

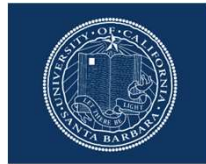


The Ecology of Man-Made Structures in the Marine Environment....

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Man-made structures for:

Coastal defense

Transport infrastructure

Leisure facilities

Industry: Oil and gas

Offshore wind

Transport

Fisheries

Wrecks (..war)

Truk Lagoon: about forty ships — two [light cruisers](#), four [destroyers](#), nine auxiliary ships, and about two dozen cargo vessels —

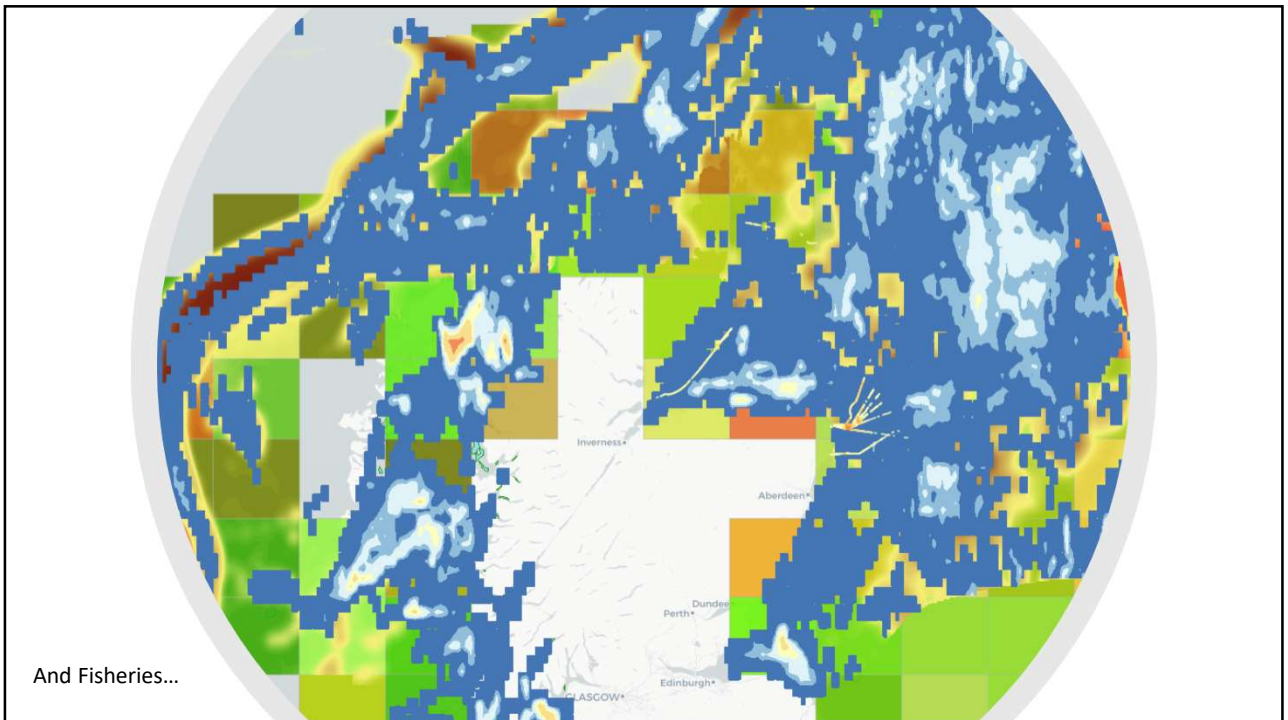
Archeology



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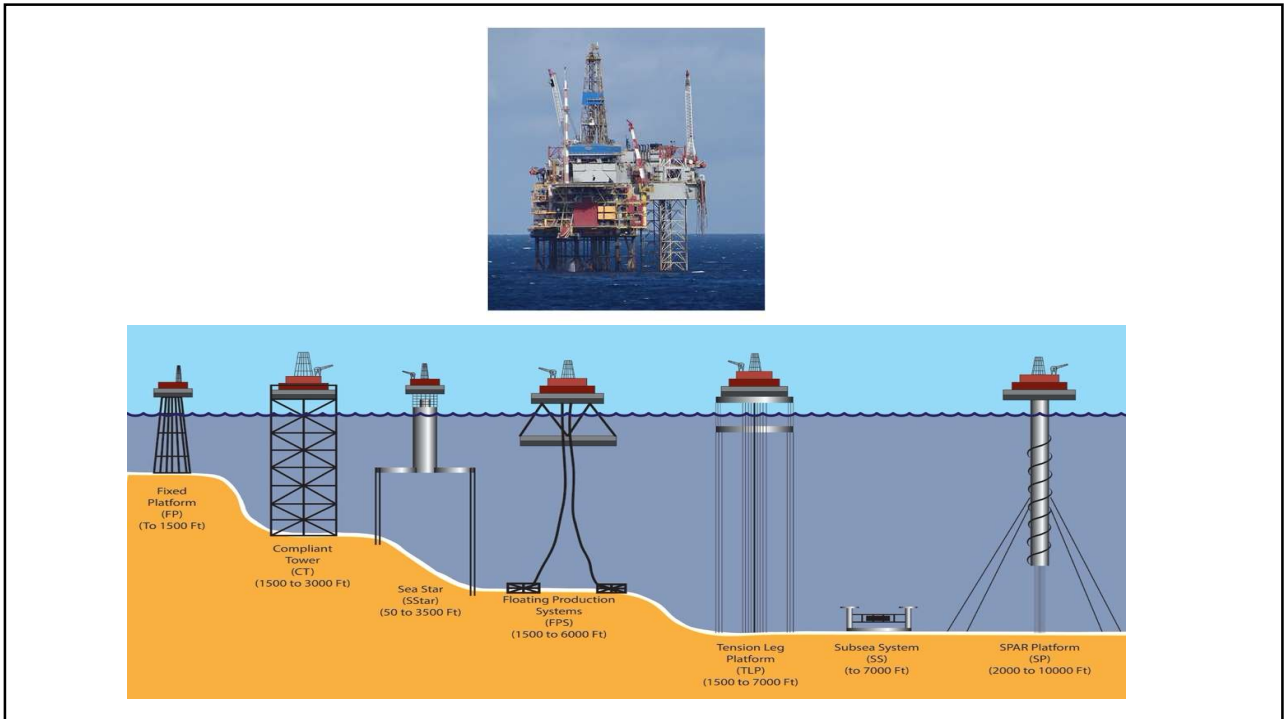


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And Fisheries...

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Stressor 1

Sound, light,

