Optimising the decommissioning and artificial reef creation of pipeline protection structures in the North Sea

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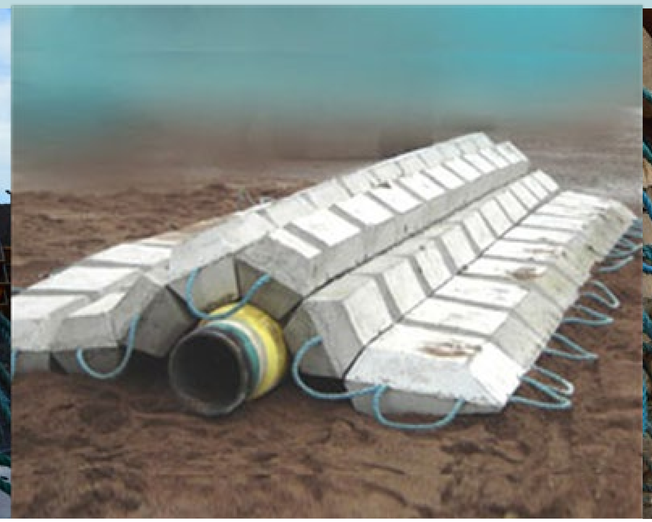

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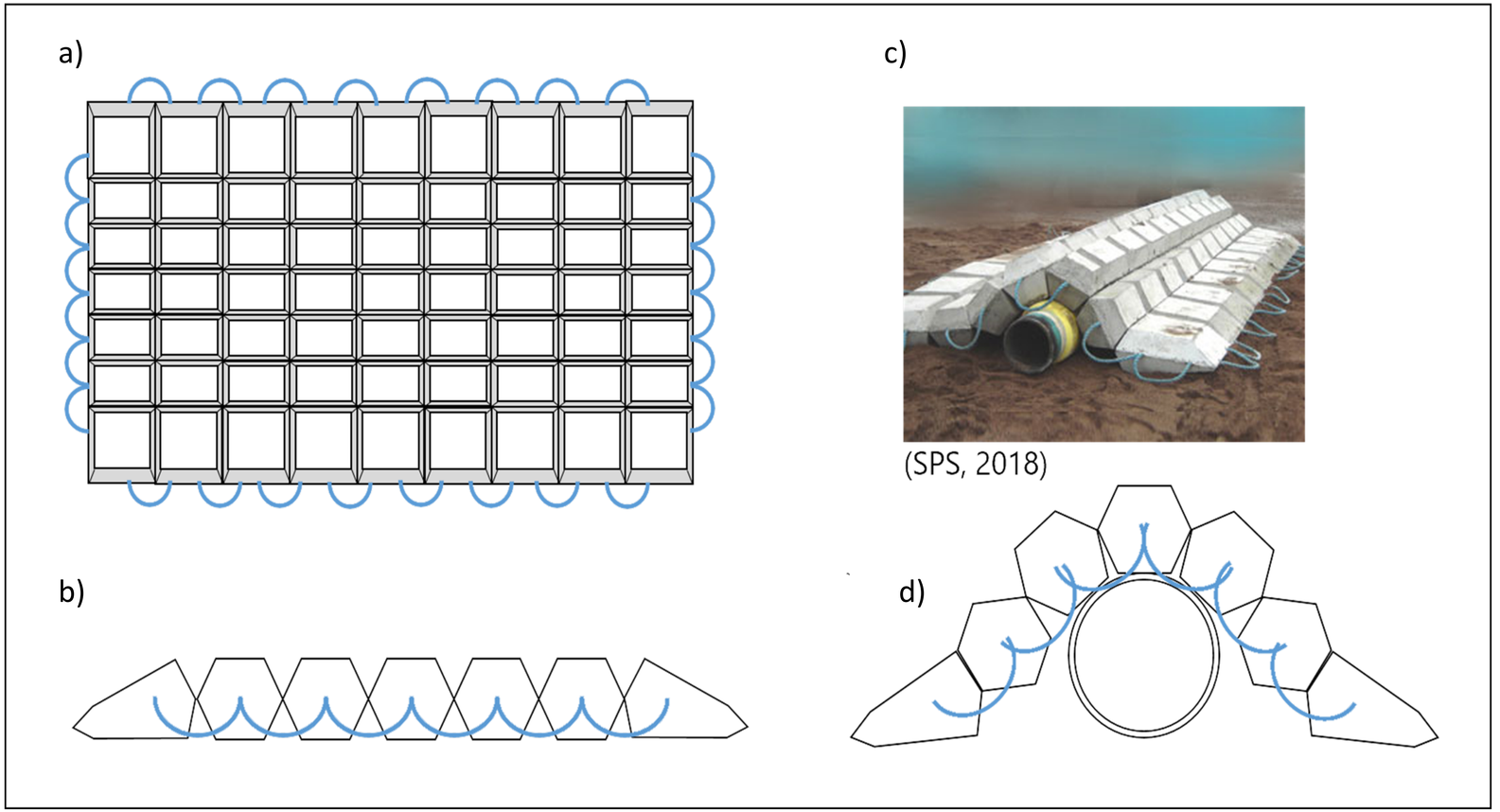
Pipeline protection structures

