PICES Annual Meeting, Qingdao 2015

A European Perspective on Integrated Ecosystem Assessment

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UNIVERSITY OF LIVERPOOL

European regional seas

- Coastal/shelf seas
- High level interaction with land activities
- Heavily utilised/busy!
- Subject to same major policies/societal objectives

Vary, in terms of:
- Environment
- Biodiversity
- Mix of EU/non EU bordering states
- Political conditions
- Economic drivers
- Socio-cultural conditions
- Governance in place

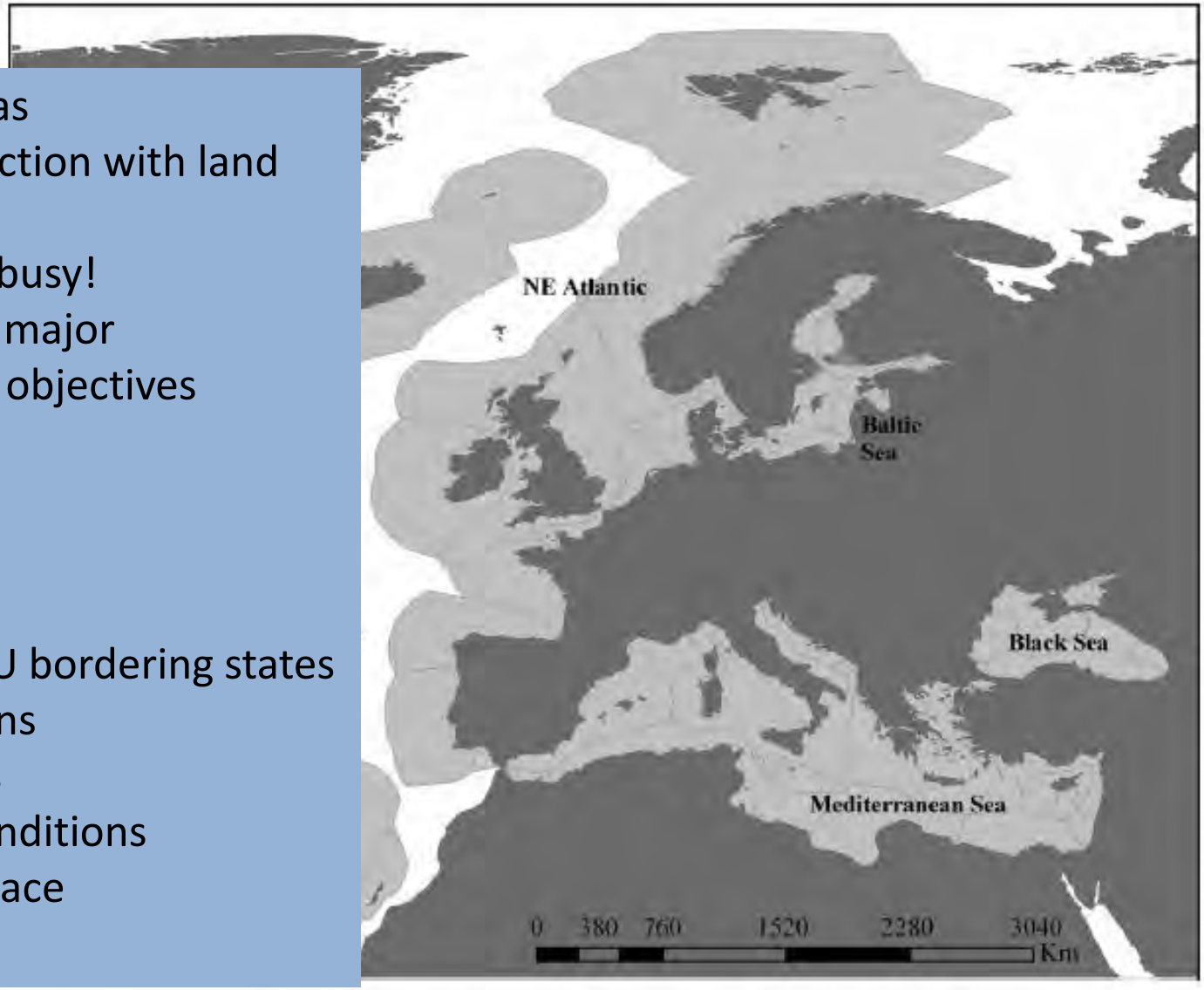
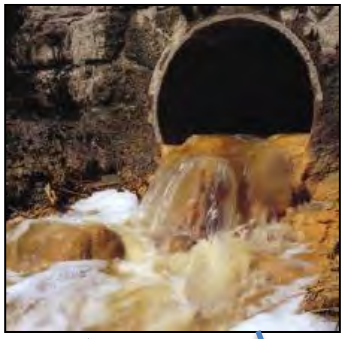


Figure 1. Regional Sea areas of Europe as defined by the MSFD (light grey areas indicate the spatial coverage of the directive). Impact chains were assessed at the scale of the region for the NE Atlantic, Baltic Sea, Black Sea, and Mediterranean Sea. Exclusive economic zone (EEZ) borders are shown.