10 km Emergent

1-100 m submerged

Plus new habitat: Interactive

Species

Presence: +
Habitat: areal
Sensitivity: High
Behaviour: Attraction

Summary effect: Unknown

Species

Presence. +++
Habitat. Demersal
Sensitivity. Low
Behaviour Attraction

Summary effect: Positive

Saithe

Saithe Pollachius virens © Scandinavian Fishing Year Book

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Stressor 2

Pollutant, larvae (NNS)

Species

Presence: +
 Habitat: areal
 Sensitivity: High
 Behaviour: Attraction

Summary effect: Unknown

1 km

100 km

[Barrel Sponge Spawning in the Florida Keys - Video floridakeystreasures.com](https://www.floridakeystreasures.com)

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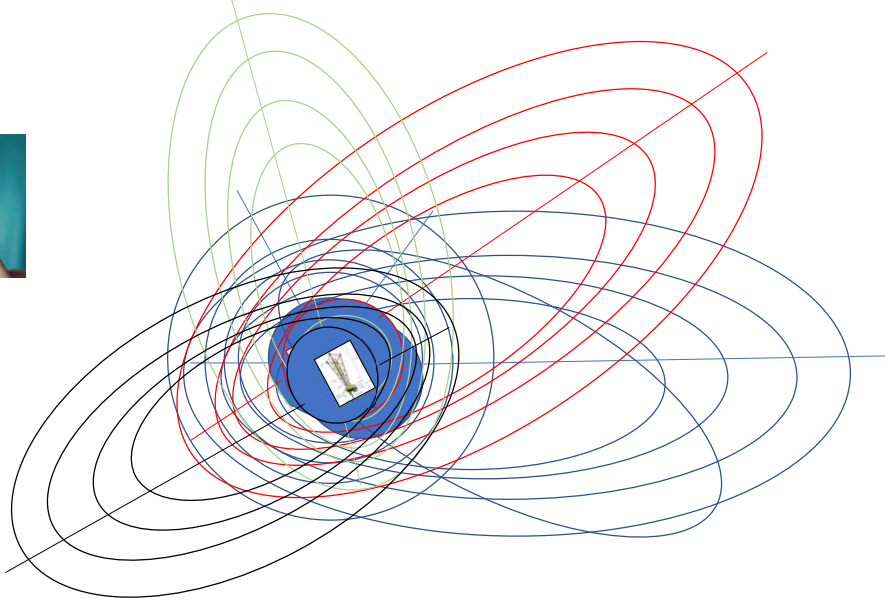

