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Risk Assessment and Risk Management Relating to Inputs and Impacts of Retaining or Removing Marine Structures

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Dept. of Biological & Marine Sciences, University of Hull,
& International Estuarine & Coastal Specialists Ltd.

DEVOTES
www.devotes-project.eu
Development of innovative tools for understanding marine biodiversity and assessing good environmental status

VECTORS

CERES

International Estuarine and Coastal Specialists

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Challenges for marine science & management:

There is only one big idea in marine management: *how to maintain and protect ecological structure and functioning while at the same time allowing the system to produce ecosystem services from which we derive societal benefits.*

Or: "to look after the natural stuff and deliver the human stuff"

- Recovery/coping with historical legacy
- Endangered coastal and marine ecosystem functions
- Legal & administrative framework
- Economic prosperity and delivery of societal benefits
- Coping with climate change & moving baselines

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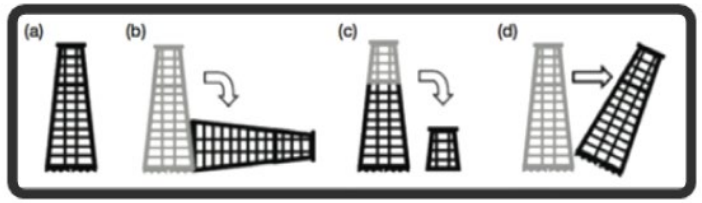
The North Sea – the scale of oil and gas activities

Key Questions to be Addressed:

1. What oil, gas and OWF structures need to be decommissioned?
2. What decommissioning options are available?
3. What are the potential environment impacts on interest features?
4. What are the potential impacts on ecosystem service provision?
5. Are they located within/adjacent to an MPA?
6. What are the potential impacts on conservation objectives and site integrity?



Underpinning framework Sub-system *(DAPSI(W)R(M))*


Marine Pollution Bulletin 118 (2017) 27–40

Contents lists available at ScienceDirect

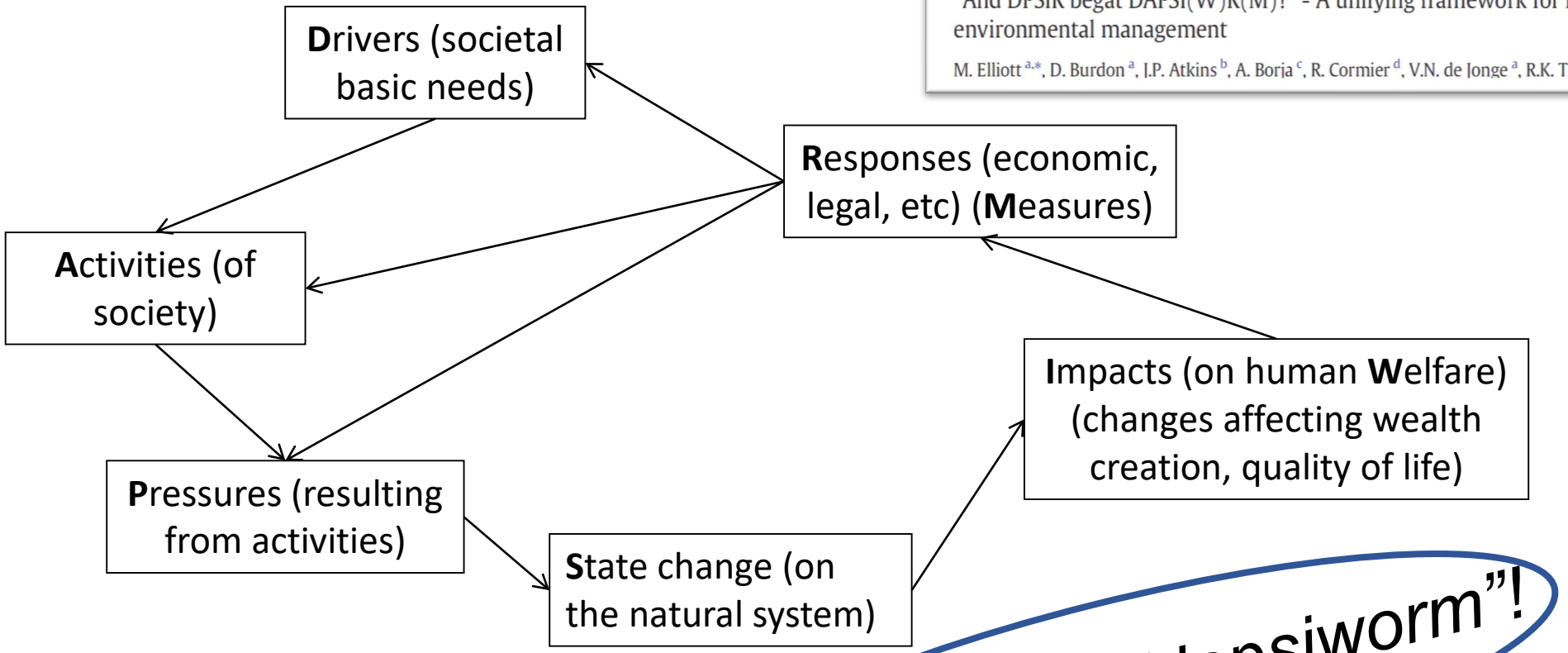
Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Viewpoint

"And DPSIR begat DAPSI(W)R(M)!" - A unifying framework for marine environmental management

M. Elliott [a,*], D. Burdon [a], J.P. Atkins [b], A. Borja [c], R. Cormier [d], V.N. de Jonge [a], R.K. Turner [e]



(for each EnMP cf. Ex

Pronounced "dapsiworm"!

DAPSI(W)R(M) Framework applied to Oil, Gas and OWF Decommissioning

Element	Relevance to Decommissioning
Drivers	Legal and societal demand for clean, safe, productive, diverse and healthy environment
Activities	Appropriate decommissioning options and their associated activities e.g. removal of rigs
Pressures	Widescale pressure list: above-water noise, abrasion, siltation, collision risk, contamination by chemicals, litter, light, etc.
State changes	Potential biological loss, gain or damage to hydrodynamics, ecology, ecosystem services
Impact (on human Welfare)	Potential loss or gain of societal goods and benefits, commercial, recreational and cultural aspects
Responses (using management Measures)	Management measures to further enhance provision of ecosystem services; mitigation and/or compensation to minimise effects

(Burdon et al., Mar. Poll. Bull. 2018)

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Challenges for management (RA&RM):

Risk Assessment:

- Where are the problems and what changes do they cause? (ExUP & EnMP)
- What is their impact on ecosystem structure and functioning?
- What are the repercussions for ecosystem valuation based on economy-ecology interactions?
- What are the future environmental changes and economic futures?

Risk Management:

- What governance framework is there, what do stakeholders need & what are successes & failures? (Risk Management)
- What can we do about the problems, hazards & risks and how to address them now and in the future?
- How ‘good’ is the decision-making?

