP 2.267 to KP 2.863 was classified as A5.143 - *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand. Grab sample site S36, located within this section at approximate KP 2.507 showed low abundances of infauna which was characterised by polychaetes *P. kefersteini*, *Glycera lapidum*, *Exogone verugera* and Nematods as well as sipunculid *Phascolion strombus*.

The substrate between KP 2.863 and KP 3.491 was predominantly classified as A5.25 - Circalittoral fine sand and comprised grab sample site S35 at approximate KP 3.014. The analysed infauna showed similarly low diversity in taxa, but with higher abundances, compared to S36. The sample was characterised by molluscs *A. alba* and *Timoclea ovata*, amphipod *Bathyporeia elegans* and different polychaetes.

From KP 3.491 to KP 5.121 the majority of the final route was classified as A5.143 with a section classified as A5.252 - *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand between KP 3.745 and KP 3.974.

Grab sample site S34 was located within the fine sand habitat A5.252, at approximate KP 3.899. The infauna analysed showed similar diversity and abundances as S36 and S35 with some species overlapping between these sites. The characterising fauna were molluscs *Abra prismatica*, *T. ovata*, polychaetes *Travisia forbesii*, *Ophelia borealis* and amphipod *B. elegans*.

Grab sample site S33 at approximate KP 4.740 showed similar faunal composition to that of S36 and was characterised by *P. kefersteini*, *G. lapidum*, *Notomastus* and *Nematods*.

The seabed between KP 5.121 and KP 10.031 is dominated by fine sands, A5.25, with pockets and small sections, found from KP 6.220 to KP 6.882 and from KP 8.840 to KP 9.450, classified as A5.44 - Deep circalittoral mixed sediments (Figure 11). The areas classified as A5.44 were derived from the interpretations of geophysical data.

From KP 5.122 to KP 8.841 and from KP 9.405 to KP 10.029, two areas with sand and coarse sediment were classified as Annex I (1110) - Sandbanks which are slightly covered by sea water all the time (Figure 11 and Figure 12).

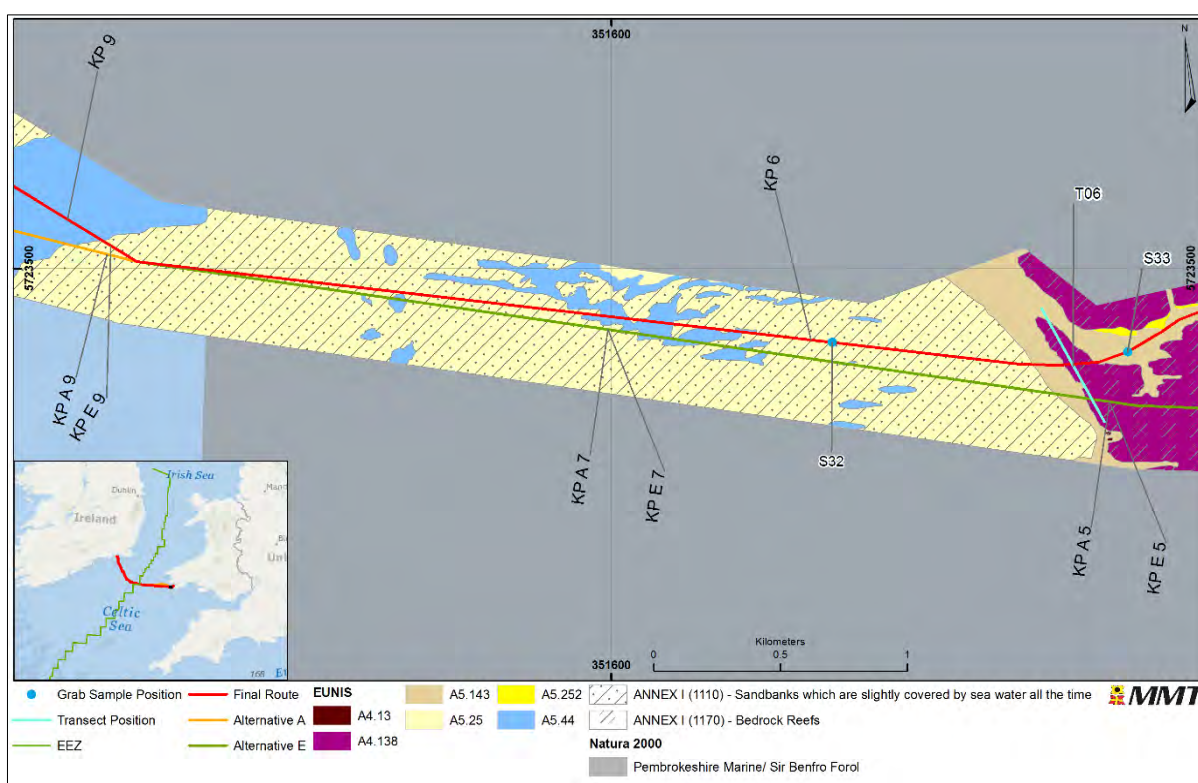


Figure 11 Overview of UK EEZ KP 5 to KP 9.

Grab sample sites S32, approximate KP 5.917, and S31 approximate KP 9.862 were located within A5.25. At site S32 the infauna was characterised by molluscs *Goodallia triangularis*, *Asbjornsenia pygmaea*, polychaete *Nephtys cirrosa*. Grab sample site S31 showed higher diversity and abundances in comparison to S32. The infauna was characterised by molluscs *A. prismatica*, *T. ovata*, *Kurtiella bidentata*, polychaetes *O. borealis*, *Lumbrineris cingulate*, *Glycinde nordmanni* and different amphipods.

Habitat A5.451 - Polychaete-rich deep Venus community in offshore mixed sediments dominated the seabed between KP 10.031 and KP 14.528 but for a few rocky sections (Figure 12).

Areas of the habitats A4.213 - *Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock and A4.221 - *Sabellaria spinulosa* encrusted circalittoral rock were present between KP 10.338 and KP 11.139 within habitat A5.451.

Habitats A4.213 and A4.221 were assigned to these sections through extrapolation, and based on the imagery data derived from transect A_T01, which was collected on the adjacent route Route A (Route A approximate KP 12.036) (Figure 12).

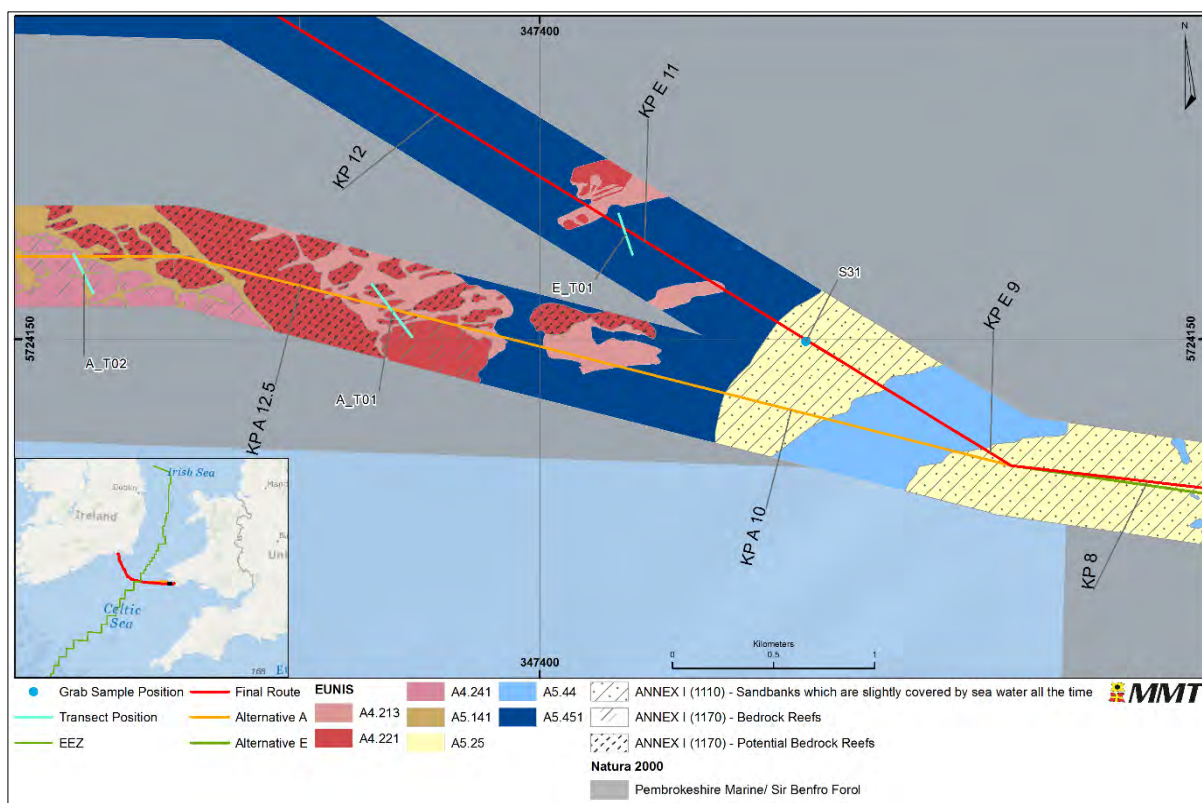


Figure 12 Overview of UK EEZ KP 9 to KP 12.

These two areas were however not assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009) as the geophysical data indicated that the bedrock was largely covered with sand and gravel and cobbles/boulders.

The imagery from transects E_T01, approximate KP 10.919 and E_T02, approximate KP 13.720, showed an increase in gravel on the surface with increasing KP and appeared superficially to be the same habitat (A5.451) as grab sample site S30 (Figure 13).

The analysis of infauna at grab sample site S30, approximate KP 13.856, indicated high diversity and abundances. The infauna was characterised by numerous polychaetes which were dominated by *Sabellaria spinulosa* and *Syllis armillarisa* as well as molluscs *Kellia suborbicularis*, *Modiolula phaseolina*, *Gari telinella*, *Venus casina*, *Hiatella arctica* and *Sphenia binghami*. The sample also contained numerous specimens of echinoderm *Amphipholis squamata*.

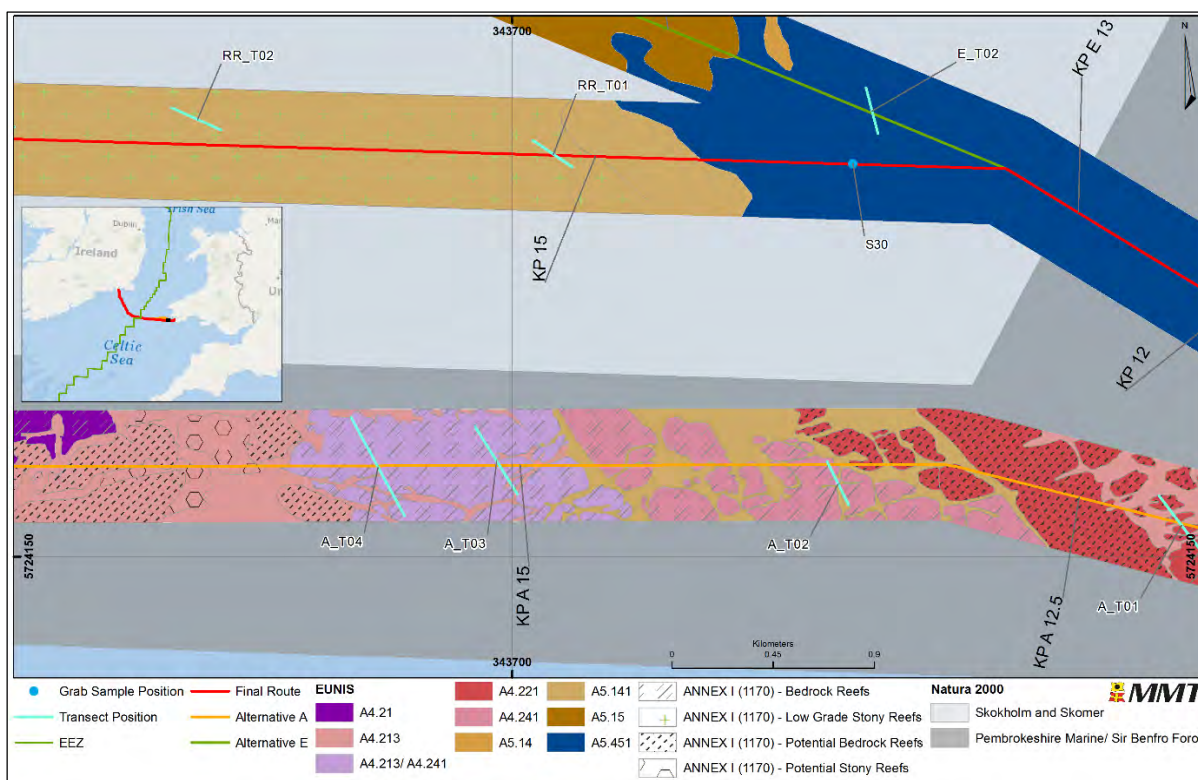


Figure 13 Overview of UK EEZ KP 12 to KP 18.

From KP 14.528 to KP 23.534 the seabed was characterised by heterogeneous coarse sediments, cobbles and boulders. The seabed was classified predominantly as A5.141 - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles from KP 14.528 to KP 20.200, KP 20.622 to KP 21.309 and KP 21.462 to KP 22.091. Areas classified as A5.14 - Circalittoral coarse sediment extended from KP 20.209 to KP 23.534.

Transect RR_T01, which crosses the final route at approximate KP 15.181, showed cobbles and boulders, with intermediate muddy gravel and *Ostrea* shells. The encrusting fauna included small clusters, of low rugosity and of varying density, of *S. spinulosa*. Other characterizing taxa noted were bryozoans, Balanidae, Serpulidae, *Urticina* sp., and Paguridae.

Transects RR_T02, approximate KP 16.711, and RR_T03, approximate KP 17.650, were located in the same superficial substrate and comprised the same epifaunal coverage as RR_T01 but without any apparent presence of *S. spinulosa*.

Transects RR_T04, crossing the final route at approximate KP 19.457, and RR_T05, approximate KP 21.509, showed more similarity to RR_T01 than RR_T02 and T03 mainly with regards to the presence of *S. spinulosa* in small clusters as well as more silt coverage (Figure 14). The general characterizing epifaunal coverage was similar between all five transects. With increasing KP, from RR_T01 towards RR_T05, the heterogeneous appearance, which was cobble dominated, of the seabed surface faded towards coarser sands and gravel. These five transects were assessed to be more similar to habitat A5.141 - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles than potentially A4.221 - *Sabellaria spinulosa* encrusted circalittoral rock. It is possible that the presence, or absence of larger clusters, of *S. spinulosa* at RR_T01 and T04 -T05 is the result of seasonal variation and scour action which can prevent establishment of *S. spinulosa*.

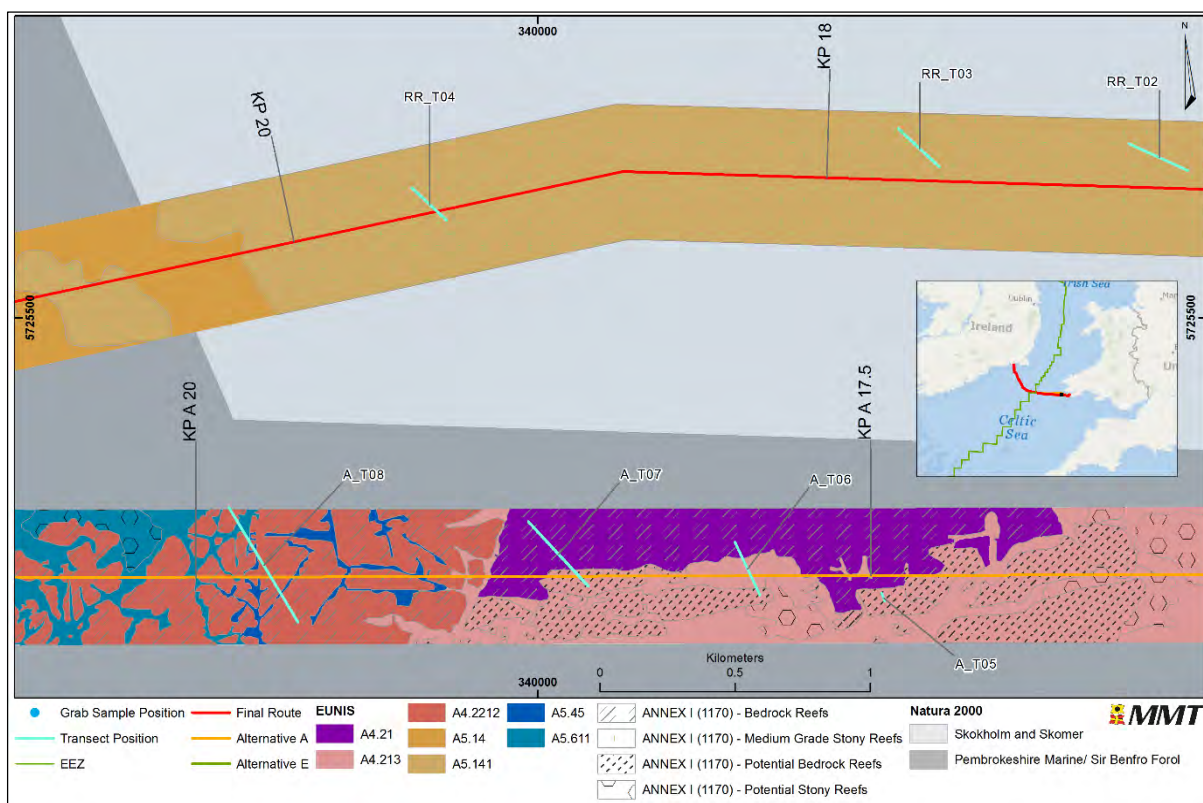


Figure 14 Overview of UK EEZ KP 18 to KP 22.

Four single camera drops (RR_D01 – D04) were performed to investigate large boulders prior to geotechnical sampling between KP 16.261 and KP 20.376. The imagery indicates the presence of habitat A4.111 - *Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock. It is possible that there are patches of A4.111 which are not distinguishable from A5.141 in geophysical data.

Areas of A5.141, between KP 15.002 and KP 22.091, were also assessed to meet the criteria of Annex I (1170) – Medium Grade Stony Reefs (Irving, 2009).

The seabed between KP 23.534 and KP 24.925 was classified as A5.15 - Deep circalittoral coarse sediment (Figure 15). Areas of A4.213 - *Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock were classified from KP 23.535 to KP 23.743 and crossing the final route at KP 24.192. An area classified as A5.611 - *Sabellaria spinulosa* on stable circalittoral mixed sediment was identified along the final route corridor, at the boundary of route Route A, KP 23.532 to KP 23.696.

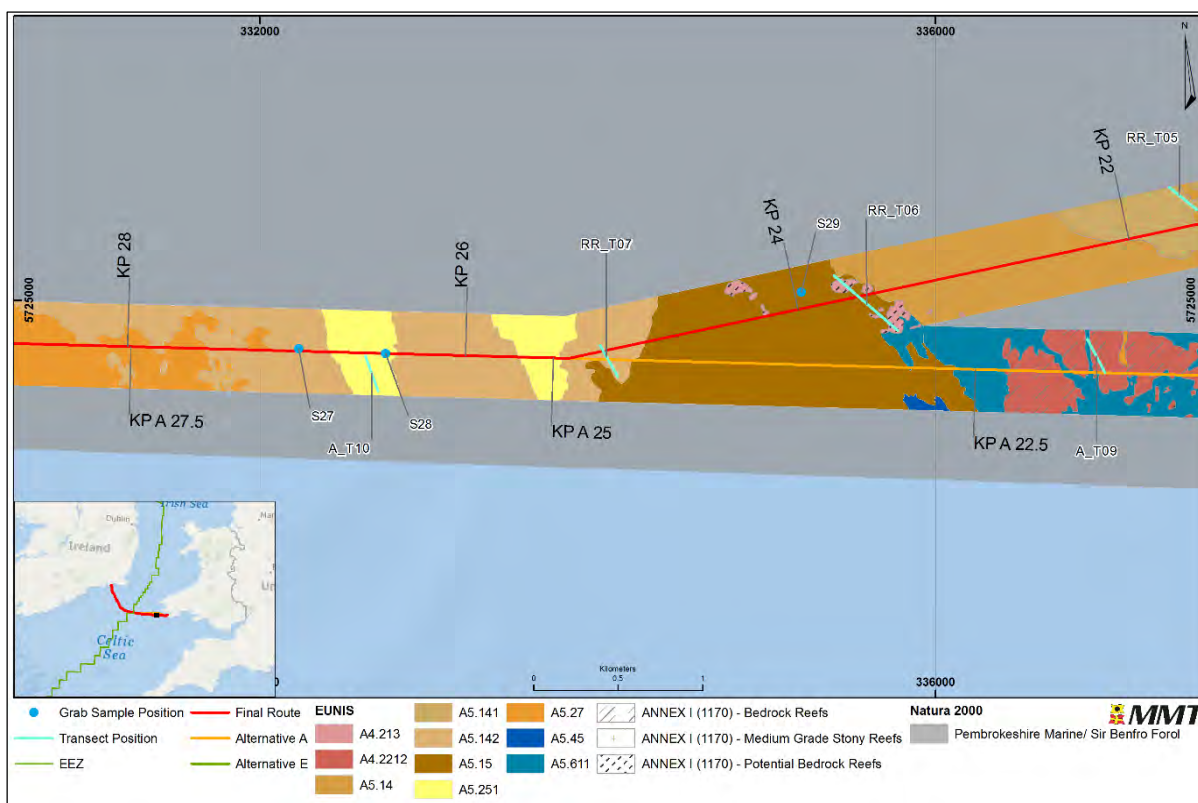


Figure 15 Overview of UK EEZ KP 22 to KP 28.

Transect RR_T06, crossing the final route at approximate KP 23.632, showed low laying and occasionally protruding Old Red Sandstone surrounded by coarse sands, pebbles and gravel. The characterizing epifauna comprised Balanidae, *Urticina sp.*, *Sagartiidae*, *Tubularia sp.* with small cluster of *S. spinulosa*. Sections of RR_T06 where the bedrock was noted were classified as Annex I (1170) – Potential Bedrock Reefs due to the low degree of bedrock visible (Irving, 2009). The surrounding coarse sands were classified as A5.15.

Grab sample site S29, at approximate KP 23.942, was located in A5.15. The infaunal assemblage was characterised by echinoderm *E. pusillus*, polychaetes *Paradoneis lyra* and *Lumbrineris cingulate*, Nemertea and mollusc *Clausinella fasciata*. Small isolated clusters of *S. spinulosa* were present.

From KP 24.925 to KP 27.170 the seabed was predominantly classified as A5.142 - *Mediomastus fragilis*, *Lumbrineris spp.* and venerid bivalves in circalittoral coarse sand or gravel based on the findings at S27 at KP 26.991.

Transect RR_T07, crossing the final route at approximate KP 25.182, showed embedded coarse surface which was heavily silted. The characterizing fauna from the analysed imagery shows small *S. spinulosa* aggregations which are heavily silted and abraded, Balanidae, hydroids and bryozoans, *Tubularia sp.*, *Ophiura albida* and Pectinidae.

Sections of A5.251 - *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand were classified from KP 25.438 to KP 25.684 and from KP 26.408 to KP 26.803.

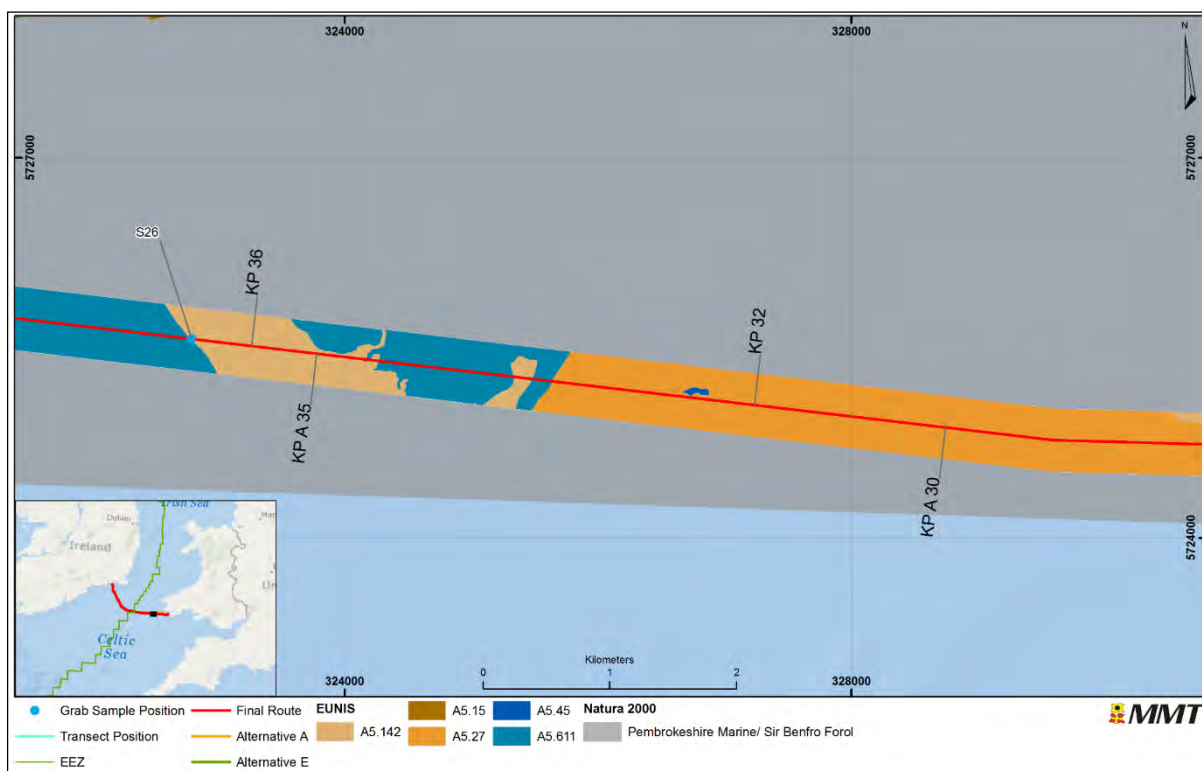


Figure 16 Overview of UK EEZ KP 28 to KP 37.

Grab sample site S28, at approximate KP 26.480, was located within A5.251 and was characterised by echinoderm *E. pusillus*, polychaetes *O. borealis* and *G. lapidum* and mollusc *C. fasciata*.

Transect A_T10, at approximate KP 26.601 and south of S28, was superficially similar to S28 in the analysed imagery. Epifauna was sparse and comprised small *S. spinulosa* presence, echinoderm *Marthasterias glacialis* and Paguridae.

Grab sample site S27, at approximate KP 26.26.989, was located within A5.142 and was characterised gravely coarse sediments with echinoderm *Ophiura albida*, hydrozoa and bryozoans. The infaunal assemblage was characterised echinoderms *E. pusillus* and *Amphipholis squamata*, numerous polychaetes such as *Ampharete lindstroemi*, *Ampharete octocirrata*, *L. cingulate*, a high abundance of the amphipod *Ampelisca spinipes* as well as molluscs *Thracia villosiuscula*, *T. ovata* and *Diplodonta rotundata*. Based on these characteristics the site was assessed to be a close match to A5.142.

From KP 27.170 to KP 28.287 the seabed transitioned between A5.142 and A5.27 - Deep circalittoral sand. From KP 28.287 the habitat A5.27 becomes the dominating habitat throughout the route corridor to KP 33.607. A small section of A5.45 - Deep circalittoral mixed sediments is interpreted to be present between KP 32.367 and KP 32.570. The habitat classified within these sections as A5.27 and A5.45 re based on the interpretations of the geophysical data.

From KP 33.607 to KP 58.587 the route corridor is predominantly classified into large sections as A5.611 - *Sabellaria spinulosa* on stable circalittoral mixed sediment but is interrupted by areas of A5.142, A5.15 - Deep circalittoral coarse sediment, A5.27, and A4.221 - *Sabellaria spinulosa*, didemnid and small ascidians on tide-swept moderately wave exposed circalittoral rock.

From KP 33.607 to KP 35.100, habitat A5.611 dominates the final route. Between KP 35.100 and 36.485, adjacent to the boundary of A5.611, the seabed was classified as A5.142.

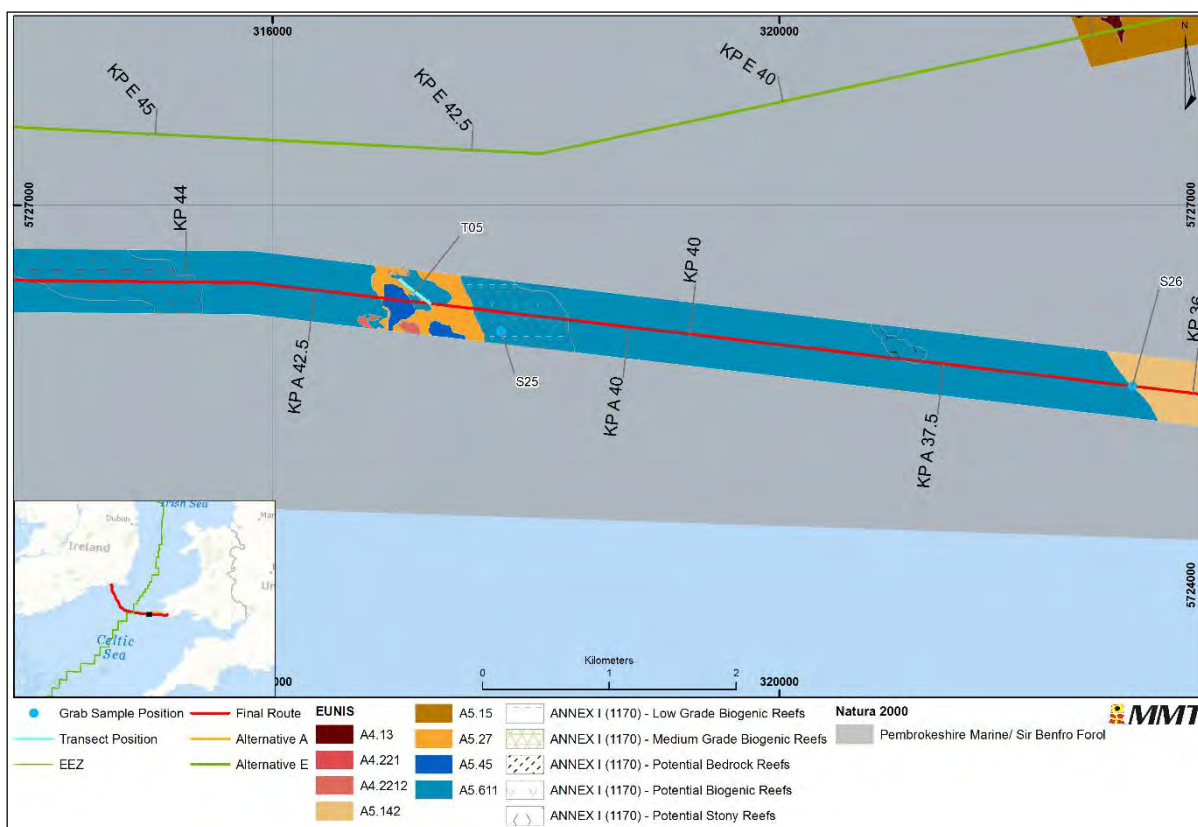


Figure 17 Overview of UK EEZ KP 36 to KP 45.

Grab sample site S26, at approximate KP 36.480, was located within habitat A5.142 (Figure 17). The substrate was composed of rippled coarse sands and gravel with pebbles, shells and *S. spinulosa* crusts in the ripple troughs. Fauna comprised *Lanice conchilegala* tubes, Actiniaria, Hydrozoa and echinoderm *Ophiura albida*. The infaunal assemblage was similar to S27 and characterised by echinoderm *E. pusillus*, and *A. squamata*, numerous polychaetes such as *A. lindstroemi*, *A. octocirrata*, *L. cingulata*, a high abundance of the amphipod *A. spinipes* as well as numerous molluscs *A. alba*, *Hiatella arctica*, *K. Suborbicularis* and *K. Bidentata*. Based on these characteristics the site was assessed to be a close match to A5.142.

From KP 36.485 to KP 41.720 the route corridor is dominated by A5.611. One area of A5.611, crossing the final route between KP 38.150 and KP 38.364 was interpreted as an Annex I (1170) – Potential Stony Reefs (Irving, 2009) due the density of cobbles and boulders interpreted from the geophysical data and its similarity to areas assessed between KP 40.957 and KP 42.634.

Between KP 40.961 and KP 41.721, one section of A5.611 was assessed to meet the criteria of Annex I (1170) – Low Grade Biogenic Reefs (Holt, 1998). Grab sample site S25 was located within this section and the infauna was dominated by *S. spinulosa* and other polychaetes. The analysed imagery showed silted mixed substrates with aggregations of *S. spinulosa* within distinct tube formations.

From KP 41.721 to KP 42.458 the dominating habitat was A5.27 with A5.611 crossing the route between 41.939 and 42.212. Patches of sand covered bedrock was identified crossing the final route between KP 42.066 and KP 42.106 and was classified as A4.2212. Habitat A4.2212 re-occurs north and south of the final route towards the outermost boundaries of the route corridor. A section of A5.45 crossed the final route between KP 42.212 and 42.430.

Transects T05, crossing the final route at approximate KP 42.061, showed rippled sand with high occurrences of *S. spinulosa* aggregation elevated from the surrounding seabed.

Sections of the transects classified as A4.2212 were assessed to meet the criteria of Annex I (1170) – Medium Grade Biogenic Reefs (Holt, 1998). The classification and reef assessment was extrapolated to the rocky areas at the northern most corridor boundary assessed to be of similar nature while the rocky areas at the southernmost corridor boundary indicate more flat bedrock and are possibly not colonised to the same extent thus those areas were assessed to be Annex I (1170) – Potential Biogenic Reefs (Holt et al, 1998).