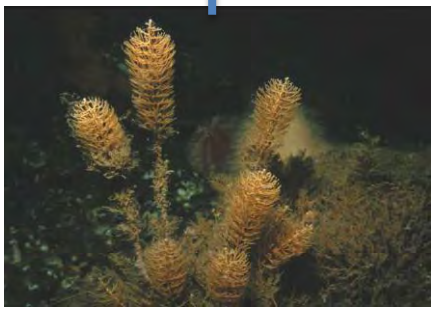


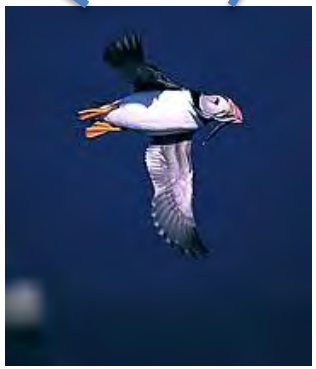



EBM – understanding how humans and natural ecosystems interact to enable sustainable use (IEA)

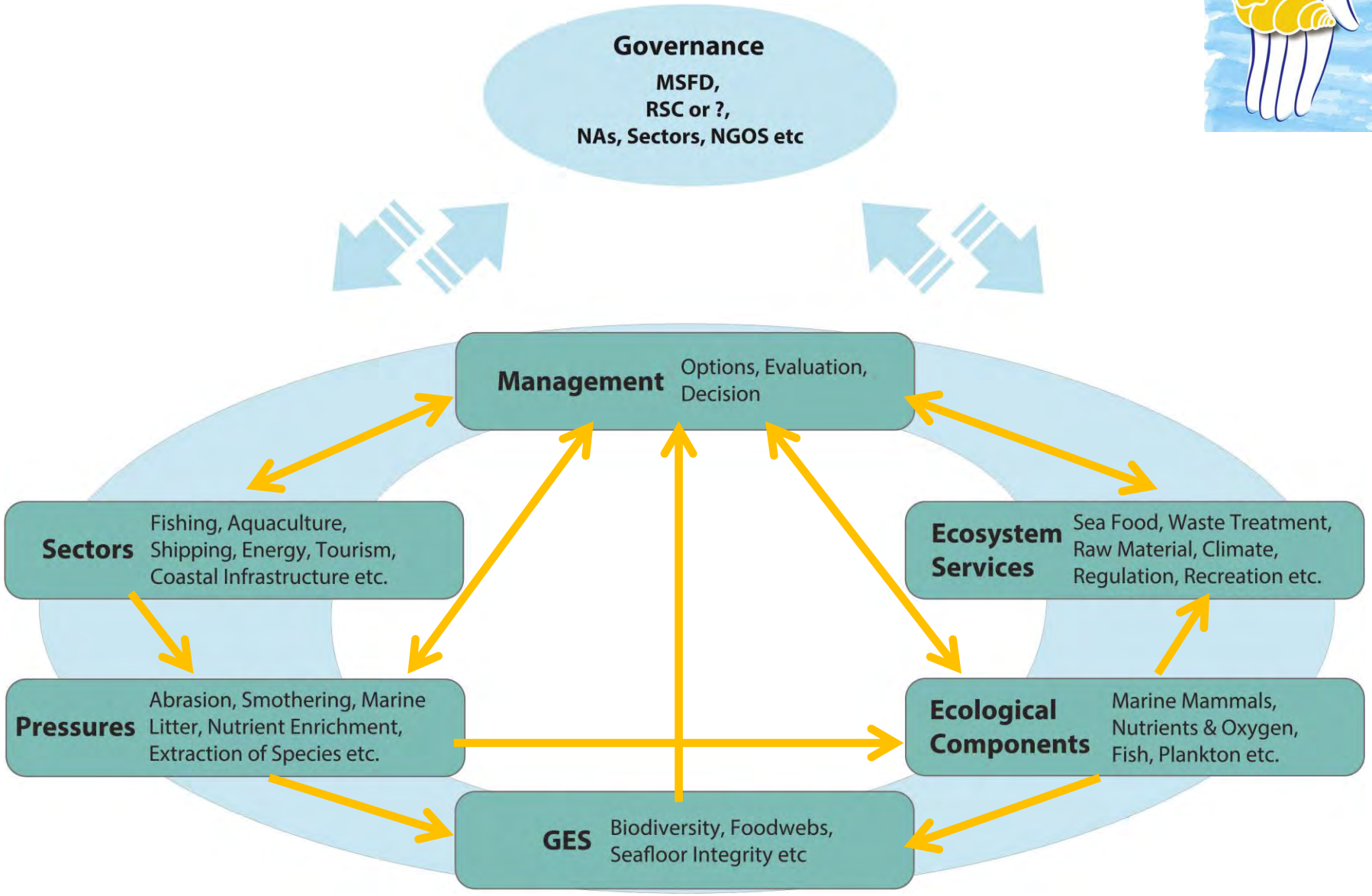



How does change in ecosystems affect human wellbeing?
IEA that can tell us about ESs (and wellbeing)





The ODEMM approach



ODEMM considered there to be five key principles to an approach that would make EBM operational. It must:

1. Have clear objectives that are determined by society and set in relevant policy, and then link these objectives to specific components of the ecosystem (i.e. work within a fully integrated ecosystem assessment framework)

