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Putting Sediment Impacts in to Context Using New Approaches to Comparative Assessment in Oil and Gas Decommissioning

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OIL AND GAS DECOMMISSIONING IN THE UK AND IRELAND

There are approximately 200 oil and gas (O&G) rigs located in UK and Irish waters. Many of these are now approaching the end of their operational life and require decommissioning. In the UK, full removal of these fields is ordinarily required. However, in these deep sea environments, it may be hazardous, technically challenging, costly and ecologically unsound to do so. A comparative assessment (CA) of alternative disposal options can be conducted in some instances.

REGULATORY DRIVERS

- The Republic of Ireland and the UK are contracting parties to the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (the OSPAR Convention).
- There is a requirement under the OSPAR Convention to conserve the marine environment.
- OSPAR Decision 98/3 bans the disposal of offshore installations at sea, requiring full removal of structures and potential sediment contamination associated with drill cuttings and operation.
- There is, however, the potential for derogation for complex structures.
- The fields are offshore and often at depths of approximately 100m with ecological communities and productive fisheries established over decades.

There is growing evidence that the full removal of subsea infrastructure may not be the best option. For example, decommissioning programmes that exist in other regions include the USA rigs-to-reefs programme where the purposeful sinking of O&G structures form artificial reefs to provide marine habitat and boost regional biodiversity.

Comparative Assessment (CA)

Comparative Assessment (CA) is a process that weighs up the pros and cons of various decommissioning options against key criteria (Table 1). The process is described in *Oil & Gas UK Guidelines for CA in Decommissioning Programmes* (2011)[1].

Main criterion	Sub-criteria (matters to be considered)
Safety	Risk to personnel
	Risk to other users of the sea
	Risk to those on land
Environmental	Marine impacts
	Other environmental impacts (including emissions to the atmosphere)
	Other environmental consequences (including cumulative effects)
Technical	Risk of major project failure
Societal	Fisheries impacts
	Amenities
	Communities
Economic	Cost estimates

Table 1. The criteria used in comparative assessment.

Potential decommissioning options

A range of decommissioning options have been evaluated in CAs undertaken by Ramboll Environ. Options are defined by specialist O&G engineers and determine the technical feasibility of each option, the safety of vessels, crew and divers during decommissioning, materials needed and disposal considerations.

The options vary depending on the type of infrastructure and may include the following:

- Leave the drill cuttings pile, structure or pipelines *in situ*.
- Leave linear features *in situ*, but cut and tie off ends.
- Leave infrastructure *in situ* and cover (eg rock dumping).
- Partial removal of infrastructure (eg remove uppermost structure whilst retaining footings and structure extending to 25m above sea bed).
- Partial removal of pipelines where these are >50% exposed above seabed.
- Full removal of infrastructure.

THE APPROACH

Ramboll Environ evaluated a range of decommissioning options for clients to identify a preferred option using CA. The projects considered safety, environment, technical, societal and economic criteria. We adopted an ecosystem services approach to account for environmental and societal criteria, which relies on a scoring system to assess the 'quality' of the habitat followed by environmental economic techniques for valuing the change in habitat services before and after decommissioning to integrate spatial and temporal changes associated with each option.