Between KP 42.458 to KP 48.872 the route corridor was dominated by A5.611. Two areas crossing the final route between KP 43.911 and KP 45.234, and from KP 45.603 to KP 46.596 were assessed to be Annex I (1170) – Potential Biogenic Reefs (Holt, 1998) based on the texture difference seen in the geophysical data between these areas and the surrounding seabed classified as A5.611 and also with regards to the frequent occurrence of *S. spinulosa* at grab sample site S24.

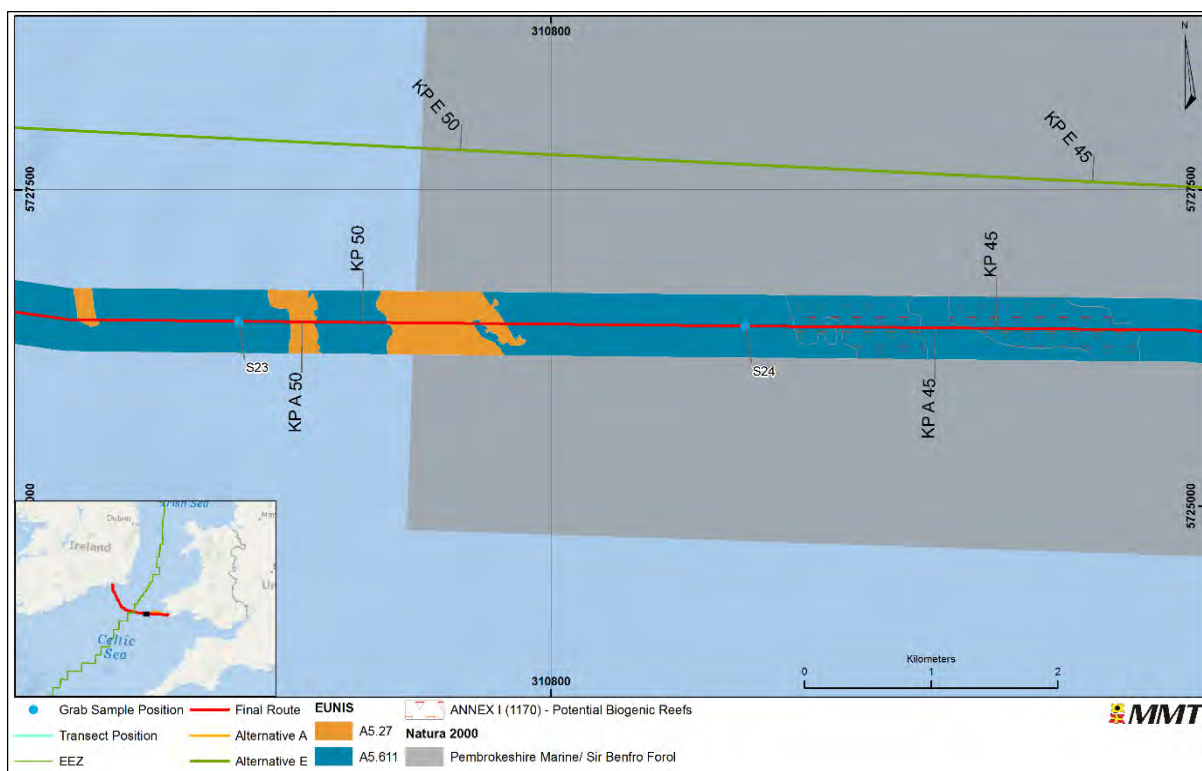


Figure 18 Overview of UK EEZ KP 44 to KP 53.

Grab sample site S24, at approximate KP 46.981, was located within habitat A5.611 (Figure 18). The visibility was poor at the current location and seabed comprised gravelly sand with *S. spinulosa* remnants and occasional cobbles and boulders. The infauna was characterised by an abundance of *S. spinulosa*. Other characterizing species were *A. lindstroemi*, *L. cingulate*, *Ampelisca spinipes*, *K. suborbicularis* and *K. suborbicularis*.

From KP 48.872 to KP 53.469 habitat A5.611 continued to dominate. Based on the geophysical interpretations, three locations (KP 48.872 to KP 49.824, KP 50.390 to KP 50.579, KP 52.098 to KP 52.255) crossing the final route were classified as A5.27.

Grab sample site S23, at approximate KP 50.981, was located within habitat A5.611. The substrate was dominated by coarse sand and gravel. The infauna was in line with the findings of S24 but showed lower abundances of the characterizing species.

Transect T04, crossing the final route at KP 53.305, and transect T04_X, located south of the final route at KP 53.305, were located within habitat A5.611 (Figure 19). The transects cover the same feature interpreted from geophysical data.

The analysed imagery, at T04 and T04_X, showed gravelly sediments with occasional cobbles and boulders. The gravelly sediments comprised *S. spinulosa* in the sediment, *Sabella sp.*, hydrozoans, actinarians and bryozoans and different echinoderms. The cobbles and boulders are dominated by *Tubularia sp.*, hydrozoa and bryozoans and *Caryophyllia smithii*. The boulders within this transects could be classified as A4.111 but could not be delineated from the surrounding seabed in the geophysical data and was of small extent, and was thus not classified as A4.111.

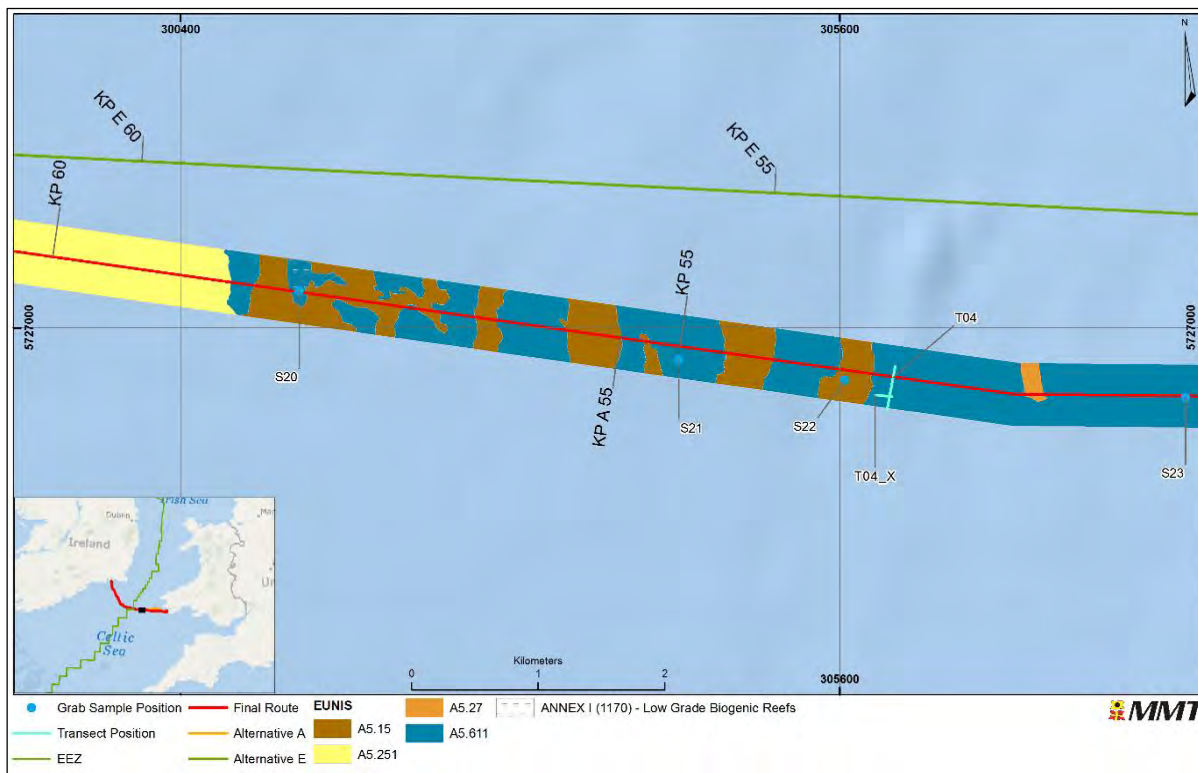


Figure 19 Overview of UK EEZ KP 51 to KP 60.

Between KP 53.469 and KP 58.578 the area alternated between A5.15 and A5.611.

Grab sample site S22, at approximate KP 53.669, was located within habitat A5.15 with coarse sands and the infauna was dominated by echinoderm *Amphiura filiformis*.

Grab sample sites S21, at approximate KP 54.989, and S20, at approximate KP 58.036, were located within habitat A5.611. The substrate was characterised by coarse sands and gravel with *S. spinulosa* clusters in the sediment. The infaunal analysis of these sites showed that *S. spinulosa* occurred frequently at both locations but with a higher density in S20. Other characterizing taxa were echinoderm *A. filiformis*, and polychaetes *Owenia sp.* and *L. cingulate*.

Grab sample site S20 and the surrounding seabed, crossing the final route, from KP 57.984 to KP 58.113 was further assed to meet the criteria of Annex I (1170) – Low Grade Biogenic Reefs (Holt, 1998).

From KP 58.579 to KP 73.906 the seabed was composed of fine rippled sands and classified predominantly as A5.251 (Figure 20). A section between KP 65.660 and KP 70.350 was classified as A5.272 - *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand.



Figure 20 Overview of UK EEZ KP 58 to KP 75.

Grab sample site S19, at approximate KP 61.481, was located within habitat A5.251. The infaunal composition was characterised by echinoderm *E. pusillus*, polychaetes *O. borealis*, *L. cingulate* and Nemertea.

From KP 65.660 to KP 70.350 the seabed was composed of sands with sand waves and large ripples and was classified as A5.272. Grab sample site S18, at approximate KP 66.982, was located within habitat A5.272. The infaunal composition was characterised by echinoderm *A. filiformis*, polychaetes *L. cingulate* and *Owenia* sp. and Nemertea.

Grab sample site S17, at approximate KP 71.485, was located within habitat A5.251. The infaunal composition was characterised by echinoderms *A. filiformis*, *E. pusillus*, polychaetes *O. borealis*, and *L. cingulate*.

5.1.2| ROUTE A

Route A diverges from the final route at approximate KP 8.881 (FR KP 8.680) and converges with the final route at approximate KP 24.905 (FR KP 25.385).

From KP 8.881 to KP 22.327 the seabed is dominated by bedrock across the route corridor with channels of homogenous coarse sands, cobbles and gravel (Figure 12).

From KP 8.885 to KP 9.150 and from KP 9.818 to KP 10.340, two areas with sand and coarse sediment were classified as Annex I (1110) - Sandbanks which are slightly covered by sea water all the time.

Along Route A, from KP 10.340 to KP 11.474, the seabed was classified A5.451 - Polychaete-rich deep Venus community in offshore mixed sediments with habitat A4.213 - *Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock between KP 10.868 and KP 11.245.

From KP 11.245 to KP 13.525 a large section of bedrock was classified as A4.221 - *Sabellaria spinulosa* encrusted circalittoral rock and in parts assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009) (Figure 13).

The bedrock is characterised by channels of A4.213. Several areas of this bedrock are heavily covered by mobile sediments and have thus been classified as Annex I (1170) – Potential Bedrock Reefs (Irving, 2009).

Transect A_T01, crossing Route A at approximate KP 12.038, showed *S. spinulosa* crust on the bedrock with hydrozoans, bryozoans, *Urticina sp.*, and Ascidiacea on the intermediate cobble substrate and was located within habitat A4.221 and further assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009).

From KP 13.525 to KP 14.731 the bedrock was surrounded by habitat A5.141 - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles. The bedrock within this section was classified as A4.241 - *Mytilus edulis* beds with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rock and was further assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009).

Transect A_T02, crossing Route A at approximate KP 13.626, showed an abundance of *Mytilus edulis*, occasional small *S. spinulosa* crusts, *Urticina sp.*, Ascidian *Dendrodoa grossularia*, hydrozoans and bryozoans. Transect A_T02 was located within habitat A4.241 and further assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009).

From KP 14.731 to KP 16.056 the bedrock was classified as a habitat complex of and A4.241. The majority of the bedrock was assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009) with some areas that appear sediment covered which were thus classified as Annex I (1170) – Potential Bedrock Reefs. The channel between the outcropping bedrock was classified as A4.213.

Transects A_T03, crossing Route A at approximate KP 15.082, and A_T04, crossing Route A at approximate KP 15.635, were located within habitat complex A4.213/ A4.241 and assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009). The bedrock was characterised by numerous species with a dense presence of Mytilids, patches of *S. spinulosa* between the Mytilids, crustaceans, Balanidae, hydrozoans, bryozoans, *Pentapora foliacea*, Ascidiacea, Didemnidae and poriferas.

The habitat was assigned as a complex of A4.213 and A4.241 as the individual habitat boundaries could not be delimited from the geophysical data.

Two areas, between KP 16.140 and KP 16.712 within habitat A4.213, based on the epifaunal coverage in the area and the density of boulders and cobbles interpreted from the geophysical data, were also classified as Annex I (1170) – Potential Stony Reefs (Irving, 2009).

From KP 16.786 to KP 18.906, the seabed south of Route A was primarily classified as A4.213 while the seabed north of Route A was primarily classified as A4.21 - Echinoderms and crustose communities on circalittoral rock (Figure 14).

Transects A_T05, crossing Route A at approximate KP 17.500, A_T06, crossing Route A at approximate KP 17.950 and A_T07, crossing Route A at approximate KP 18.583 were located crossing habitats A4.213 and A4.21. Areas of A4.21 within this section was assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009) while areas of A4.213 were in some areas classified as Annex I (1170) – Potential Bedrock Reefs.

The imagery analyses of A_T05 – T07 showed gravelly coarse sediments in the southern sections of the transects with *Urticina sp.* while the northern parts on bedrock were characterised by hydrozoans and bryozoan turf, numerous *Urticina sp.*, Sagartiidae, *Caryophyllia sp.*, *Tubularia sp.*, occasional clusters of *S. spinulosa*, Balanidae, Ascidiacea, *Crossaster papposus* and *Marthasterias glacialis*.

Between KP 18.906 and KP 22.316 was classified as A4.2212 - *Sabellaria spinulosa*, didemnid and small ascidians on tide-swept moderately wave-exposed circalittoral rock and was assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009). Channels of A5.45 – Deep circalittoral mixed sediments were classified on the bedrock with areas of A5.611 - *Sabellaria spinulosa* on stable circalittoral mixed sediment from KP 19.847 to KP 22.627.

Transects A_T08, crossing Route A at approximate KP 19.717, and A_T09, crossing Route A at approximate KP 21.731, were located within habitat A4.2212 and were characterised by dense cluster of *S. spinulosa*, *Alcyonidium diaphanum*, *Cellaria sp.*, *Pentapora foliacea*, Ascidians, *Caryophyllia sp.*, Sagartiidae, *Urticina sp.* and poriferns.

Between KP 22.627 to KP 24.528 the seabed was classified as A5.15 - Deep circalittoral coarse sediment, and from KP 24.528 to 24.905 the seabed was classified as A5.142 - *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel.

5.1.3 | ALTERNATIVE E

Route Alternative E diverges from the final route at approximate KP 13.376 (Final Route KP 13.175) and converges with the final route at approximate KP 69.227 (FR KP 68.598). However, the survey only extended to approximate KP 37.608.

Form KP 13.376 to KP 14.676 the seabed was classified as A5.451 - Polychaete-rich deep Venus community in offshore mixed sediments (Figure 21).

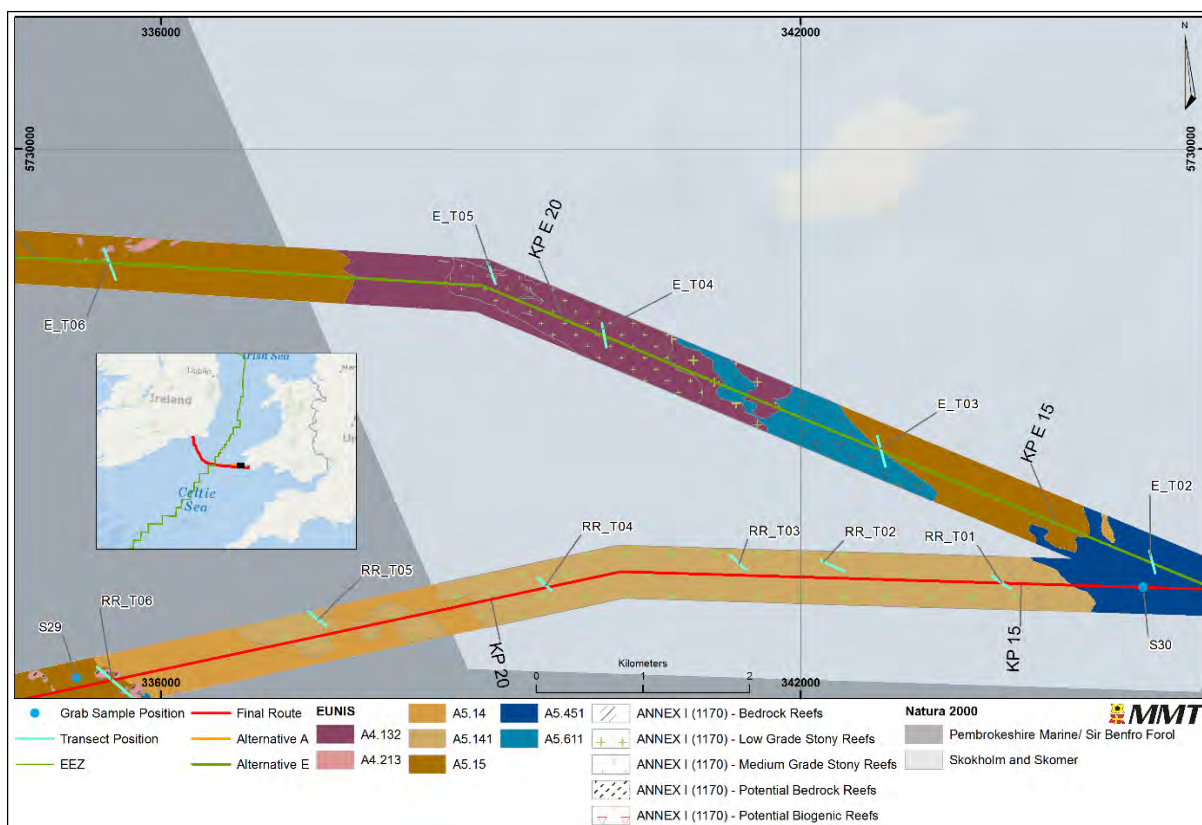


Figure 21 Overview of Alternative E in UK EEZ KP 13 to KP 25.

Transects E_T02, crossing Alternative E at approximate KP 14.017, was located within habitat A5.451. The analysed imagery showed silty gravelly sediment with *Ostrea* and *Mytilid* shells.

From KP 14.676 to KP 16.754 the seabed comprised rippled sands and was classified as A5.15 - Deep circalittoral coarse sediment, becoming coarser between KP 16.754 and KP 18.139 which was classified as A5.611 - *Sabellaria spinulosa* on stable circalittoral mixed sediment.

Transects E_T03, crossing Alternative E at approximate KP 16.769, was located to the north in habitat A5.15 and to the south in habitat A5.611.

The analysed imagery showed homogenous fine shell gravel to the north and *S. spinulosa* cluster south of Alternative E. Habitat A5.611, between KP 16.754 and KP 18.139 was further classified as Annex I (1170) – Potential Biogenic Reefs (Holt et al, 1998).

Areas classified as A4.132 - *Corynactis viridis* and a mixed turf of crisiids, Bugula, Scrupocellaria, and Cellaria on moderately tide-swept exposed circalittoral rock were identified from KP 17.805 to KP 22.015. One section of habitat A4.132, between KP 17.805 and KP 18.924, was further assessed to meet the criteria of Annex I (1170) – Low Grade Stony Reefs while a second section between KP 18.924 and KP 21.167 was assessed to meet the Annex I (1170) – Medium Grade Stony Reefs (Irving, 2009).

Transects E_T04, crossing Alternative E at approximate KP 19.589, and E_T05, at approximate KP 20.762, were located within habitat A4.13 (Stony Reefs). The seabed was characterised by large boulders and cobbles with a hydrozoan and bryozoan turf, *Flustra foliacea*, Galatheidæ, Ascidiacea, abundance of *Corynactis* sp. and Parazoanthidae with poriferans.

From KP 22.015 to KP 26.287 the seabed was classified as A5.15, with patches of outcropping bedrock between KP 24.329 and KP 24.634 classified as A4.213 - *Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock. The bedrock areas were further assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009).

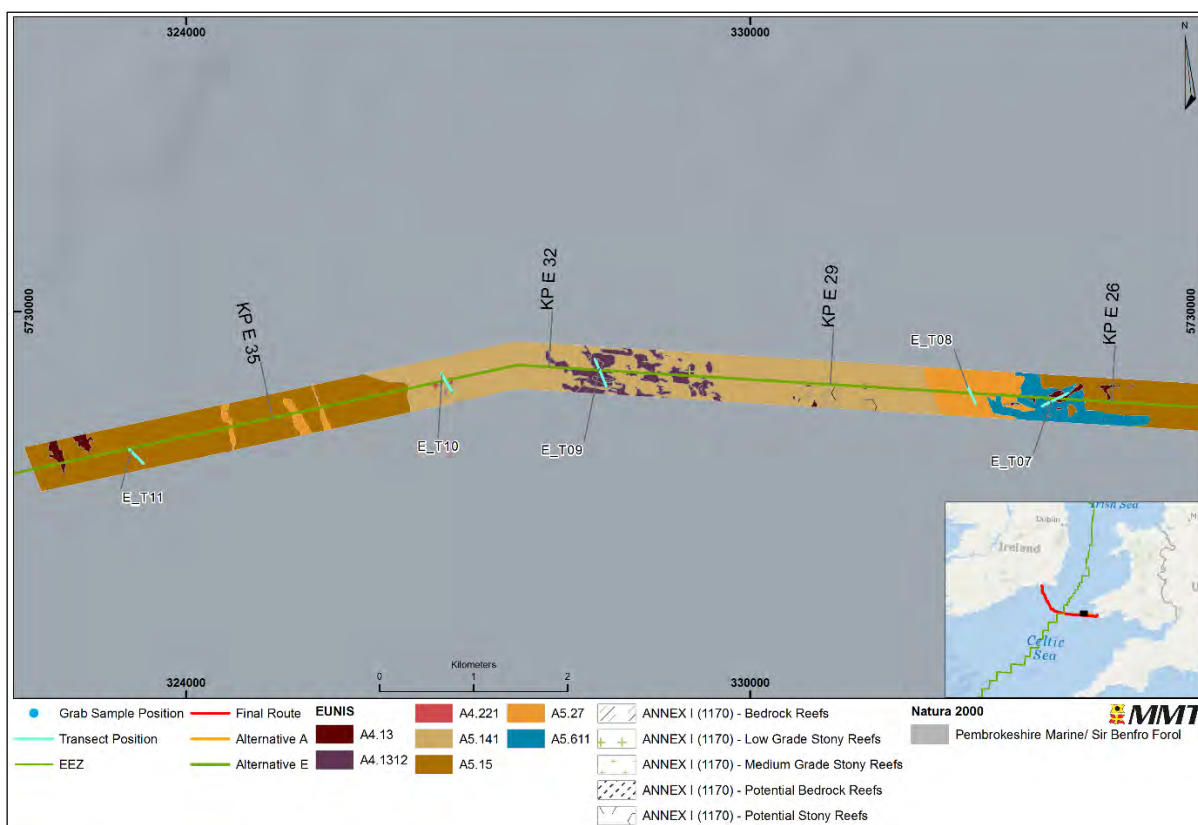


Figure 22 Overview of Alternative E in UK EEZ KP 25 to KP 37.

Transects E_T06, crossing Alternative E at approximate KP 24.322 was located predominantly in habitat A5.15 but crosses areas of A4.213. The rocky areas of the transect were characterised by Ascidiacea, *Tubularia sp.*, *Urticina sp.* with and hydrozoans and bryozoans.

From KP 26.287 to KP 26.987 was classified as A5.611 followed by A5.27 - Deep circalittoral sand between KP 26.987 and KP 27.927. An area of outcropping bedrock, KP 26.475 to KP 26.646 was classified as A4.13 - Mixed faunal turf communities on circalittoral rock and further assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009) (Figure 22).

Transects E_T07, crossing Alternative E at approximate KP 26.594, was located within habitat A4.13. The rocky areas of the transect were characterised by Balanidae, small crusts of *S. spinulosa*, *F. foliacea*, *Urticina sp.*, *Tubularia sp.*, *Mytilus sp.*, hydrozoans and bryozoans as well as poriferans.

Transects E_T08, crossing Alternative E at approximate KP 27.505, was located within habitat A5.27. The seabed was characterised by silty sand with occasional buried cobbles and boulders. Sparse abraded *S. spinulosa* aggregations and *Mytilus sp.* were noted as well as *Urticina sp.* on the rocky substrate.

From KP 26.987 to KP 33.516 the seabed was predominantly classified as A5.141 - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.

Between KP 28.489 and KP 29.312, four areas within habitat A5.141 were classified, based on geophysical interpretations, as Annex I (1170) – Potential Stony Reefs (Irving, 2009). The geophysical data was interpreted to show similar texture and topography as the seabed at transect E_T09. A few scattered outcrops of bedrock, at southern most edge of the corridor boundary at KP 29.236, were classified as A4.13 and Annex I (1170) – Potential Bedrock Reefs (Irving, 2009).

Between KP 30.255 and KP 32.036 the corridor was classified as A4.13 surrounded by A5.141. The rocky areas classified as A4.13 were further assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009).

Transects E_T09, crossing Alternative E at approximate KP 31.457, was located within habitat A4.13 and characterised by a hydrozoan and bryozoan turf with Ascidiacea, *Caryophyllia smithii*, *Corynactis sp.*, Sagartiidae and poriferans.

From KP 33.025 to KP 33.278 rocky areas were identified and classified as A4.221 - *Sabellaria spinulosa* encrusted circalittoral rock which were further assessed to meet the criteria of Annex I (1170) – Low Grade Stony Reefs (Irving, 2009) interrupted by A5.141.

Transect E_T10, crossing Alternative E at approximate KP 33.116, was located within habitats A4.221 and A5.141. The transect was characterised by coarse sediments and bedrock with *S. spinulosa*, Balanidae, Ascidiacea, *Corynactis sp.*, *Urticina sp.* and Sagartiidae.

From KP 33.516 to KP 37.608 the seabed was predominantly classified as A5.15 with intrusions of A5.27 – Deep circalittoral sand.

Transect E_T11, Alternative E at approximate KP 36.561, was located within habitats A5.15 and was characterised by coarse, gravelly mixed sediment with sparse *Tubularia sp.* and Sertularioidea.

An area of outcropping bedrock was identified between KP 36.869 and KP 37.317 and was classified as A4.13 and Annex I (1170) – Potential Bedrock Reefs (Irving, 2009) based in the interpretations of the geophysical data.

5.2 | SEDIMENT PARTICLE SIZE DISTRIBUTION

Samples for sediment particle distribution were acquired along the Final Route only. The full laboratory analyses results are presented in Appendix F].

The results of the particle size analysis show that the sediment at the grab sample sites consisted mainly of coarse sediment. The main component in the sediment was sand, amounting to an average of $69 \pm 22\%$ of the total sediment, together with gravel ($25 \pm 22\%$). However, the proportions of the two varied greatly (Figure 23 and Table 21). The mud content (clay and silt) was low throughout all of the samples ($6 \pm 4\%$).

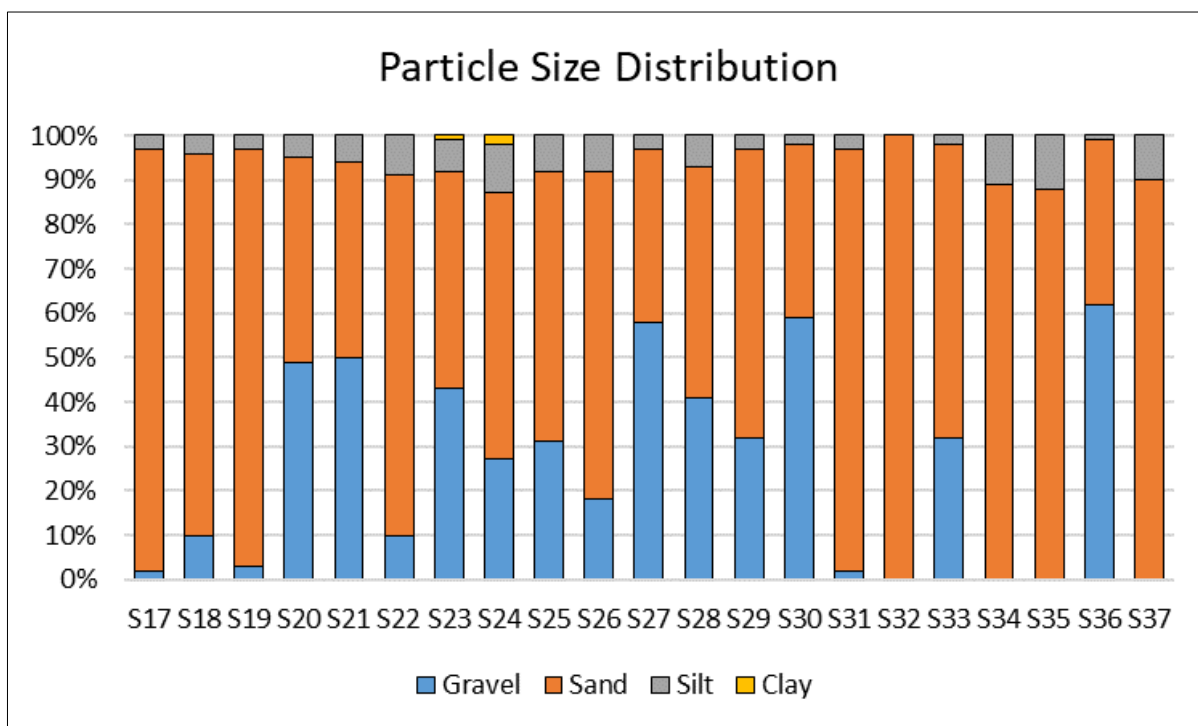


Figure 23 Bar chart displaying sediment fraction distribution across all grab sample sites.

Table 21 Summary of sediment distribution across all grab sample sites in the Wales area.

GRAB SAMPLE ID	AREA	DEPTH	SEDIMENT FRACTION				MUD (CLAY & SILT)	FOLK
			GRAVEL	SAND	SILT	CLAY		
S17	UK	114	2	95	3	0	3	Sand
S18	UK	116	10	86	4	0	4	Gravelly muddy sand
S19	UK	111	3	94	3	0	3	Sand
S20	UK	115	49	46	5	0	5	Sandy gravel
S21	UK	119	50	44	6	0	6	Sandy gravel
S22	UK	127	10	81	9	0	9	Gravelly muddy sand
S23	UK	107	43	49	7	1	8	Gravelly muddy sand
S24	UK	84	27	60	11	2	13	Gravelly muddy sand
S25	UK	67	31	61	8	0	8	Gravelly muddy sand
S26	UK	63	18	74	8	0	8	Gravelly muddy sand

GRAB SAMPLE ID	AREA	DEPTH	SEDIMENT FRACTION				MUD (CLAY & SILT)	FOLK
			GRAVEL	SAND	SILT	CLAY		
S27	UK	58	58	39	3	0	3	Sandy gravel
S28	UK	59	41	52	7	0	7	Gravelly muddy sand
S29	UK	55	32	65	3	0	3	Gravelly sand
S30	UK	49	59	39	2	0	2	Sandy gravel
S31	UK	47	2	95	3	0	3	Sand
S32	UK	31	0	100	0	0	0	Sand
S33	UK	35	32	66	2	0	2	Gravelly sand
S34	UK	31	0	89	11	0	11	Muddy sand
S35	UK	29	0	88	12	0	12	Muddy sand
S36	UK	27	62	37	1	0	1	Sandy gravel
S37	UK	19	0	90	10	0	10	Muddy sand
Mean			25	69	6	0	6	-
SD			22	22	4	0	4	-
Min			0	37	0	0	0	-
Max			62	100	12	2	13	-
Median			27	66	5	0	5	-

5.2.1 | MULTIVARIATE ANALYSES FOR SEDIMENT

Multivariate analyses were undertaken on the PSA data set, to identify spatial patterns in the sediment distribution. Analyses included hierarchical clustering employing the Euclidean distance resemblance matrix and the principal component analysis (PCA). The dataset was normalised prior to analysis being undertaken.

The results from the hierarchical clustering analysis are presented in Figure 24 and Figure 25.

The SIMPROF analysis for the PSD output identified eight groups (black lines) separating the 20 grab sample sites within the survey area. Of these 20 groups, four sub-groups were identified with similar characteristics.