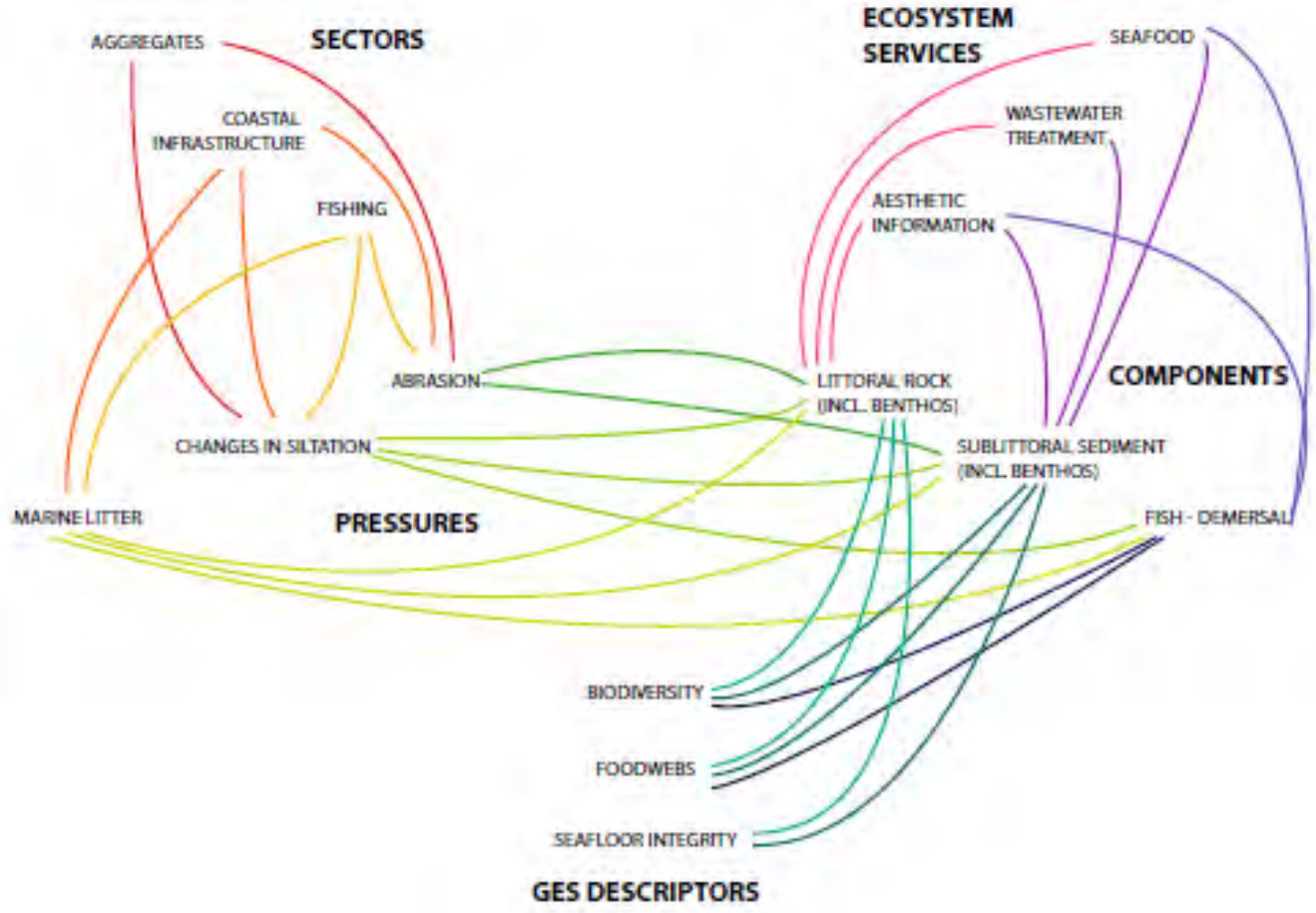
2. Account for all possible interactions that are relevant to the policy objectives no matter how insignificant they may at first seem (be holistic), and then be able to weight and rationalise what is important and what management and/or monitoring and research should focus on

3. Be based on structured, transparent and repeatable analyses that can work in data-poor situations (as well as those that are data-rich), because EBM should be holistic in evaluation of objectives and thus needs to account for issues even if there is little data available on them

4. Include evaluation of management options that considers the implications in terms of ecological, social and economic outcomes (be able to consider trade-offs)

5. Have clear consideration of the relevant governance settings and how these might influence performance in achieving the EBM goals, at both a broad and specific (e.g. Management Option Evaluation) level.

1. Network of linkages (IEA framework)



Robinson et al. (2014) www.odemm.com

ODEMM typologies and linkages

Sectors

- Shipping
- Fishing
- Oil & Gas
- Nuclear power
- Aquaculture
- Agriculture
- Renewables
- Tourism
- Land-based industry
- Aggregates
- Waste water
- Nav. dredging
- Military
- Research
- Harvesting
- Telecoms
- Desalination
- Coastal infrastructure