(Elliott, 2014 Mar. Poll. Bull.)

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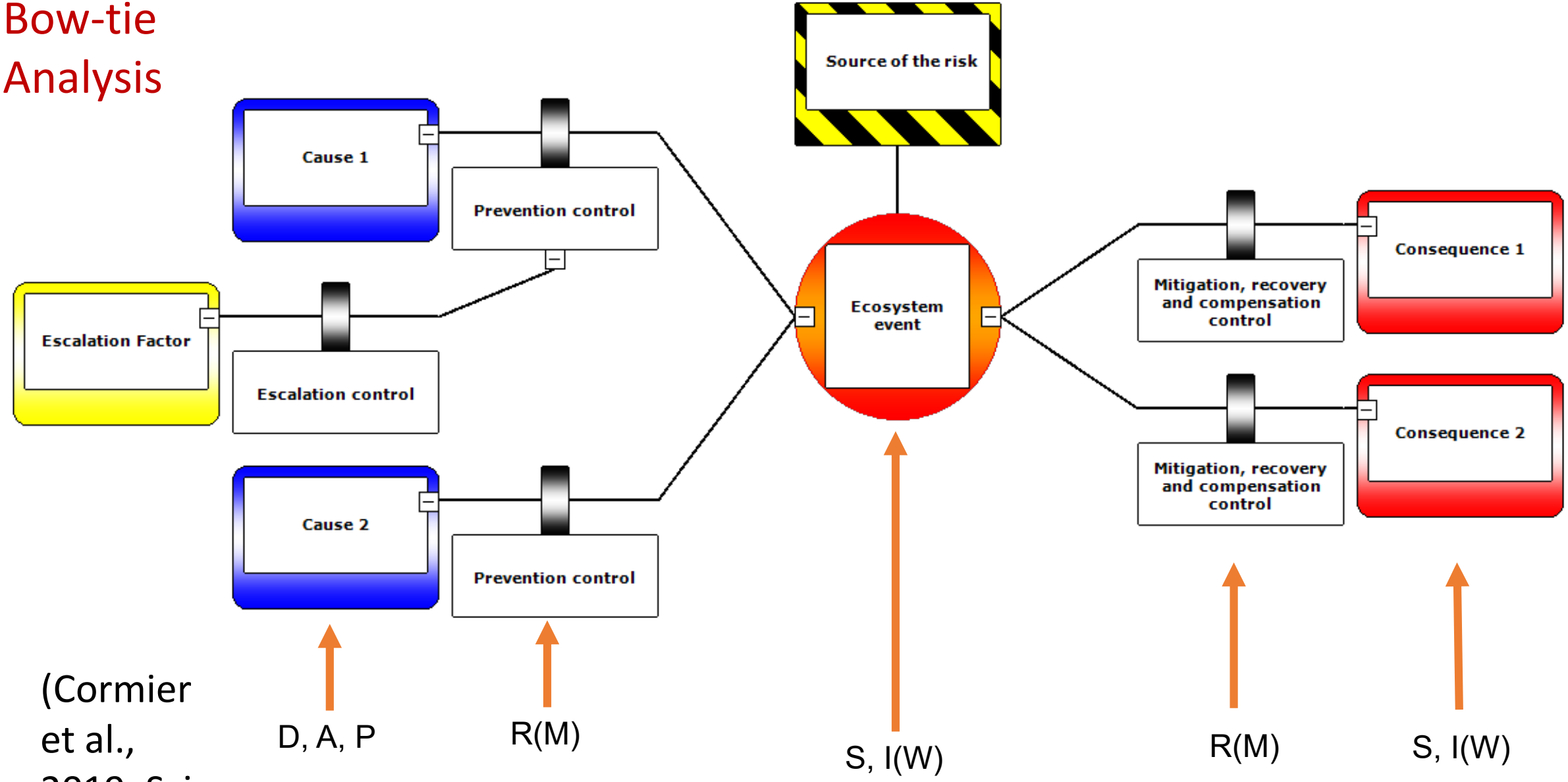
Stage	Detail
1. Problem Formulation	What needs to be assessed?
2. Hazard Identification	What can go wrong? (What are the hazards?)
3. Cause Identification	What can lead to the hazard occurring? (What causes the hazard?) Quantitative: How often or how likely is it that these causes will occur?
4. Exposure Assessment (This is a quantitative step that is not necessary but adds value to the risk assessment)	Quantitative: How does the hazard reach the receptor? At what intensity? How long for and/or how frequently does the hazard reach or affect the receptor? Quantitative: How likely is it that the receptors will be exposed to the hazard?
5. Consequence or Effect Identification	What are the consequences of the hazard if it occurs?
6. Risk Characterisation and Estimation for Consequences	What are the risks (quantitative or qualitative measure)? Quantitative: What is the probability of the consequence happening? Estimated for both before and after preventative and mitigation measures are put in place.

Bow-tie Analysis



(Cormier et al., 2019, Sci. Tot. Env.)

Stakeholder consultation – to determine causes and consequences and to agree the responses throughout the sequence

Bow-Tie Analysis linked to **DAPSI(W)R(M)** Framework for Risk Assessment and Risk Management (**D**rivers, **A**ctivities, **P**ressures (as mechanisms of change), **S**tate change (on the natural system), **I**mpact (on human **W**elfare), **R**esponses (using **M**easures based on 10-tenets – econ., tech, ecol., legal, admin, cult., polit., moral, comm., social aspects)