Biodiversity

- Succession
- Biofilms, epifauna – mussels, hydroids, corals, anemones
- Mobile invertebrates – crabs
- Fish – demersal, pelagic
- Sea mammals and sea turtles
- Birds & insects

Images; North Sea Bird Club, SERPENT project




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Stressor stress



The diagram consists of a central blue circle containing a small image of an offshore oil rig. This central circle is surrounded by several layers of overlapping concentric circles in black, blue, red, and green. The circles are not perfectly concentric, creating a complex, swirling pattern that expands outwards from the center.

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Smart transition??

The diagram shows a sequence of four complex, swirling diagrams of overlapping concentric circles in black, blue, red, and green. Each diagram has a small image of an offshore oil rig at its center. A large blue arrow points from the first diagram on the left towards the second and third diagrams in the middle. The fourth diagram is on the right, positioned above a photograph of a calm blue ocean under a clear sky. The text "Smart transition??" is centered below the diagrams.

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MCDA in the literature (Fowler *et al.*, 2014, Henrion *et al.*, 2015, Lorenzo de Sousa, 2019, Burdon *et al.*, 2018, Martins *et al.*, 2019).

Methods of MCDA ; CA OGUK 2015, AHP, SAW, PROMETHEE



SPIDA: Screening Potential Impacts of Decommissioning Activities
1: Selection of decommissioning approach

1: Infrastructure selection
Select class of infrastructure: Platforms
Select specific infrastructure type: Platform-jackets

2: Decommissioning objective
Select decommissioning objective: Full removal

3: Decommissioning method
Select decommissioning method: Single lift using an anchored vessel

Select to:
Extract relevant activities and record activities of spatial-temporal footprints
Quit SPIDA ANY MODIFICATIONS WILL BE LOST!

Qualitative : 😊 😐 😞

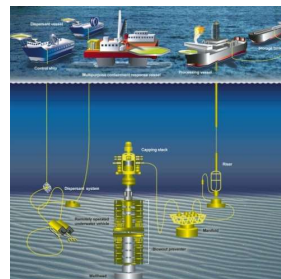
Quantitative; £, \$, hours at sea, kg CO₂

But ... lack of eco data (habitat assessment) and subject to baseline error, subjective, need measures of uncertainty, probability and regular review.

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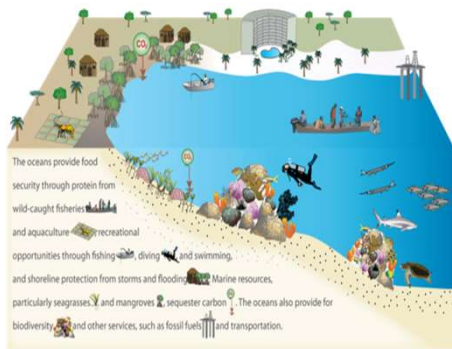
Fixed MMS platforms

- 6000 worldwide
- Range of depths (10-3000 m) and distances to shore (<2 -> 200 km)
- Small spatial footprint yet significant hard surface area
- Well heads, FPSO, pipelines, bundles
- Ecological interactions?
- Decommissioning forecast > 2000 next 20 years



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Functional baseline

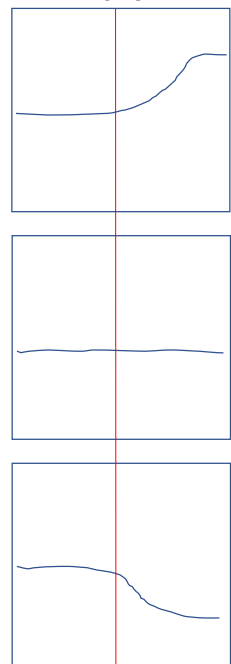


The oceans provide food security through protein from wild-caught fisheries and aquaculture and recreational opportunities through fishing, diving, and swimming, and shoreline protection from storms and flooding. Marine resources, particularly seagrasses and mangroves, sequester carbon. The oceans also provide for biodiversity and other services, such as fossil fuels and transportation.