Pressures

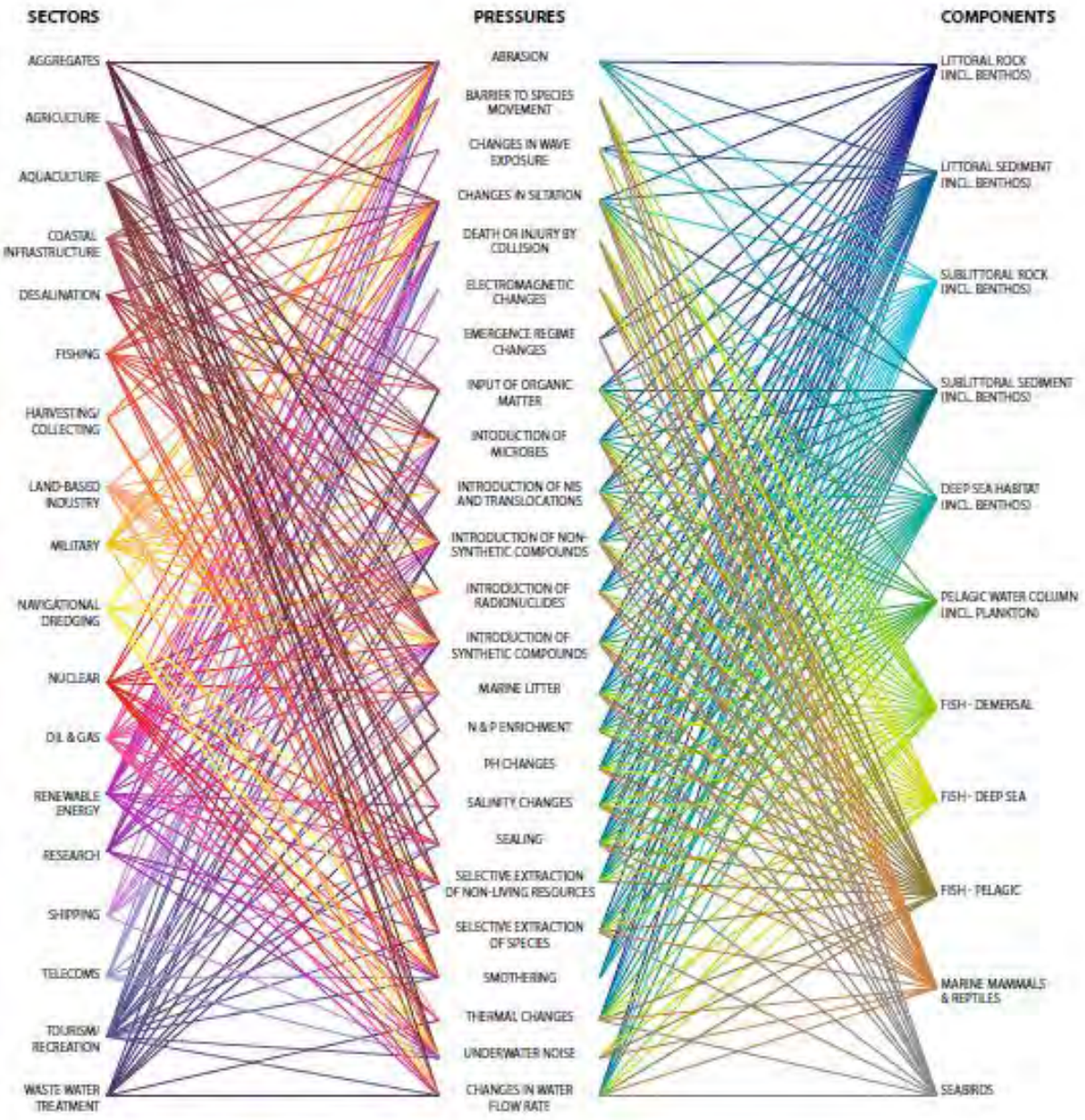
- Water flow
- Chemicals
- Siltation
- Litter
- Abrasion
- Sealing
- Smothering
- pH change
- Species extraction
- Parasites/microbes
- Temperature
- Salinity
- Organic material
- Invasive species
- N&P Enrichment
- Wave exposure
- Noise
- etc

Policy Objectives

- Food webs
- Biodiversity
- Commercial species
- Seafloor Integrity
- Marine Litter
- ……..