Rock dump

Grout bag



a) concrete mattress from above (polypropylene rope in blue) b) concrete mattress side view c) concrete mattress laid on pipe (SPS, 2018) d) cross profile of deployed mattress.

Pipeline protection decommissioning

- With increased decommissioning activity, the potential re-use/recycling of structures is becoming a major priority for operators and policy makers.

- OSPAR 98/3 does not provide guidance on pipeline protection decommissioning, however, UK legislation does.

- Majority of mattresses are currently being taken onshore.

Concrete mattresses stored in quarry.

What we will cover today

Elise
Optimising the decommissioning

Characterising the current state of pipeline protection structures

Determining organic and inorganic contaminant concentrations in concrete mattresses

Michael
Artificial reef creation potential

Quantifying the marine life currently utilising protections

Understanding the effect of scale dependant habitat complexity offered by protections

Quantifying heavy metal contamination of protections

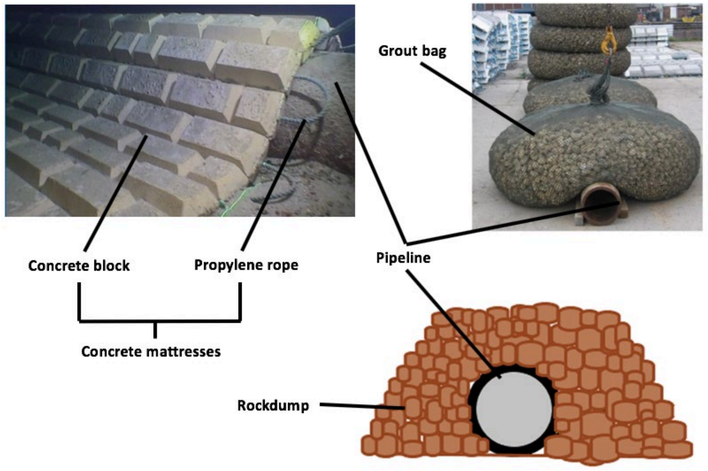
Project overview

Inform further legislation on decommissioning of pipeline protection structures by

- Providing regional-scale recommendations to policy-makers and industry on decommissioning strategies
- Contributing evidence to enable comparative assessments of decommissioning programmes