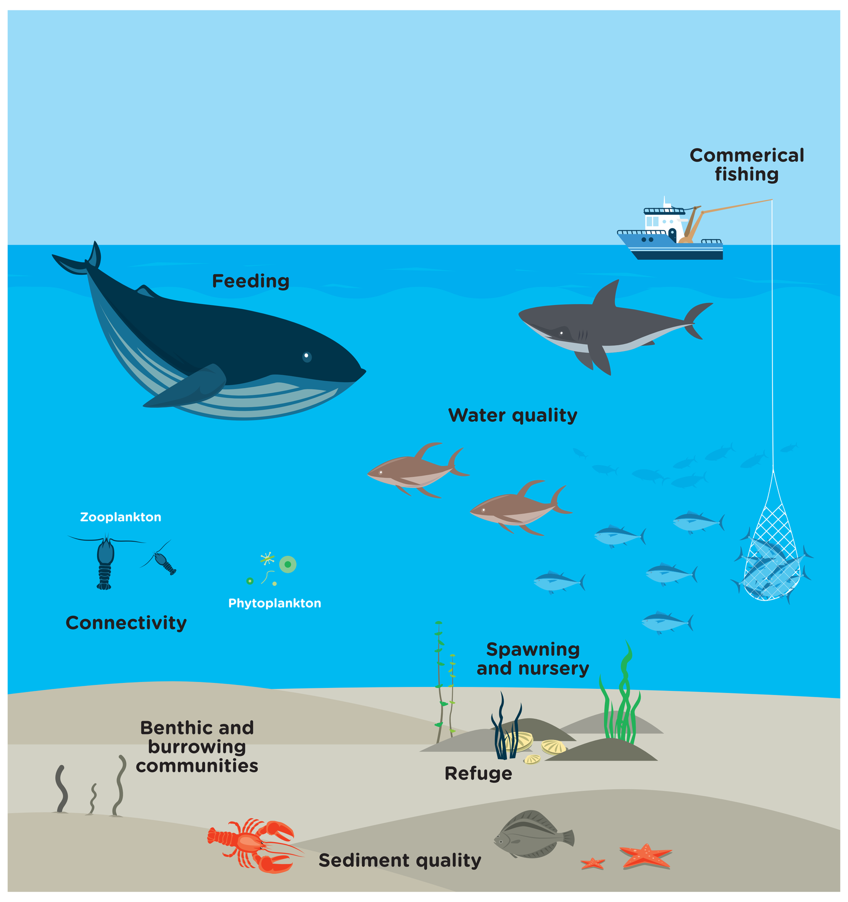

Figure 2: A holistic approach to the valuation of Habitat Services is undertaken in the CA.

Step 1

Scoring calculates the severity of the impact, as follows:

1a Identify site-specific indicators covering:

- Physico-chemical, eg sediment quality.
- Biological structure, eg benthic habitats, key species.
- Ecological functionality, eg nursery and spawning grounds.

1b Calculate an environmental stake index for each indicator, which provides a measure of value, such as rarity, potential for recovery and abundance.

1c Rate each indicator at a series of time points, such as baseline, immediately post-decommissioning and following long-term recovery.

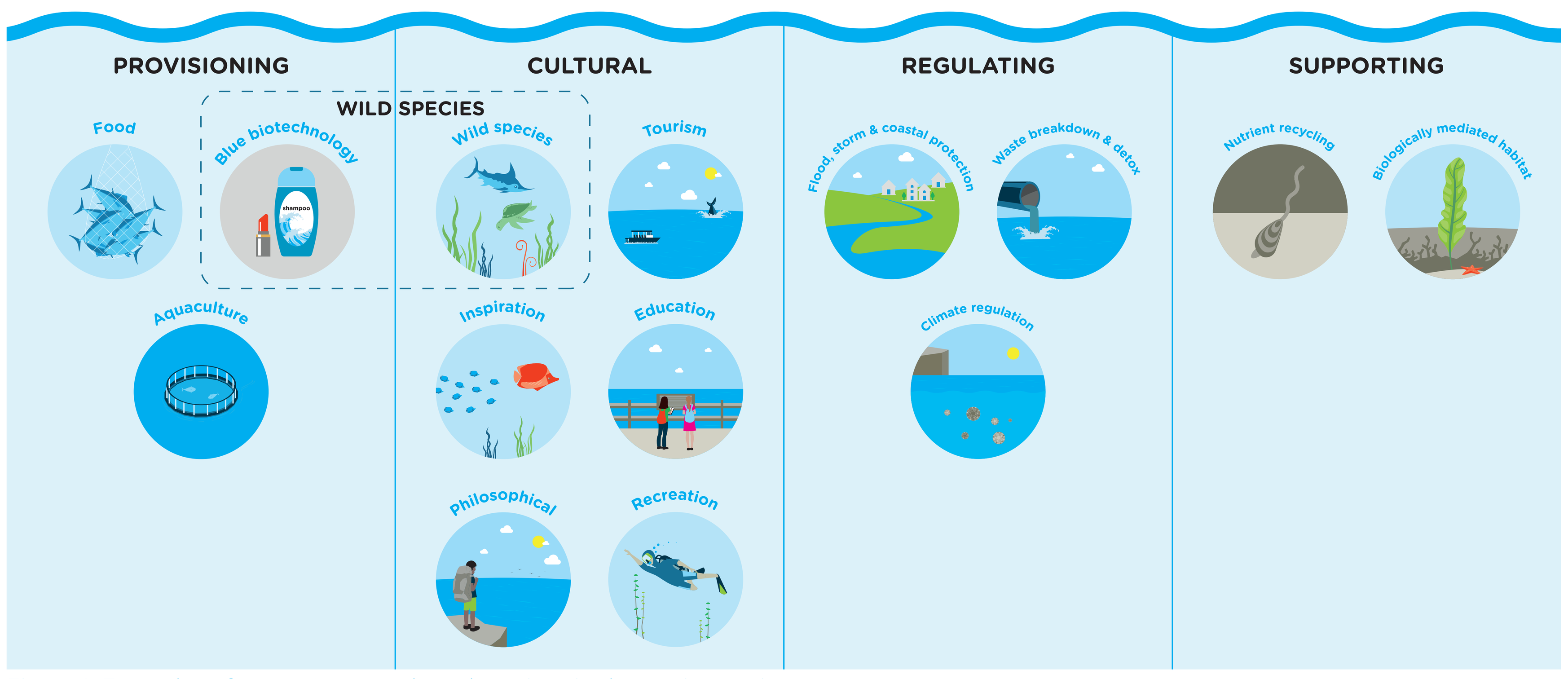

Figure 1: Examples of ecosystem goods and services in the marine environment.