Conceptual diagram illustrating the ecosystem services provided by oceans and the ways in which humans depend on oceans.
Symbols library courtesy of the Integration and Application Network (ian.umces.edu/symbols), University of Maryland Center for Environmental Science.
Conceptual diagram illustrating the ecosystem services provided by oceans and the ways in which humans depend on oceans.
Diagram courtesy of the Integration and Application Network (ian.umces.edu). Source: Simoes C, Barro L, Orlach W. 2016. Preprint/Ocean, Science and Knowledge Division, Copernicus International, Leipzig, Germany, EU.

ACTION

BASELINE
OUTCOME




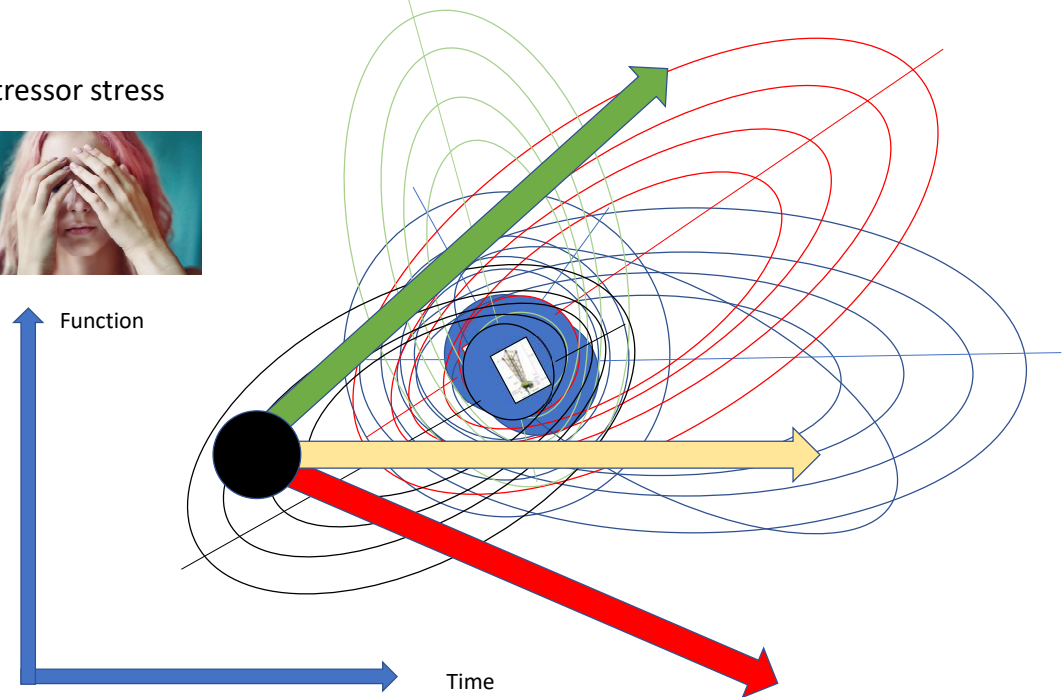
How do we decide a change is good or bad? Compare with baseline?