Science of the Total Environment 648 (2019) 293–305

Contents lists available at ScienceDirect

Science of the Total Environment

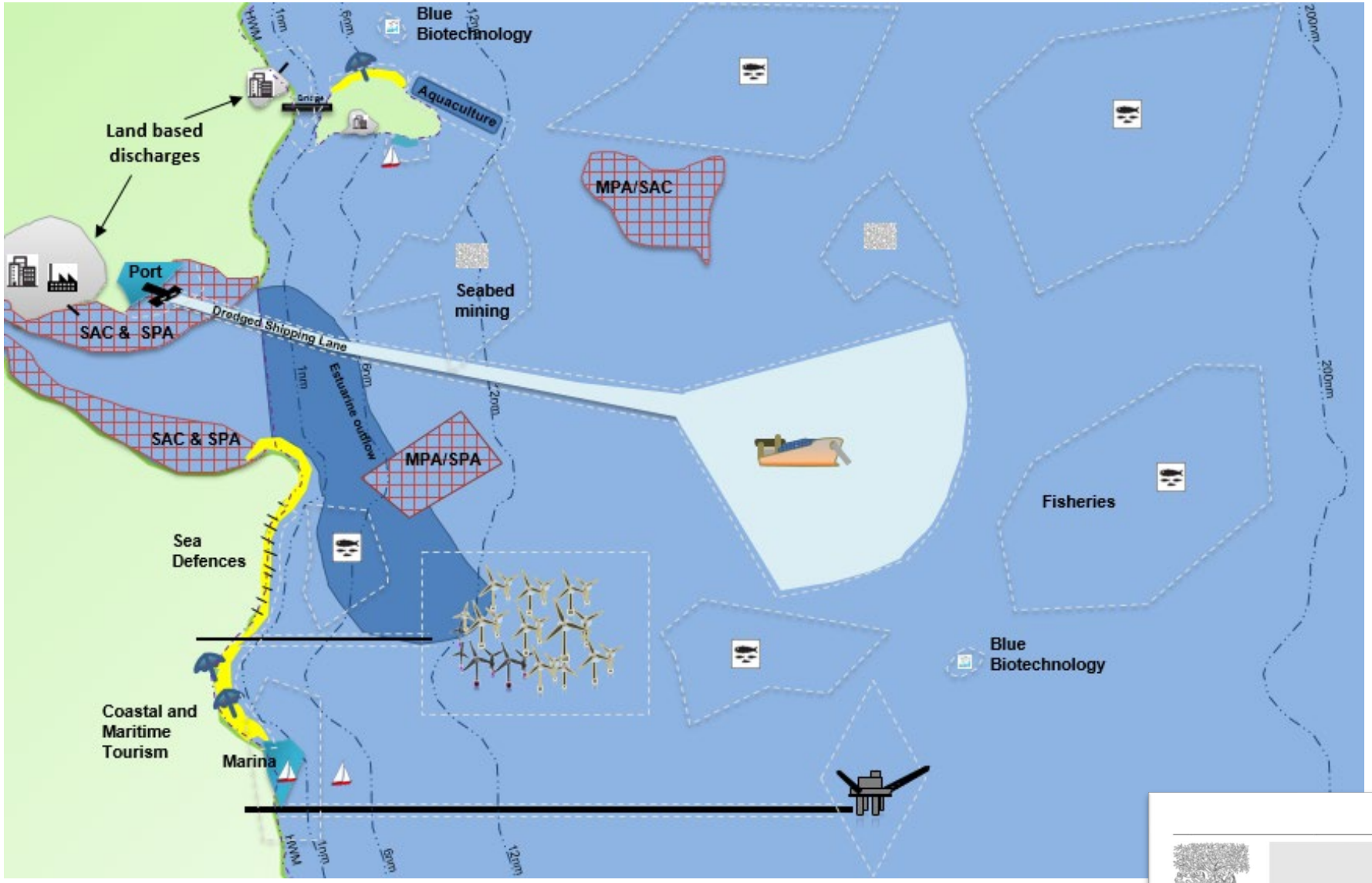
journal homepage: www.elsevier.com/locate/scitotenv

Putting on a bow-tie to sort out who does what and why in the complex arena of marine policy and management

Roland Cormier [a,*], Michael Elliott [b], Jake Rice [c]

Bow-tie in a nutshell:

- What is the problem I am worrying about?
- What are the causes?
- What are the prevention mechanisms?
- What are the mitigation /compensation measures?
- What are the consequences?



And another challenge – coping with a complex marine space

Challenge – to merge environmental quality management (e.g. MSFD) with maritime spatial planning and Blue Growth initiatives (e.g. MSPD)


Marine Pollution Bulletin 133 (2018) 367–377
Contents lists available at ScienceDirect
Marine Pollution Bulletin
journal homepage: www.elsevier.com/locate/marpolbul

Viewpoint

Using best expert judgement to harmonise marine environmental status assessment and maritime spatial planning

Michael Elliott[a,*], Suzanne J. Boyes[a], Stephen Barnard[a], Ángel Borja[b]

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How to manage the impacts: Assimilative Capacity/Carrying Capacity

	Previously	Proposed
Assimilative capacity	the ability of a body of water to assimilate a contaminant without showing adverse changes	the amount of an activity or activities allowed in a body of water before it adversely affects the quality
Carrying capacity	the amount of biota (e.g. number of birds or fishes) that a given habitat can support	the ability of a body of water to support a given amount of activity or activities or ecological component


Marine Pollution Bulletin 133 (2018) 367–377

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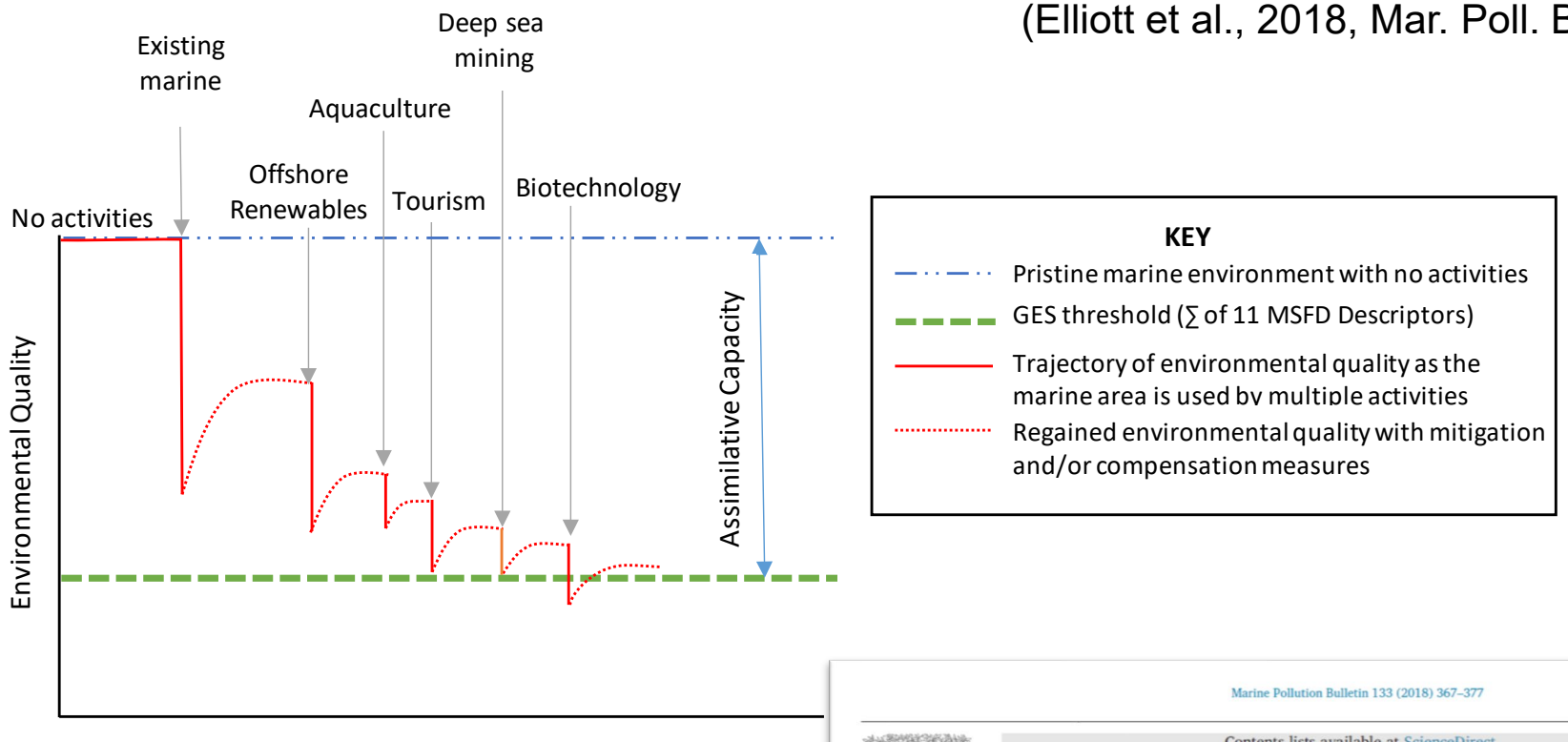
Viewpoint