IMPACT PATHWAYS

Potential impacts associated with decommissioning are defined and may include chemical impact pathways, primarily to sediments:

- Oil well cutting piles produced during installation drilling (these may be thousands of cubic meters).
- Gas well cutting pile (considerably smaller and may have been completely dispersed).
- Sacrificial zinc anodes and bracelets on pipelines and structures to prevent corrosion.
- Bitumen joints between manufactured sections of pipelines used as a sealant during installation.

Potential physical impact pathways associated with sediment dispersion may include:

- Mass flow excavation techniques for exposing buried pipelines and footings.
- Rock dumping into excavations.
- Direct removal of infrastructure.
- Rock dumping of structures or pipelines.
- Disturbance of sediments or rock cover.

Valuation of habitat services for CA

Biodiversity and habitats are at the heart of many ecosystem services, such as fisheries, genetic resources and waste detoxification. In these CAs emphasis is placed on the valuation of habitat services. A new innovative method was adapted by Ramboll Environ based on Bas *et al*, (2016)[2]. The approach provides a valuation of the whole of the marine ecosystem in order to put potential sediment impacts into a wider context.

The Bas *et al* (2016) method is a two step approach combining a scoring system and habitat equivalency analysis (HEA).

Step 2

Habitat equivalency analysis values changes to habitat services in service hectare years, as follows:

- Environmental economics tool based on damage assessment methodology (eg NOAA, 1995[3]; Gala, 2008[4]).
- Accounts for scale (area impacted).
- Duration of environmental recovery (eg 15 years).

INFORMATION SOURCES

The assessments rely on a range of information sources including:

- Regulatory, conservation agency and fisheries maps and databases.
- Published scientific literature.
- Client's documentation, such as environmental impact assessments, monitoring, maintenance, operational reports and remotely operated vehicle footage (Figures 3 and 4).

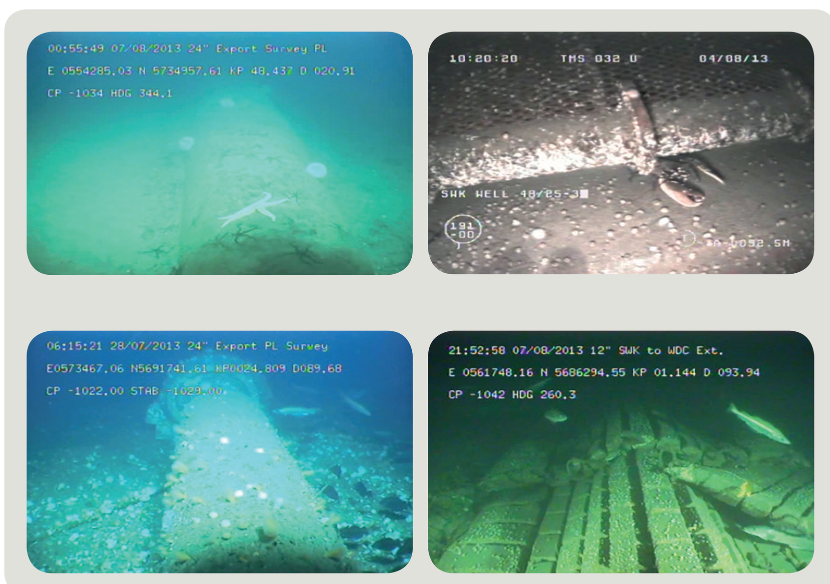

Figure 3: Client's remotely operated vehicle (ROV) footage analysis.