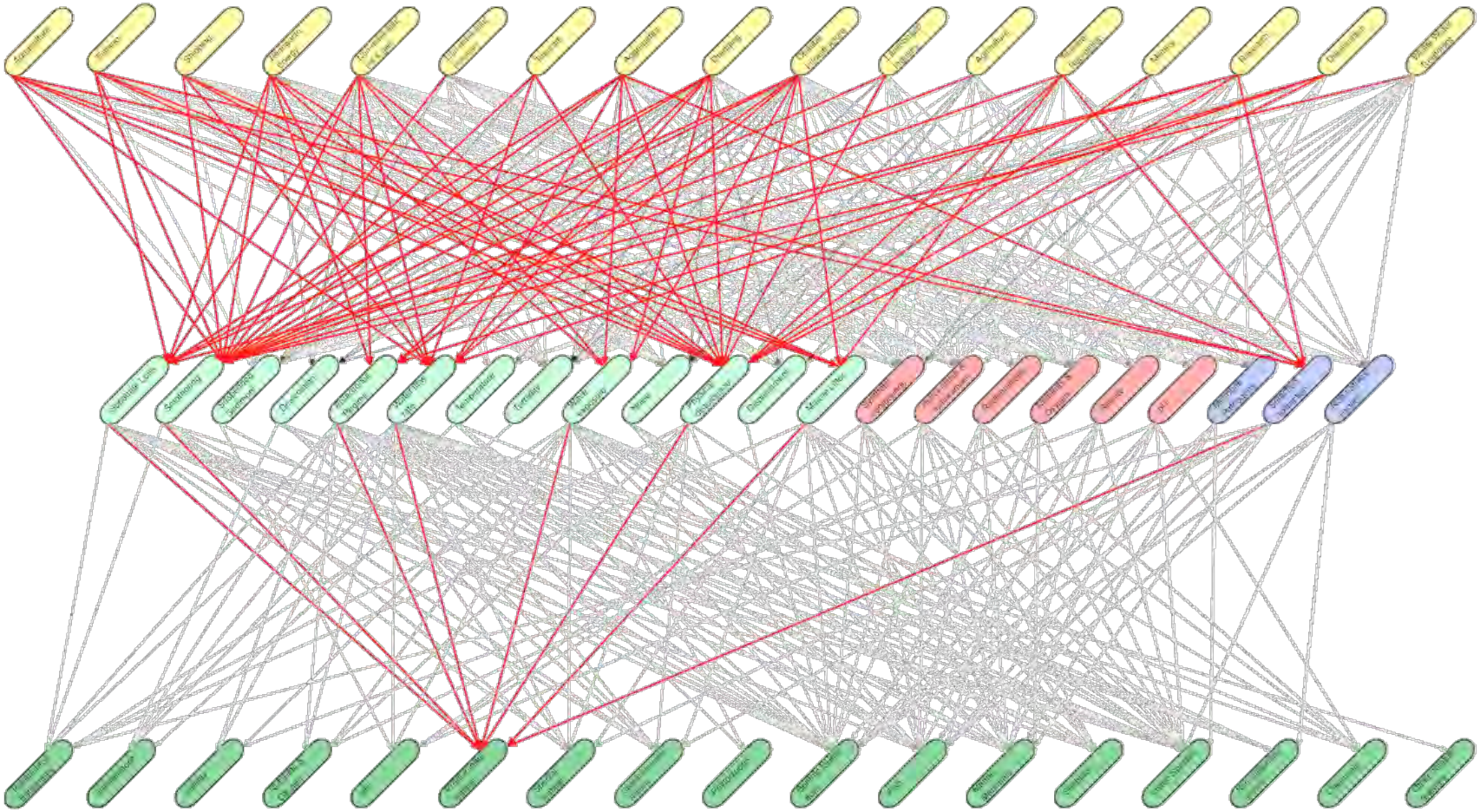
Ecological components

- Fish
- Birds
- Mammals
- Reptiles
- Benthic flora and fauna
- Habitat structure