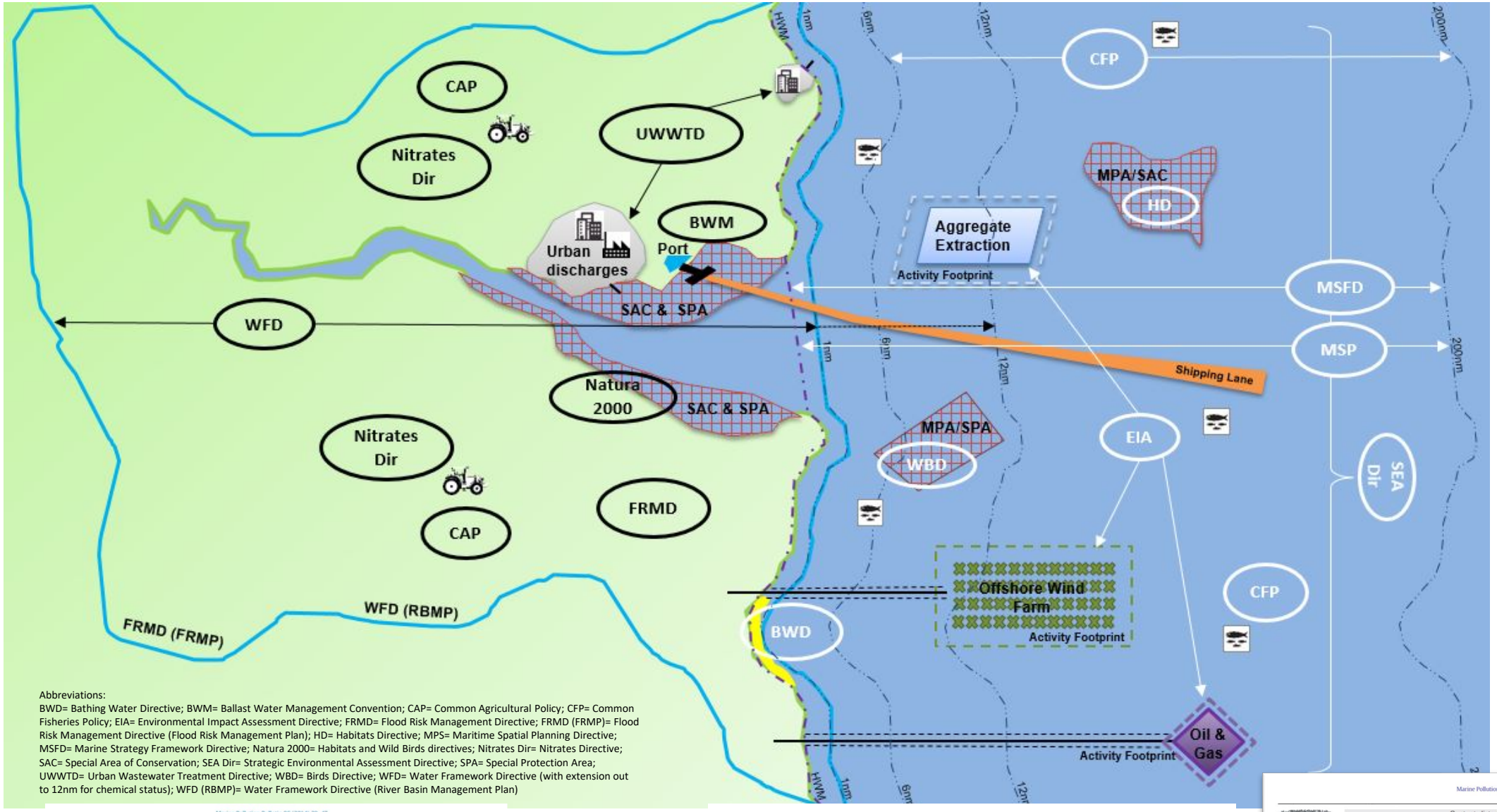
Using best expert judgement to harmonise marine environmental status assessment and maritime spatial planning

Michael Elliott[a,*], Suzanne J. Boyes[a], Stephen Barnard[a], Ángel Borja[b]

Environmental Quality Model incl. mitigation measures for cumulative Blue Growth Activities

(Elliott et al., 2018, Mar. Poll. Bull.)





Abbreviations:
BWD= Bathing Water Directive; BWM= Ballast Water Management Convention; CAP= Common Agricultural Policy; CFP= Common Fisheries Policy; EIA= Environmental Impact Assessment Directive; FRMD= Flood Risk Management Directive; FRMD (FRMP)= Flood Risk Management Directive (Flood Risk Management Plan); HD= Habitats Directive; MPS= Maritime Spatial Planning Directive; MSFD= Marine Strategy Framework Directive; Natura 2000= Habitats and Wild Birds directives; Nitrates Dir= Nitrates Directive; SAC= Special Area of Conservation; SEA Dir= Strategic Environmental Assessment Directive; SPA= Special Protection Area; UWWTD= Urban Wastewater Treatment Directive; WBD= Birds Directive; WFD= Water Framework Directive (with extension out to 12nm for chemical status); WFD (RBMP)= Water Framework Directive (River Basin Management Plan)

Geographical scope of EU legislation – all solutions possible

("where there's a will, there's a way out"!


Marine Pollution Bulletin 86 (2014) 39–47
Contents lists available at ScienceDirect
Marine Pollution Bulletin
journal homepage: www.elsevier.com/locate/marpolbul
Viewpoint
Marine legislation – The ultimate 'horrendogram': International law, European directives & national implementation
Suzanne J. Boyes *, Michael Elliott


Marine Pollution Bulletin 111 (2016) 41–44
Contents lists available at ScienceDirect
Marine Pollution Bulletin
journal homepage: www.elsevier.com/locate/marpolbul
Viewpoint
Brexit: The marine governance horrendogram just got more horrendous!
Suzanne J. Boyes *, Michael Elliott


Marine Pollution Bulletin 111 (2016) 18–32
Contents lists available at ScienceDirect
Marine Pollution Bulletin
journal homepage: www.elsevier.com/locate/marpolbul
Review
Is existing legislation fit-for-purpose to achieve Good Environmental Status in European seas?
Suzanne J. Boyes [a,*], Michael Elliott [a], Arantza Murillas-Maza [b], Nadia Papadopoulou [c], Maria C. Uyarra [b]

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Hazard & Risk Typology: Source of Problems & Cause for Management

= Risk Assessment & Risk Management (RA&RM):

- Hazard Identification:
- Risk Assessment:
- Risk Management:
- Risk Communication:

All hazards caused or exacerbated by climate change or the societal responses to climate change!!