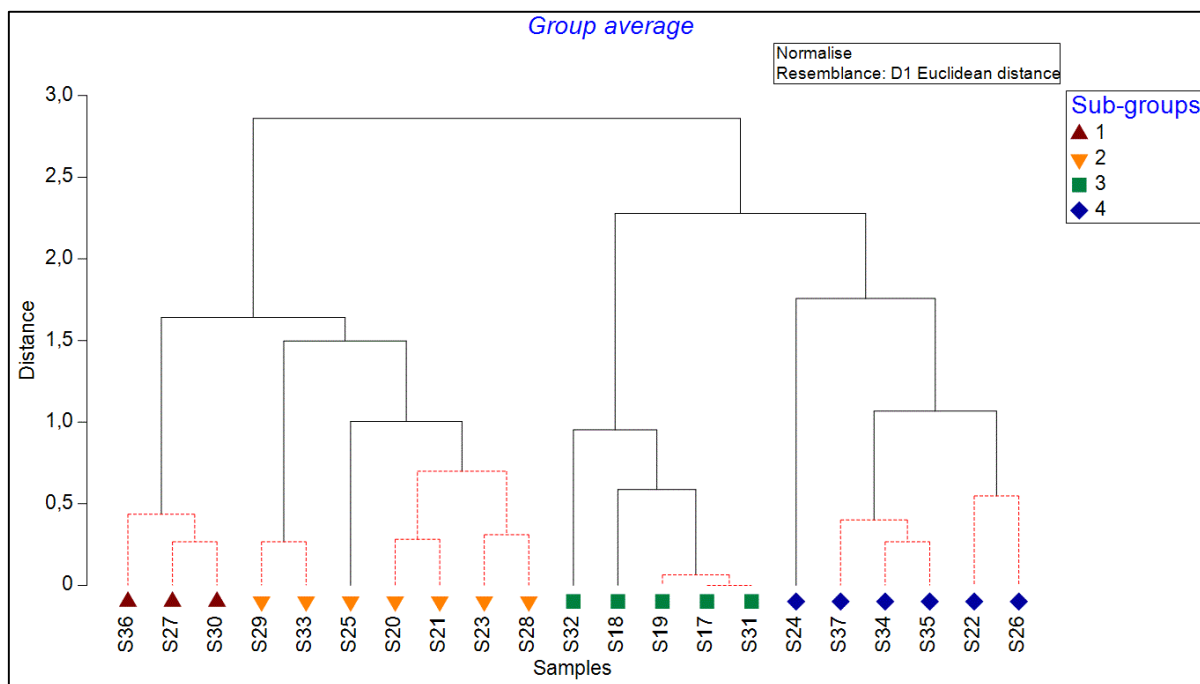


Figure 24 SIMPROF dendrogram based on sediment composition for each grab sample site.

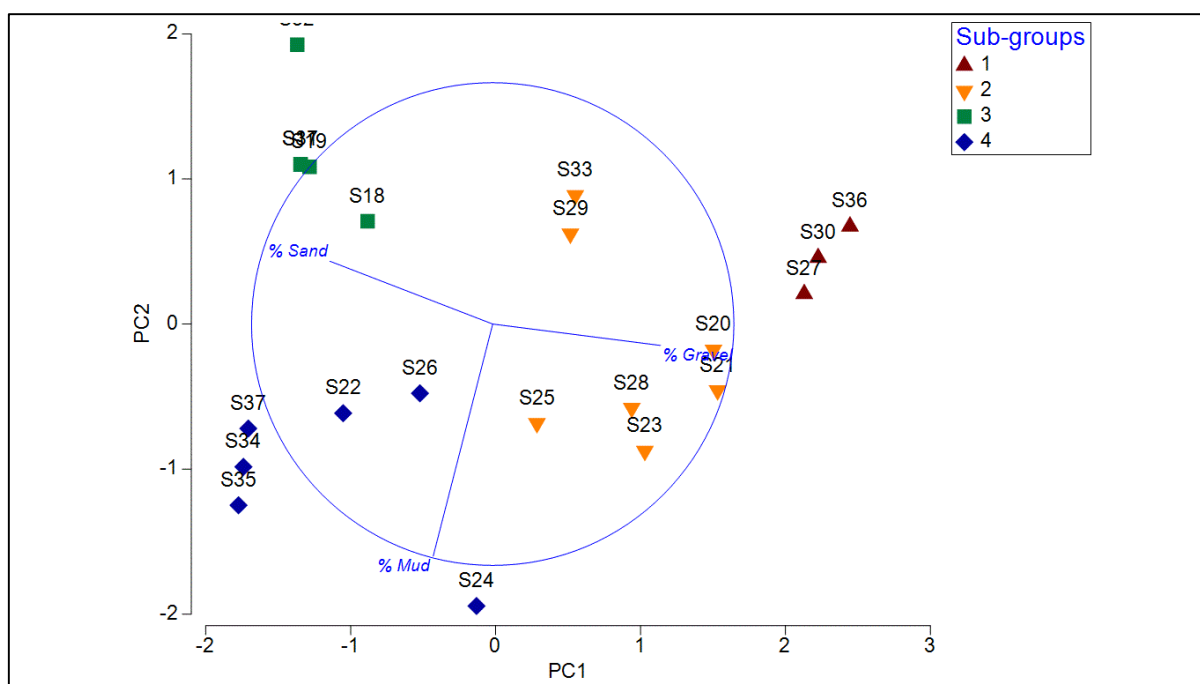


Figure 25 PCA plot of sediment data for each grab sample site, groups based on SIMPROF.

5.3 | CHEMICAL ANALYSES

All grab sample sites were selected for analyses of concentration of metals, organics and PAHs. Detailed results from the chemical analyses are stated in Appendix G]. Grab samples for chemical analyses were not received from site S20, S21, S24, S25, S27, S29, S32 and S36 due to insufficient sample volume.

5.3.1 | METALS

Metal concentrations were low across all grab sample sites and rarely exceeded any threshold values with the exception of Arsenic (As) that exceeded CCME ISQG threshold value for all sites except S17, S35 and S37 (Figure 26 and Table 22).

Table 22 Summary of metal concentrations (µg/g dry weight) in sediment across grab sample sites together with threshold values.

Highlighted cells indicate where threshold values have been exceeded.

ANALYTE	ARSENIC	CADMIUM	CHROMIUM	COPPER	LEAD	MERCURY	NICKEL	TIN
Limit of Detection	1	0.1	0.5	2	2	0.01	0.5	0.5
OSPAR ERL	-	1.2	81	34	47	0.15	-	-
CEFAS AL2	100	5	400	400	500	3	200	-
CEFAS AL1	20	0.4	40	40	50	0.3	20	-
CCME PEL	41.6	4.2	160	108	112	0.7	-	-
CCME ISQG	7.24	0.7	52.3	18.7	30.2	0.13	-	-
Dutch RIVM	85	14	380	240	580	10	210	-
Units	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
S17	6.1	<0.1	15.3	7.5	12.1	<0.01	8.9	0.6
S18	11.6	<0.1	12.6	7	15.1	<0.01	6.5	2.8
S19	9.2	<0.1	21.3	8.6	13.9	<0.01	11.1	1.1
S22	16	<0.1	25.3	8.3	18.4	0.01	16.9	1.2
S23	7.4	<0.1	10.7	5.5	7.3	0.01	6.3	0.7
S26	7.7	<0.1	19.2	15	11.6	0.01	9.9	1.1
S28	9.3	0.1	14.6	7	7.8	<0.01	10	0.6
S30	12.8	0.1	15.8	8.6	7.9	<0.01	15.9	0.8
S31	9.9	<0.1	9.5	7.2	8.5	<0.01	5.7	<0.5
S33	10.9	<0.1	3.2	5.3	9.6	<0.01	5.7	0.7
S34	8.8	<0.1	17.2	9.5	10.9	<0.01	9.1	0.7
S35	6.8	<0.1	15.2	8.1	11.3	0.02	7.1	0.7
S37	6.7	<0.1	21.7	8.4	9.8	0.01	6.5	0.7
Mean	9.5	0.0	15.5	8.2	11.1	0.00	9.2	0.9
SD	2.8	0.0	5.8	2.4	3.2	0.00	3.7	0.6
Min	6.1	0.1	3.2	5.3	7.3	0.01	5.7	0.6
Max	16.0	0.1	25.3	15.0	18.4	0.02	16.9	2.8
Median	9.2	0.1	15.3	8.1	10.9	0.01	8.9	0.7

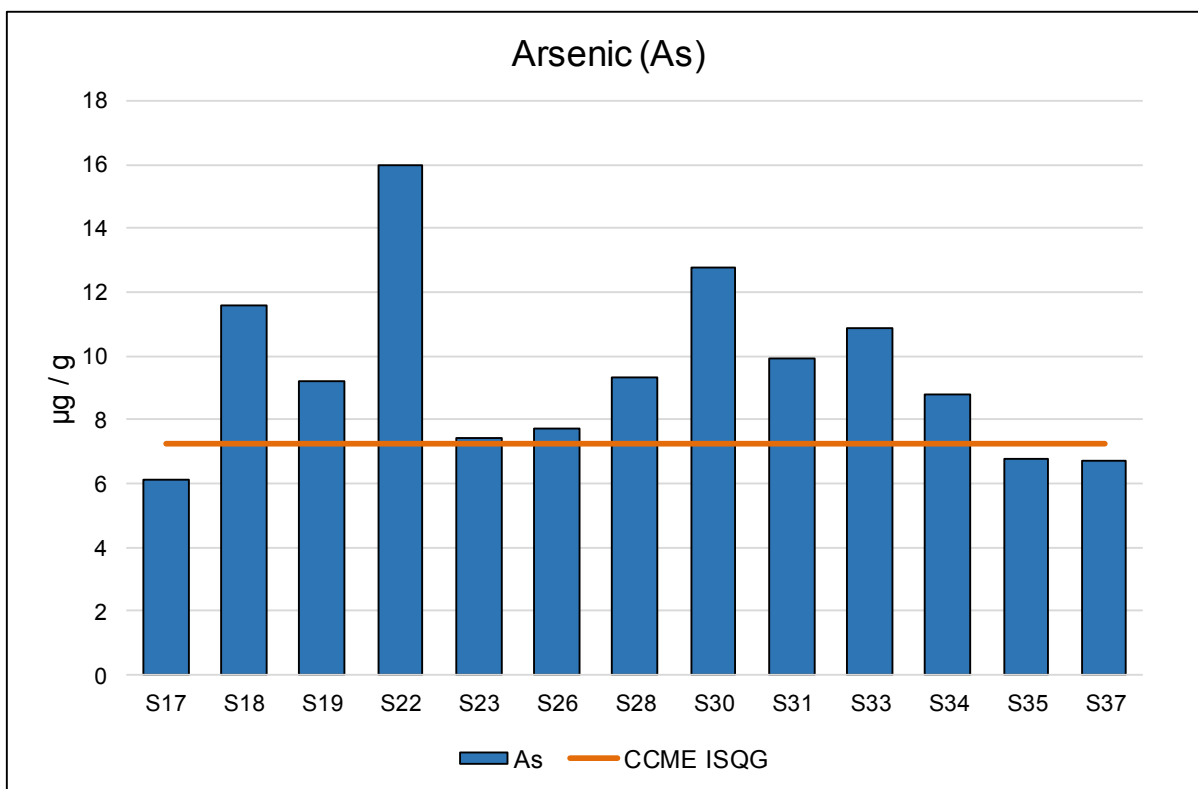


Figure 26 Arsenic (As) concentrations ($\mu\text{g/g}$ dry weight) in sediment across grab sample sites together with threshold values for CCME ISQG.

5.3.2 | ORGANICS AND MOISTURE

Concentrations of organics and moisture content showed moderate variation between grab sample sites (Table 23).

Table 23 Summary of organics and moisture concentrations in sediment across grab sample sites.

ANALYTE	TOC	LOI	MOISTURE
Limits of detection	0.02	0.2	0.2
Units	%	%	%
S17	0.14	1.4	26.0
S18	0.24	1.7	29.4
S19	0.17	1.9	29.0
S22	0.30	2.3	29.8
S23	0.34	2.3	24.2
S26	0.32	1.5	24.0
S28	0.10	0.8	21.8
S30	0.17	1.4	24.2
S31	0.20	1.0	26.7
S33	0.38	1.9	16.0
S34	0.18	1.0	27.9
S35	0.21	1.0	28.0
S37	0.24	1.1	23.6
Mean	0.23	1.5	25.4
SD	0.08	0.5	3.6
Min	0.10	0.8	16.0
Max	0.38	2.3	29.8
Median	0.21	1.4	26.0

5.3.3 | PAH

Concentrations of PAH's varied greatly between grab samples sites (Table 24). Grab sample sites S22, S23 and S37 had markedly higher concentrations of PAH's, whereas grab sample sites S28 had markedly low concentrations. Threshold values were exceeded at grab sample site S33 for naphthalene (36.1 µg/Kg) for CCME ISQG (34.6 µg/Kg).

Table 24 Summary of PAH concentrations ($\mu\text{g/Kg}$ dry weight) across grab sample sites.
Highlighted cells indicate where threshold values have been exceeded.

ANALYTE	NAPHTHALENE	ACENAPHTHYLENE	ACENAPHTHENE	FLUORENE	PHENANTHRENE	DIBENZOTHIOPHENE	ANTHRACENE	FLUORANTHENE	PYRENE	BENZO[A]ANTHRACENE	CHRYSENE	BENZO[B]FLUORANTHENE	BENZO[K]FLUORANTHENE	BENZO[E]PYRENE	BENZO[A]PYRENE	INDENO[123,CD]PYRENE	DIBENZO[A,H]ANTHRACENE	BENZO[GH]PERYLENE	SUM OF ALL
LIMIT OF DETECTION	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
OSPAR ERL	160	-	-	-	240	190	85	600	665	-	384	-	-	-	430	240	-	85	-
CEFAS AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-
CCME PEL	391	128	88.9	144	544	-	245	1494	1398	693	846	-	-	-	763	-	135	-	-
CCME ISQG	34.6	5.87	6.71	21.2	86.7	-	46.9	113	153	74.8	108	-	-	-	88.8	-	6.22	-	-
UNITS	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$	$\mu\text{g/Kg}$
S17	3.64	<1	<1	1.89	5.40	<1	<1	6.47	4.50	2.74	4.70	5.77	3.33	4.50	3.30	5.19	1.04	5.16	57.63
S18	2.50	<1	<1	1.11	3.41	<1	<1	3.84	2.78	1.54	2.91	3.65	1.82	2.69	2.01	3.28	<1	2.95	34.49
S19	1.11	<1	<1	<1	1.68	<1	<1	1.86	1.37	<1	1.47	1.68	<1	1.39	<1	1.25	<1	1.47	13.28
S22	5.13	<1	1.28	2.82	10.90	1.33	2.32	15.1	11.40	6.84	10.50	10.10	4.06	7.56	7.34	7.77	1.62	7.81	113.88
S23	9.20	1.20	1.43	4.54	14.30	2.08	3.20	20.2	14.4	10.30	16.0	15.40	9.54	12.80	10.70	13.60	2.96	13.00	174.85
S26	6.45	<1	1.27	2.93	10.4	1.44	2.01	11.6	9.11	5.35	8.69	9.71	3.30	7.40	5.73	6.95	1.57	6.58	100.46
S28	<1	<1	<1	<1	<1	<1	<1	1.07	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.07
S30	1.98	<1	<1	<1	2.43	<1	<1	2.12	1.54	<1	2.09	1.84	1.08	1.45	<1	1.38	<1	1.61	17.52

ANALYTE	NAPHTHALENE	ACENAPHTHYLENE	ACENAPHTHENE	FLUORENE	PHENANTHRENE	DIBENZOTHIOPHENE	ANTHRACENE	FLUORANTHENE	PYRENE	BENZO[A]ANTHRACENE	CHRYSENE	BENZO[B]FLUORANTHENE	BENZO[K]FLUORANTHENE	BENZO[E]PYRENE	BENZO[A]PYRENE	INDENO[123,CD]PYRENE	DIBENZO[A,H]ANTHRACENE	BENZO[GH]PERYLENE	SUM OF ALL
LIMIT OF DETECTION	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
OSPAR ERL	160	-	-	-	240	190	85	600	665	-	384	-	-	-	430	240	-	85	-
CEFAS AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-
CCME PEL	391	128	88.9	144	544	-	245	1494	1398	693	846	-	-	-	763	-	135	-	-
CCME ISQG	34.6	5.87	6.71	21.2	86.7	-	46.9	113	153	74.8	108	-	-	-	88.8	-	6.22	-	-
UNITS	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
S31	2.36	<1	<1	<1	2.67	<1	<1	2.38	2.05	1.22	2.11	2.34	1.18	1.70	1.30	1.67	<1	1.62	22.59
S33	36.1	<1	2.31	3.42	16.1	2.75	<1	1.95	1.73	1.22	3.77	2.21	<1	1.70	<1	1.08	<1	1.28	75.63
S34	1.07	<1	<1	<1	1.32	<1	<1	1.44	1.04	<1	1.38	1.53	1.00	1.42	1.08	1.42	<1	1.38	14.06
S35	1.38	<1	<1	<1	1.92	<1	<1	1.77	1.24	<1	1.64	1.99	1.31	1.53	<1	1.51	<1	1.48	15.77
S37	1.31	<1	4.44	3.78	14.1	1.29	2.11	20.8	13.9	9.55	14.4	13.8	5.65	9.73	10.4	7.87	2.07	7.36	142.58
Mean	5.56	0.09	0.82	1.58	6.51	0.68	0.74	6.96	5.00	2.98	5.36	5.39	2.48	4.14	3.22	4.07	0.71	3.98	60.29
SD	9.80	-	1.35	1.15	5.68	0.63	0.54	7.37	5.24	3.74	5.27	5.09	2.70	3.93	3.93	3.95	0.72	3.73	56.55
Min	1.07	1.20	1.27	1.11	1.32	1.29	2.01	1.07	1.04	1.22	1.38	1.53	1.00	1.39	1.08	1.08	1.04	1.28	1.07
Max	36.12	1.20	4.44	4.54	16.08	2.75	3.20	20.76	14.40	10.30	16.00	15.40	9.54	12.80	10.70	13.60	2.96	13.00	174.85
Median	2.43	1.20	1.43	2.93	4.41	1.44	2.21	2.38	2.41	4.04	3.34	3.00	2.56	2.19	4.52	2.47	1.62	2.28	34.49

5.4| **MULTIVARIATE ANALYSIS OF GRAB SAMPLES**

Multivariate analysis was undertaken using the Plymouth Routines in PRIMER v7.0 statistical package (Clarke K. &, 2015). The statistical analyses are based on macrofaunal data derived from the taxonomic analysis of the grab samples at each location. All grab samples were located along the Final Route.

The SIMPROF analysis on faunal composition produced ten statistically distinct groups (black lines). Of these ten groups, three sub-groups were identified (Figure 27, Figure 28 and Table 25).

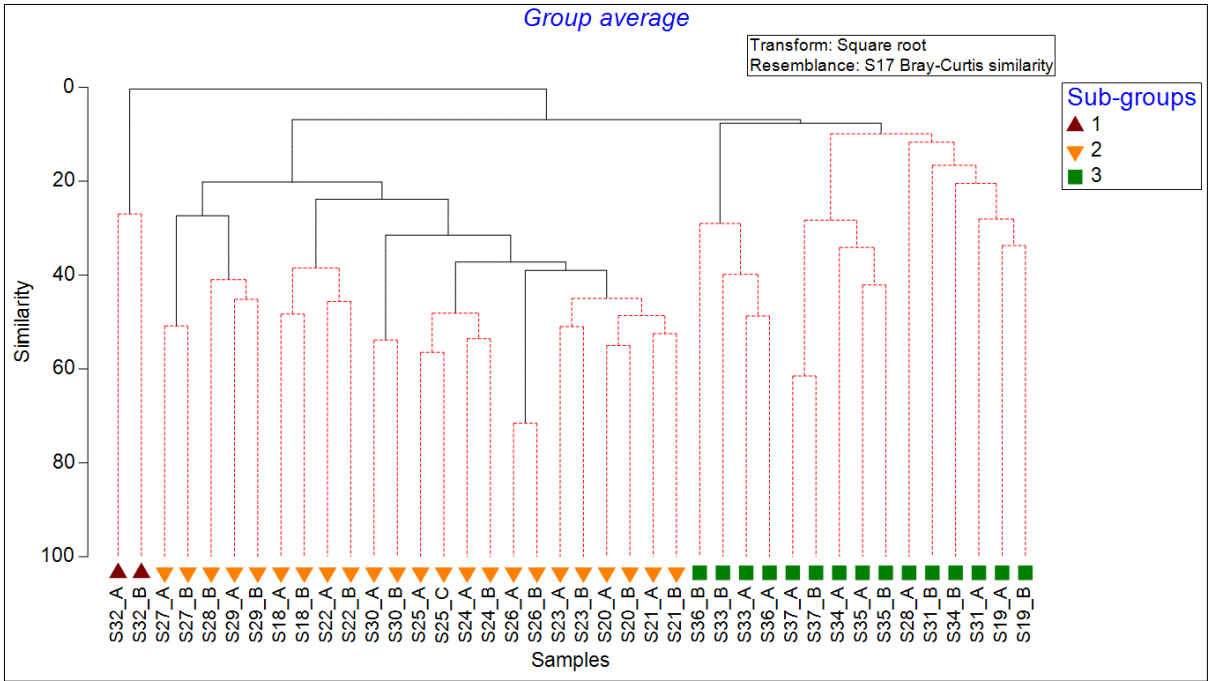


Figure 27 SIMPROF dendrogram based on faunal composition for each grab sample site and replicate.

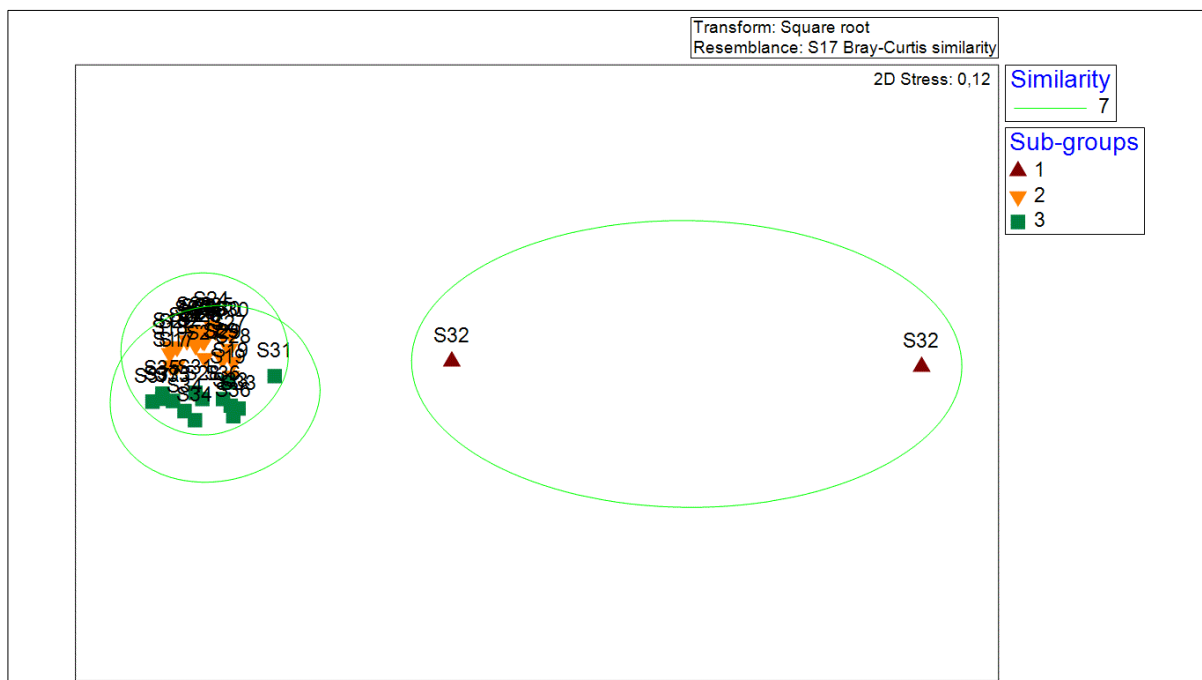


Figure 28 nMDS plot on faunal composition for each grab sample site and replicate, groups based on SIMPROF.

Group 1 consisted of both replicates from site S32 (S32_A, S32_B) and group 2 consisted of the majority of grab sample sites and group 3 was the group with the second most samples. There was no significant intra-variability within the replicates in the samples, except in sample S19 and S38, where one replicate (S19_A and S28_B) grouped into Group 2 and the other (S19_B and S28_A) grouped into Group 3. The highest average similarity was found in group 2 (26.32 %) and the lowest in group 3 (14.01 %). This low similarity within groups suggest a difference in faunal composition within the groups. Grab site S32 showed a big difference from the rest of the samples. This site was the only one with 100 % sand in the PSD, with a low diversity relative to the rest of the samples.

Table 25 Characteristics of groups identified by SIMPROF analysis on abundance of non-colonial fauna.

GROUP	SAMPLES	PHYSICAL FEATURES	SPECIES	AVERAGE ABUNDANCE	CONTRIBUTION (%)
1	S32 (A&B)	Depth:31 m Sediment: Sand	<i>Gastrosaccus spinifer</i>	1	100
2	S17 (A&B) S18 (A&B) S19_A S20 (A&B) S21 (A&B) S22 (A&B) S23 (A&B) S24 (A&B) S25 (A&C) S26 (A&B) S27 (A&B) S28_B S29 (A&B)	Depth: 49 – 127 m Sediment: Gravelly muddy sand, Sandy gravel, Gravelly sand	<i>Echinocyamus pusillus</i> <i>Amphiura filiformis</i> <i>Lumbrineris cingulata</i> <i>Sabellaria spinulosa</i> <i>Nemertea</i> <i>Aspidosiphon muelleri</i> <i>Galathowenia oculata</i> <i>Modiolula phaseolina</i> <i>Ampharete lindstroemi</i> <i>Owenia sp.</i> <i>Ampelisca spinipes</i> <i>Kurtiella bidentata</i> <i>Glycera lapidum</i>	10.2 14.0 5.3 39.2 3.4 3.9 11.3 6.8 6.5 1.4 4.2 3.7 1.3	8.8 7.22 6.57 6.11 3.51 3.27 3.17 3.04 2.62 2.47 2.4 2.23 2

GROUP	SAMPLES	PHYSICAL FEATURES	SPECIES	AVERAGE ABUNDANCE	CONTRIBUTION (%)
	S30 (A&B)				
3		Depth: 19 – 111 m		1.4	25.19
				1.0	11.95
	S19_B		Nematoda	6.4	9.55
	S28_A			1.1	6.32
	S31 (A&B)	Sediment:	<i>Timoclea ovata</i>	0.7	5.81
	S33 (A&B)	Muddy sand,	<i>Abra alba</i>	0.4	5.15
	S34 (A&B)	Sand,	<i>Ophelia borealis</i>	0.6	4.44
	S35 (A&B)	Gravelly	<i>Abra prismatica</i>	0.7	4.19
	S36 (A&B)	muddy sand,	Nemertea		
	S37 (A&B)	Sandy	<i>Glycera lapidum</i>		
Average Similarity: 14.01 %		Gravelly sand	<i>Bathyporeia elegans</i>		

The resulting EUNIS habitat classification for each site is presented in Figure 29. Sub-group 1, with grab sample site S32, was classified as A5.25. Sub-group 2, that contained most of the samples, included six different classifications (A5.142, A5.15, A5.251, A5.252, A5.451 and A5.611). Sub-group 3 contained five classifications (A5.143, A5.261, A5.25 A5.251 and A5.252). The different habitats do not have a strong relation to the identified sub-groups. EUNIS habitat classification A5.611 and A5.143 were the only two habitats (of those habitats that were found in more than one grab sample site) that were grouped in the same sub-group by the SIMPROF analysis.

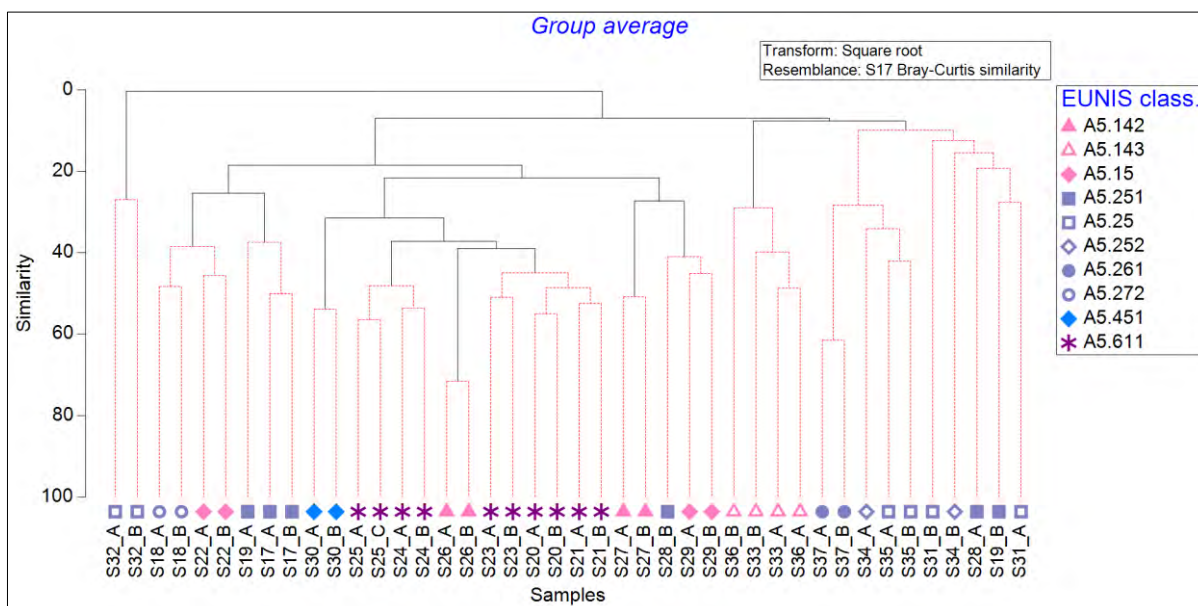


Figure 29 SIMPROF dendrogram based on faunal composition with EUNIS habitat classification overlay for each grab sample site and replicate.

5.5 | POTENTIAL AREAS AND SPECIES OF CONSERVATION

The habitats in the UK EEZ corresponding to those defined in the EC Habitats directive (EUR 27, 2007) are listed in separate sections for each route alternative.

Figures displaying detailed overview of the potential areas of conservation concern is displayed in Figure 30 to Figure 37.

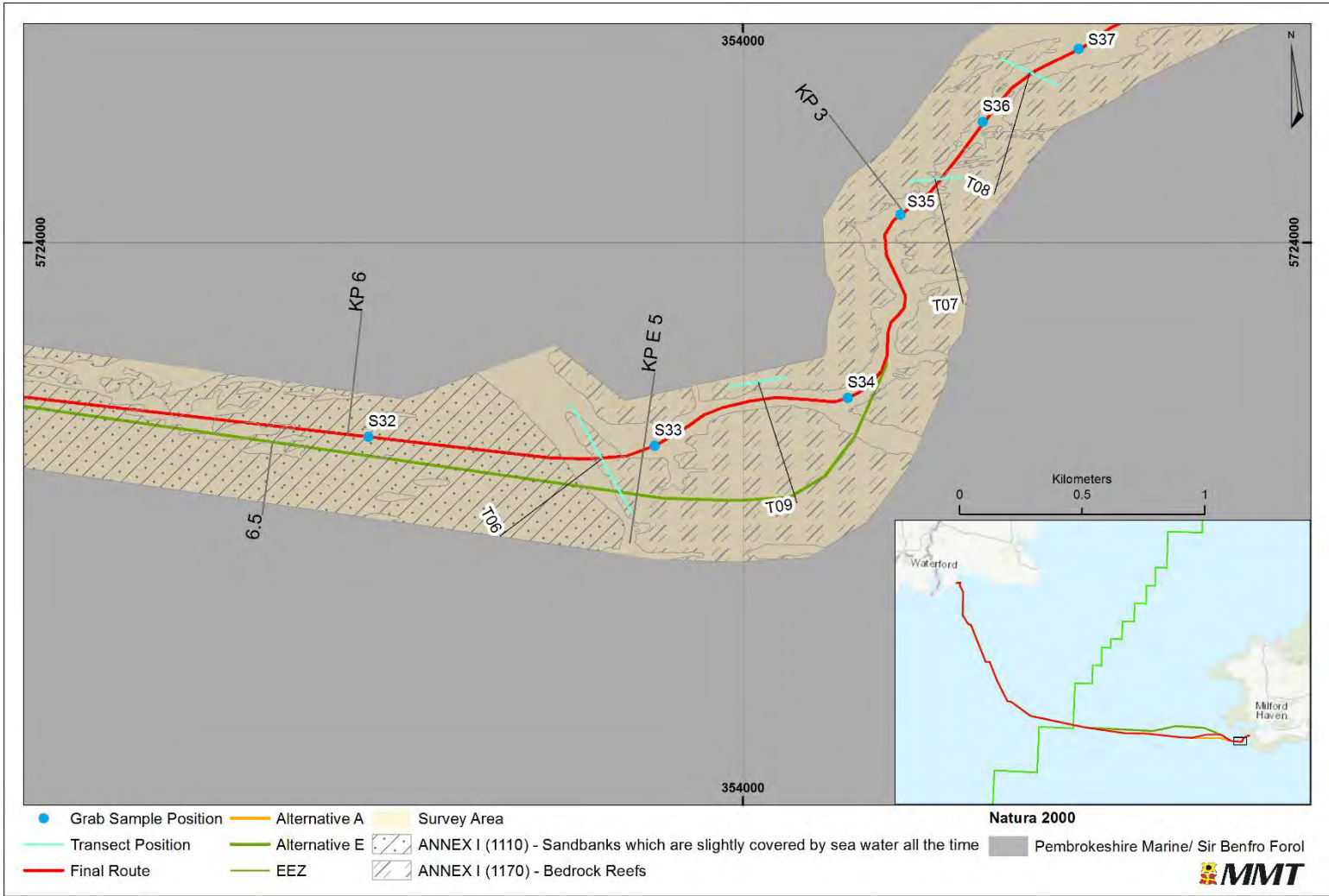


Figure 30 Overview of Annex I areas in UK EEZ between KP 1 and KP 7.5.