Research aims

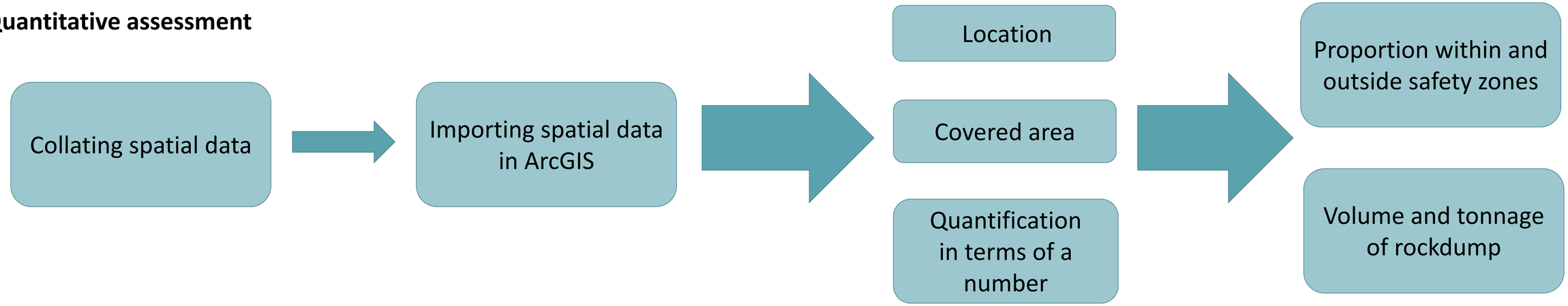
- Quantifying and evaluating the integrity of pipeline protection structures (PPS)
- Quantifying organic and inorganic contaminants in concrete mattresses including polypropylene ropes
- Investigating reuse/recycling options for concrete mattresses according to current legislation
- Estimating the resource required and CO_2 emissions for different decommissioning scenarios



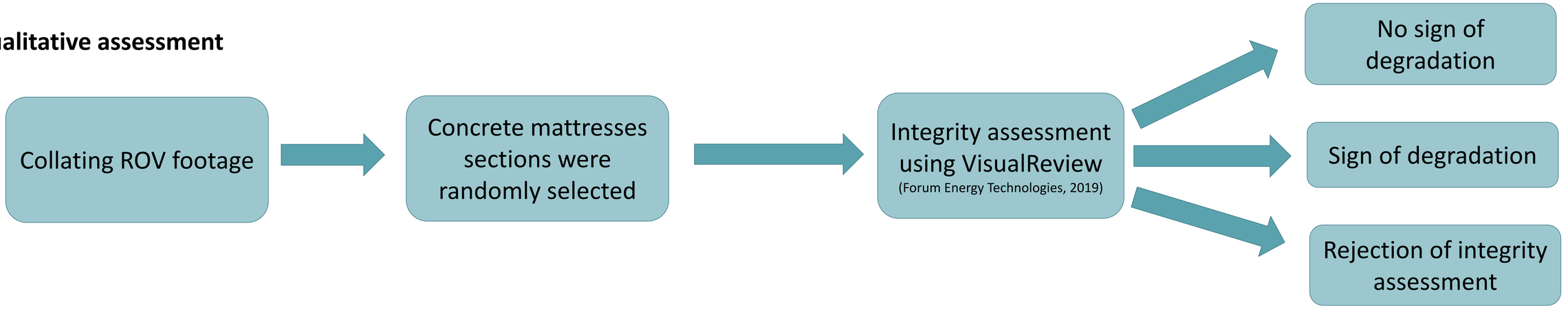
Characterising the current state of pipeline protection structures