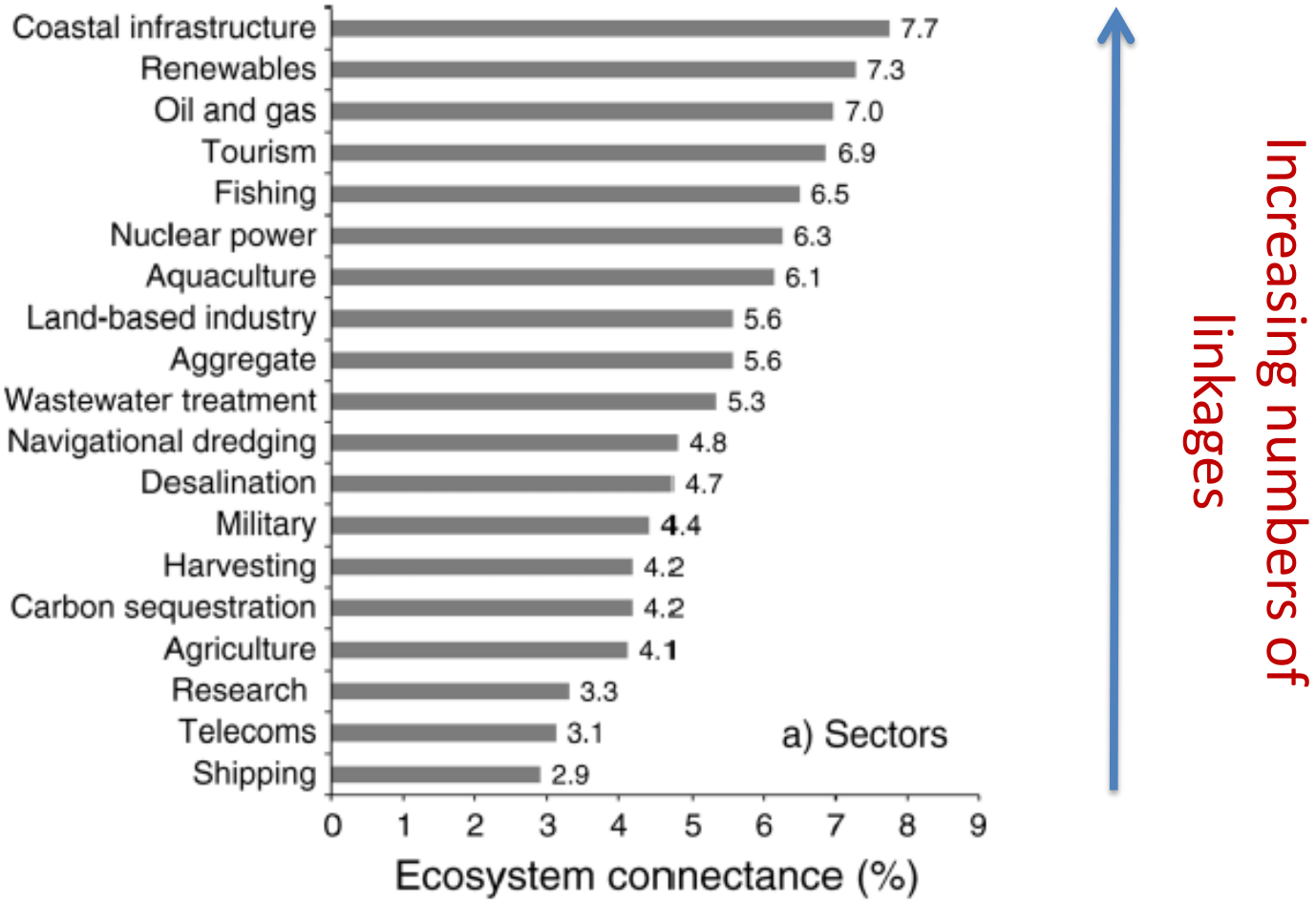


Robinson et al. (2014) www.odemm.com

From the full network of interactions can locate relevant links for particular issue….

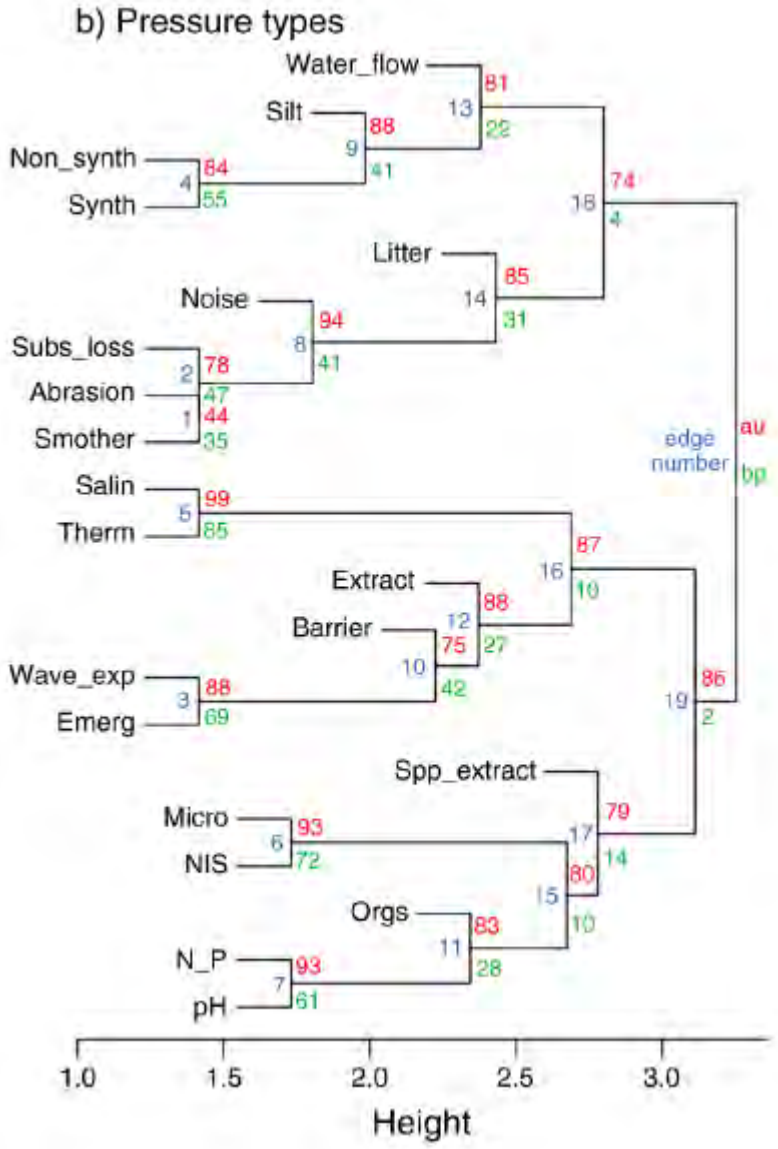


Can also consider network properties (e.g. connectance, linkage strength)