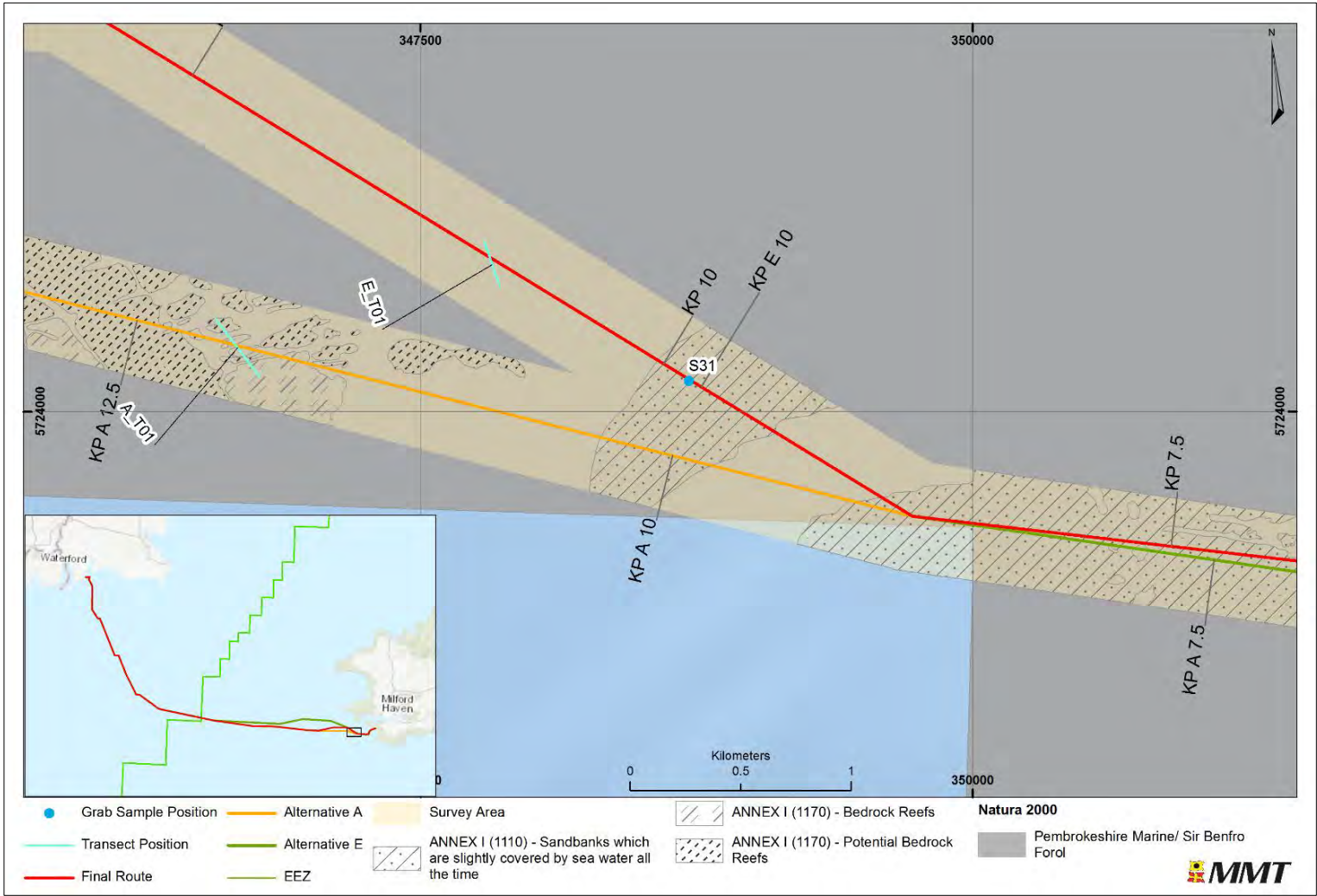
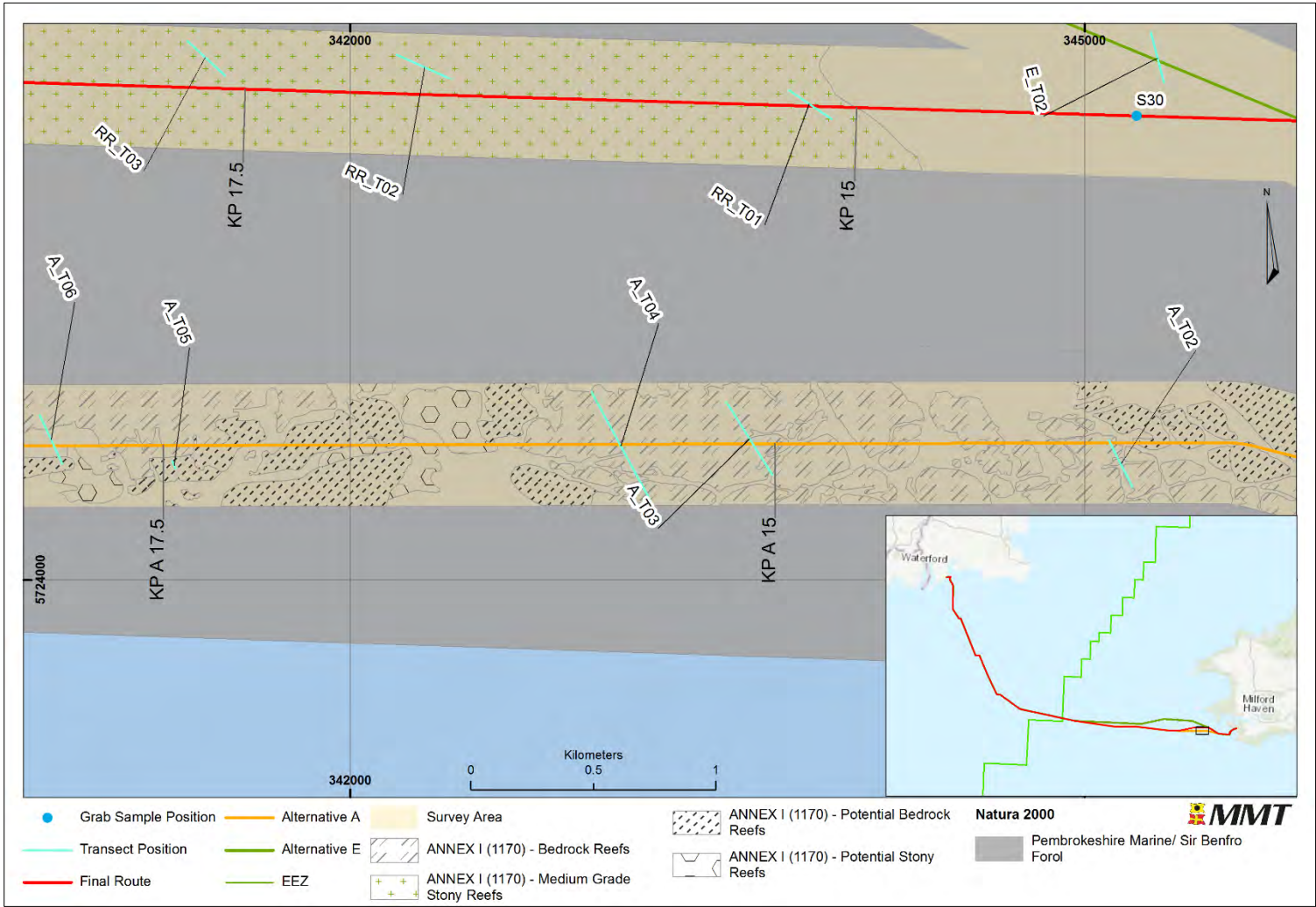


Figure 31 Overview of Annex I areas in UK EEZ between KP 7 and KP 13.



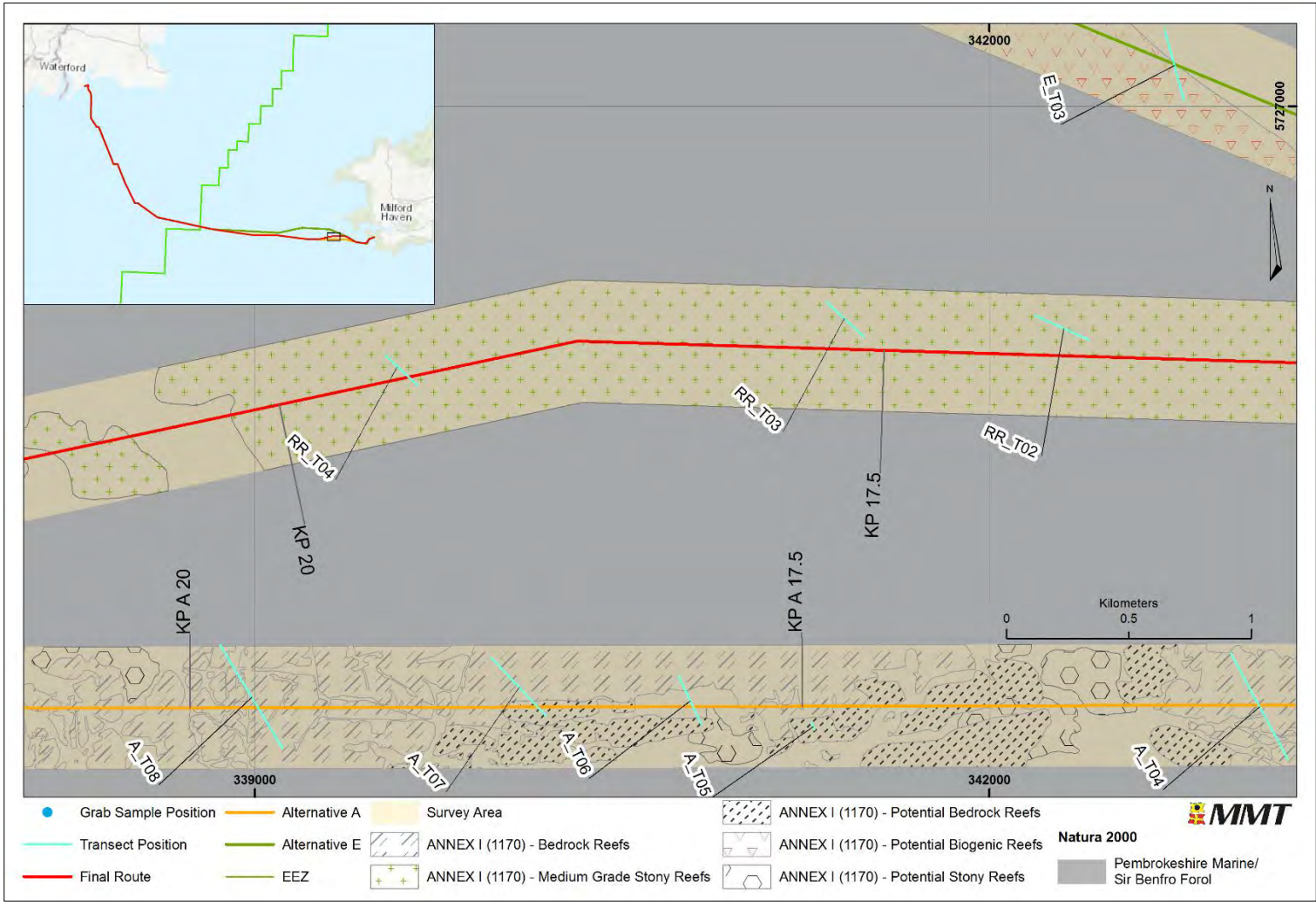


Figure 33 Overview of Annex I areas in UK EEZ between KP 16 and KP 21.

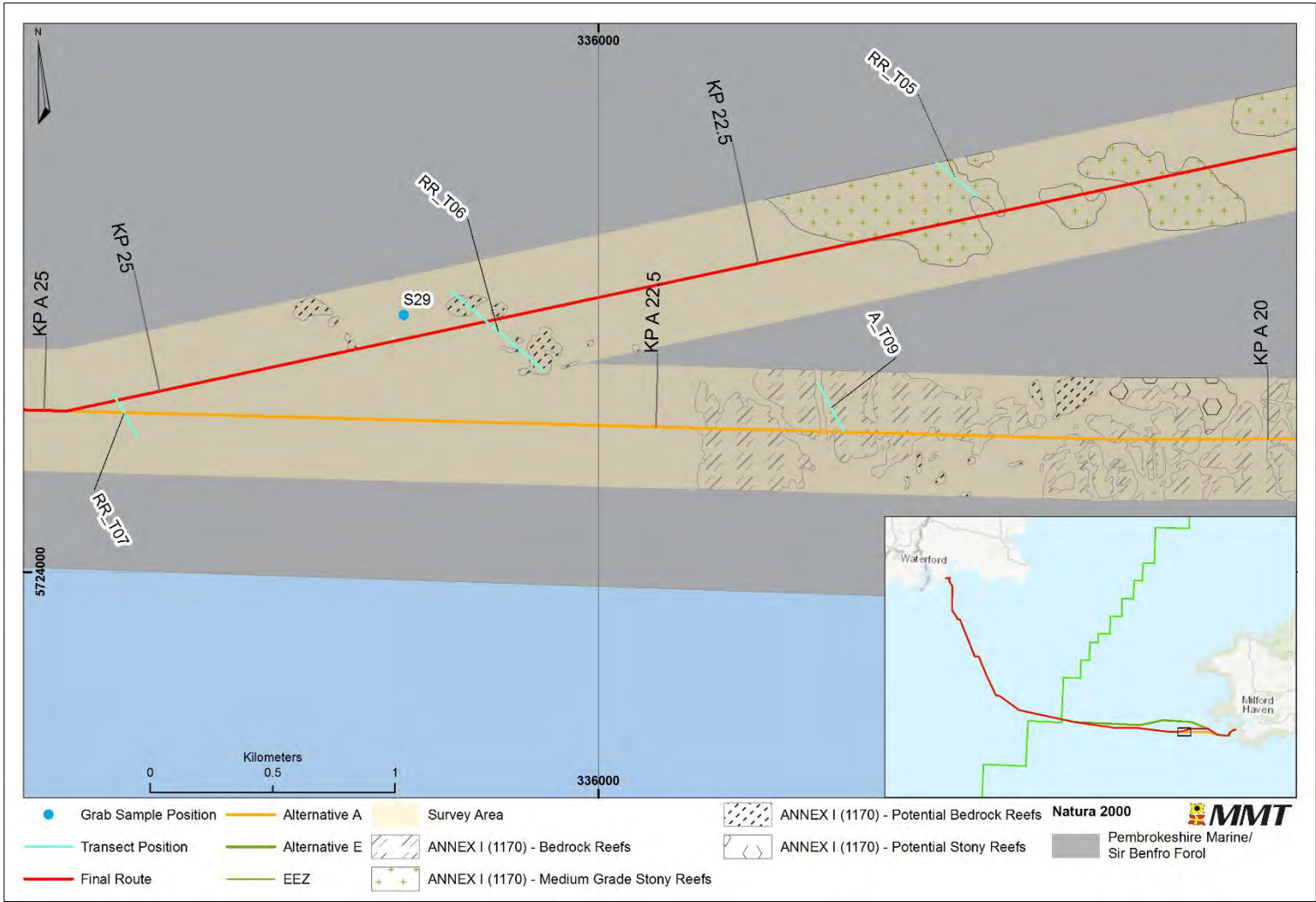


Figure 34 Overview of Annex I areas in UK EEZ between KP 20 and KP 25.

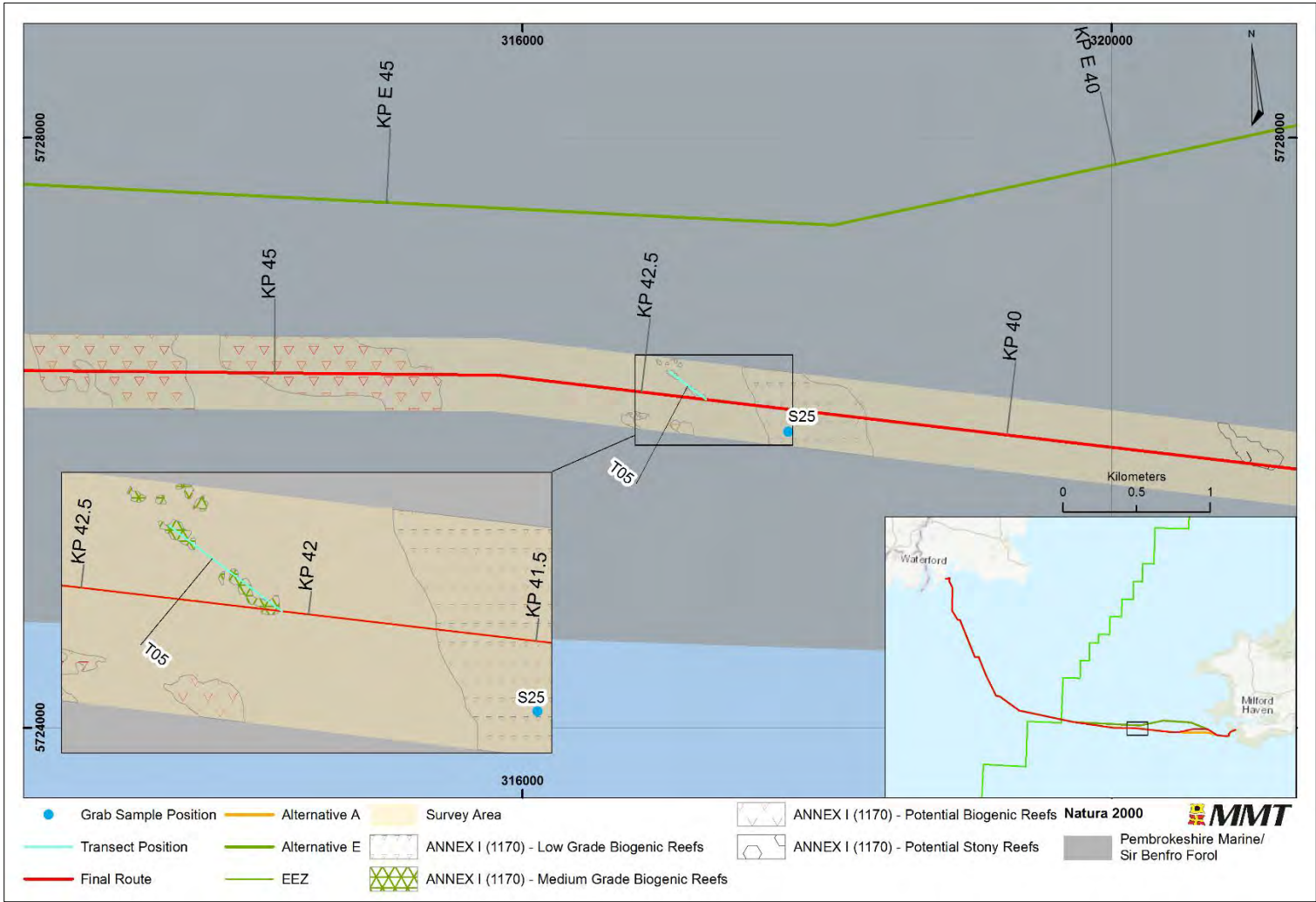


Figure 35 Overview of Annex I areas in UK EEZ route Route A between KP 38 and KP 47.

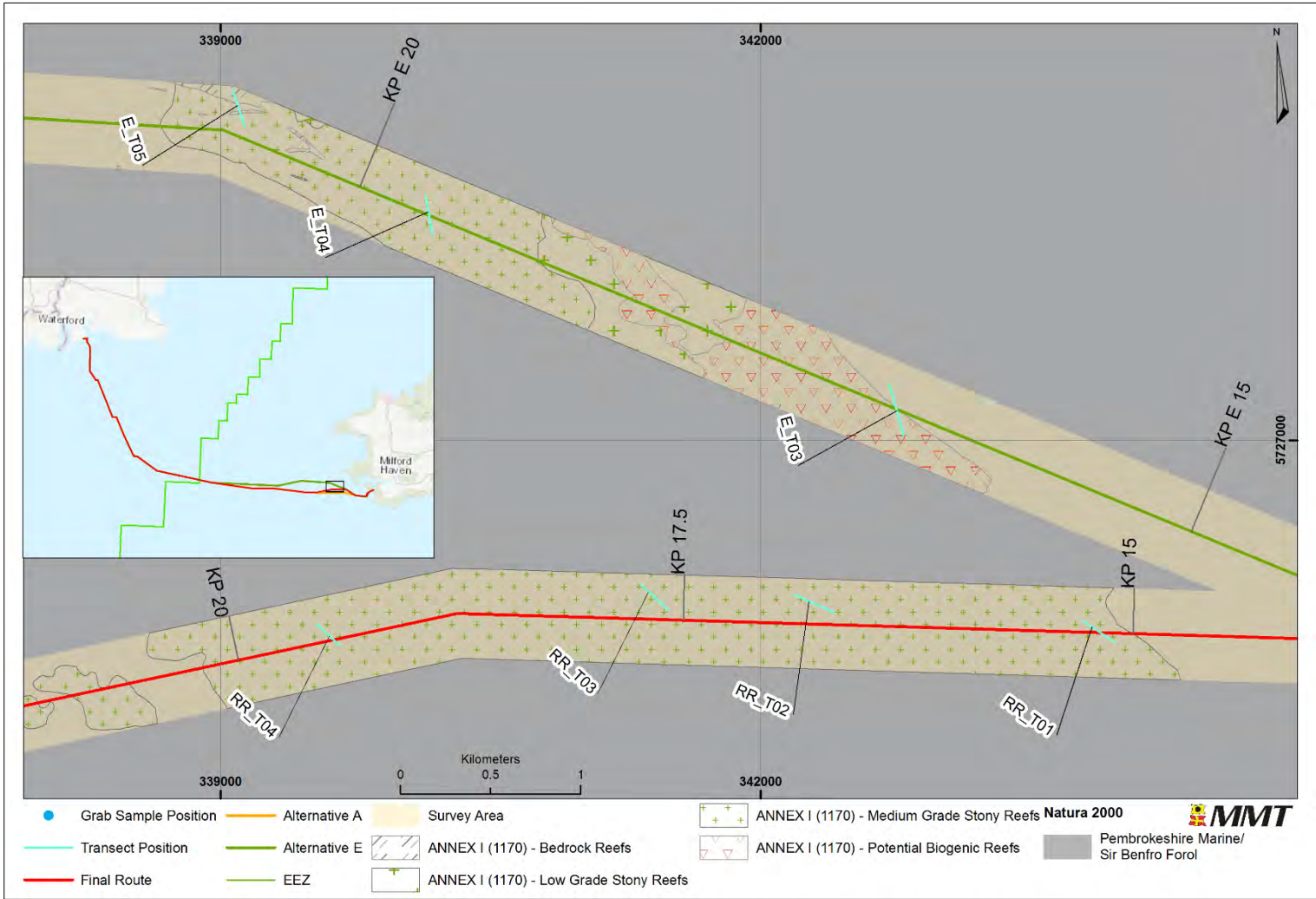


Figure 36 Overview of Annex I areas in UK EEZ route Alternative E between KP 15 and KP 22.

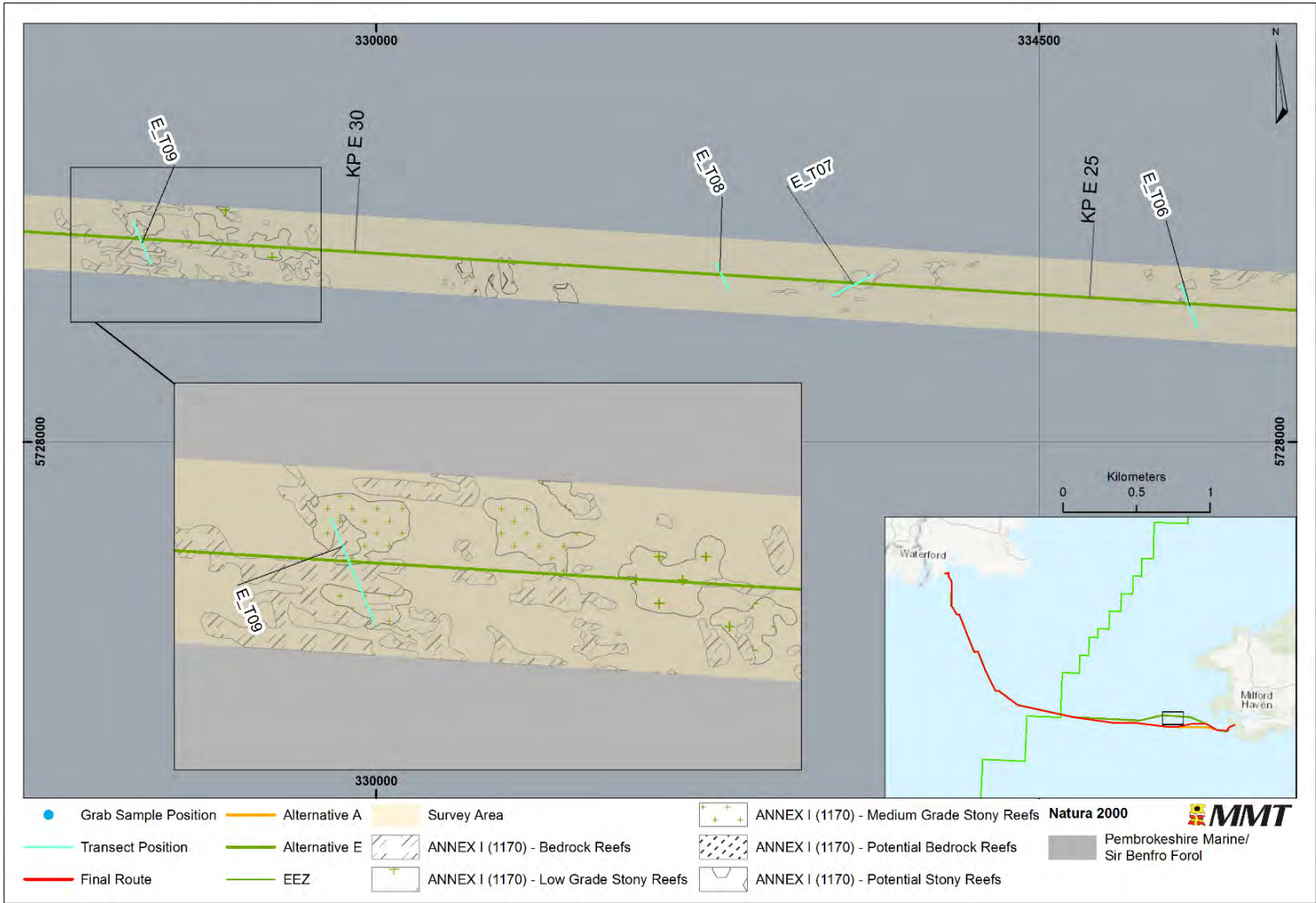
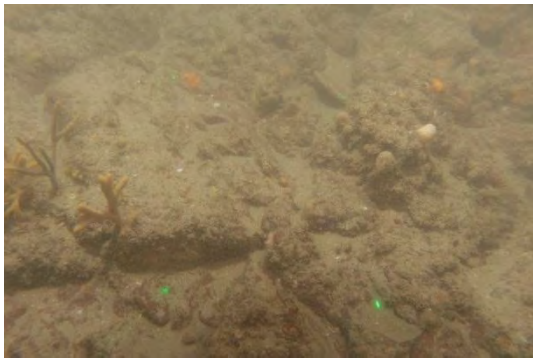


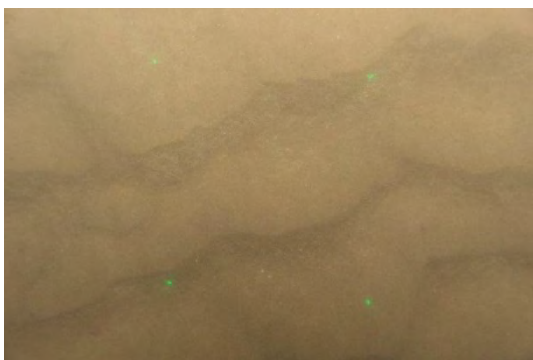
Figure 37 Overview of Annex I areas in UK EEZ route Alternative E between KP 24 and KP 32.

5.5.1 | FINAL ROUTE

Annex I habitats identified within the final route survey corridor are presented in Table 26.

Table 26 Annex I habitats identified within the survey corridor.

HABITAT IMAGE	ANNEX I	OSPAR/MPA	SITE ID
	Annex I (1170) - Bedrock Reefs	Pembrokeshire Marine/Sir Benfro Forol SAC area	T06, T09, T08, T07
	Annex I (1170) - Potential Bedrock Reefs	Pembrokeshire Marine/Sir Benfro Forol SAC area	RR_T06
	Annex I (1170) – Medium Grade Stony Reefs	Pembrokeshire Marine/Sir Benfro Forol SAC area	RR_T01, RR_T02, RR_T03, RR_T04, RR_T05
	Annex I (1170) – Low Grade Biogenic Reef	Pembrokeshire Marine/Sir Benfro Forol SAC area	S25, T05,

HABITAT IMAGE	ANNEX I	OSPAR/MPA	SITE ID
	Annex I (1170) – Low Grade Biogenic Reef		S20
	Annex I (1110) - Sandbanks which are slightly covered by sea water all the time	Pembrokeshire Marine/Sir Benfro Forol SAC area	S31, S32

ANNEX I (1170) - STONY REEFS

Transect T08 crosses the Final Route centre line at KP 2.213. The centre line is surrounded by muddy sand. The start and end of the transect runs across Annex I (1170) – Bedrock Reefs, dominated by ascidians and hydrozoans.

Transect T07 (crossing the centre line at KP 2.786) and transect T06 (crossing the centre line at KP 4.961) showed similar characteristics and the bedrock surrounding the narrow channel of sand was also classified as Annex I (1170) – Bedrock Reefs (Figure 38).

Transect T09 also showed Annex I (1170) - Bedrock Reefs, as it ran along the direction of the corridor on the northern side of the route around KP 4.100.



Figure 38 Image T06_014 of Annex I (1170) – Bedrock reefs with the habitat A4.138 – Molgula manhattensis with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock.

Transect RR_T01, RR_T02, RR_T03 (Figure 39), RR_T04 and RR_T05 were all located in an area with boulders and cobbles with a rich epifauna community. Cobbles greater than 0.064 m in diameter covered between 50 % to 80 % of the area along the transects, and were in general clast supported with a maximum elevation of approximately 0.2 m. The seabed in this area meets the criteria of a medium grade stony reef (Table 27 to Table 31).

Table 27 Reef assessment for assessed stony reef in RR_T01.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	-	-	50 %- 70%	-
Elevation	-	≤0.064 m	-	-
Extent	-	>25 m ²		

Table 28 Reef assessment for assessed stony reef in RR_T02.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	-	-	70 %- 80%	-
Elevation	-	-	0.064 – 0.2 m	-
Extent	-	>25 m ²		

Table 29 Reef assessment for assessed stony reef in RR_T03.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	-	-	70 % - 80%	-
Elevation	-	-	0.064 – 0.2 m	-
Extent	-	>25 m ²		

Table 30 Reef assessment for assessed stony reef in RR_T04.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	-	-	50 % - 60%	-
Elevation	-	-	0.064	-
Extent	-	>25 m ²		

Table 31 Reef assessment for assessed stony reef in RR_T05.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	-	10% - 40%	-	-
Elevation	-	-	0.064	-
Extent	-	>25 m ²		



Figure 39 Image RR_T03_001 of Annex I (1170) – Medium Grade Stony Reef with the habitat A5.141 – Pomatoceros triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.

Transect RR_T06 crossed smaller areas of bedrock that was identified in the geophysical data. The bedrock was largely covered by sediment, with only small outcropping patches. The outcropping bedrock had a sparse epifauna consisting of mainly anemones and hydrozoans. Due to the lack of conspicuous bedrock reef formations, the bedrock was classified as Annex I (1170) – Potential Bedrock Reefs.

ANNEX I (1110) - SANDBANKS WHICH ARE SLIGHTLY COVERED BY SEA WATER ALL THE TIME

Two areas between approximate KP 5.122 to KP 8.841 and from KP 9.405 to KP 10.029 comprising of sand and ripples were classified as Annex I (1110) - Sandbanks which are slightly covered by sea water all the time. Grab sample sites S31 and S32 were located within these sections.

ANNEX I (1170) - SABELLARIA SPINULOSA REEFS

All grab sampling locations where *S. spinulosa* was identified are listed in Table 32, along with abundances (grab samples) and coverage (photos).

Table 32 Summary of *S. spinulosa* quantities at sample locations where it occurred (Final Route, UK).

SAMPLE LOCATION	QUANTITY OF SABELLARIA SPINULOSA PER m ²		AVERAGE NUMBER OF INDIVIDUALS PER SAMPLE LOCATION PER m ²	AVERAGE PERCENTAGE COVERAGE IN SITE PHOTOS
	REPL. 1	REPL. 2		
S20	2330	1110	1720	24%
S21	540	170	355	10%
S22	10	0	5	-
S23	250	320	285	10%
S24	1120	360	740	-
S25	1460	1530	1495	12%
S26	40	170	105	1%
S27	40	0	20	-
S29	0	10	5	2%
S30	180	560	370	-

S. spinulosa was identified from both grab samples at S30, with an average abundance of 350 specimens per m². The images from the site does not indicate any presence of reef formations, and no conspicuous elevated formations of possible *S. spinulosa* aggregations was identified in the geophysical data.

A few specimen of *S. spinulosa* was identified in one of the grab samples at S29. The grab sample site was located within an area of coarse sediment. Minor aggregations of *S. spinulosa* was identified in the images from the site, showing an average coverage of 2%. This was also reflected in the geophysical data, that showed a homogenous seabed with coarse sediment. Grab site S27 showed similar characteristics, but no aggregations of *S. spinulosa* were identified in the images. The areas were not considered meeting the criteria to qualify as a *S. spinulosa* reef.