Overall Method

Quantitative assessment



Qualitative assessment



Characterising the current state of pipeline protection structures

Overall results
Quantification assessment from 4 major operators

Pipeline protection structures

48,910 min

Mattresses

24,170 min

Grout bags

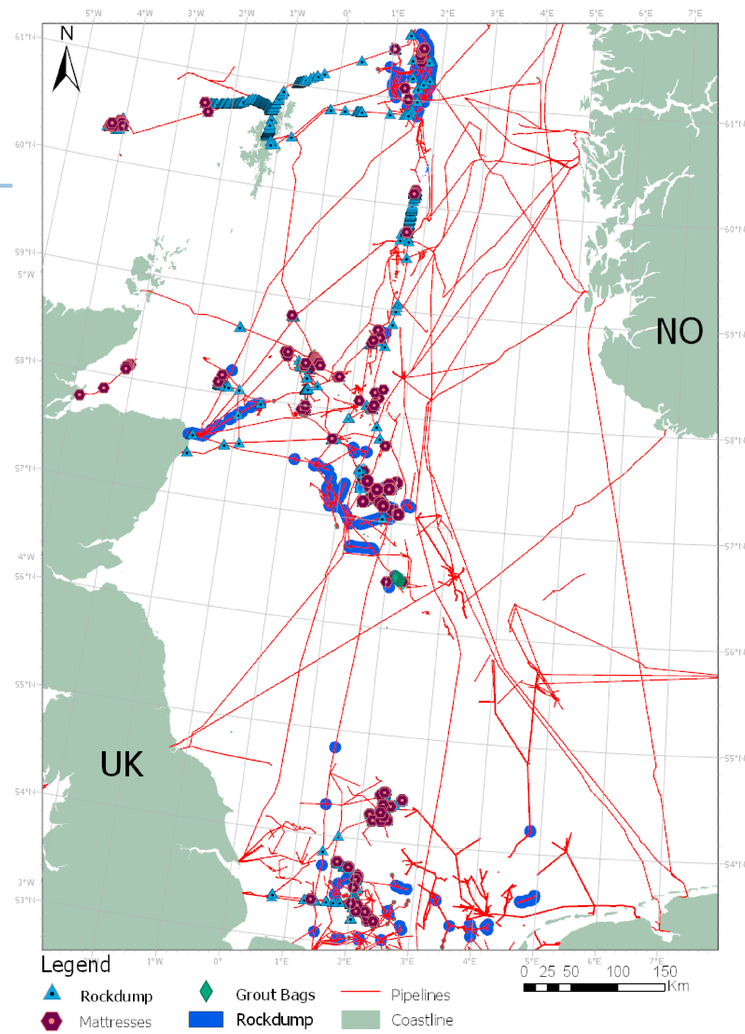
24,740 min

Rockdump

467 km min

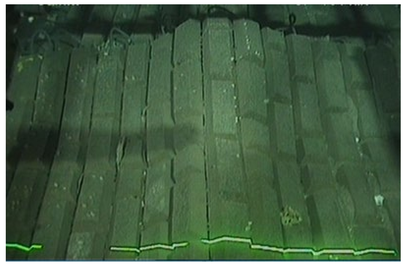
- From 8,639 km of pipelines surveyed

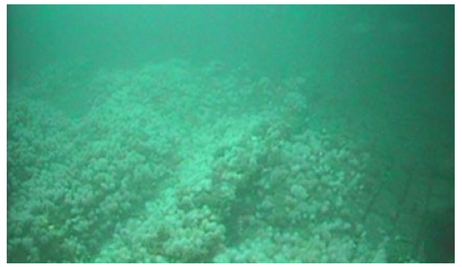
Pipeline protection structures	Within safety zone (%)	Outside safety zone (%)	Estimated number inside safety zone	Estimated number outside safety zone
Mattresses	65 - 82	18 - 35	18,615 – 21,649	5,523 -6,246
Grout bags	71 – 91.5	8.5 - 29	23,508	2,245
Rockdump	18 - 50	50 - 82	NA	NA

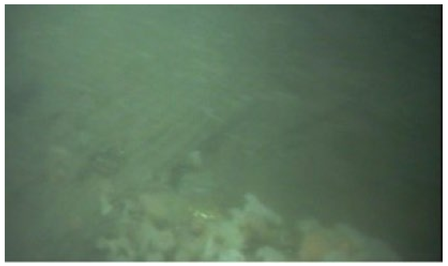


Qualitative assessment (in progress)