Ocean & Coastal Management 93 (2014) 88–99

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Review

A typology of marine and estuarine hazards and risks as vectors of change: A review for vulnerable coasts and their management

Michael Elliott [a,*], Nicholas D. Cutts [a], Anna Trono [b]

Chapter 1

A Synthesis: What Is the Future for Coasts, Estuaries, Deltas and Other Transitional Habitats in 2050 and Beyond?

Michael Elliott*, John W. Day†, Ramesh Ramachandran‡, Eric Wolanski§

Decommissioning Activities: Hazard leading to Risk (depending on assets) (High, Medium, Low, - Not Likely;)	
A) Surface hydrological hazards (e.g. flooding)	-
B) Surface physiographic removal by natural processes - chronic/long-term (e.g. erosion)	-
C) Surface physiographic removal by human actions - chronic/long-term (e.g. land-claim, space removal)	-
D) Surface physiographic removal - acute/short-term (e.g. cliff failure)	-
E) Climatological hazards - acute/short term (e.g. storminess)	H
F) Climatological hazards - chronic/long term (e.g. NAO changes, sea-level rise)	H
G) Tectonic hazards - acute/short term (e.g. earthquakes, land-slip)	M
H) Tectonic hazards - chronic/ long term (e.g. subsidence, isostatic rebound)	-

(Modified from Elliott et al., Ocean & Coastal Manag. 2014)

Decommissioning Activities: Hazard leading to Risk (depending on assets) (High, Medium, Low, - Not Likely;)	
I) Anthropogenic microbial biohazards (e.g. sewage pollution)	-
J) Anthropogenic macrobial biohazards (e.g. non-indigenous species)	M/L
K) Anthropogenic introduced technological hazards (e.g. infrastructure, sediments)	H
L) Anthropogenic extractive technological hazards (e.g. fishing, aggregates)	M
M) Anthropogenic acute chemical hazards (e.g. oil spills)	H
N) Anthropogenic chronic chemical hazards (e.g. diffuse and point-source contaminants)	H
O) Anthropogenic acute geopolitical hazards (e.g. wars, unrest, terrorism)	-
P) Anthropogenic chronic geopolitical hazards (e.g. human migrations, civil-war)	-

(Modified from Elliott et al., Ocean & Coastal Manag. 2014)

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Specific Challenges for Marine Infrastructure – need for evidence:

- Recovery from historical pollution by industrial wastes
- Accommodating continuing endogenic managed pressures from new industries and ports, etc.
- Accommodating exogenic unmanaged pressures such as climate change impacts
- Determining spatial and temporal effects-footprints

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Endogenic Managed Pressures – ✓ for decommissioning

Smothering	✓
Substratum loss	✓
Changes in siltation	✓
Abrasion	✓
Selective extraction of non-living resources (habitat removal)	✓
Underwater noise	✓
Litter	✓
Thermal regime change	
Salinity regime change	
Introduction of synthetic compounds	✓
Introduction of non-synthetic compounds	✓
Introduction of radionuclides	✓
Introduction of other substances	✓

Nitrogen and phosphorus enrichment	
Input of organic matter	✓?
Introduction of microbial pathogens	
Introduction of non-indigenous species and translocations	✓
Selective extraction of species	✓?
Death or injury by collision	✓
Barrier to species movement	✓?
Emergence regime change	?
Water flow rate changes	✓
pH changes	
Electromagnetic changes	✓
Change in wave exposure	✓

(from Elliott et al 2017 Mar Poll Bull)

(NB, the pressure is the mechanism of change as the result of the activity)

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Challenges for science & management

There is only one big idea in marine management: *how to maintain and protect ecological structure and functioning while at the same time allowing the system to produce ecosystem services from which we derive societal benefits.*

MSFD

MSPD

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Influence of Oil, Gas and OWF decommissioning on MSFD

MSFD Descriptor	Relevance to Oil, Gas and OWF decommissioning
D01 biodiversity	Biodiversity/MPA change against uncertain baselines
D02 alien species	Surfaces for attachment and spread of NIS?
D03 foodwebs	Biomass and feeding area changes; reef-effect & loss;
D04 seafloor integrity	Disturbance through drill cuttings, cabling, tunnelling, scour-protection and surface structures;
D05 fishing	*De facto* no-take zones with structures vs. regaining fishing grounds after removal
D06 eutrophication	No changes, minimal response
D07 hydrography	Removal of impediments to flow, local changes in local hydrodynamics
D08 contamination in environment	Release of contaminants due to physical disturbance of from anoxic sediments (H_2S, CH_4 etc)
D09 contamination in seafood	Uptake of any released contaminants but perhaps dispersion means non-detectable additional contamination
D10 litter	Remaining materials (pipelines, mattresses) regarded as 'litter' with eventual dispersion
D11 energy/noise	Noise, vibration (use of explosives) and energy use in removal

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Challenges – measuring change

- Defining thresholds, tipping points, reference conditions
- Separate surveillance from true monitoring
- Achieving criteria for monitoring
- Defining and testing indicators – criteria for indicators
- But also defining targets against which change measured by monitoring is judged
- Separate contamination from pollution per se (e.g. microplastics)

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The Marine Assessment Paradox:

That there are more and more initiatives requiring assessments (below) but there is less funding for achieving them (or the funding is put on industry)

- Catchment quality (e.g. Water Framework Directive, Clean Water Acts)
- Habitat and species conditions (e.g. Habitats Directive, Conservation legislation)
- Marine regional quality (e.g. Marine Strategy Framework Directive, Oceans Acts)
- Cumulative impacts assessment (e.g. CIA Directive)
- Strategic environmental assessment (e.g. SEA Directive)
- Environmental Impact Assessment (e.g. EIA legislation worldwide)
- Permit conditions for industry and marine activities

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Industry Obligations: Proactive/*A priori* assessment:

- EIA (process) linked to outcome (ES) (Directive, planning permission)
- Appropriate Assessment (linked to HSD)
- Habitat regulations Assessment (link to HSD)
- Status and pressures Monitoring (linked to WFD, MSFD)
- Cumulative Impact Assessment
- Strategic Environmental Assessment - linked to Marine Spatial Planning
- H1/EpiSuite - linked to complex effluents, IPPC authorisation (IPPC Directive)
- Data-base toxicology assessment (linked to licence creation, assess re. ability to accumulate, be persistence, magnify, be toxic) (but limitations cf. synergy/antagonism)