Grab sample site S26 was located in an area with sand and gravel at KP 35.997. Specimens of *S. spinulosa* were identified from both samples at this site, with an average abundance of 105 specimens per m². Small, low aggregations of *S. spinulosa* was scattered across the seabed, amounting to an average coverage of 1 %. The area was not considered meeting the criteria to qualify as a *S. spinulosa* reef.

Grab sample site S25, located further west at KP 40.990, showed a higher presence of *S. spinulosa*. An average abundance of 1495 specimens per m². The *S. spinulosa* aggregations visible in the images from the site showed a coverage between 7% and 17%, with an average coverage of 12% (Figure 40). The elevation of the tube aggregations was assessed to vary between flat seabed and 5 cm. The reef meets the criteria of an Annex I (1170) – Low Grade Biogenic reef according to the *S. spinulosa* reef assessment by Gubbay (2007) (Table 33).



Figure 40 Image S25_003 of Annex I (1170) – Low Grade Biogenic reef with the habitat A5.611 – *Sabellaria spinulosa* on stable circalittoral mixed sediment.

Table 33 Assessment of *S. spinulosa* at sample location S25 (Gubbay, 2007).

CHARACTERISTIC	NOT A REEF	“REEFINESS”		
		LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	-	0-5	-	-
Extent (m ²)		-	Approx. 75 000	-
Patchiness (% cover)	-	7 % to 17 % (Average 12 %)	-	-

Specimens of *S. spinulosa* were found in both grab samples from site S24, with an average abundance of 740 individuals per m². No *S. spinulosa* aggregations were identified in the grab sample site photos (Figure 41), but tubes of the species is scattered across the seabed. A homogenous seabed with coarse sediment was identified from the geophysical data in the area, with no indication of any elevated reef formations. Thus, the area is not considered meeting the criteria to qualify as a *S. spinulosa* reef.

S. spinulosa was also identified from both grab samples at S23 (average abundance 285 ind/m²), and was located within the same habitat as S24 (A5.611).

No *S. spinulosa* was identified in the site images, but the visibility was poor in the area. It was noted that *S. spinulosa* tubes were present in the gravel on the seabed, but no erect tubes were visible. As the geophysical data showed a rippled coarse sediment, with no indications of reef formations, the area was not considered meeting the criteria to qualify as a *S. spinulosa* reef.

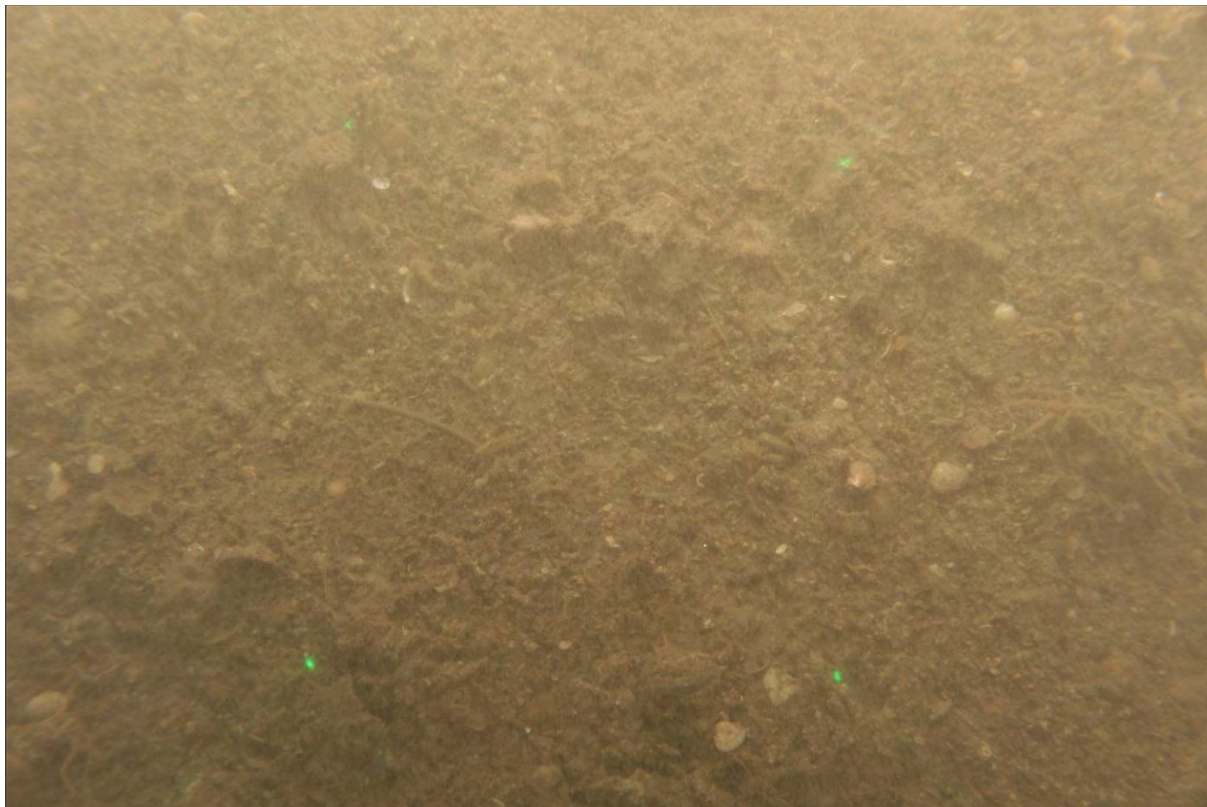


Figure 41 Image S24_001 of the habitat A5.611 – Sabellaria spinulosa on stable circalittoral mixed sediment.

An average abundance of 325 individuals per m² of *S. spinulosa* was recorded at grab sample site S21. The *S. spinulosa* aggregations were visible in the site photos, with an average percentage cover of 10 %. The average elevation of the tubes was assessed to be below 2 cm. Therefore, the area was not considered meeting the criteria to qualify as a *S. spinulosa* reef.

Specimens of *S. spinulosa* were identified from both samples at site S20, located at KP 58.035. S20 had an average abundance of 1720 specimens per m². The *S. spinulosa* aggregations visible in the images from the site showed a coverage between 12 % and 35 %, with an average coverage of 24 % (Figure 42). The elevation of the tube aggregations was assessed to vary between flat seabed and 5 cm. Although the patchiness matched a Medium Graded *S. spinulosa* reef, the generally low elevation of the aggregations caused the reef to be assessed to meet the criteria of an Annex I (1170) – Low Grade Biogenic reef (Table 34).



Figure 42 Image S20_005 of Annex I (1170) – Low Grade Biogenic reef with the habitat A5.611 – *Sabellaria spinulosa* on stable circalittoral mixed sediment.

Table 34 Assessment of *S. spinulosa* at sample location S20 (Gubbay, 2007).

CHARACTERISTIC	NOT A REEF	“REEFINESS”		
		LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	-	0-5	-	-
Extent (m ²)	-	-	Approx. 375 000	-
Patchiness (% cover)	-	-	12 % to 35 % (Average 24 %)	-

All transects where *S. spinulosa* was identified are listed in Table 35, along with abundances (grab samples) and coverage (photos).

Table 35 Average coverage and standard deviation of *S. spinulosa* in transects where it occurred in ascending KP (Final Route, UK).

TRAN- SECT	DDV_001	DDV_002	DDV_003	DDV_004	DDV_005	DDV_006	DDV_007	DDV_008	DDV_009	DDV_010	DDV_011	DDV_012	DDV_013	DDV_014	DDV_015	DDV_016	AVERAGE	SD
T06	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	<1%	0%	<1%	0%	0%	0.2% (Total 18 photos)	0%
T07	7%	0%	0%	0%	0%	5%	0%	0%	-	-	-	-	-	-	-	-	0.9%	2%
RR_T01	1%	0%	<1%	4%	7%	7%	0%	<1%	-	-	-	-	-	-	-	-	2.5%	3%
RR_T04	3%	0%	0%	0%	<1%	0%	0%	-	-	-	-	-	-	-	-	-	0.5%	1%
RR_T05	<1%	0%	<1%	0%	<1%	0%	0%	0%	-	-	-	-	-	-	-	-	0.2%	0%
RR_T06	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.2% (Total 19 photos)	1%
RR_T07	0%	0%	0%	<1%	0%	7%	0%	0%	-	-	-	-	-	-	-	-	0.9%	2%
A_T10	0%	0%	0%	0%	0%	<1%	0%	-	-	-	-	-	-	-	-	-	0.1%	0%
T05	0%	1%	0%	0%	0%	0%	0%	16%	0%	0%	0%	0%	-	-	-	-	1.4%	4%
T04	<1%	0%	<1%	<1%	0%	0%	0%	<1%	0%	0%	0%	0%	0%	-	-	-	0.2%	0.2%
T04_X	0%	<1%	<1%	15%	0%	<1%	-	-	-	-	-	-	-	-	-	-	3%	5%

Scattered aggregations of *S. spinulosa* were recorded on bedrock at transect T07 and T06. It was interpreted to have a limited spatial distribution. As bedrock was the prevalent reef forming substrate in the area, the *S. spinulosa* aggregations was not considered representing a reef.

S. spinulosa was also identified along transect RR_T01, RR_T04 and RR_T05, all located within a large area of cobbles and pebbles. All recordings showed scattered small aggregations of *S. spinulosa* with low percentage coverage and elevation. The area was not considered meeting the definition of a *S. spinulosa* reef (Gubbay, 2007).

Small aggregations of *S. spinulosa* was recorded in transect RR_T06. The aggregations with the highest percentage coverage (2%) was observed on bedrock. A few small aggregations were recorded on the gravelly seabed. The occurrences of *S. spinulosa* was not considered being a reef.

S. spinulosa was recorded in transect RR_T07, which crossed a coarse gravelly seabed. The elevation of the aggregations visible in the transect photos was <2 cm. Areas of solidified sandy aggregations, possibly abraded remnants of an *S. spinulosa* reef, was observed along the transect. Due to the low elevation of the few newly formed tubes in the area, the area was not considered to meet the definition of a *S. spinulosa* reef.

A single record of *S. spinulosa* was done in shellgravel at transect A_T10.

S. spinulosa was identified on bedrock along the transect T05, located at KP 42.055. No reef characteristics were identified in the photos analysed. The aggregations were low (<2 cm) and the coverage was patchy and spatially limited.

When reviewing all raw photo data from the transect, areas of *S. spinulosa* aggregations with considerably higher elevation and coverage were visible (Figure 43). The transect traversed bedrock, that was identified in the geophysical data. It is difficult to assess to what extent outcropping bedrock underneath the *S. spinulosa* aggregations added to the perceived elevation of the reef, as no bedrock were possible to identify due to the dense aggregations of *S. spinulosa*.

As the bedrock was not the prevalent reef forming substrate in the area, the *S. spinulosa* aggregations was considered representing a reef. Due to the elevation, extent, and percentage cover of the *S. spinulosa* when assessing all raw photo material from the transect, the area was considered to meet the definition of a Annex I (1170) - *S. spinulosa* reef (Table 36).

Table 36 Assessment of *S. spinulosa* at transect T05 (Gubbay, 2007).

CHARACTERISTIC	NOT A REEF	"REEFINESS"		
		LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	-	-	0-10	-
Extent (m ²)		-	10 000	-
Patchiness (% cover)	-	-	20 % - 30 %	-



Figure 43 Raw image T05_013 of Annex I (1170) – Medium Graded Biogenic Reef on the habitat A4.2212 – Sabellaria spinulosa didemnid and small ascidians on tide-swept moderately wave-exposed circalittoral rock.

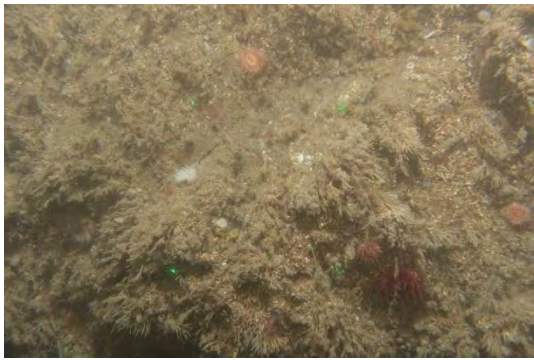
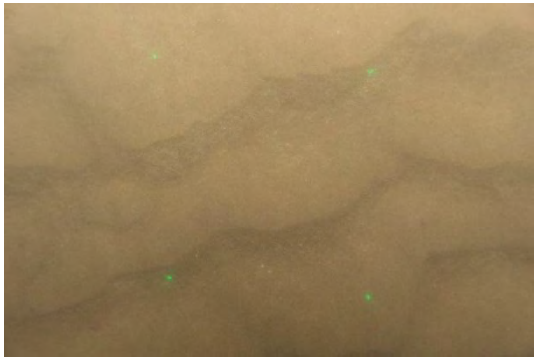
Transect T04 with the cross transect T04_X was located in an area with boulders and mixed sediment. The seabed substrate was heterogeneous, with areas of sand mixed with patches of cobbles and boulders, and shell gravel.

Polychaeta *S. spinulosa* was occurring along both transects, with a coverage ranging between 0 % to 15 %, predominantly on sand. The average coverage of *S. spinulosa* was 3 % in T04_X, and 0.2 % in T04. The area was not considered to meet the definition of a *S. spinulosa* reef.

5.5.2| ROUTE A

Annex I habitats identified within Route A survey corridor are presented in Table 37.

Table 37 Annex I habitats identified within the survey corridor.

HABITAT IMAGE	ANNEX I	OSPAR/MPA	SITE ID
	Annex I (1170) - Bedrock reef		A_T01, A_T02, A_T03, AT04, A_T06, A_T07, A_T08, A_T09
	Annex I (1170) - Potential Bedrock Reefs		A_T05, A_T06, A_T07
	Annex I (1110) - Sandbanks which are slightly covered by sea water all the time	Pembrokeshire Marine/Sir Benfro Forol SAC area	S31

ANNEX (1170) - STONY REEFS

Large areas of bedrock were present along the route A. The bedrock was primarily identified from the geophysical data. The DDV imagery showed that the bedrock was partly covered by sand and gravel, which limited the coverage of epifauna.

A_T01 was characterised by *S. spinulosa* encrusted bedrock, that was partly covered by sand, gravel and pebbles. Bedrock Reefs were identified at A_T01.

The seabed substrate along A_T02 was dominated by coarse gravel, pebbles and cobbles, with a relatively high number of epifaunal species such as ascidians, and different species of bryozoans and cnidarians. The habitat was classified as A5.141 and the area was evaluated according to Irvings (2008) reef assessment for stony reefs. The characteristics of the seabed along A_T02 are presented in Table 38. The habitat had a low resemblance of being a stony reef. Bedrock was surrounding the A5.141 and was classified as Annex I (1170) - Bedrock Reef.

Table 38 Reef assessment for assessed stony reef in A_T02.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	<10%	-	-	-
Elevation	-	≤0.064 m	-	-
Extent	-	>25 m ²		

Transect A_T05 was performed across an area of bedrock on the route A. The bedrock was almost entirely covered by sediment in the beginning of the transect, then gradually transcended to bedrock only partly covered by sediment, with a high coverage by epifauna (Figure 44). Epifauna, such as anemones and hydrozoans, were also scattered in the beginning of the transect in areas with no visible protruding bedrock. Therefore, the bedrock in the beginning of the transect, including the adjacent areas with a similar appearance in the geophysical data, was classified as Annex I (1170) – Potential Bedrock Reefs. The remainder of the transect was classified as Annex I (1170) –Bedrock Reefs.



Figure 44 Annex I (1170) – Bedrock Reef at A_T05_009.

The transect A_T06 moved across the bedrock area further west along the Route A. The bedrock was partly covered by sand and gravel, and showed similar characteristics to that of A_T05.

An area of coarse sediment with pebbles and cobbles was located in the middle of the transect, in between bedrock outcrops. The area of pebbles and cobbles were evaluated against the stony reef criteria's (Table 39), and was not considered being a stony reef.

Table 39 Reef assessment for assessed stony reef in A_T06.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	<10 %	-	-	-
Elevation	-	≤0.064 m	-	-
Extent	-	>25 m ²		

The transect A_T08 moved across bedrock, that had minor intrusions of mixed sediments. The bedrock had a high epifaunal coverage with *S. spinulosa*, and turfs of different species of hydrozoans and bryozoans. Crustaceans like *Ebalia* sp. and pagurids were also common, along with different mollusc species.

ANNEX I (1110) - SANDBANKS WHICH ARE SLIGHTLY COVERED BY SEA WATER ALL THE TIME

Two areas between approximate KP 8.885 to KP 9.150 and from KP 9.818 to KP 10.340 comprising of sand and ripples were classified as Annex I (1110) - Sandbanks which are slightly covered by sea water all the time. Grab sample sites S31 was located within this section.

ANNEX I (1170) - SABELLARIA SPINULOSA REEFS

The transects where *S. spinulosa* occurred are listed in Table 40 with average coverage and standard deviations to illustrate distribution and density.

Table 40 Average coverage and standard deviation of *S. spinulosa* in transects where it occurred (Route A, UK).

TRAN- SECT	DDV_001	DDV_002	DDV_003	DDV_004	DDV_005	DDV_006	DDV_007	DDV_008	DDV_009	DDV_010	DDV_011	DDV_012	DDV_013	DDV_014	DDV_015	DDV_016	AVERAGE	SD
A_T01	0%	0%	0%	0%	0%	15%	0%	20%	0%	0%	0%	<1%	0%	0%	-	-	2.5%	6%
A_T02	0%	0%	2%	0%	0%	0%	0%	0%	-	-	-	-	-	-	-	-	0.3%	1%
A_T03	0%	3%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0.3%	1%
A_T04	<1%	<1%	0%	0%	<1%	0%	<1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.1% (Total 21 photos)	0%
A_T06	<1%	0%	0%	0%	0%	0%	0%	-	-	-	-	-	-	-	-	-	0.1%	0%
A_T07	12%	3%	2%	0%	80%	0%	0%	0%	<1%	41%	-	-	-	-	-	-	13.9%	25%

TRAN- SECT	DDV_001	DDV_002	DDV_003	DDV_004	DDV_005	DDV_006	DDV_007	DDV_008	DDV_009	DDV_010	DDV_011	DDV_012	DDV_013	DDV_014	DDV_015	DDV_016	AVERAGE	SD
A_T08	<1%	0%	35%	0%	0%	0%	0%	<1%	0%	2%	0%	29%	0%	0%	0%	27%	5.5% (Total 17 photos)	12%
A_T09	69%	28%	0%	0%	35%	0%	0%	10%	-	-	-	-	-	-	-	-	17.8%	23%

Potential biogenic reef was classified at T07 but it was mixed with boulders and cobbles and is thus classified as a mix potential stony reef/biogenic reef.

The transect A_T01 had a relatively high coverage of *S. spinulosa*, ranging from <1 % to 20 % coverage. The colonies were abraded with only minor patches of newly formed tubes. The *S. spinulosa* was in general found encrusting bedrock (Figure 45). The area was classified to A4.221 – *Sabellaria spinulosa* encrusted circalittoral rock, and was not considered being a biogenic reef, as the bedrock was the feature that dominated and characterised this area. Minor patches of *S. spinulosa* on bedrock was also present at transect A_T03 and A_T04.



Figure 45 Image A_T01_008 of *S. spinulosa* encrusted circalittoral rock.

Similar occurrences of *S. spinulosa* on bedrock was also noted in transect A_T06 and A_T07, both classified as Annex I (1170) – Bedrock Reefs due to the predominance of rocky outcrops (Figure 46). Transect A_T07 had a higher coverage than A_T06, that varied from 0 % up to 80 %.

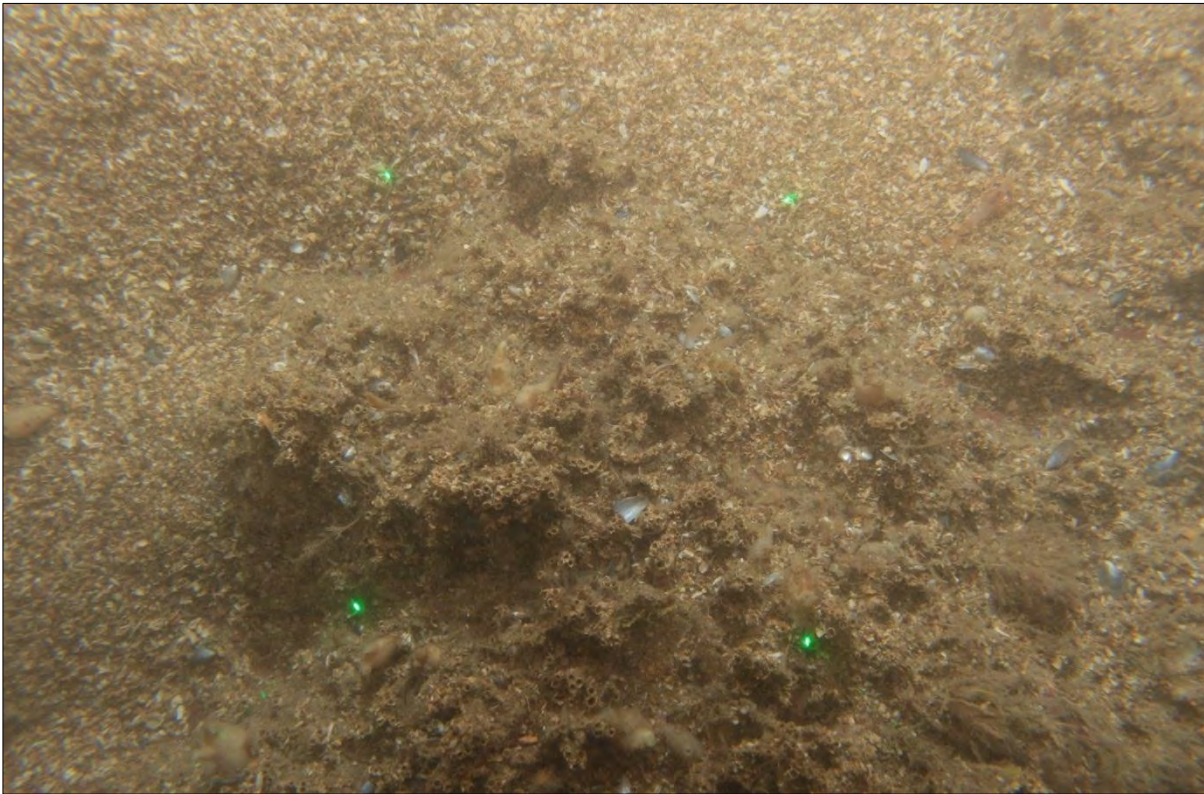


Figure 46 Image A_T07_010 of *S. spinulosa* on the habitat A4.21 – Echinoderms and crustose communities on circalittoral rock on Annex I (1170) – Bedrock reefs.

Transect A_T08 and A_T09 showed areas of relatively high coverage by *S. spinulosa* on bedrock outcrops, varying from 0 % coverage to 35 % coverage (A_T08) and 0 % coverage to 69 % coverage (A_T09). The conditions of the aggregations varied from abraded to newly formed classified as Annex I (1170) – Bedrock Reefs due to the predominance of rocky outcrops.

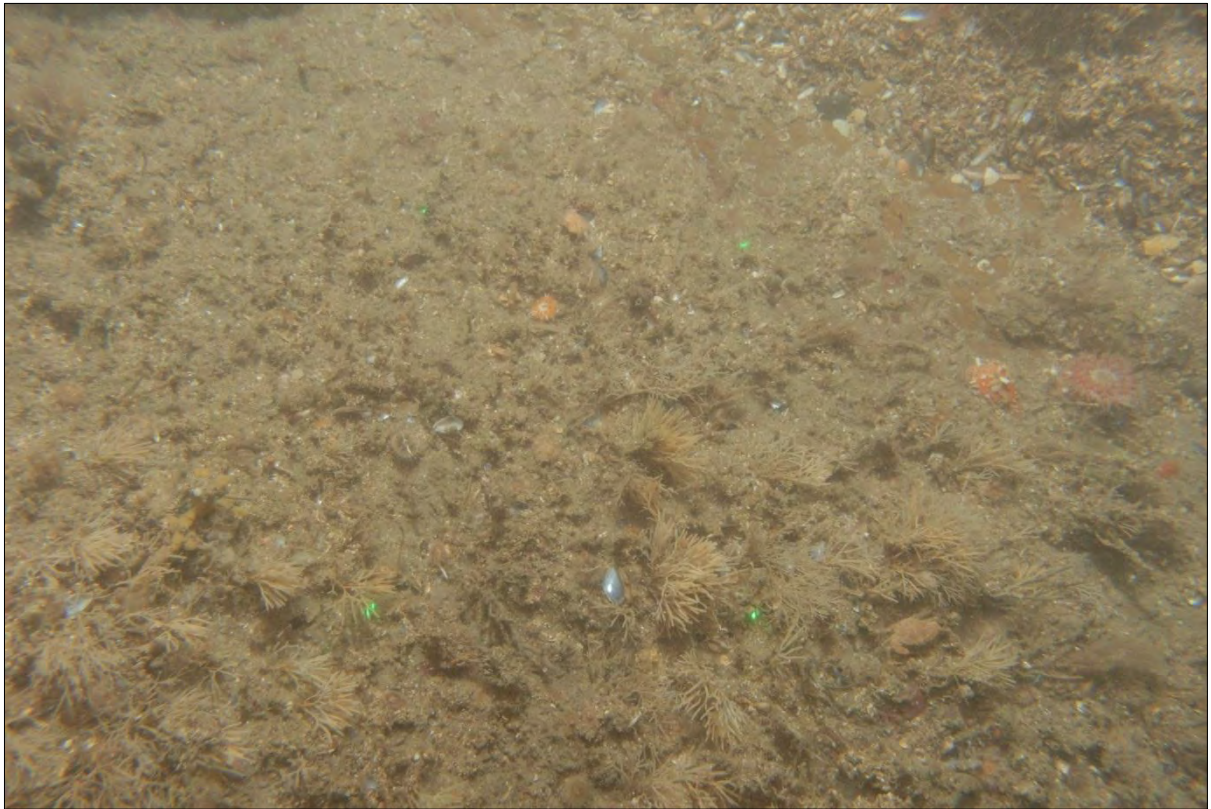


Figure 47 Image A_T09_001 of *S. spinulosa* on the habitat A4.13 – Mixed faunal turf communities on circalittoral rock, on Annex I (1170) – Bedrock reefs.

ANNEX I (1170) - MYTILUS BIOGENIC REEF

The imagery from A_T02 showed large patches of dense beds of *Mytilus edulis* on bedrock (Figure 48). The area around the transect A_T02 was classified as a bedrock reef, as the bedrock was the major epifauna supporting habitat. Transects T03 and T04 showed an average percentage coverage of 30 % and 12 %.

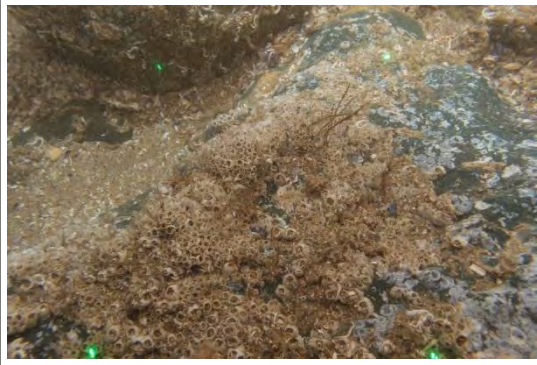


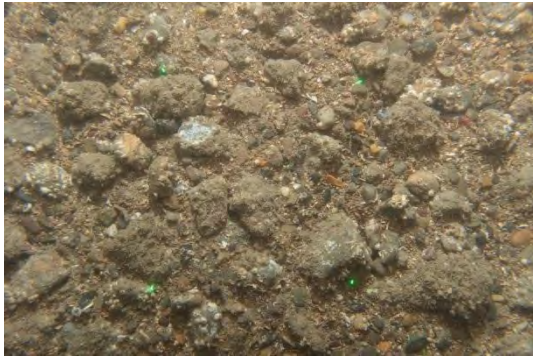
Figure 48 Image A_T02_008 of *M. edulis* on the habitat A4.13 – Mixed faunal turf communities on circalittoral rock, on Annex I (1170) – Bedrock reefs.

5.5.3 | ALTERNATIVE E

Annex I habitats identified within Alternative E survey corridor are presented in Table 41.

Table 41 Annex I habitats identified within the survey corridor.

HABITAT IMAGE	ANNEX I	OSPAR/MPA	SITE ID
	Annex I (1170) - Bedrock Reefs		E_T05, E_T07

HABITAT IMAGE	ANNEX I	OSPAR/MPA	SITE ID
	Annex I (1170) – Potential Biogenic Reefs		E_T03
	Annex I (1170) – Medium Grade Stony Reefs		E_T04, E_T05, E_T09, E_T10
	Annex I (1170) – Low Grade Stony Reefs		E_T10

STONY REEFS

The seabed along E_T04 and E_T05 was dominated by pebbles, cobbles, and boulders with a high number of epifaunal species such as ascidians, and different species of bryozoans, poriferans and cnidarians (Figure 49). The habitat was classified as A4.132 and the area was evaluated according to Irvings (2008) reef assessment for stony reefs. The characteristics of the seabed along A_T02 are presented in Table 42. The seabed in this area meets the criteria of a medium grade stony reef.

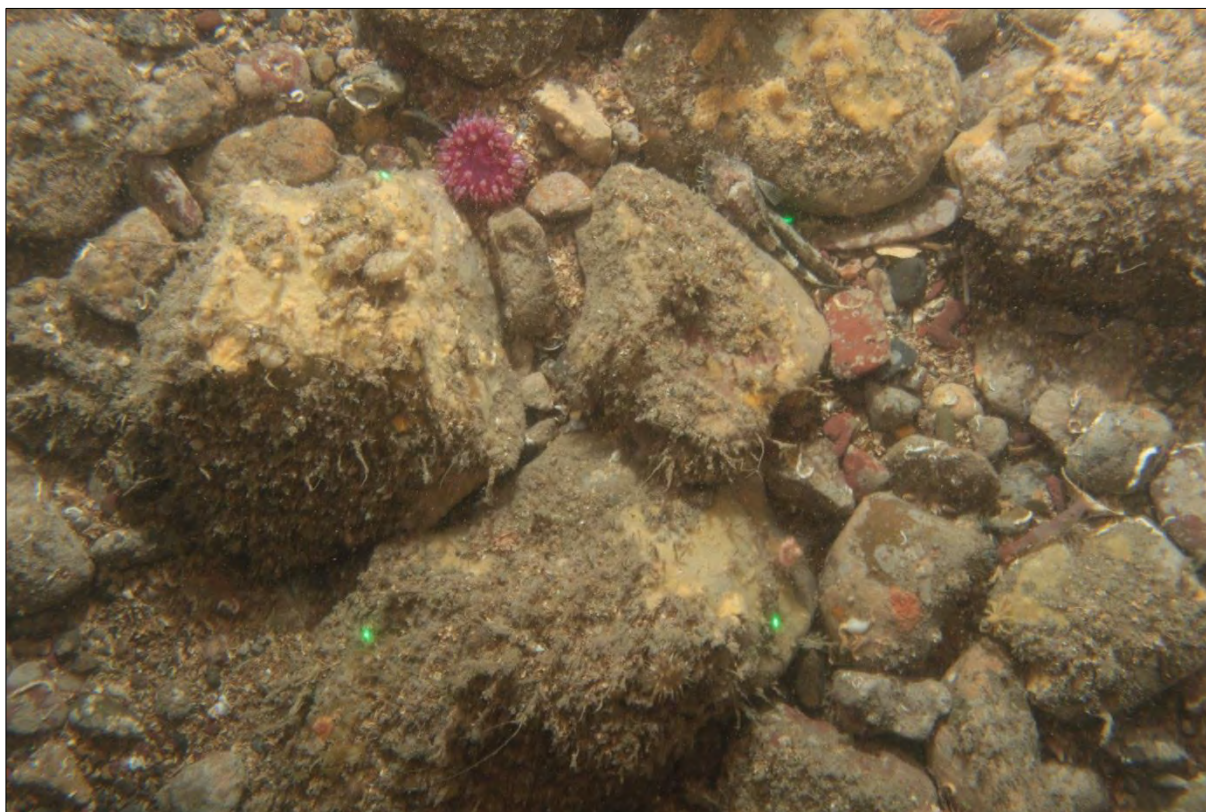


Figure 49 Image E_T04_004 of the habitat A4.132 –*Corynactis viridis* and a mixed turf of *crisiids*, *Bugula*, *Scrupocellaria*, and *Cellaria* on moderately tide-swept exposed circalittoral rock, on Annex I (1170) – Medium Grade Stony Reefs.

Table 42 Reef assessment for assessed stony reef in E_T04 and E_T05.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	-	-	40-95 %	-
Elevation	-	-	0.064 m-2 m	-
Extent	-	>25 m ²		

The recorded substrate and fauna along transect E_T09 matched the findings described in Table 42, and were classified to medium grade stony reef.

The seabed along E_T10 was characterised by matrix supported pebbles and cobbles, with an average elevation of approximately 0.064 m, and a maximum elevation of around 0.1 m. The area matched the assessment for an Annex I (1170) – Low Graded Stony Reef (Table 43).

Table 43 Reef assessment for assessed stony reef in E_T10.

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Composition	-	10-30%	-	-
Elevation	-	0.064 m	-	-
Extent	-	>25 m ²		

ANNEX I (1170) - SABELLARIA SPINULOSA REEFS

The transects where *S. spinulosa* occurred are listed in Table 40.

Table 44 Average coverage and standard deviation of *S. spinulosa* in transects where it occurred (Alternative E, UK).