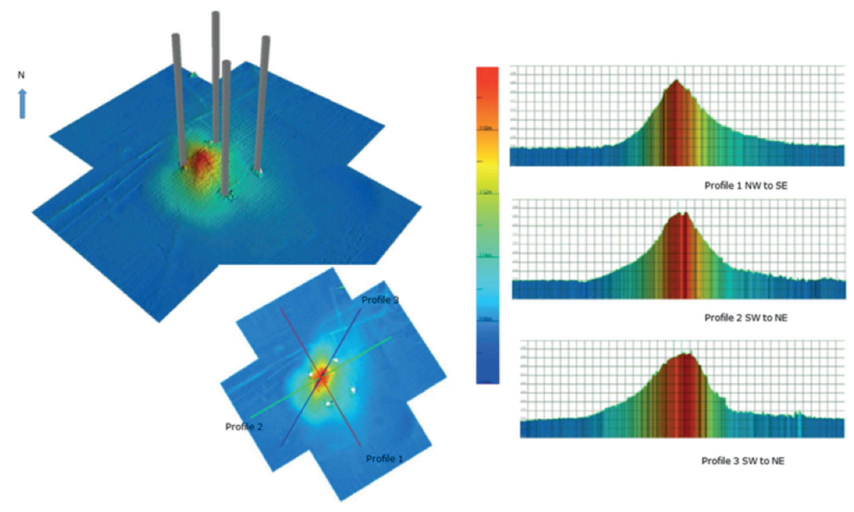

Figure 4: Chemical sampling of sediments and comparison with environmental quality standards.

RESULTS

The value of changes to ecosystem services may be reported quantitatively or qualitatively. The focus is on habitat services and potential impacts associated with each decommissioning option. Results in Figure 5 show that option 1a (pipeline removal) has the greatest impact to habitat services, corresponding to the environmental criterion in the CA. The option with the lowest predicted impact on habitat services is to leave the pipeline *in situ* and cut the ends.

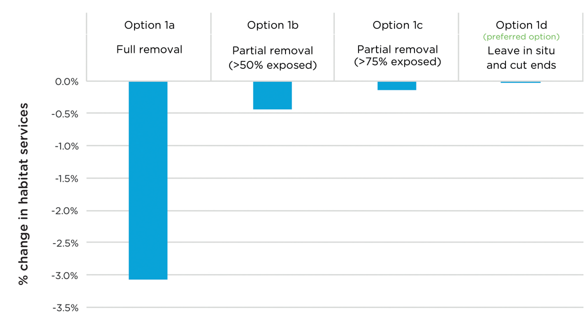

Figure 5: Habitat service results for a range of pipeline decommissioning options.

The results for the environmental criterion are combined with the results for the technical feasibility, safety, greenhouse gas emissions and costs of each decommissioning option. An example is provided below (Figure 6) in which the preferred decommissioning action for the pipeline based on all criteria is to leave the pipe *in situ* and cut the ends (option 1d).

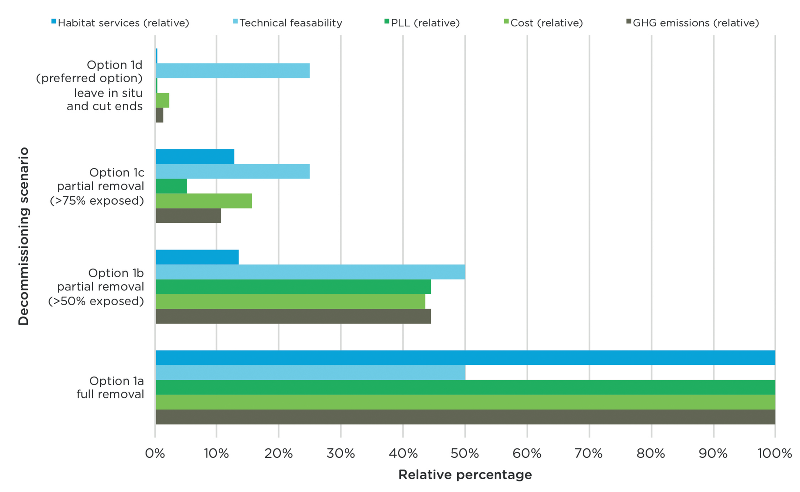

Figure 6: Comparative Analysis results for four decommissioning options for pipelines.

CONCLUSIONS

The use of ecosystem services approaches to value the environment allow for the potential impact or benefit to be measured and compared spatially and to take account of changes (e.g. recovery) over time. The new method provides a holistic assessment of the ecological functioning of the marine ecosystem as a whole and places potential impacts on marine sediments in to a wider environmental context and the economic, safety and technical feasibility contexts. Key findings from CA undertaken so far include:

- Our methods allow for a greater use of professional judgment, while accounting for a broader set of indicators than may traditionally be used when valuing environmental damage (impacts).
- Surface contamination associated with drill cuttings piles has been leached or degraded over time. Residual contamination is buried deep within piles, with low potential for bioaccessibility and availability while undisturbed.
- Decommissioning options vary in their disturbance potential and different effects on marine organisms.
- Variation across the ecosystem can be captured by using a range of relevant indicators to give context.
- Costs and benefits of decommissioning options vary with infrastructure – it is not a 'one size fits all' management decision.

REFERENCES

References are available on a separate sheet.

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