Trajectory of ecosystem service

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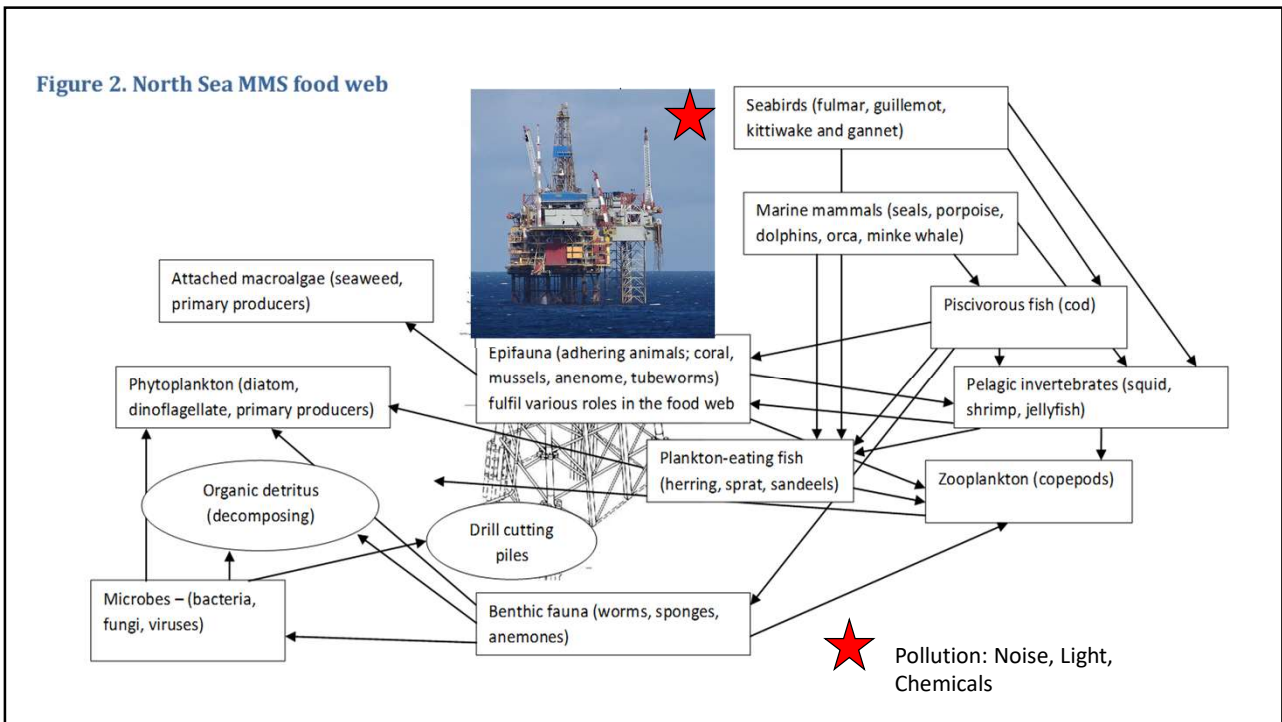
Stressor stress





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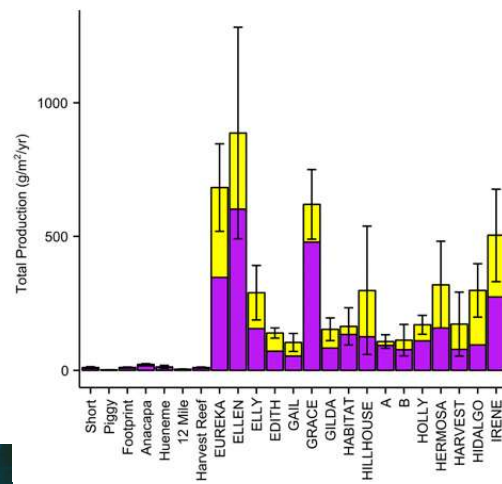
Figure 2. North Sea MMS food web



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Habitat assessment

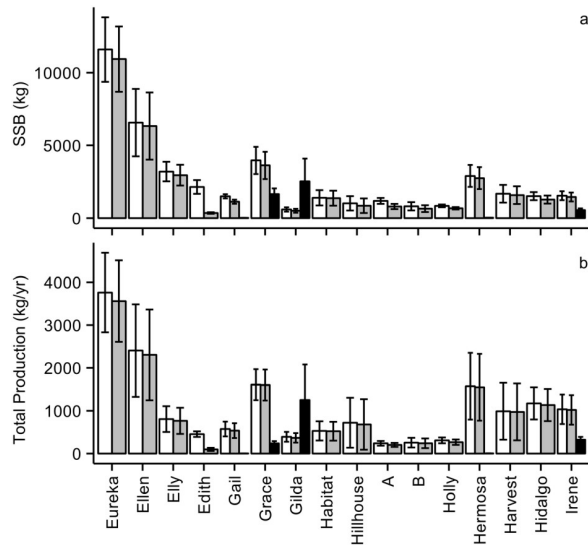
- Biological productivity
- Biodiversity metrics
- Foodweb
- Ecosystem services
- Connectivity
- INNS



Annual Total Production by site. Average of annual values/m² seafloor with SE bars . Somatic production (purple) and recruitment production (yellow). Claisse et al., 2014

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Impact of partial MMS removal on fish biomass and production



(a) Standing Stock Biomass (SSB) and (b) Total Production with SE error bars for complete platforms (white bars), partially removed platforms (gray bars), and for the entire shell mounds associated with some platforms (black bars). Claisse et al. 2017. PLoS ONE 10(9): e0135812. doi:10.1371/journal

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Regional context

- Geography
- Stakeholders
- Re-use goals/function (enhance fishing stocks vs MPA)
- Species migration and INNS