TRAN-SECT	DDV_001	DDV_002	DDV_003	DDV_004	DDV_005	DDV_006	DDV_007	DDV_008	DDV_009	DDV_010	DDV_011	DDV_012	DDV_013	DDV_014	DDV_015	DDV_016	AVERAGE	SD
E_T03	0%	0%	0%	0%	0%	0%	9%	4%	9%	0%	0%	-	-	-	-	-	2.0%	3%
E_T07	20%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	-	-	-	-	-	2.0%	6%
E_T08	0%	0%	3%	0%	0%	0%	0%	0%	-	-	-	-	-	-	-	-	0.4%	1%
E_T10	0%	0%	0%	0%	1%	2%	0%	-	-	-	-	-	-	-	-	-	0.4%	1%

Small aggregations of *S. spinulosa* was recorded in transect E_T03 (Figure 50). The elevation of the aggregations visible in the transect photos was <2 cm, and the coverage varied between 0 % and 9 %, with an average coverage of 2 %. Due to the low elevation and the patchiness of the aggregations visible in the photos, the area was not considered to meet the definition of a *S. spinulosa* reef. However, the geophysical data showed that the area was characterised by a coarse seabed, and it cannot be ruled out that areas of *S. spinulosa* aggregations meeting the reef definition is present within this section.



Figure 50 Image E_T03_009 of *S. spinulosa* on the habitat A5.611 – *Sabellaria spinulosa* on stable circalittoral mixed sediment.

The transect E_T07 had a coverage of *S. spinulosa* ranging from 0 % to 20 % coverage. The *S. spinulosa* was encrusting bedrock, and had in general a low elevation (<2 cm) and had very patchy distribution in (Figure 45). The area was not considered being a biogenic reef, as the bedrock was the feature that dominated and characterised this area.

S. spinulosa was recorded in transect E_T08 and E_T10. The coverage was low (<3 %). The area was not considered to meet the definition of a *S. spinulosa* reef.

5.5.4| PROTECTED AREAS

CASTLEMARTIN COAST SPA

The route run inside the Castlemartin Coast SPA between landfall in Freshwater West, KP 0, and KP 0.325. The SPA was designated to protect a population of Red-billed Chough *Pyrrhocorax pyrrhocorax* (JNCC, 2015).

PEMBROKESHIRE MARINE/ SIR BENFRO FOROL SAC

The route crosses the Pembrokeshire Marine/ Sir Benfro Forol SAC from the landfall in Freshwater West, KP 0, and KP 49.592.

The SAC include the following Annex I habitats: 1110 - Sandbanks which are slightly covered by sea water all the time, 1130 - Estuaries, 1140 - Mudflats and sandflats not covered by seawater at low tide, 1150 - Coastal lagoons, 1160 - Large shallow inlets and bays, 1170 - Reefs, 1330 - Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*), and 8330 - Submerged or partially submerged sea caves (JNCC, 2015).

The section of the survey corridor that crosses the SAC includes sections classified as 1170, both stony, bedrock, and biogenic reefs. It is possible that the habitat 1140 occurs in the intertidal zone close to landfall around KP 0.

From KP 5.122 to KP 8.841 and from KP 9.405 to KP 10.029, two areas with sand and coarse sediment could potentially be classified as 1110 - Sandbanks which are slightly covered by sea water all the time. The area is situated at a depth of about 28 m for the shallowest parts, which is generally too deep for 1110, and the geophysical data acquired does not support the interpretation of a distinct sand bank as present. However, there is a high confidence of this area to comprise of 1110, according to JNCC and NRW assessments for the Pembrokeshire Marine/ Sir Benfro Forol SAC, and therefore the area is classified as 1110.

The areas classified as 1170 - Bedrock Reefs are mainly located between KP 1.333 and KP 4.997 and along route alternative A, whereas areas classified as 1170 - Low Grade Stony Reefs are found between KP 15.003 and KP 22.071, and along route alternative E where also areas classified as 1170 - Medium Grade Stony Reef are found. Between KP 40.961 and KP 42.433 are areas classified as 1170 – Biogenic Reefs found, both Low Grade and Medium Grade, and areas classified as Potential Biogenic Reefs are found between KP 42.106 and KP 46.595.

SKOMER, SKOKHOLM AND THE SEAS OFF PEMBROKESHIRE / SGOMER, SGOGWM A MOROEDD PENFRO SPA

The route crosses the Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro SPA between KP 12.850 and KP 20.475.

The SPA was designated to protect the large populations of birds breeding on the islands Skomer, Skokholm and Middleholm, which are located North of the route. They are important breeding locations for Storm petrel *Hydrobates pelagicus*, Red-billed Chough *Pyrrhocorax pyrrhocorax*, Short-eared owl *Asio flammeus*, Manx shearwater *Puffinus puffinus*, Puffin *Fratercula arctica*, and Lesser Black-backed gull *Larus fuscus* (JNCC, 2017).

6 | IRELAND

Reported KP for the Ireland EEZ Environmental survey are KP 73.906 to KP 159.070. A total of three transect were performed within the Irish EEZ, distributed between route A, and the route Final Route. Transect T01 and T02 were located within the Final Route corridor in the Irish EEZ. Transect T03 was located within the route A corridor.

Grab sample site S00 to S16 was located within the Irish EEZ. All grab sample sites were located within the Final Route corridor (Figure 51). See Appendix A| for a full list of positions of grab sample sites and transects. Field protocols are available in Appendix B| and Appendix C|. Grab identification protocols and Transect identification protocols are found in Appendix D| and Appendix E|.

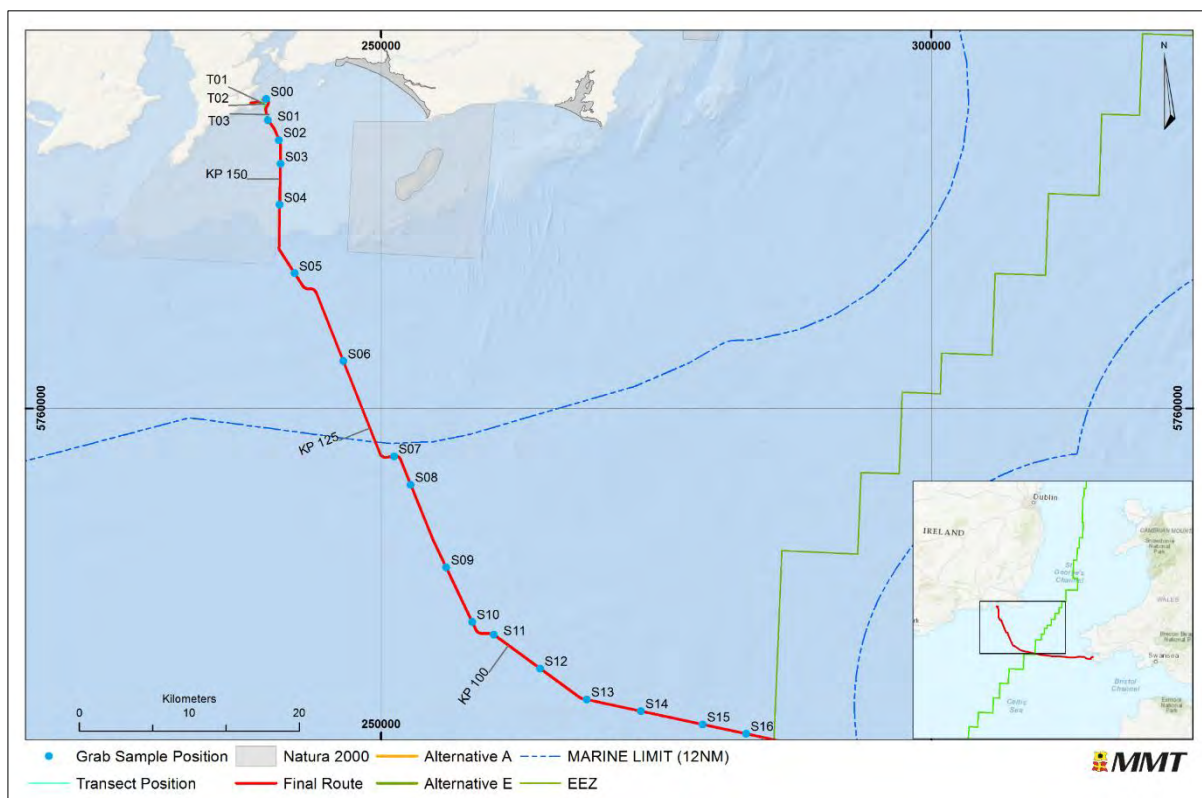


Figure 51 Overview of sampling and transect locations in the Irish EEZ.

See Table 45 for the number of sample sites and Table 46 and Table 47 for details regarding planned location coordinates and geophysical features overview.

Table 45 Number of sample sites.

NUMBER OF SAMPLE SITES	PHOTO TRANSECT SITES	GRAB SAMPLE SITES	PSA/CHEM SAMPLE SITES
	3	17	17

Table 46 List of proposed transects along Final Route in Ireland waters.

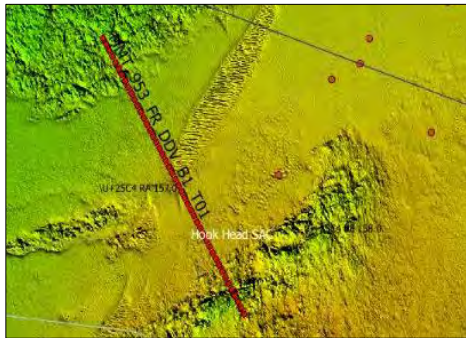
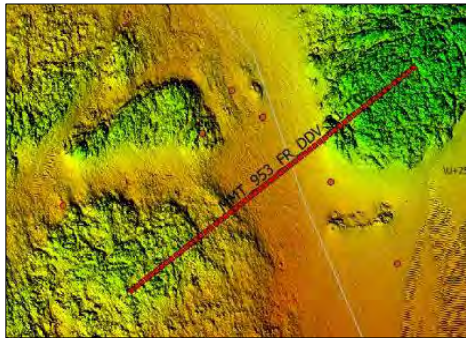
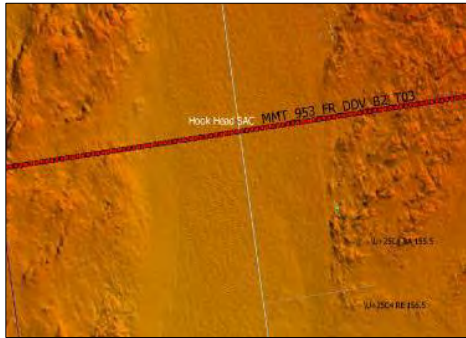
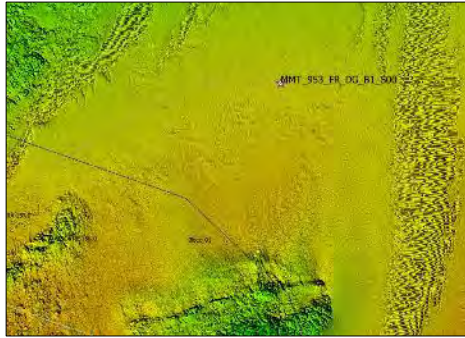
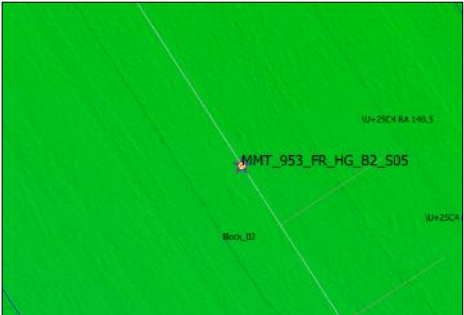
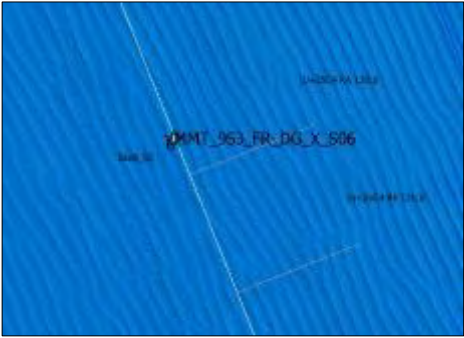
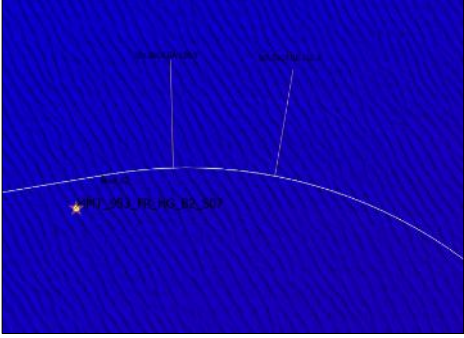
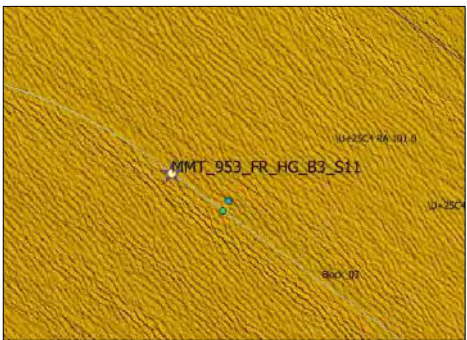
TRANSECT ID	START EASTING	START NORTHING	END EASTING	END NORTHING	GEOPHYSICAL OVERVIEW
DDV_T01	239016	5787998	239133	5787788	
DDV_T02	239238	5787430	239473	5787617	
DDV_T03	239320	5786591	239814	5786661	

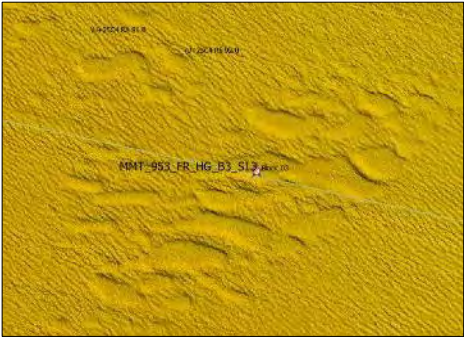
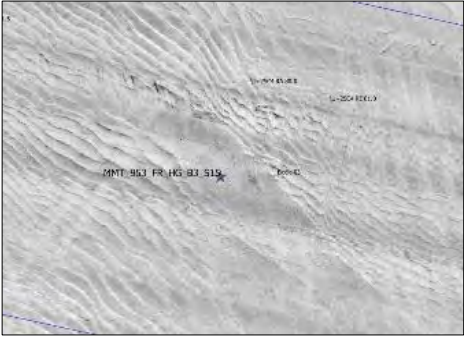
Table 47 List of proposed sampling sites performed in Irish waters.

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S00	239542	5788098	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S01	239719	5786155	
S02	240705	5784364	
S03	240850	5779049	
S04	240767	5778486	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S05	242135	5772259	
S06	246562	5764282	
S07	251155	5755631	
S08	252670	2753045	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S09	255916	5745527	
S10	258279	5740584	
S11	260245	5739415	
S12	264443	5736344	

SITE ID	EASTING	NORTHING	GEOPHYSICAL OVERVIEW
S13	268685	5733542	
S14	273604	5732472	
S15	279212	5731266	
S16	283177	5730430	

6.1 | DETAILED AREA DESCRIPTIONS

6.1.1 | FINAL ROUTE

From KP 73.906 to KP 74.557 the seabed comprised rippled sands and was classified as A5.251 - *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (Figure 52). Between KP 74.557 and KP 98.689 the seabed was predominantly classified as A5.252 - *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand. A few gravelly areas classified as A5.272 - *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand were identified between KP 88.715 and KP 92.655, occasionally crossing the final route.

Grab sample site S16 at approximate KP 76.476, S15 at approximate KP 80.529, S14 at approximate KP 86.263, S12 at approximate KP 96.422 were located within habitat A5.252. The infaunal composition at these locations was characterised by molluscs *Abra prismatica*, *A. alba*, *Phaxas pellucidus*, cumaceans *Eudorellopsis deformis*, numerous polychaetes, *B. elegans* and echinoderms *A. filiformis* and *E. pusillus*.

Grab sample site S13 at approximate KP 91.300 (Figure 52) , was located within habitat A5.272. the infaunal composition was characterised polychaetes *Spiophanes kroyeri*, *Owenia* sp., *Goniada maculata*, echinoderms *A. filiformis* and molluscs *Corbula gibba* and *Nucula hanleyi*.

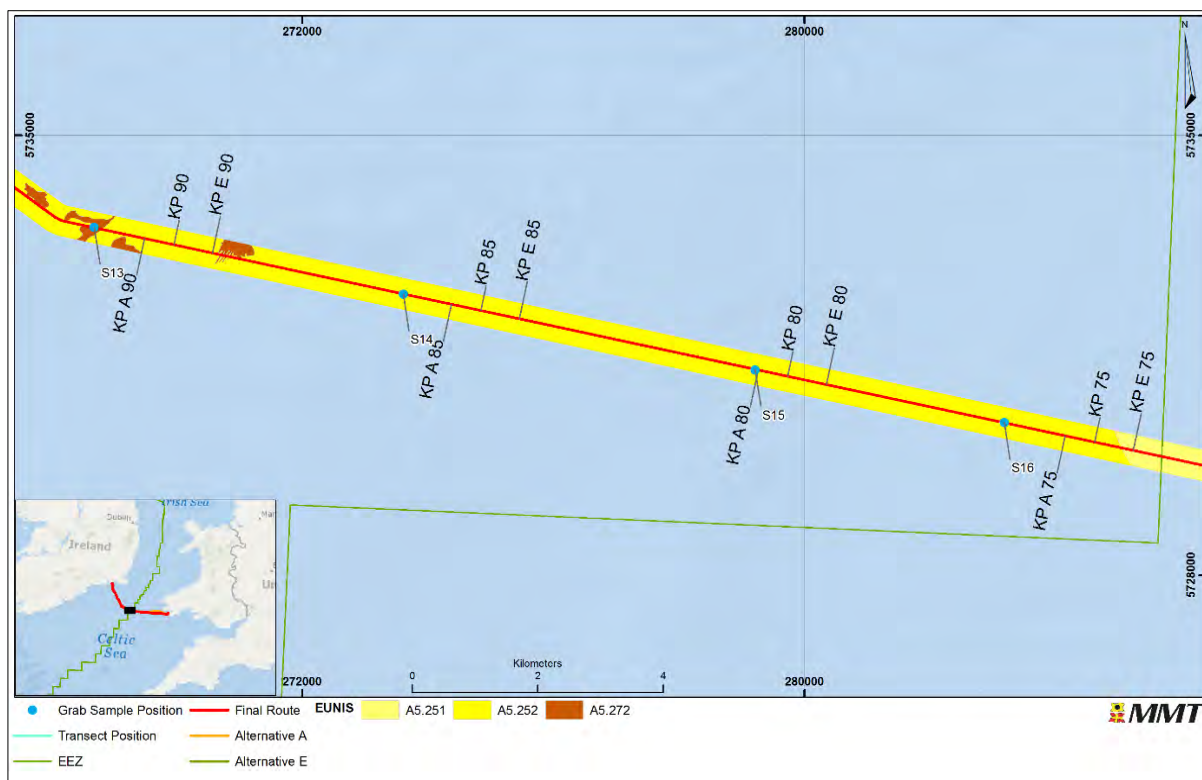


Figure 52 Overview of Irish EEZ KP 74 to KP 91.

From KP 98.689 to KP 104.107 the seabed comprised rippled sands and was classified as A5.272 (Figure 53). Grab sample site S11, at approximate KP 101.624 was located within habitat A5.272 and the infaunal composition was characterised by polychaetes *Owenia* sp., *O. borealis*, *Lagis koreni*, molluscs *Nucula nitidosa*, *C. gibba*, *Thyasira flexuosa*, echinoderms *A. filiformis* and *E. pusillus*.

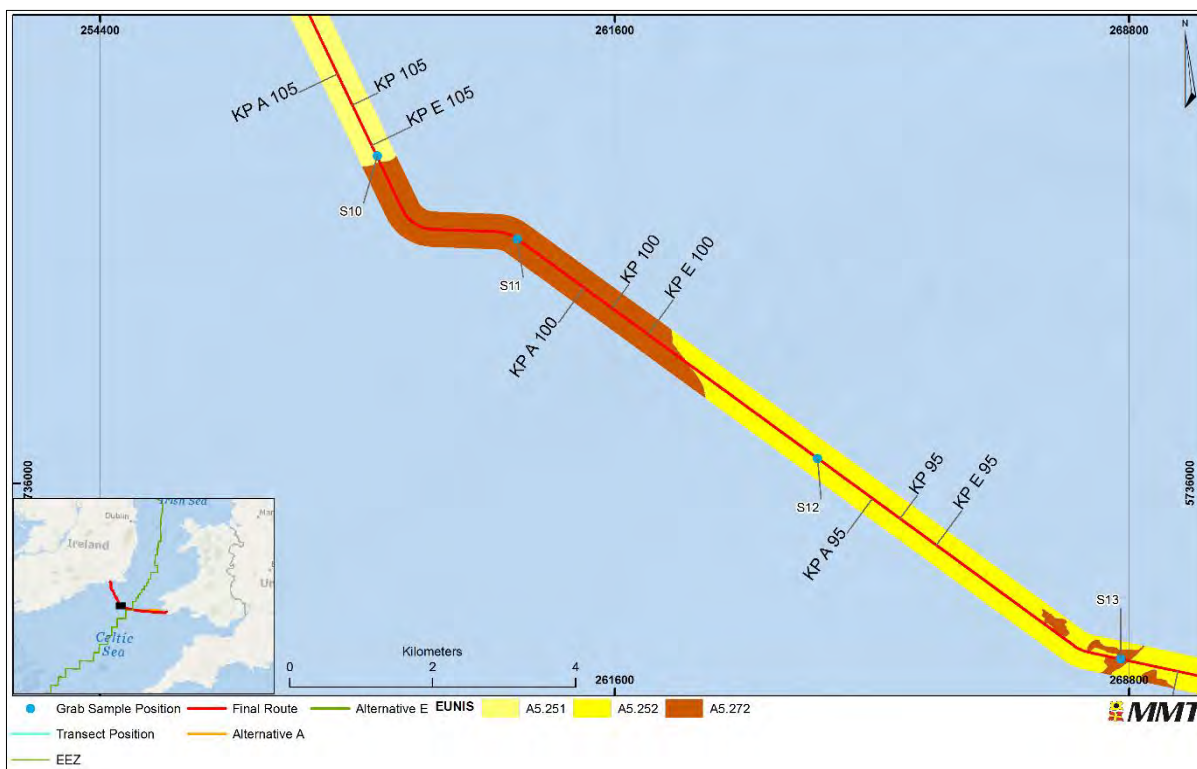


Figure 53 Overview of Irish EEZ KP 90 to KP 106.

From KP 104.107 to KP 117.805 the seabed comprised rippled sands and was classified as A5.251 (Figure 54).

Grab sample site S10, at approximate KP 104.203, and S09, at approximate KP 109.684, were located within habitat A5.251. The infaunal composition was similar at both locations, although less diverse and abundant at S09 than compared to S10, and was characterised by echinoderm *E. pusillus*, polychaetes *O. borealis*, and *Spiophanes bombyx*, amphipod *B. elegans* and molluscs *A. prismatica*, *T. flexuosa* and *K. bidentata*.

A small section classified as A5.25 - Circalittoral fine sand was located between KP 117.806 and KP 117.948. Grab sample site S08, at approximate KP 117.873, was located within habitat A5.25. No residue was acquired for analysis of infauna.

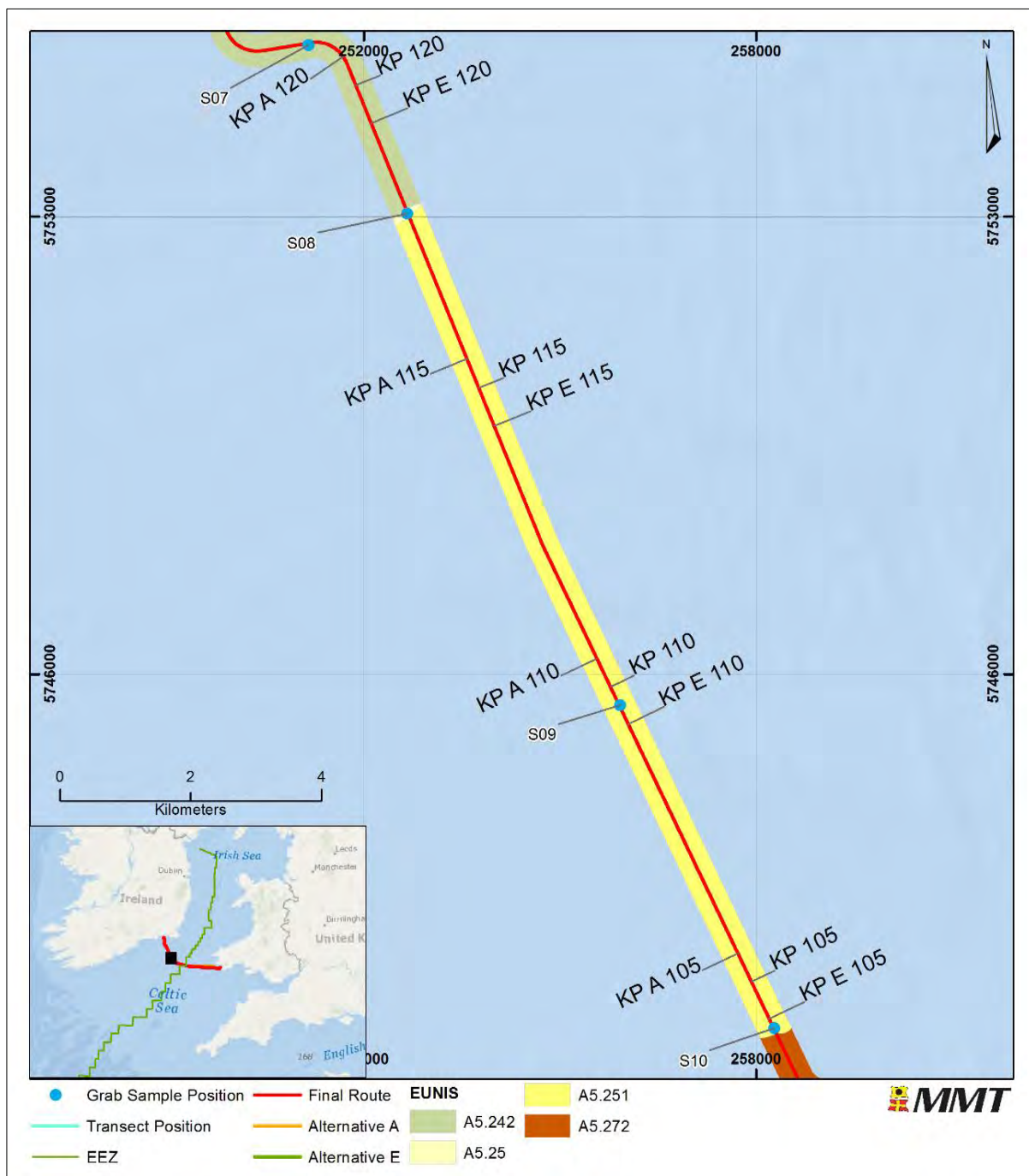


Figure 54 Overview of Irish EEZ KP 105 to KP 120.

From KP 117.948 to KP 148.306 the seabed was classified as A5.242 - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand. Grab sample site S07, at approximate KP 121.090, S06 at approximate KP 131.546, S05 at approximate KP 141.046 and S04 at approximate KP 147.691 were all located within habitat A5.242 (Figure 55).

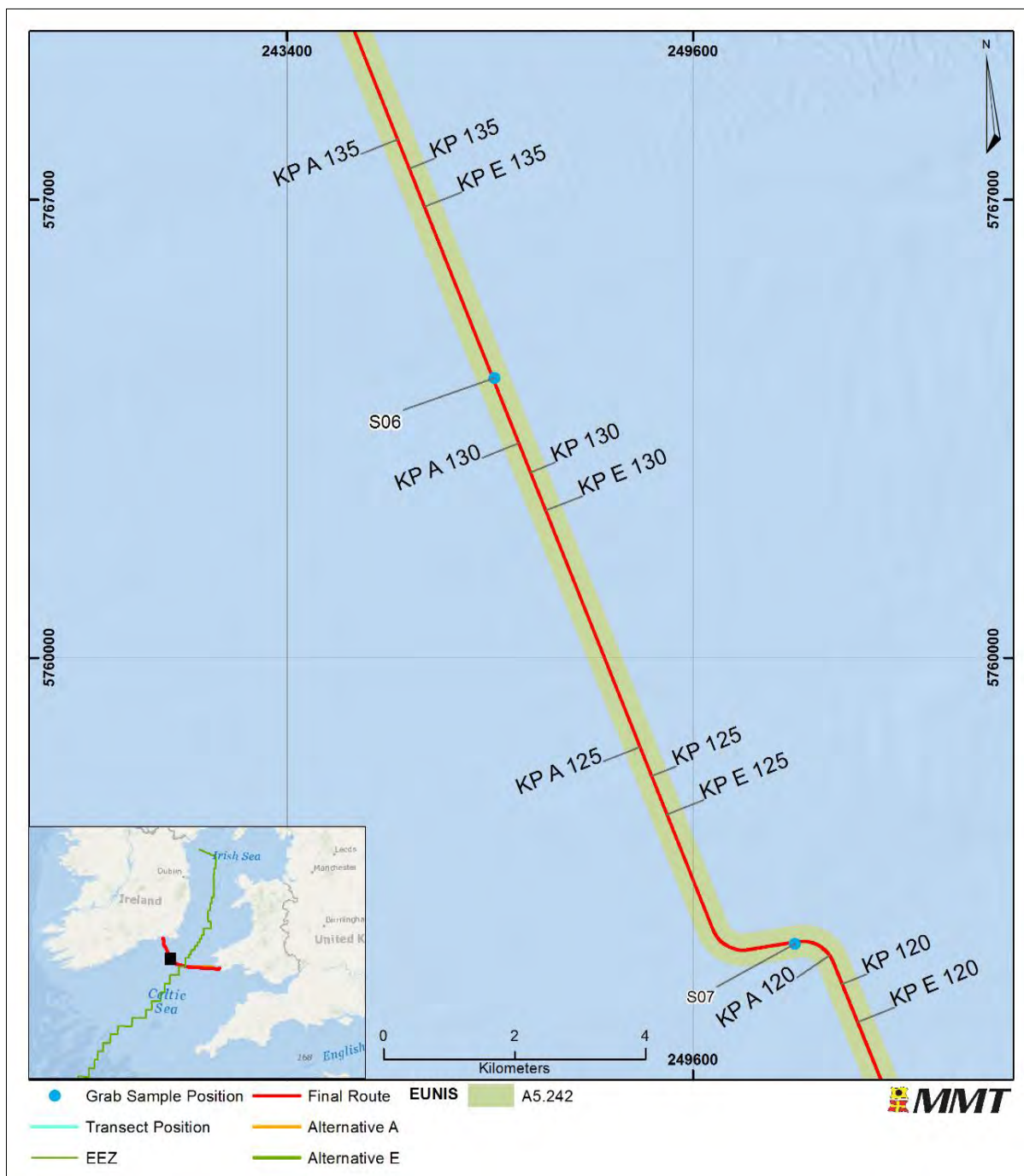


Figure 55 Overview of Irish EEZ KP 120 to KP 135.

The infaunal composition at sites S07 to S04 was similar and characterised by molluscs *Fabulina fabula*, *A. prismatica*, *N. nitidosa*, *Gari fervensis*, polychaetes *Magelona johnstoni*, *Magelona filiformis*, *N. cirrosa*, amphipods *Bathyporeia tenuipes*, *B. elegans* and echinoderms *E. pusillus* and *A. filiformis*.

From KP 148.306 to KP 152.363 the seabed comprised of coarse sediments and dominating habitat was classified as A5.14 - Circalittoral coarse sediment with frequent bands across the route corridor composed of finer sediments classified as A5.252 (Figure 56).