- Northern North Sea: no sign of degradation in northern North Sea
- Southern North Sea: integrity assessment rejected
- *NB some signs of degradation were observed from other pipelines surveyed (not part of this study)*



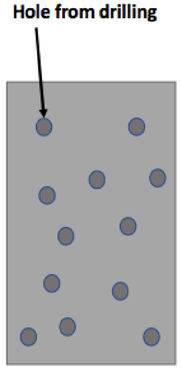




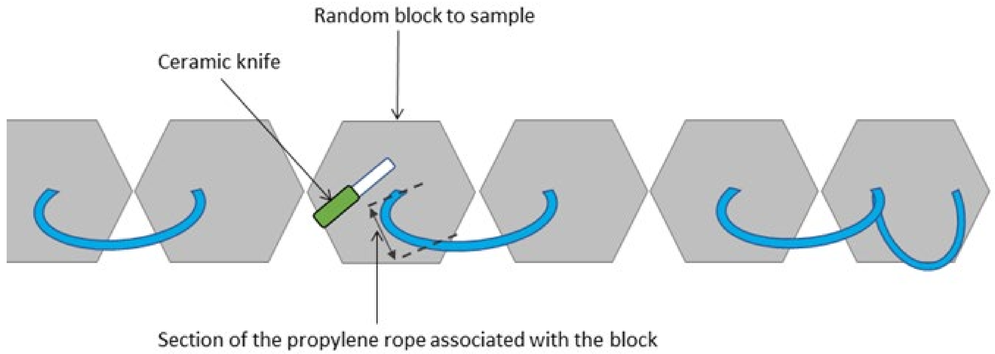
Determination of organic and inorganic contaminant concentrations in decommissioned concrete mattresses

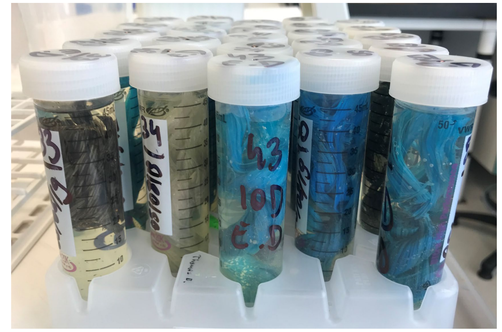
Overall Method

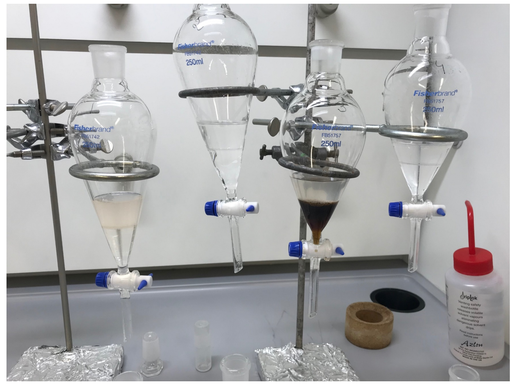
45 samples



Top view of the block







PAHs analysis
using GC-MS

Metal analysis
using ICP-MS

Preliminary results and discussion

Initial Results

- Metal concentrations (µg/g)

	Li	V	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Zr	Nb	Mo	Cd	Pb	U
Samples	2 - 16	43 - **122**	11 - **411**	76 - 1247	2 - 15	6 - 45	16 - **95**	190 - **1781**	3 - 57	226 - **4951**	449 - 5089	0 - 2	0 - 12	0 - **5**	18 - **1513**	0 - **4**
Control green	0.1	29.1	0.9	0.9	0.1	ND*	1.6	12.7	0.4	1.5	3.1	0.1	ND*	0.1	1.7	<0.1
Control white	0.1	29.8	0.6	0.4	0.1	ND*	2	2.8	0.3	1	2.2	0.1	ND*	0.1	2.6	<0.1
Control blue	0.1	32.6	0.7	0.9	0.1	ND*	4.7	6.8	0.4	2.5	5.1	0.1	ND*	0.1	4.6	<0.1
Control yellow	0.1	31.9	7.8	0.6	0.1	ND*	1.1	3.7	0.4	2.7	5.6	0.2	ND*	0.1	36.9	<0.1