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Evidence Needs - Recipe Leading to Integrated Marine Management

- Need to understand how our activities lead to which pressures
- Need to understand which pressures are within and outside our control
- Need to understand ecological structure and functioning
- Need to understand what state changes on the natural system occur from those pressures (effects-footprints)
- Lead to describing the impact on human welfare as effects on Ecosystem services and Societal goods and benefits
- Lead to defining the appropriate responses as management measures
- Require implementation of governance (policies, politics, administration and legislation)
- Within a multiuser system requiring resolution of conflicts amongst users
- Communicate by working with stakeholders

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The relevance of the 10-tenets of sustainable management to Oil, Gas and Offshore windfarm (OWF) decommissioning

Tenet	Relevance to Oil, Gas and OWF decommissioning
Ecologically sustainable	Effects of loss or gain of habitats and surfaces; changes in ecological equilibrium; increase or removal of pressures
Technologically feasible	Are there the techniques and technologies for removal?
Economically viable	Costs/benefits/increase/decrease/legacy issues of energy/GHG/jobs/ecosystem services/societal goods and benefits in removal and recycling
Socially desirable/ tolerable	Societal views of remain/removal and company responsibility; repercussions for other societal users and uses
Legally permissible	Legal requirements to remove or allow retention; challenges to legal practice
Administratively achievable	National bodies to implement international regulations and decide removal and derogations
Politically expedient	Politics of austerity, environmental protection and Blue Growth
Ethically defensible (morally correct)	Ethics of leaving and/or decommissioning debts for future generations
Culturally inclusive	Influence on indigenous peoples' land and on high seas areas
Effectively communicable	Delivery of relevant and unbiased information

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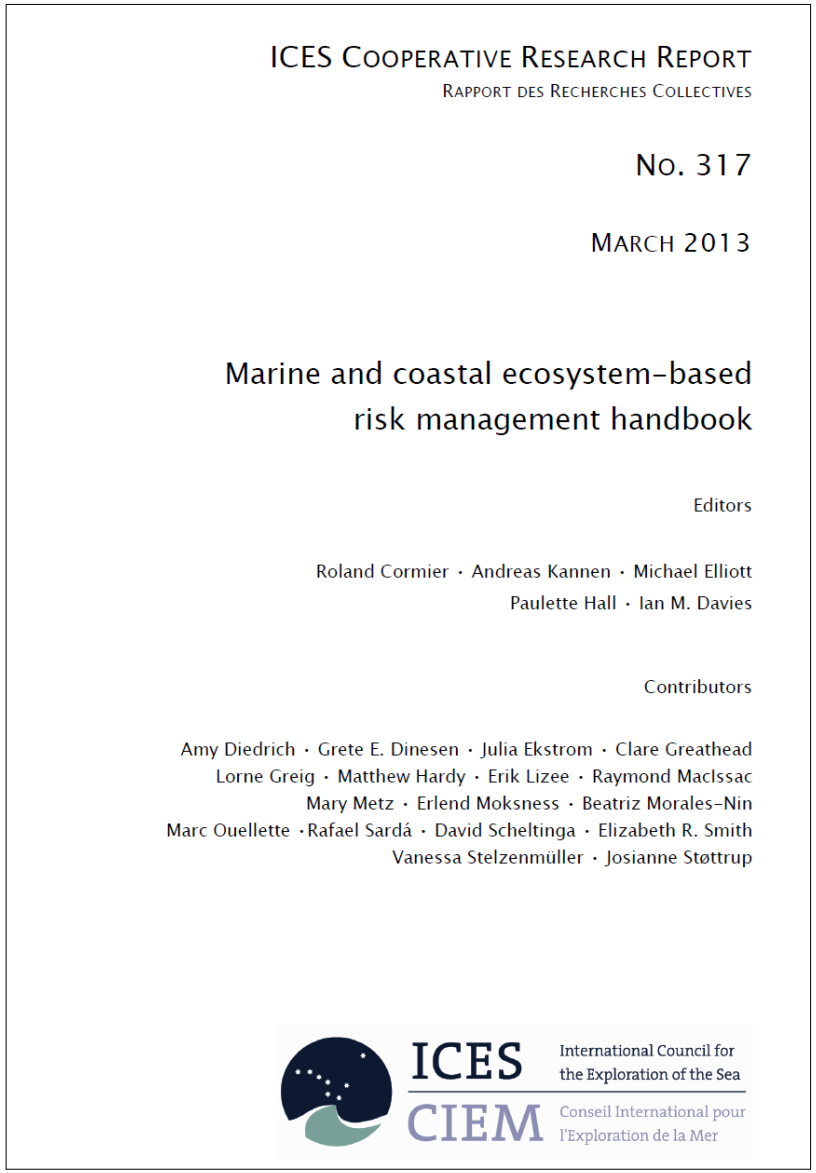
Quality Assurance in Marine Decision-making



ICES Cooperative Research Report

Rapport des Recherches Collectives

No. 317

March 2013

Marine and coastal ecosystem-based risk management handbook

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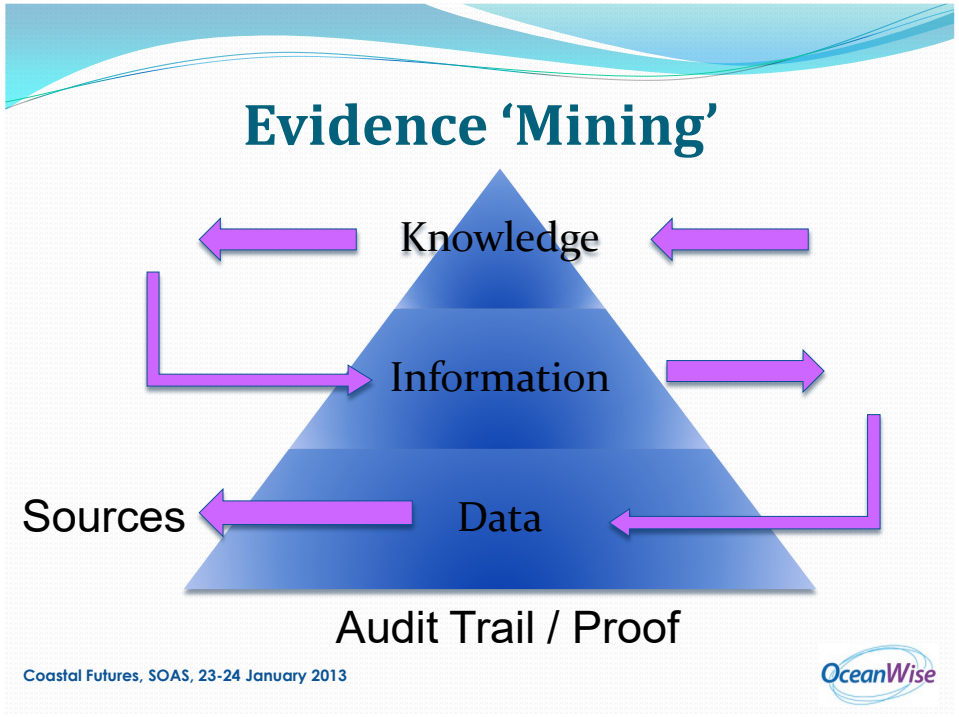
ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer



Importance of audit trails, defendable actions and policies

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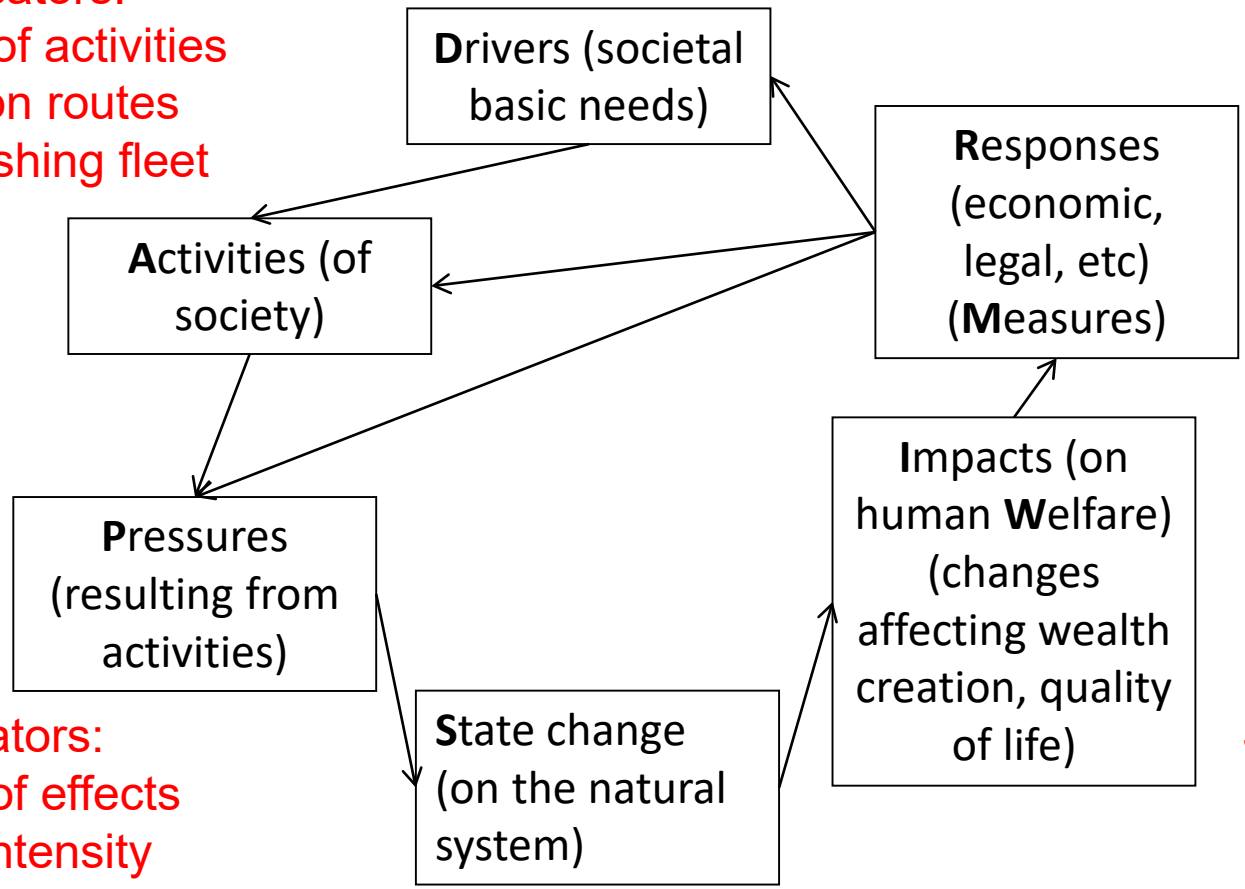
Achievement Sub-system *(checking outcomes vs. outputs)*

E.g. Indicators:
Number of activities
Navigation routes
Size of fishing fleet



E.g. Indicators:
Number of regulations
Economic costs
10-tenets values

Indicator-based DAPSI(W)R(M) framework

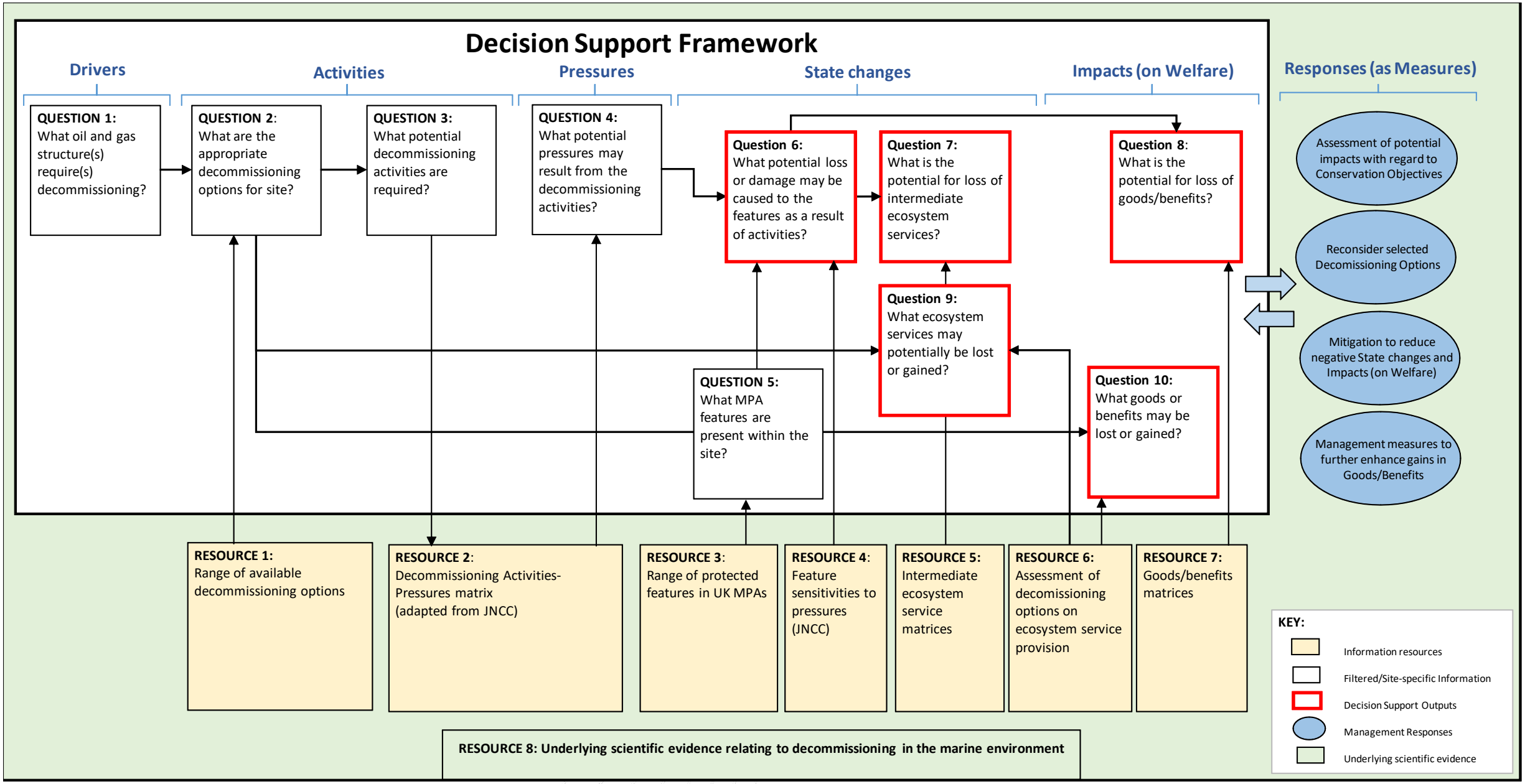
E.g. Indicators:
Footprint of effects
Stressor intensity