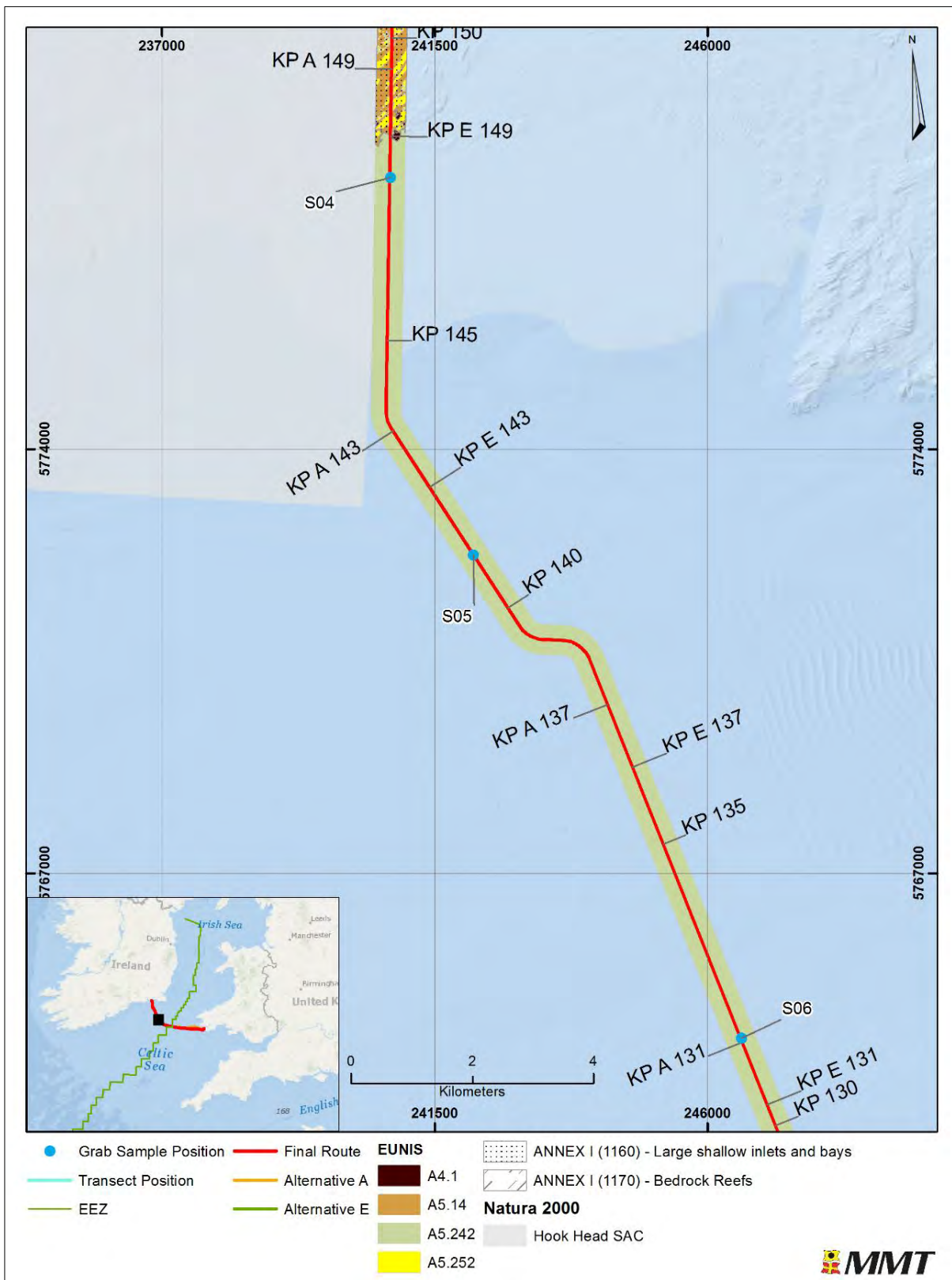


Figure 56 Overview of Irish EEZ KP 131 to KP 150.

Between KP 148.306 and KP 148.797 several areas of outcrops were classified as A4.1 - Atlantic and Mediterranean high energy circalittoral rock. These areas were predominantly located in the outer edges of the route corridor and further assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009). The assessment of these areas was predominately based on the interpretations of the geophysical data.

Between KP 150.442 and KP 150.726 a few scattered areas in the outer edges of the corridor were classified as A4.1 and as Annex I (1170) – Bedrock Reefs (Irving, 2009) with a few patches of A5.44 - Circalittoral mixed sediments (Figure 57). These interpretations were predominantly based on the interpretations of the geophysical data.

Grab sample site S03, at approximate KP 151.395, was located within habitat A5.252. The infaunal was characterised by polychaetes *O. borealis*, and *Spiophanes bombyx*, *L. cingulate*, amphipods *B. elegans*, *Urothoe elegans* and molluscs *A. prismatica* and *T. ovata*.

From KP 152.363 to KP 154.505 habitat A5.14 continued to dominate with intrusions of A5.25, KP 153.284 to KP 154.505. A few rocky areas interpreted from the geophysical data, between KP 153.118 and KP 154.484 were classified as A4.1 and as Annex I (1170) – Bedrock Reefs (Irving, 2009). These were predominantly located in the outer edges of the route corridor.

Grab sample site S02, at approximate KP 153.593, was located within habitat A5.14. the infaunal composition at S02 was characterised by polychaetes *Pista mediterranea*, *Psamathe fusca*, echinoderms *Amphipholis squamata*, holothurian *Thyone fusus*, molluscs *Gari telinella* and *Clausinella fasciata*.

From KP 154.505 to KP 157.712 the seabed along the final route was classified as A5.44. Between KP 154.505 and KP 155.966 a few rocky areas along the outer edges of the corridor were classified as A4.1 and as Annex I (1170) – Bedrock Reefs (Irving, 2009). These interpretations were predominantly based on the interpretations of the geophysical data. Intrusions of A5.14 and A525 were classified between KP 154.505 and KP 155.966.

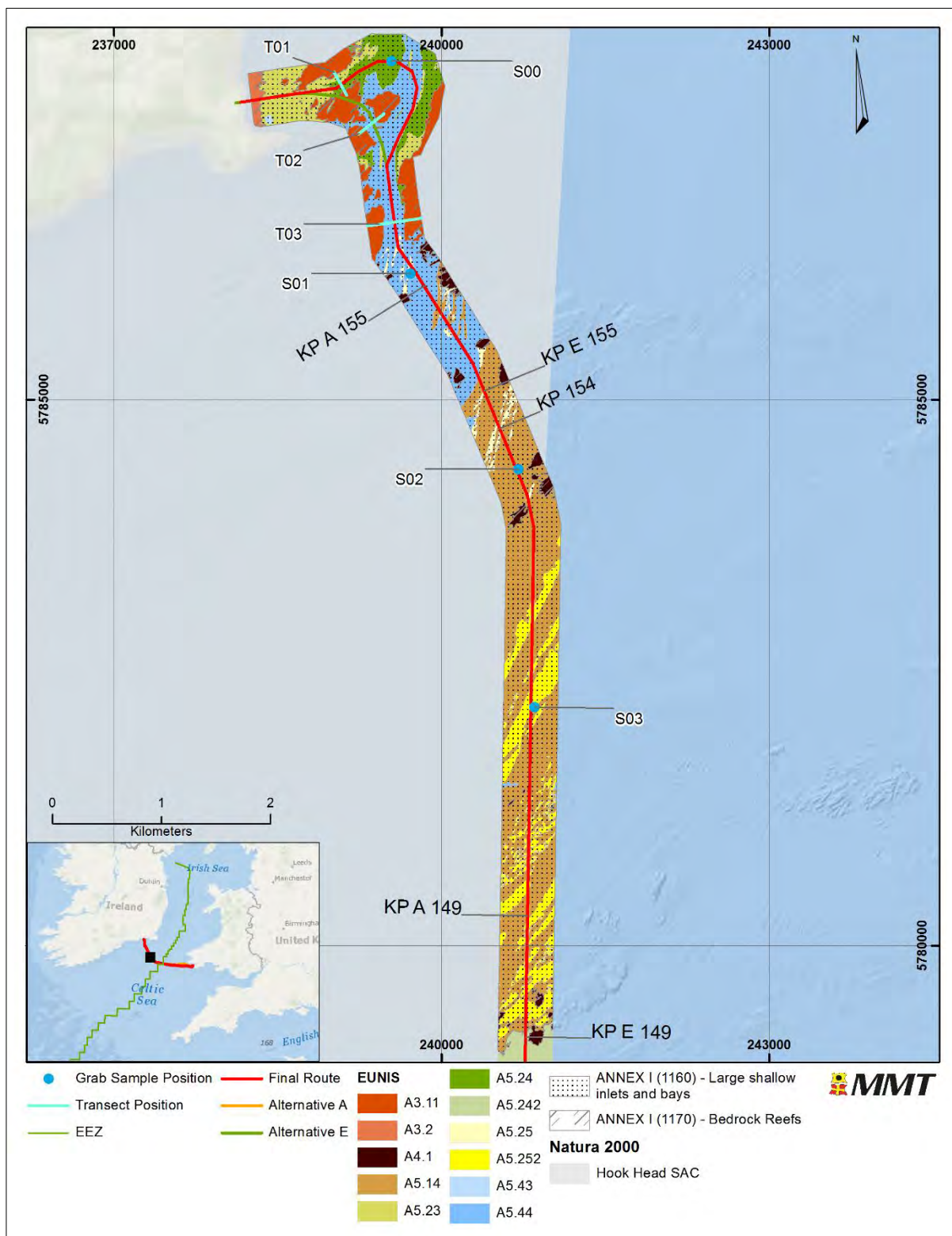


Figure 57 Overview of Irish EEZ KP 105 to KP 159.

Grab sample site S01, at approximate KP 155.639, was located at the boundary between A5.44 and A5.25. The infaunal analysis showed a small sample with regards to abundance and diversity, which was primarily characterised by crustaceans and polychaetes.

Transect DDV_T03, crossing the final route at approximate KP 156.149, had poor visibility.

From KP 155.966 to KP 157.712 areas of bedrock were interpreted along the edges of the route corridor. These were classified as A3.11 - Kelp with cushion fauna and/or foliose red seaweeds and assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009).

In the channel between the bedrock, KP 156.541 to KP 157.711 areas of A5.23 - Infralittoral fine sand and A5.24 - Infralittoral muddy sand were classified.

From KP 157.711 to KP 158.424 the seabed was classified as A5.24 with bands of A5.23. Grab sample site S00, at approximate KP, was located within habitat A5.24. The infaunal composition was characterised by molluscs *A. alba*, *F. fabula*, *Spisula subtruncata* and polychaetes *M. johnstoni* and *Nephtys hombergii*.

Transect DDV_T01 at approximate KP 158.266 had poor visibility in the imagery acquired.

From KP 158.424 to KP 159.070 the seabed along the route was classified as A5.23 with surrounding areas of bedrock classified as A3.11 which were assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009). From KP 159.070 to KP 159.267 the seabed was classified as A3.2 - Atlantic and Mediterranean moderate energy infralittoral rock and assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009). The assessment of the bedrock areas was predominately based on the findings at T01 as well as the interpretations of the geophysical data.

6.1.2 | ALTERNATIVE E

Route Alternative E diverges from the final route at approximate KP 156.190 (Final Route KP 156.667) and converges with the final route at approximate KP 157.412 (Final Route KP 158.759) (Figure 57).

From KP 156.190 to KP 156.817 the seabed along Alternative E was classified as A5.44 - Circalittoral mixed sediments.

An area of bedrock was classified as A3.11 - Kelp with cushion fauna and/or foliose red seaweeds and assessed to meet the criteria of Annex I (1170) – Bedrock Reefs (Irving, 2009). The bedrock areas extended from KP 156.817 to KP 157.049. Transect DDV_T02 at approximate KP 157.168 had poor visibility but kelp and red foliose red seaweeds were visible in the imagery acquired.

From KP 157.049 to KP 157.412 the seabed was dominated by A5.23 - Infralittoral fine sand with intrusions of A5.24 - Infralittoral muddy sand.

6.2 | SEDIMENT PARTICLE SIZE DISTRIBUTION

Samples for sediment particle distribution were acquired along the Final Route only. The full laboratory analyses results are presented in Appendix F|.

The results of the particle size analysis show that the sediment at the sites consisted mainly of sand, but for the three shallowest sites. Out of the three most shallow sites, site S00 mainly consisted of mud (clay and silt; 70 %), site S01 consisted mainly of sand (60 %) and site S02 consisted mainly of gravel (75 %) (Figure 58; Table 48). The sediment at the rest of the sites mainly consisted of sand (91 ± 6 %) tighter with smaller fractions of gravel (3 ± 2 %) and mud (6 ± 6 %).

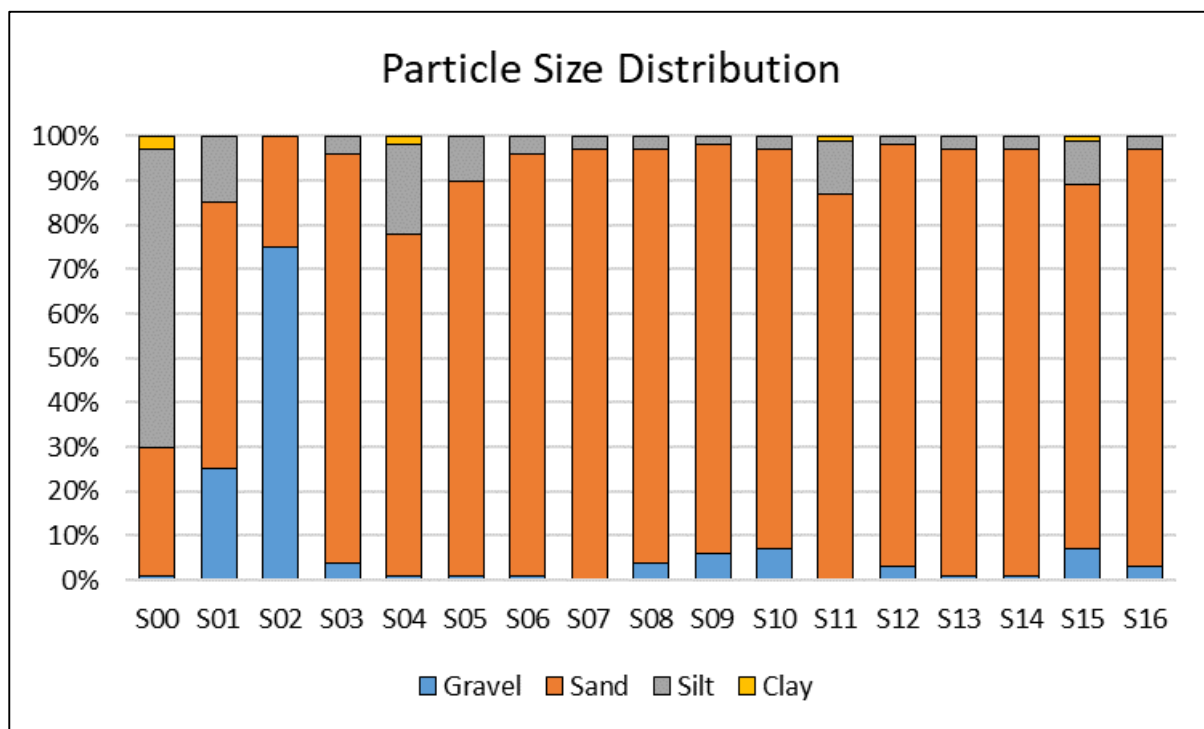


Figure 58 Bar chart displaying sediment fraction distribution across all grab sample sites.

Table 48 Summary of sediment distribution across all grab sample sites for Ireland.

GRAB SAMPLE ID	AREA	DEPTH	SEDIMENT FRACTION					FOLK DESCRIPTION
			GRAVEL	SAND	SILT	CLAY	MUD (CLAY & SILT)	
S00	IRL	13	1	29	67	3	70	Sandy mud
S01	IRL	21	25	60	15	0	15	Gravelly muddy sand
S02	IRL	27	75	25	0	0	0	Sandy gravel
S03	IRL	43	4	92	4	0	4	Sand
S04	IRL	31	1	77	20	2	22	Gravelly muddy sand
S05	IRL	43	1	89	10	0	10	Muddy sand
S06	IRL	57	1	95	4	0	4	Sand
S07	IRL	67	0	97	3	0	3	Sand
S08	IRL	70	4	93	3	0	3	Sand
S09	IRL	68	6	92	2	0	2	Gravelly sand
S10	IRL	66	7	90	3	0	3	Gravelly sand
S11	IRL	68	0	87	12	1	13	Muddy sand
S12	IRL	73	3	95	2	0	2	Sand
S13	IRL	71	1	96	3	0	3	Sand
S14	IRL	86	1	96	3	0	3	Sand
S15	IRL	104	7	82	10	1	11	Gravelly muddy sand

GRAB SAMPLE ID	AREA	DEPTH	SEDIMENT FRACTION					FOLK DESCRIPTION
			GRAVEL	SAND	SILT	CLAY	MUD (CLAY & SILT)	
S16	IRL	104	3	94	3	0	3	Sand
Mean			8	82	10	0	10	-
SD			18	23	16	1	17	-
Min			0	25	0	0	0	-
Max			75	97	67	3	70	-
Median			3	92	3	0	3	-

6.2.1 | MULTIVARIATE ANALYSES FOR SEDIMENT

Multivariate analyses were undertaken on the PSA data set, to identify spatial patterns in the sediment distribution. Analyses included hierarchical clustering employing the Euclidean distance resemblance matrix and the PCA. The dataset was normalised prior to analysis being undertaken.

The results from the hierarchical clustering analysis are presented in Figure 59 and Figure 60.

The SIMPROF analysis for the PSD output identified eight groups (black lines) separating the 18 grab sample sites within the survey area. Of these eight groups, three sub-groups were identified with similar characteristics.

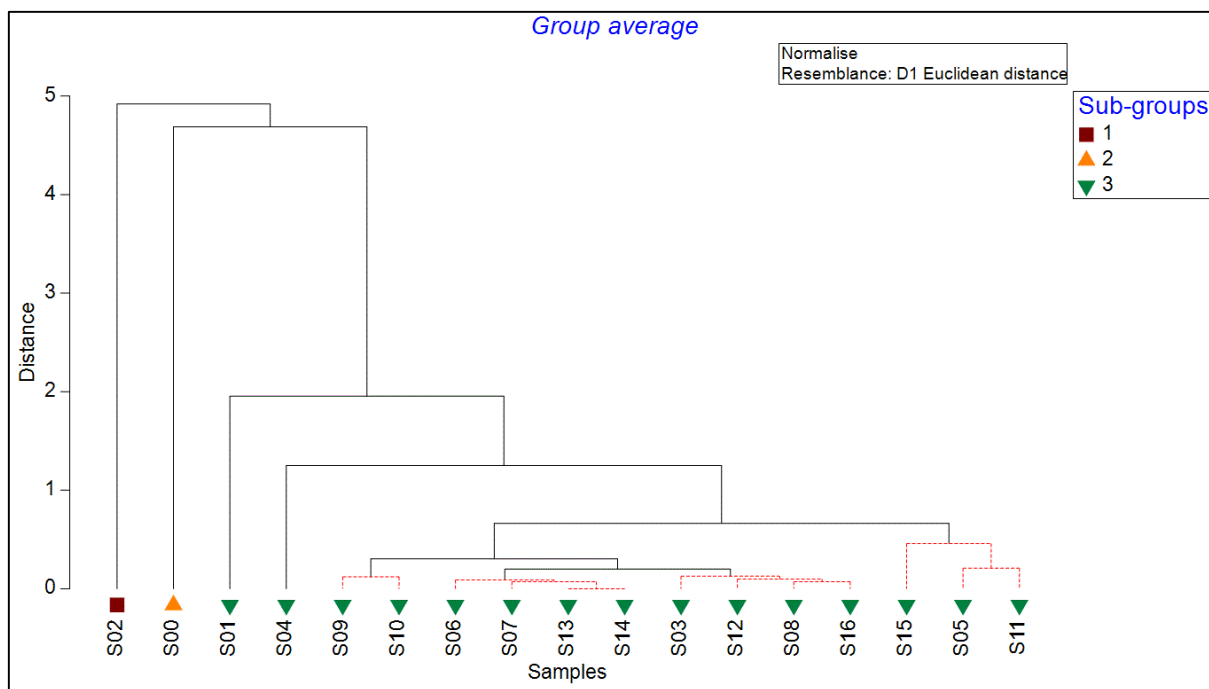


Figure 59 SIMPROF dendrogram based on sediment composition for each grab sample site.

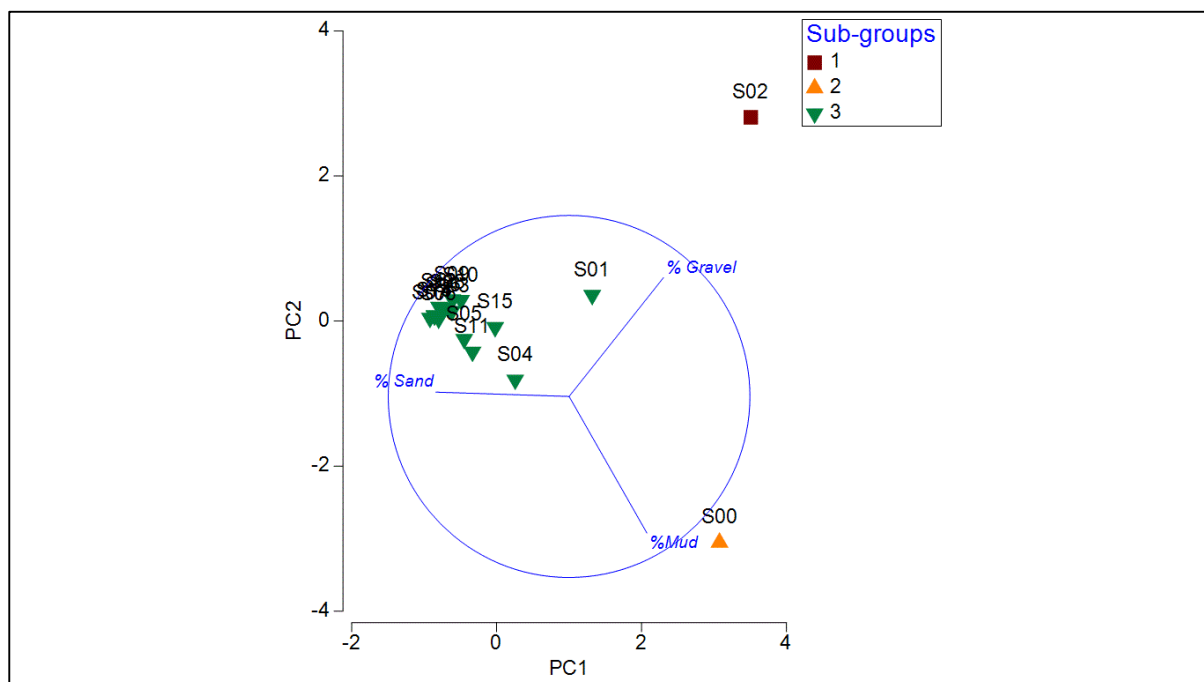


Figure 60 PCA plot of sediment data for each grab sample site, groups based on SIMPROF.

6.3 | CHEMICAL ANALYSES

All grab sample sites were selected for analyses of concentration of metals, organics and PAHs. Detailed results from the chemical analyses are stated in Appendix G|.

Grab samples for chemical analyses were not received from site S01, S02, S08 and S09 due to insufficient sample volume.

6.3.1 | METALS

Metal concentrations were low across all grab sample sites and rarely exceeded any threshold values with the exception of Arsenic (As) at grab sample sites S07, S10 and S12, where concentrations exceeded the CCME ISQG (Figure 61 and Table 49).

*Table 49 Summary of metal concentrations (µg/g dry weight) in sediment across grab sample sites together with threshold values.
Highlighted cells indicate where threshold values have been exceeded.*

ANALYTE	ARSENIC	CADMIUM	CHROMIUM	COPPER	LEAD	MERCURY	NICKEL	TIN
Limit of Detection	1	0.1	0.5	2	2	0.01	0.5	0.5
OSPAR ERL		1.2	81	34	47	0.15	-	-
CEFAS AL2	100	5	400	400	500	3	200	-
CEFAS AL1	20	0.4	40	40	50	0.3	20	-
CCME PEL	41.6	4.2	160	108	112	0.7	-	-
CCME ISQG	7.24	0.7	52.3	18.7	30.2	0.13	-	-
Dutch RIVM	85	14	380	240	580	10	210	-
Units	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
S00	5	0.2	28.2	6.8	12.9	0.01	11.3	1.1
S03	5.8	0.1	8.7	4.7	11.8	<0.01	4.6	<0.5
S04	2.8	<0.1	15.2	4.5	10.4	<0.01	5.6	<0.5
S05	2.8	<0.1	11	6.6	7.3	0.02	5.4	<0.5
S06	3	<0.1	13.5	5.3	7.3	0.01	5.5	<0.5
S07	9.3	<0.1	14	4.7	11.6	<0.01	6.2	<0.5
S10	8	<0.1	12.7	5.7	9.8	0.01	5.7	<0.5
S11	5.1	<0.1	11.9	7.5	9.5	<0.01	5.3	<0.5
S12	16.2	<0.1	15.8	6.2	10.1	<0.01	8.8	0.6
S13	5	<0.1	10.2	5.1	10	<0.01	4.9	0.5
S14	4	<0.1	14	6.3	8.4	<0.01	7.8	1
S15	5.1	<0.1	11	5.6	8	<0.01	5.4	0.4
S16	6.4	<0.1	16.2	7.6	10.9	<0.01	6.8	0.6
Mean	6.0	0.0	14.0	5.9	9.8	0.00	6.4	0.3
SD	3.6	0.1	4.8	1.0	1.7	0.01	1.9	0.3
Min	2.8	0.1	8.7	4.5	7.3	0.01	4.6	0.4
Max	16.2	0.2	28.2	7.6	12.9	0.02	11.3	1.1
Median	5.1	0.2	13.5	5.7	10.0	0.01	5.6	0.6

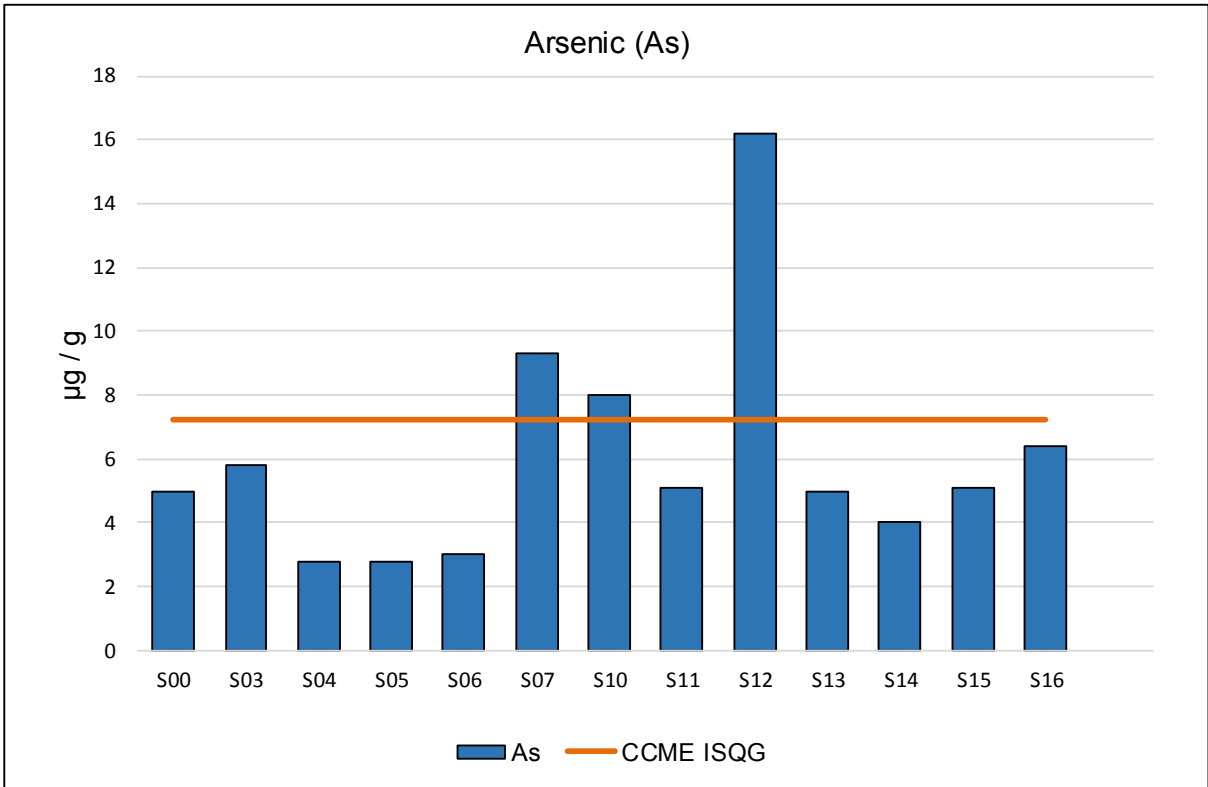


Figure 61 Arsenic (As) concentrations ($\mu\text{g/g}$ dry weight) in sediment across sample sites together with threshold values for CCME ISQG.

6.3.2 | ORGANICS AND MOISTURE

Concentrations of organics showed great variations between grab sample sites, whereas moisture content showed limited variation (Table 50).

Table 50 Summary of organics and moisture concentrations in sediment across grab sample sites.

ANALYTE	TOC	LOI	MOISTURE
Limits of detection	0.02	0.2	0.2
Units	%	%	%
S00	0.32	1.7	32.2
S03	0.16	1.5	26.2
S04	0.11	0.8	28.0
S05	0.12	0.8	24.0
S06	0.09	0.7	26.8
S07	0.08	0.6	27.7
S10	0.12	1.0	26.4
S11	0.08	5.4	25.3
S12	0.12	1.0	26.7
S13	0.11	1.0	16.0
S14	0.09	0.9	27.0
S15	0.25	1.6	23.0
S16	0.13	1.2	27.7
Mean	0.14	1.4	25.9
SD	0.07	1.2	3.6
Min	0.08	0.6	16.0
Max	0.32	5.4	32.2
Median	0.12	1.0	26.7

6.3.3 | PAH

Concentrations of PAHs varied greatly between grab samples sites (Table 51). Grab sample sites S00 and S15 had markedly higher concentrations of PAHs, whereas grab sample sites S03 and S11 had markedly low concentrations. Threshold values were not exceeded at any of the grab sample sites.

Table 51 Summary of PAH concentrations (µg/Kg dry weight) across grab sample sites.

ANALYTE	NAPHTHALENE	ACENAPHTHYLENE	ACENAPHTHENE	FLUORENE	PHENANTHRENE	DIBENZOTHIOPHENE	ANTHRACENE	FLUORANTHENE	PYRENE	BENZO[A]ANTHRACENE	CHRYSENE	BENZO[B]FLUORANTHENE	BENZO[K]FLUORANTHENE	BENZO[E]PYRENE	BENZO[A]PYRENE	INDENO[123,CD]PYRENE	DIBENZO[A,H]ANTHRACENE	BENZO[GH]PERYLENE	SUM OF ALL
LIMIT OF DETECTION	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
OSPAR ERL	160	-	-	-	240	190	85	600	665	-	384	-	-	-	430	240	-	85	-
CEFAS AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-
CCME PEL	391	128	88.9	144	544	-	245	1494	1398	693	846	-	-	-	763	-	135	-	-
CCME ISQG	34.6	5.87	6.71	21.2	86.7	-	46.9	113	153	74.8	108	-	-	-	88.8	-	6.22	-	-
UNITS	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
S00	1.78	<1	<1	1.17	4.03	<1	<1	7.47	5.74	3.48	4.71	5.94	3.67	3.94	3.88	4.84	<1	4.59	55.24
S03	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
S04	<1	<1	<1	<1	<1	<1	<1	1.34	<1	<1	<1	1.60	<1	1.09	<1	1.61	<1	1.61	7.25
S05	<1	<1	<1	<1	<1	<1	<1	1.03	<1	<1	<1	1.29	<1	<1	<1	1.36	<1	1.29	4.97
S06	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.11	<1	<1	<1	1.22	<1	1.26	3.59
S07	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.11	<1	<1	<1	1.15	<1	1.20	3.46
S10	<1	<1	<1	<1	1.14	<1	<1	1.34	<1	<1	1.02	1.66	<1	1.23	<1	1.62	<1	1.63	9.64
S11	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
S12	3.65	<1	<1	1.25	4.03	<1	<1	3.71	2.58	1.52	3.02	3.63	1.51	2.97	1.59	3.86	<1	3.78	37.10

ANALYTE	NAPHTHALENE	ACENAPHTHYLENE	ACENAPHTHENE	FLUORENE	PHENANTHRENE	DIBENZOTHIOPHENE	ANTHRACENE	FLUORANTHENE	PYRENE	BENZO[A]ANTHRACENE	CHRYSENE	BENZO[B]FLUORANTHENE	BENZO[K]FLUORANTHENE	BENZO[E]PYRENE	BENZO[A]PYRENE	INDENO[123,CD]PYRENE	DIBENZO[A,H]ANTHRACENE	BENZO[GH]PERYLENE	SUM OF ALL
LIMIT OF DETECTION	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
OSPAR ERL	160	-	-	-	240	190	85	600	665	-	384	-	-	-	430	240	-	85	-
CEFAS AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-
CCME PEL	391	128	88.9	144	544	-	245	1494	1398	693	846	-	-	-	763	-	135	-	-
CCME ISQG	34.6	5.87	6.71	21.2	86.7	-	46.9	113	153	74.8	108	-	-	-	88.8	-	6.22	-	-
UNITS	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
S13	1.92	<1	<1	<1	2.81	<1	<1	2.07	1.45	<1	1.73	1.48	<1	1.58	<1	1.75	<1	1.70	16.49
S14	1.08	<1	<1	<1	1.49	<1	<1	1.76	1.18	<1	1.30	1.77	<1	1.39	<1	1.70	<1	1.70	13.37
S15	4.57	<1	<1	1.97	5.89	<1	<1	6.75	4.67	2.80	4.76	6.18	3.18	4.64	3.27	5.43	1.06	5.09	60.26
S16	2.32	<1	<1	1.23	3.84	<1	<1	4.08	2.86	1.77	3.16	3.64	1.98	2.99	2.05	3.76	<1	3.60	37.28
Mean	1.2	0.0	0.0	0.4	1.8	0.0	0.0	2.3	1.4	0.7	1.5	2.3	0.8	1.5	0.8	2.2	0.1	2.1	19.1
SD	1.3	-	-	0.4	1.6	-	-	2.4	1.8	0.9	1.5	1.9	1.0	1.4	1.1	1.6	-	1.5	21.2
Min	1.1	0.0	0.0	1.2	1.1	0.0	0.0	1.0	1.2	1.5	1.0	1.1	1.5	1.1	1.6	1.2	1.1	1.2	3.5
Max	4.6	0.0	0.0	2.0	5.9	0.0	0.0	7.5	5.7	3.5	4.8	6.2	3.7	4.6	3.9	5.4	1.1	5.1	60.3
Median	2.1	-	-	1.2	3.8	-	-	2.1	2.7	2.3	3.0	1.7	2.6	2.3	2.7	1.7	1.1	1.7	13.4

6.4| MULTIVARIATE ANALYSIS OF GRAB SAMPLES

Multivariate analysis was undertaken using the Plymouth Routines in PRIMER v7.0 statistical package (Clarke K. &, 2015). The statistical analyses are based on macrofaunal data derived from the taxonomic analysis of the grab samples at each location. No faunal sample was retrieved from grab sample site S08. All grab samples were located along the Final Route.