* Non detected (ND)

Discussion

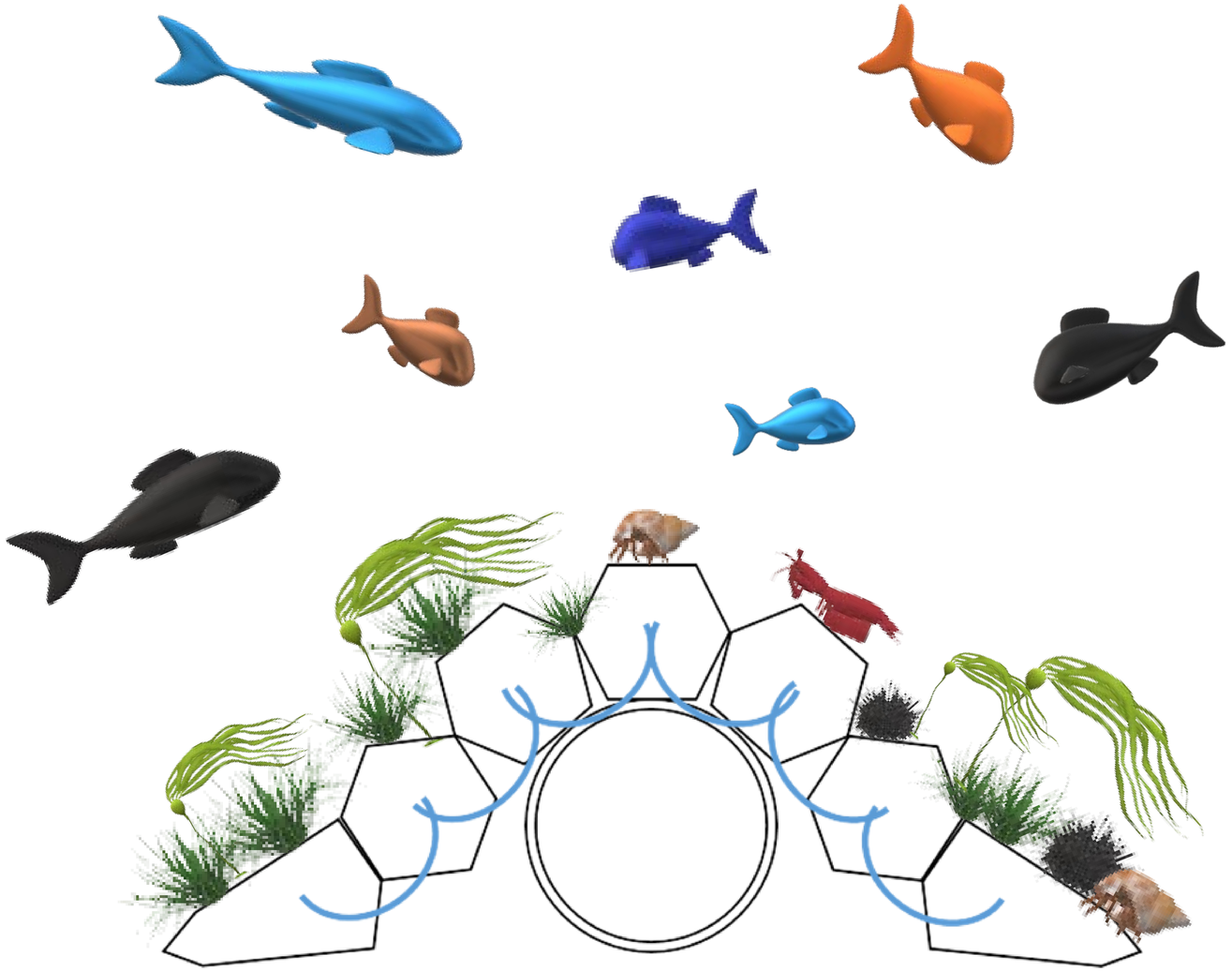
- Further analysis on Ba, Fe, Al and Hg
- Investigating natural processes and sources of contamination including post-contamination
- Incorporating metadata (distance from source) and background concentrations found in North Sea
- Contamination from production versus damage from pipeline?
- Mattresses found at production site accumulating radioactive element?
- Impact of contamination on marine environment and quality of seafood product?