E.g. Indicators:
Ecosystem service
Societal benefits
Human health status

E.g. Indicators:
Natural health status
Population levels
Community structure

(NB - DEVOTES indicators catalogue – 500 indices!)

(But make sure they are SMART!!)



Decision Support Framework for O&G Decommissioning

(Burdon et al., Mar. Poll. Bull., 2018)

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Challenges – to determine/discuss:

- the inputs and removals of pollutants/contaminants
- the loss and gain of habitats and surfaces
- the loss and gain of ecosystem services and societal goods and benefits
- the value of removing structures with and without damage
- the whole system energy and economic budgets
- the whole cycle environmental footprints at near and far scales
- how to ensure the protection of other uses and users
- the relevant baseline/reference condition (with or without structures)
- the harmonised implementation of Good Ecological Status (WFD), Good Environmental Status (MSFD) and Favourable Conservation Status (HD).

and

- what are the bottlenecks, showstoppers and train-wrecks?

"I suppose I'll be the one to mention the elephant in the room."

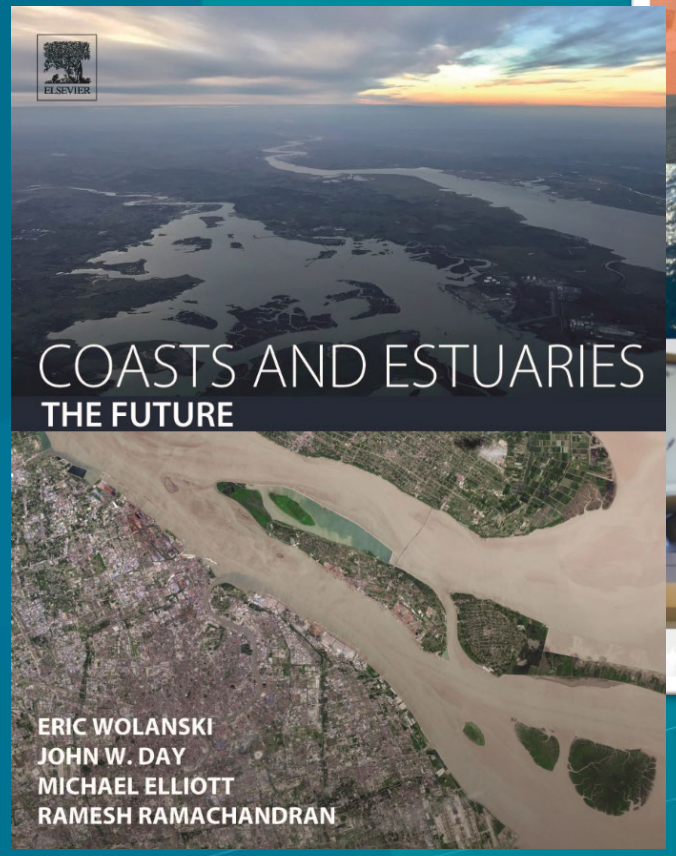
"How come it's always the old, bald-headed guy with glasses in cartoons?"

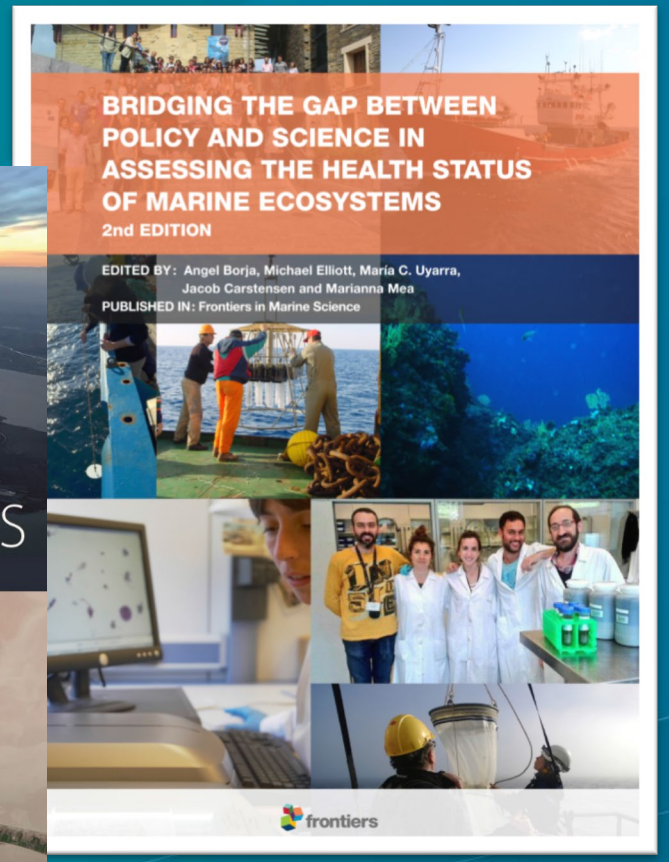
BURNING QUESTIONS

Session 2:

- What knowledge is needed in order to avoid the 'stepping-stone' effect and prevent the spread of invasive species when using decommissioned infrastructure for creating artificial reefs?
- Given climate change and warming oceans are changing the geographic range of species, should historically non-native species still be deemed as invasive?
- Are environmental controls on decommissioning concerned with ecological structure rather than ecological functioning?
- Does industry recognise the distinction between contamination and pollution?
- Does industry recognise biological, physical and chemical contaminants/pollutants equally?

(Open Access book)





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(NB Save the Date - Hull Sept. 7-11 2020 ECSA58 & EMECS13!!!)