The SIMPROF analysis on faunal composition produced nine statistically distinct groups (black lines). Of these nine groups, five sub-groups were identified. The five groups were relatively far from each other, with the basal split in the dendrogram at 20 % average similarity. Both replicates from grab sample site S02 and S01_B differed from the rest of the sample sites. (Figure 62, Figure 63 and Table 52).

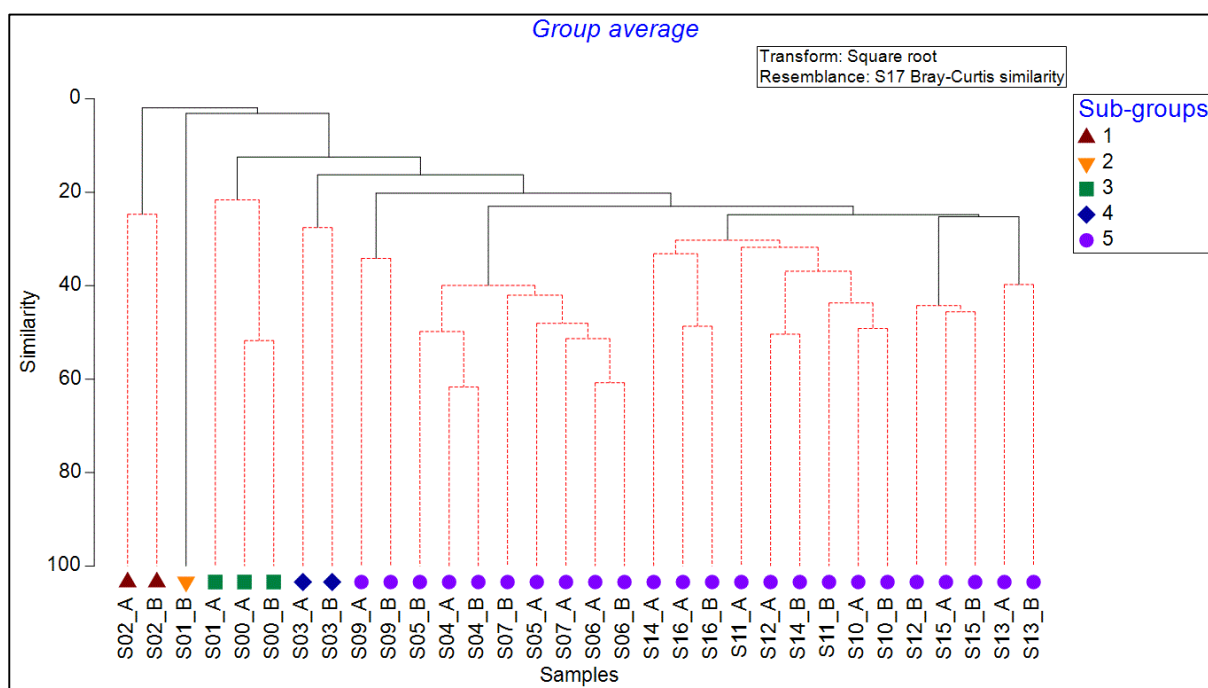


Figure 62 SIMPROF dendrogram based on faunal composition for each grab sample site and replicate.

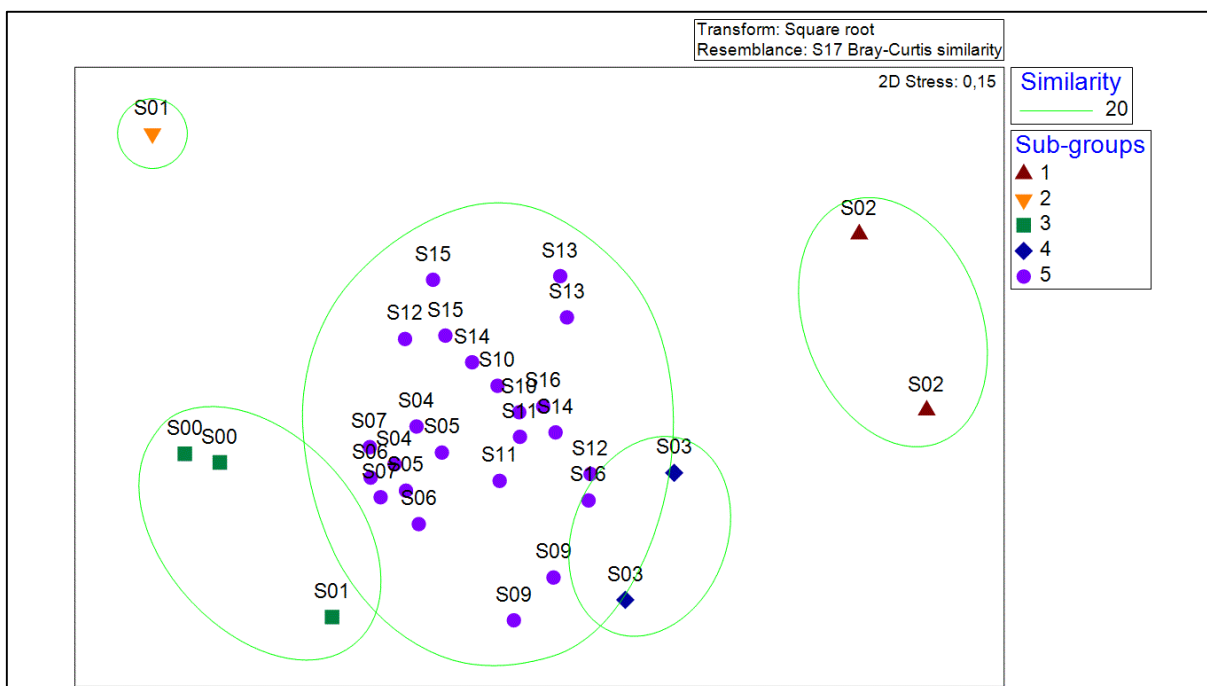


Figure 63 nMDS plot on faunal composition for each grab sample site and replicate, groups based on SIMPROF.

Group 1 consisted of both replicates from site S02 (S02_A, S02_B) and group 2 consisted of one replicate from site S01 (S01_B). Group 3 consisted of both replicates from site S00 (S00_A, S00_B) and the other replicate from site S01 (S01_A). Group 4 consisted of both replicates from site S03 (S03_A, S03_B). Group 5 was the largest group that comprised most samples and consisted of both replicates from site S04 to S16. The highest average similarity was found in group 3 (31.67 %) and the lowest in group 1 (24.73 %). This low similarity within groups suggest a difference in faunal composition in the groups.

Table 52 Characteristics of groups identified by SIMPROF analysis on abundance of non-colonial fauna.

GROUP	SAMPLES	PHYSICAL FEATURES	SPECIES	AVERAGE ABUNDANCE	CONTRIBUTION (%)		
1	S02 (A&B)	Depth: 27 m	<i>Sphaerosyllis bulbosa</i>	4.0	25.73		
Average Similarity:		Sediment: Sandy gravel	Nematoda	3.0	14.85		
24.73 %			<i>Glycera lapidum</i>	1.5	14.85		
			<i>Trypanosyllis coeliaca</i>	1.0	14.85		
2	S01_B	Depth: 21 m	<i>Sclerocheilus</i>	2	-		
Less than two samples in group		Sediment: Gravelly muddy sand	<i>Scolecopsis korsuni</i>	1			
			<i>Parexogone hebes</i>	1			
			<i>Magelona johnstoni</i>	1			
			<i>Heteroclymene robusta</i>	1			
			<i>Echinocyamus pusillus</i>	1			
3	S00 (A&B) S01_B	Depth: 13 – 21 m	<i>Abra alba</i>	17.7	28.41		
Average Similarity:		Sediment: Sandy mud, Gravelly muddy sand	<i>Nucula nitidosa</i>	3.0	26.13		
			<i>Fabulina fabula</i>	2.67	19.61		
			31.67 %				
4	S03 (A&B)	Depth: 43 m	<i>Urothoe elegans</i>	4.5	36.94		
Average Similarity:		Sediment: Sand	<i>Lumbrineris cingulata</i>	5.5	26.12		
			<i>Bathyporeia elegans</i>	1.5	18.47		
			27.54 %				
5	S04 (A&B)	Depth: 31 – 104 m	<i>Abra prismatica</i>	4.7	13.96		
	S05 (A&B)		<i>Echinocyamus pusillus</i>	2.2	12.54		
	S06 (A&B)		<i>Amphiura filiformis</i>	4.0	7.29		
	Average Similarity:	S07 (A&B)	Sediment: Sand, Gravelly muddy sand, Muddy sand, Gravelly sand	<i>Spiophanes bombyx</i>	1.9	6.51	
		S09 (A&B)		<i>Owenia sp</i>	3.4	5.68	
		S10 (A&B)		<i>Phoronis sp</i>	1.5	3.53	
		S11 (A&B)		<i>Fabulina fabula</i>	3.5	3.2	
		S12 (A&B)		<i>Scoloplos armiger</i>	1.0	3.04	
		S13 (A&B)		<i>Bathyporeia elegans</i>	1.1	2.82	
		S14 (A&B)		<i>Nucula nitidosa</i>	2.0	2.79	
		S15 (A&B)		<i>Kurtiella bidentata</i>	3.9	2.74	
		S16 (A&B)		<i>Ophelia borealis</i>	1.1	2.43	
				Nemertea	0.8	2.35	
				<i>Magelona johnstoni</i>	1.9	2.01	
		26.83 %					

The resulting EUNIS habitat classification for each site is presented in Figure 64. The different habitats can in some extent be related to the sub-groups identified in the SIMPROF analysis. EUNIS habitat classification A5.14 was the only habitat found within sub-group 1 (grab sample site S02). Habitat classification A5.242, A5.251 and A5.272 was found within sub-group 5. Habitat classification A5.252 was only found within sub-group 4 (grab sample site S03). Sub-group 2, with one replicate of S01, was classified as A5.44. Sub-group 3, with one replicate of S01 and site S00, included both A5.44 and A5.24.

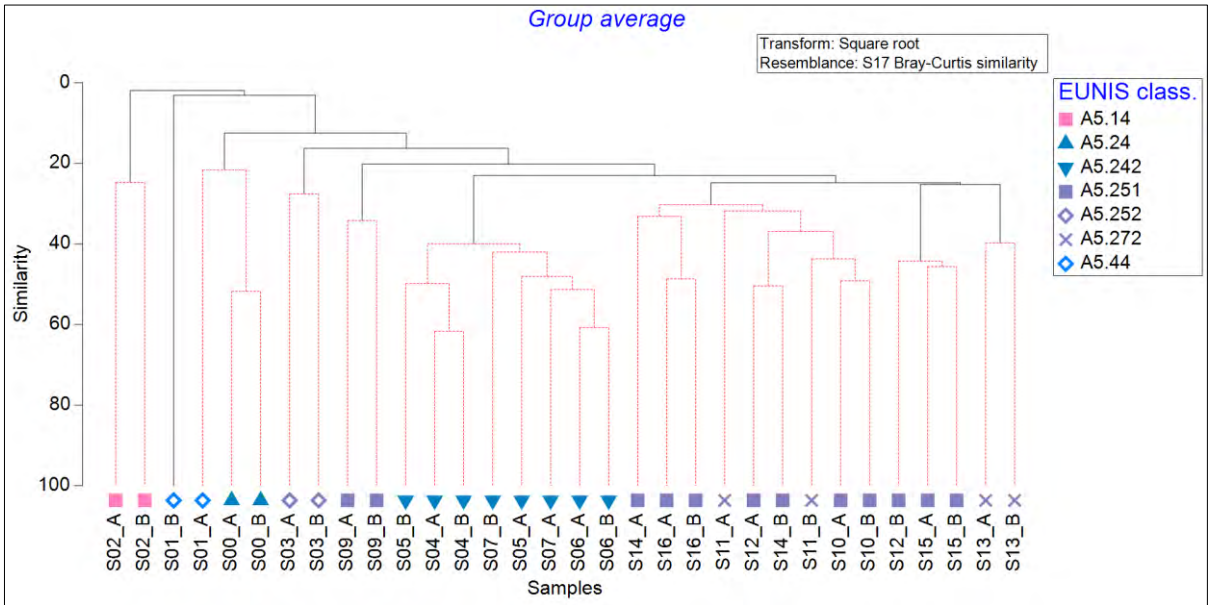


Figure 64 SIMPROF dendrogram based on faunal composition with EUNIS habitat classification overlay for each grab sample site and replicate.

6.5 | POTENTIAL AREAS AND SPECIES OF CONSERVATION

The habitats in the Irish EEZ corresponding to those defined in the EC Habitats directive (EUR 27, 2007) are listed in separate sections for each route alternative.

Figures displaying detailed overview of the potential areas of conservation concern are displayed in Figure 65.

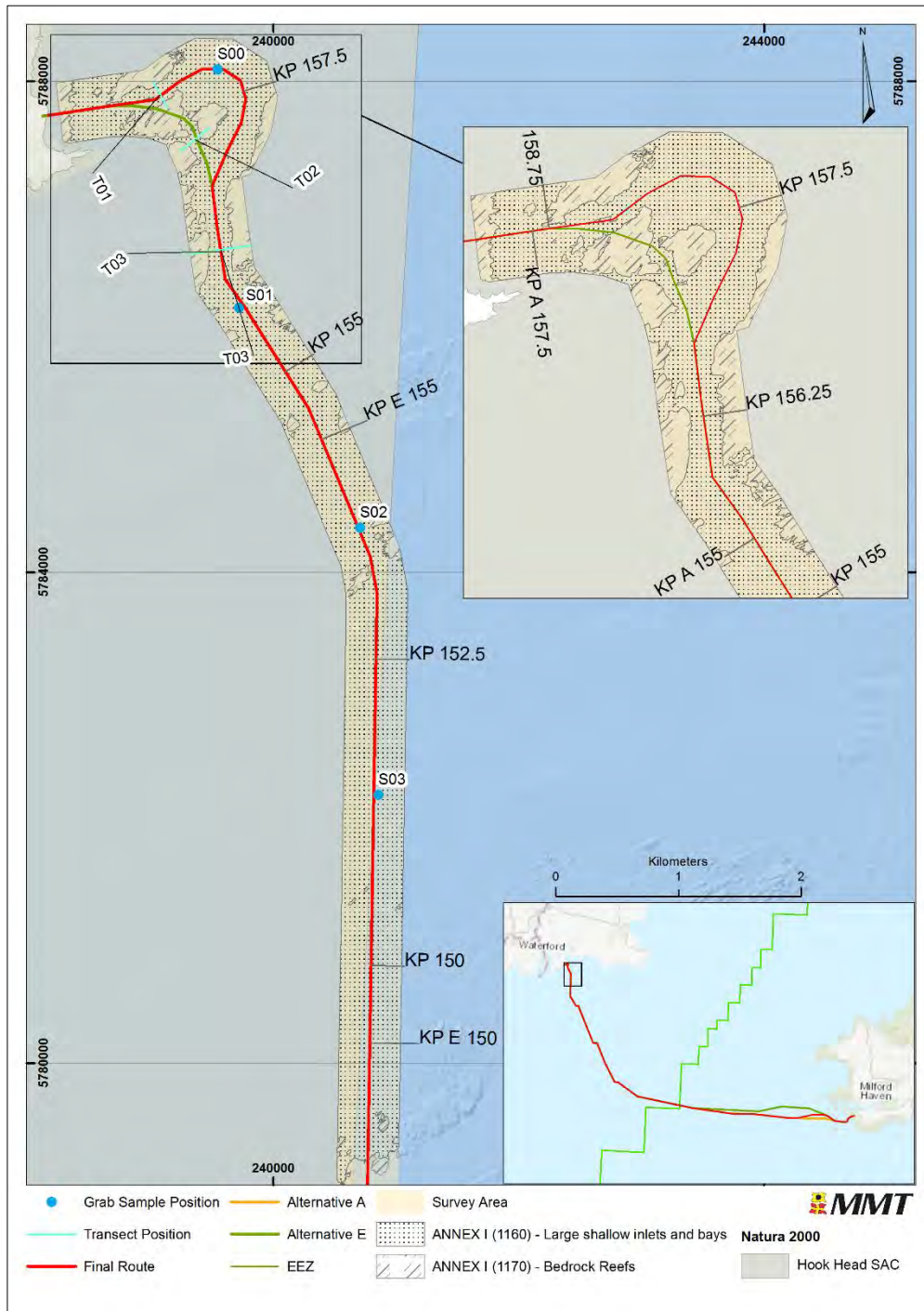
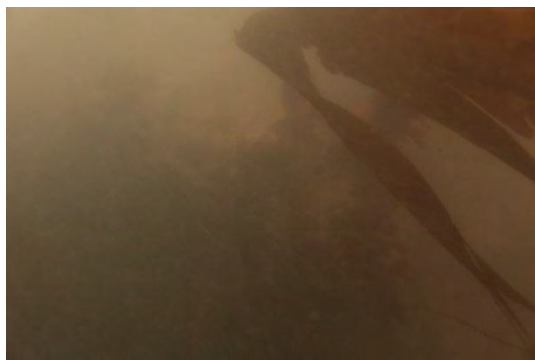


Figure 65 Overview of Annex I areas in Irish EEZ between KP 149 and KP 159.

6.5.1 | FINAL ROUTE

Annex I habitats identified within the final route survey corridor are presented in Table 53.

Table 53 Annex I habitats or species of special interest identified within the survey corridor.

HABITAT IMAGE	ANNEX I	OSPAR/MPA	SITE ID
	Annex I (1170) - Bedrock reef	Hook Head SAC	T01, T02, T03

ANNEX I (1170) - STONY REEFS

Bedrock outcrops were identified in the geophysical data edging the Final Route corridor in the Irish EEZ. Photo transects were performed across the corridor at several locations (T03 at KP 156.136, T01 at KP 158.318). However, no habitats or associated fauna was recorded from the transects located along the Final Route due to very poor visibility from suspended sediment in the water column. One successful transect was performed on alternative E (Transect T02), showing kelp on bedrock. All outcropping bedrock shallower than 20 m, were classified to A3.11 and thus assessed to meet the criteria for Annex I (1170) - Bedrock reefs. No areas that could be classified as Stony Reefs were interpreted in the data acquired.

ANNEX I (1170) - SABELLARA SPINULOSA REEFS

No *S. spinulosa* was identified in any of the grab samples in the Irish EEZ.

6.5.2 | ALTERNATIVE E

ANNEX I (1170) - STONY REEFS

Transect T02, crossing the alternative E at KP 156.911, showed rocky outcrops with kelp and red algae. Multiple areas of outcropping bedrock were identified in the geophysical data. All were classified to A3.11 (Figure 66). These areas were assessed to meet the criteria for Annex I (1170) - Bedrock reefs. No areas that could be classified as Stony Reefs were interpreted in the data acquired.



Figure 66 Image T02_001 of Annex I (1170) – Bedrock Reefs with the habitat A3.11 – Kelp with cushion fauna and/or foliose red seaweeds.

ANNEX I (1170) - SABELLARA SPINULOSA REEFS

No *S. spinulosa* was identified in any of the grab samples in the Irish EEZ. Due to the poor visibility, no fauna was identified.

6.5.3 | HOOK HEAD SAC

The route crosses the Hook Head SCA between KP 151.258 and the landfall in Baginbun, KP 159.267.

The SAC include the following Annex I habitats: 1160 - Large shallow inlets and bays, 1170 - Reefs, and 1230 - Vegetated sea cliffs of the Atlantic and Baltic coasts (NPWS, 2018).

The section of the survey corridor that crosses the SAC is mainly classified as 1160, with areas of 1170 bedrock reef. The cliffs just inside the landfall are classified as 1230 (NPWS, 2011).

None of the invertebrate species listed in the Natura 2000 standard data form for Hook Head (NPWS, 2018) was identified in the grab samples. Areas of *Laminaria* sp. was identified on outcropping bedrock within the Irish EEZ (Figure 66).

7 | DISCUSSION

In total 38 sampling locations were investigated during the benthic survey. In addition, 38 photo transects were performed over where potential areas of conservation were identified from the geophysical data.

In general, the variation was larger in the UK section of the survey corridor, than in the Irish section, this can be seen in the number of habitats identified, 25 habitats were identified in the UK section, and 12 in the Irish section, it is also reflected in the PSA, where the sites in the Irish section are more homogeneous compared to the sites in UK section.

Bedrock reefs have been hard to discriminate as much of the bedrock elevated above surrounding seabed is partly or totally covered by sand and gravel, with only small patches protruding with epifauna on them. Due to this some areas were classified as Potential Bedrock Reefs.

Two areas of low grade, and one of medium grade Biogenic Reef (1170)- *S. spinulosa* reef were identified in this survey. *S. spinulosa* habitats were identified along major parts of the UK Final Route survey corridor, but only a minority of the area were considered to meet the criteria of Annex I (1170) – Biogenic reef (Gubbay, 2007). The *S. spinulosa* that was identified in the imagery was often occurring on bedrock, and thus it fell under the Annex I (1170) - Bedrock Reefs. The elevation of the *S. spinulosa* aggregation rarely exceeded 5 cm, and was never assessed to exceed 10 cm. However, the elevation and extent of the *S. spinulosa* aggregations on bedrock are hard to evaluate outside the boundaries of the visual survey corridor, as the *S. spinulosa* structures are hard to discriminate from outcrops of bedrock with low elevation, and stony areas. Where this discrimination was arbitrary areas were classified to Potential Biogenic Reefs.

The *S. spinulosa* was often abraded, likely due to natural abrasion caused by sand drifting by the strong currents.

S. spinulosa was recorded in transect RR_T07. Areas of solidified sandy aggregations, possibly abraded remnants of an *S. spinulosa* reef, was observed along the transect. Due to the low elevation of the few newly formed tubes in the area, the area was not considered to meet the definition of a *S. spinulosa* reef. However, the area is clearly influenced by the aggregations, with a rich epifaunal community associated with the concrete sandy formation in the seabed.

The visibility was poor in the nearshore area of Irish landfall.

No *S. spinulosa* was identified in any of the grab samples acquired within the Irish EEZ. The visibility in the nearshore area of the Irish EEZ was very poor. No biogenic reefs were identified within the Irish EEZ.

The reef habitats found in Hooks Head SAC are Bedrock and Stony Reefs of three community types: Exposed to moderately exposed intertidal reef community complex, Echinoderm and sponge dominated community complex, and *Laminaria* dominated community (NPWS, 2011).

Concentrations of *Mytilus edulis* on for recorded on three transects along route alternative A, however none of these were classified as Annex I *Mytilus* reef, as the bedrock was the major epifauna supporting habitat, therefore they were classified as Bedrock Reefs.

The grab sample sites within the UK sector comprised of coarse sediment, consisting nearly exclusively of sand and gravel. However, the sand to gravel proportion differed from site to site. Whereas in the Irish sector, all grab sample sites, but the three closest to the Irish landfall, the sediment was highly homogeneous and comprised nearly exclusively of sand. The three sites closest to the Irish landfall were more heterogeneous, with site S02 comprising mainly of gravel and site S00 comprising mainly of mud.

The sediment composition of the UK and Irish areas of the route differ notably with more homogenous sandy sediment in the Irish section and more heterogeneous coarser sediment in the UK section.

The change occurs somewhere between site S19 and S20, site S19 comprising of 94% sand and site S20 comprising of 49 % gravel and 26 % sand. This transition in particle size coincides with the change in peak tidal current velocity which generally decreases with increased KP and most likely drops below 0.5 m/s in-between KP 50 and KP 70 (Coscia, Robins, Porter, Malham, & Ironside, 2013; Lewis, Neill, Robins, & Hashemi, 2015). The higher current velocity on the UK side is most likely re-suspending and transporting finer sediment, leaving behind only coarser sediment such as coarse sand and gravel (Hjulstrom, 1935).

Metal concentration were low across all grab sample sites and did not exceed any threshold values but for Arsenic (As), which exceeded the CCME ISQG threshold levels for three sites in the Irish section (S07, S010 and S12), and at all sites in the UK sector except for three sites, the two sites closest to the UK landfall (S35 & S37) and S17. No correlations were found between arsenic concentration and sediment composition nor any other parameters measured.

The concentration of organics varied more across the sites in the Irish section than across the sites in the UK section, the moisture content showed limited variation across both the UK and Irish sites. In the Irish sites the TOC correlates with the sand/mud content, TOC concentrations decreasing with increased sand content and increasing with increased mud content. Such a correlation cannot be seen in the UK sites.

The concentrations of PAH's varied greatly across all grab sample sites. The levels were overall low and did not exceed any threshold value but for site S33, where naphthalene exceeded the CCME ISQG threshold level. Any correlation between the high concentration and any other measured value was not found.

In total 38 photo transects and 38 grab sample locations were sampled, together with geophysical data, they form the basis of the assessment in this report, where a total of 33 habitats were identified within the survey corridor, 12 in the Irish section and 25 in the UK section. Further three potential Annex I habitats: 1160 Large shallow inlets and bays, 1170 Reefs, with its three subtypes "Bedrock Reef", "Stony Reef", and "Biogenic Reef", as well as 1110 Sandbanks which are slightly covered by sea water all the time were identified within the corridor.

8 | RESERVATIONS AND RECOMMENDATIONS

The definition of a reef is still a subject to debate within and among the member countries in the EU.

The JNCC report No. 405 “*Defining and managing Sabellaria spinulosa reefs: Report of an inter-agency workshop 1-2 May*” (Gubbay, 2007) presents methods for defining *S. spinulosa* reef structures and setting different criteria to assess the quality of the reef. The report stated the following as the baseline for the definition of *S. spinulosa* reefs:

“The simplest definition of Sabellaria spinulosa reef in the context of the Habitats Directive was considered to be an area of Sabellaria spinulosa which is elevated from the seabed and has a large spatial extent. Colonies may be patchy within an area defined as reef and show a range of elevations.”

A number of evaluation criteria were agreed upon in this report to be considered as “*a starting point for wider discussion rather than accepted and fully agreed thresholds for Sabellaria spinulosa reef identification*” (Gubbay, 2007).

9 | REFERENCES

- BRIG (ed. Ant Maddock). (2008 (Updated Dec 2011)). *UK Biodiversity Action Plan Priority Habitat Descriptions*. JNCC.
- Brig, M. (2008 (Updated Dec 2011)). *UK Biodiversity Action Plan Priority Habitat Descriptions*. JNCC.
- British Standard. (2010). *Methods of test for soils for civil engineering purposes 1377-2:1990*. BSI.
- BS 1377-1:1990. (n.d.). *Methods of test for soils for civil engineering purposes*. BSI.
- Clarke KR, G. R. (2006). PRIMER v6: User Manual/Tutorial. PRIMER-E. Plymouth, 192pp.
- Clarke, K. &. (2015). *PRIMER v7: User Manual/Tutorial*. Plymouth: PRIMER-E.
- Clarke, K. R., & Warwick, R. M. (2001). *Change in marine communities: An approach to statistical analysis and interpretation, 2nd edition*. Plymouth: PRIMER-E.
- Coscia, I., Robins, P. E., Porter, J. S., Malham, S. K., & Ironside, J. E. (2013). Modelled larval dispersal and measured gene flow: seascape genetics of the common cockle *Cerastoderma edule* in the southern Irish Sea. *Conservation Genetics*, 451-466.
- Dickey-Collas et al. (2010). *Lessons learned from stock collapse and recovery of North Sea herring: A review*. ICES Journal of Marine Science 67(9):1875-1886.
- Environment, C. C. (1995). *Protocol for the derivation of Canadian sediment quality guidelines for the protection of aquatic life*.
- Environment, C. C. (2001). *Canadian sediment quality guidelines for the protection of aquatic life: Introduction. Updated*.
- EUR 27. (2007). Interpretation manual of European Union Habitats. COMMISSION, EUROPEAN.
- European Commission. (2007). Interpretation manual of European Union Habitats - EUR 27. European Commission.
- European Commission. (2017, March 30). *Lead EQS dossier 2011*. Retrieved from CIRCABC: <https://circabc.europa.eu/sd/d/be12c5a9-19b2-40eb-87ce-f62eb3b43b39/Lead%20and%20its%20compounds%20EQS%20dossier%202011.pdf>
- Fariñas-Franco, J. P. (2014). *Marine Strategy Framework Directive Indicators for Biogenic Reefs formed by Modiolus modiolus, Mytilus edulis and Sabellaria spinulosa*. Peterborough: JNCC.
- Fey, D. P., Hiller, A., Laak, M. v., & Szymanek, L. (2014). *Herring - An analysis of spawning ground management, ecological conditions and human impacts in Greifswald Bay, Vistula Lagoon and Hanö Bight*. Malmö: CA Andersson.
- Fey, D. P., Hiller, A., Margonski, P., Moll, D., Nilsson, H., Pongolini, L., . . . and Szymanek. (2014). *HERRING Impact Report Herring spawning areas*.
- Gubbay, S. (2007). *Defining and managing Sabellaria spinulosa reefs: Report of an inter-agency workshop Report of an inter-agency workshop*. Joint Nature Conservation Committee.

- Hin, J. A. (2010). *Guidance document for Sediment Assessment*. Ministry of Infrastructure and the Environment.
- Hjulstrom, F. (1935). Studies of the morphological activity of rivers as illustrated by the River Fyris, Bulletin. *Geological Institute Upsala*.
- Holt et al. (1998). *Biogenic Reefs (volume IX). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs*. UK Marine SACs Project.
- Holt, T. R. (1998). *Biogenic Reefs (volume IX). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Science (UK Marine SACs Project).
- Irving, R. (2009). *The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 26-27 March 2008*. Peterborough: JNCC Report No.432.
- J. R. Ellis, S. M. (2012). *Spawning and nursery ground of selected fish species in UK waters*. Lowestoft: Cefas.
- JNCC. (2010, 12 15). *UK Priority species data collation*. Retrieved from Ammodytes marinus Ver 2: http://jncc.defra.gov.uk/_speciespages/2029.pdf
- JNCC. (2015). *NATURA 2000 - Standard Data Form, UK0013116, Pembrokeshire Marine/ Sir Benfro Forol*. Natura 2000.
- JNCC. (2015). *NATURA 2000 - Standard Data Form, UK9014061, Castlemartin Coast*. Natura 2000.
- JNCC. (2017, January 25). Retrieved from SAC Selection: <http://jncc.defra.gov.uk/protectedsites/sacselection/habitat.asp?FeatureIntCode=H1170>
- JNCC. (2017). *NATURA 2000 - Standard Data Form, UK9014051, Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a*. Natura 2000.
- Lewis, M., Neill, S. P., Robins, P. E., & Hashemi, M. R. (2015). Resource assessment for future generations of tidal-stream energy arrays. *Energy*.
- Marine Scotland. (2014). *Fish and Shellfish Stocks 2014 Edition*. The Scottish Government.
- Marine Scotland Science. (2016). *Fish and Shellfish Stocks 2016 Edition*. Edinburgh: Scottish Government.
- MESH. (2012). *Recommended Operational Guidelines (ROG) for grab sampling and sorting and treatment of samples*. MESH Atlantic.
- Offshore Energy SEA. (2017, January 18). Retrieved from <https://www.gov.uk/>: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/194336/0ES_A3a4_Fish.pdf
- OSPAR. (2011). *CEMP 2011 assessment report*.
- OSPAR. (2013). *Background document on Sabellaria spinulosa reefs*. 978-1-909159-47-1.

- PLA. (2017, March 30). *Canadian Sediment Quality Guidelines for the Protection of Aquatic Life*. Retrieved from Port of London Authority: <https://www.pla.co.uk/Environment/Canadian-Sediment-Quality-Guidelines-for-the-Protection-of-Aquatic-Life>
- Project, U. M. (2017, March 30). *UKmarinesac.org*. Retrieved from Interim marine sediment quality guidelines (ISQGs) and probable effect levels (PELs; dry weight) (from CCME 1999): http://www.ukmarinesac.org.uk/activities/water-quality/wq4_3_2.htm
- Saunders G., B. G. (2011). *Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 5. Benthic Habitats*.
- Scottish Biodiversity Forum. (2009). *Biodiversity Scotland*. Retrieved from Scottish Biodiversity List: <http://www.biodiversityscotland.gov.uk/>
- The Council of the European Communities. (1992). *Council Directive 92/43/EEC of 21 May 1992 on the conservation of the natural habitats and of wild fauna and flora*.
- Tyler-Walters, H. J. (2016, January 10). *Descriptions of Scottish Priority Marine Features (PMFs)*. Scottish Natural Heritage Commissioned Report No. 406. Retrieved from <http://www.snh.gov.uk/>: <http://www.snh.gov.uk/docs/A1327320.pdf>
- UK Marine SAC's Project. (2017, March 30). *Interim marine sediment quality guidelines (ISQGs) and probable effect levels (PELs; dry weight) (from CCME 1999)*. Retrieved from UK Marine SAC's Project: http://www.ukmarinesac.org.uk/activities/water-quality/wq4_3_2.htm
- UN. (5 June 1992). *Convention on Biological Diversity*. (pp. 1-28). Rio De Janeiro: UN.
- Worsfold, T., & Hall, D. (2010). *National Marine Biological Analytical Quality Control Scheme. Guidelines for processing marine macroninvertebrate samples: a Processing Requirements Protocol, s.l. NMBAQC*.

APPENDIX A 	SAMPLE POSITION LIST
APPENDIX B 	GRAB FIELD PROTOCOLS
APPENDIX C 	TRANSECT FIELD PROTOCOLS
APPENDIX D 	GRAB ID PROTOCOLS
APPENDIX E 	TRANSECT ID PROTOCOLS
APPENDIX F 	PARTICLE SIZE ANALYSIS RESULTS
APPENDIX G 	CHEMICAL ANALYSIS
APPENDIX H 	CTD DATA