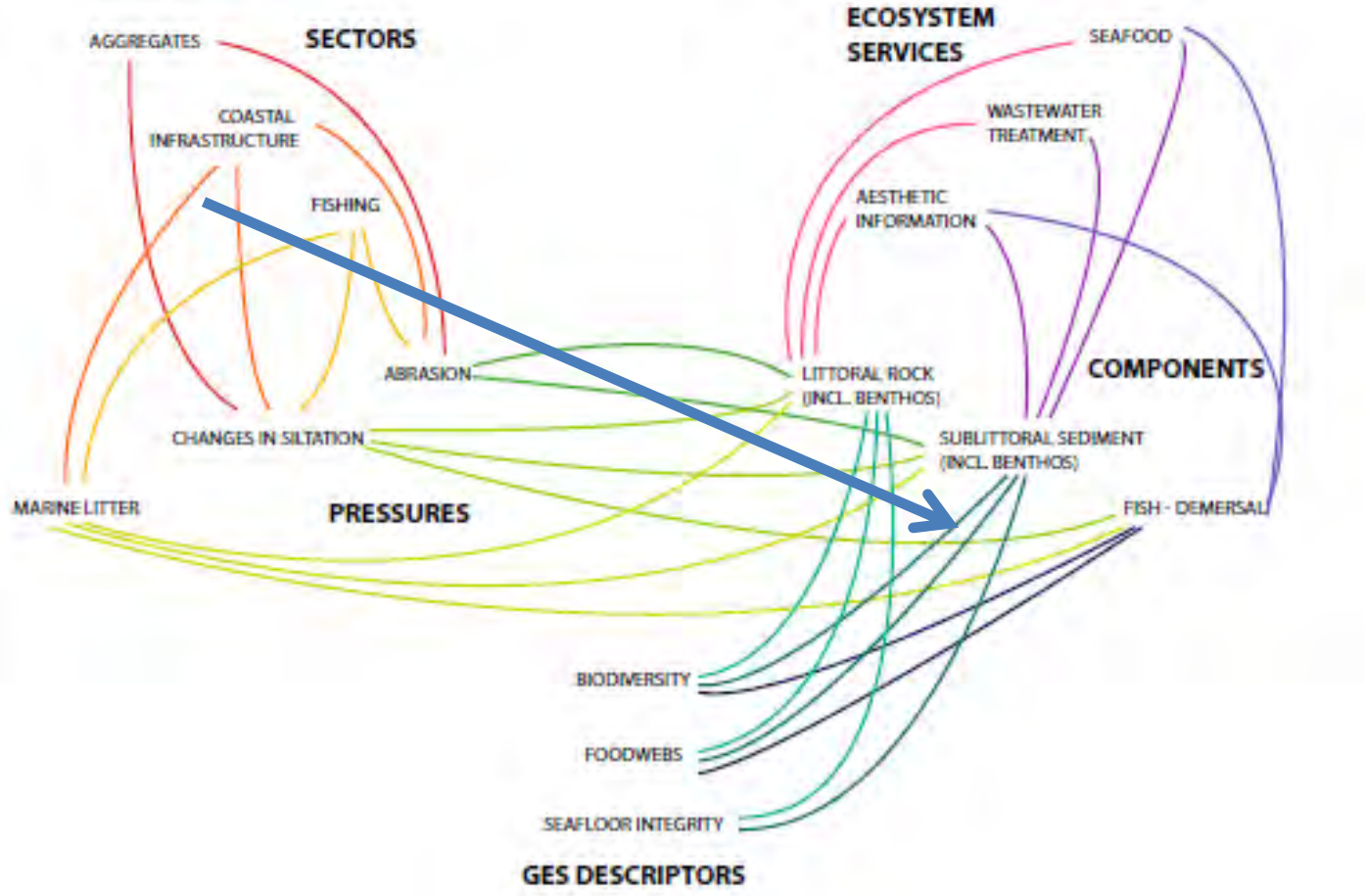
Knights et al. (2013) Ecol Apps.

Similarity in interactions – system diagnostics



Knights et al. (2013) Ecol Apps.

2. Weighting of linkages (Activity, Pressure, EC)



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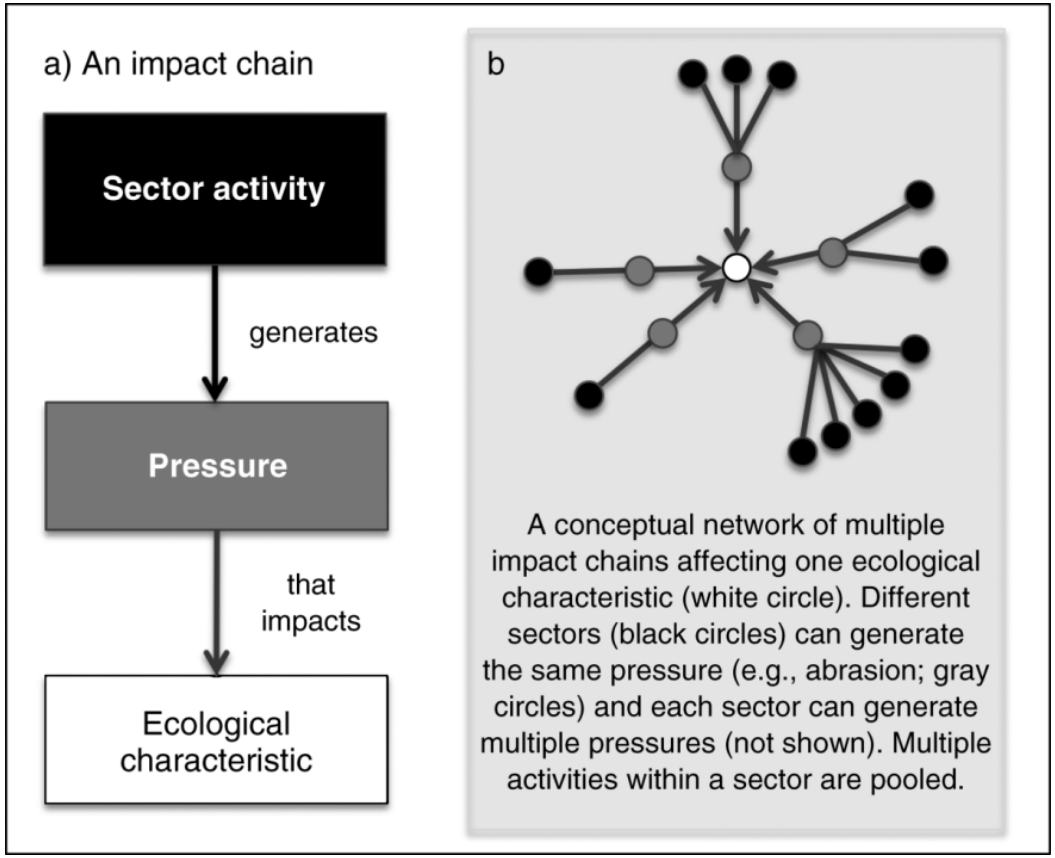
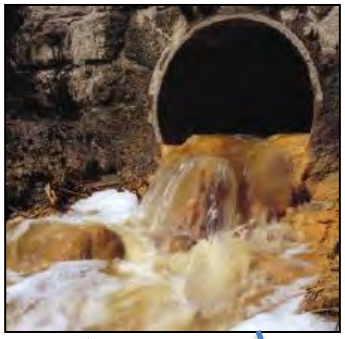