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Recycle, re-use, landfill, total energy (Carbon) budget

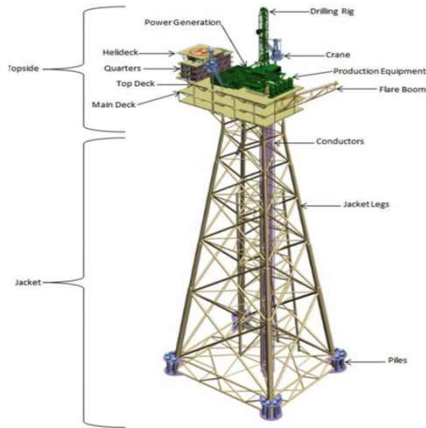
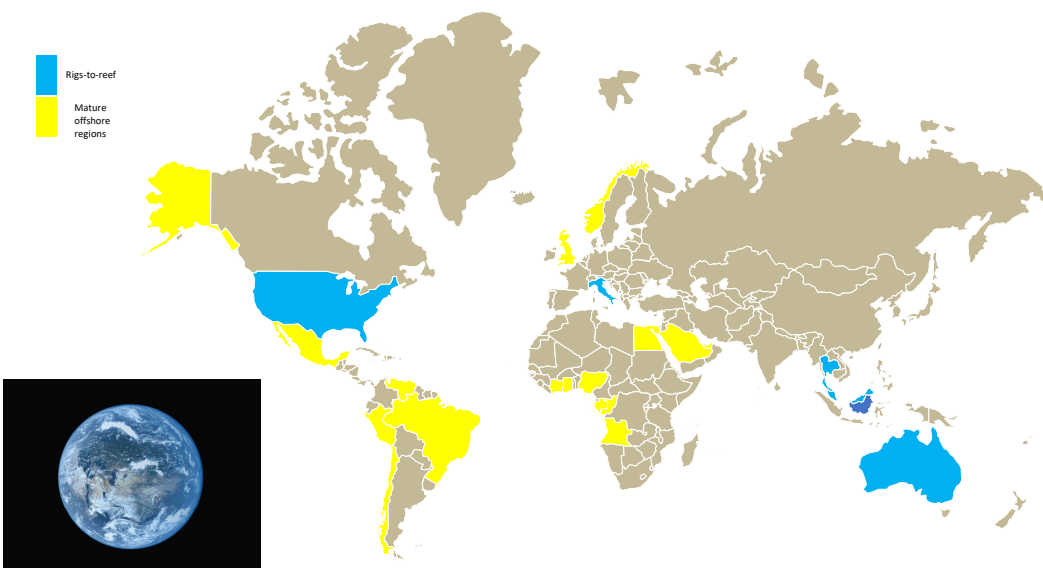


Figure 1(a) Schematic of a generalized offshore oil and gas platform. Adapted from Manago and Williamson (1998). (b) Construction of jacket support for oil platform offshore California. Note size of crane and large trucks compared to the size and configuration of underwater support for offshore platform

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Rigs-to-reefs



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Knowledge gaps

- Habitat assessments
- Post-decommissioning monitoring
- Geographical data gaps (tropical waters)
- Data sharing, standardisation & measures of uncertainty

Precautionary principle – ‘When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm’ - EU.



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Risk of known knowledge gaps to achieving best environmental practice in decommissioning				
No.	Knowledge gap	Low	Medium	High
1	Lack of comprehensive habitat assessments of SPJ ecosystems *			
2	Little knowledge on the SPJ ecosystem post-reefing or post-removal **			
3	Comparative research with natural reef/hard substrata			
4	Multi-year, seasonal, scientific observations			
5	Lack of standardised and quantitative ROV footage			
6	Lack of standardised data submission standards			
7	Environmental performance of decommissioning activities (GHG emissions, energy)			
8	Lack of international agreement and collaboration on science objectives to support decommissioning policy			
9	Acute lack of ecological data from some regions (tropical waters)			
10	Evidence of fish productivity (site fidelity, biomass/growth rates, reproduction and population structure)			
11	Degradation of SPJ (corrosion Fe input, impurities (nickel, NORM)			
12	Bird and mammal interactions with SPJ			
13	Species interactions at SPJ ecosystems			
14	Identity and function of organisms <0.5 mm including biofilms and microbes			

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Future policy?

- Science (INSITE)
- Regional context
- Flexible approach
- Case-by-case
- Compliance vs stewardship



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