Michael – Artificial reef potential

Quantifying the marine life currently utilising protections.

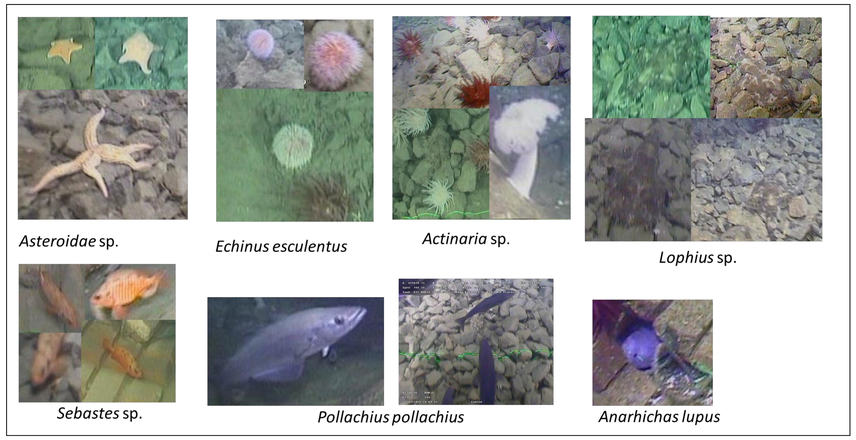
Understanding the effect of scale dependant habitat complexity offered by protections.

Quantifying heavy metal contamination of protections.



What marine life is currently using protections as habitat?

- This study analysed ROV footage from the whole of the North Sea and quantified the benthic and fish species present.



- Investigating the effect of protection type, depth, region and exclusion zone proximity on abundances of groups of species.

Findings

3.21 times higher on mattresses

2.44 times higher on mattresses

3.7 times higher on mattresses

1.27 times higher on mattresses

than bare pipeline.

Using industry collated ROV for ecological analysis

- A few studies have been published using industry ROV footage for ecological purposes.
- Authors have highlighted the issues regarding ROV use and a researchers ability to make robust conclusions.

- This work is a MASTS OGER funded piece of work that aims to conduct surveys across the UK. Utilising participants ranging from students to oil and gas professionals.

Participants needed

To be a part of this study email: Michael.Redford@sams.ac.uk

Effect of habitat complexity

- This study uses 3D photogrammetry techniques to model a variety of reef creation scenarios.

- From these images complexity values can be determined and potential faunal occupancy inferred.
- Complexity values will also assist in identifying any potential habitat bottlenecks.

But are they safe/can they be allowed for re-use as artificial reefs?

- Metal ions are present in the ocean and utilised by marine species, however, at higher concentrations they can be toxic to many species.

- Mattresses from the northern North Sea have been sampled.

- ICP-MS will be used to determine metal content.

Can you help?

- **Access to decommissioned concrete mattresses from the North Sea (particularly SNS)**

Contact either: Elise.Depauw@sams.ac.uk or Michael.Redford@sams.ac.uk

- **Looking for participants for our ROV use survey**

Contact: Michael.Redford@sams.ac.uk

- **Access to potential case studies of reuse or recycling of concrete mattresses**

Contact: Elise.Depauw@sams.ac.uk

Thank you!

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