Robinson et al. (2014) www.odemm.com
Knights et al. (2013) Ecol. Apps






What are the key pressures?

Which have most management potential?

Which are the most widespread and severe?




The ODEMM Pressure Assessment

Robinson et al. (2013); www.odemm.com

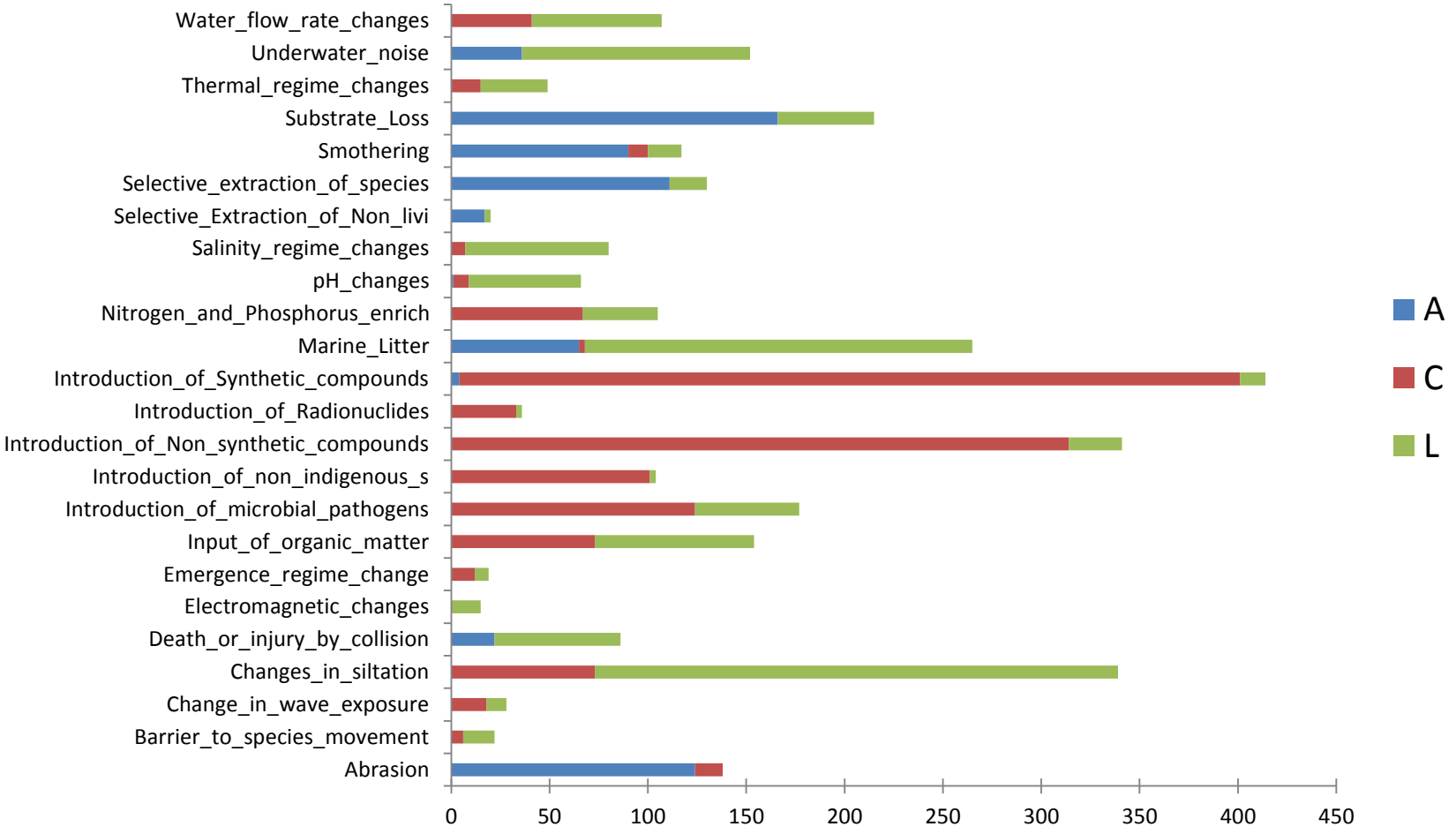
1. Categorical NOT score-based

2. Every sector/pressure/ecological component interaction assessed for:

- Extent, where overlap occurs
- Frequency of occurrence, where overlap occurs
- Degree of impact (severity of interactions, generic)
- Recovery potential (time to recovery, generic)
- Persistence of the pressure (management potential)

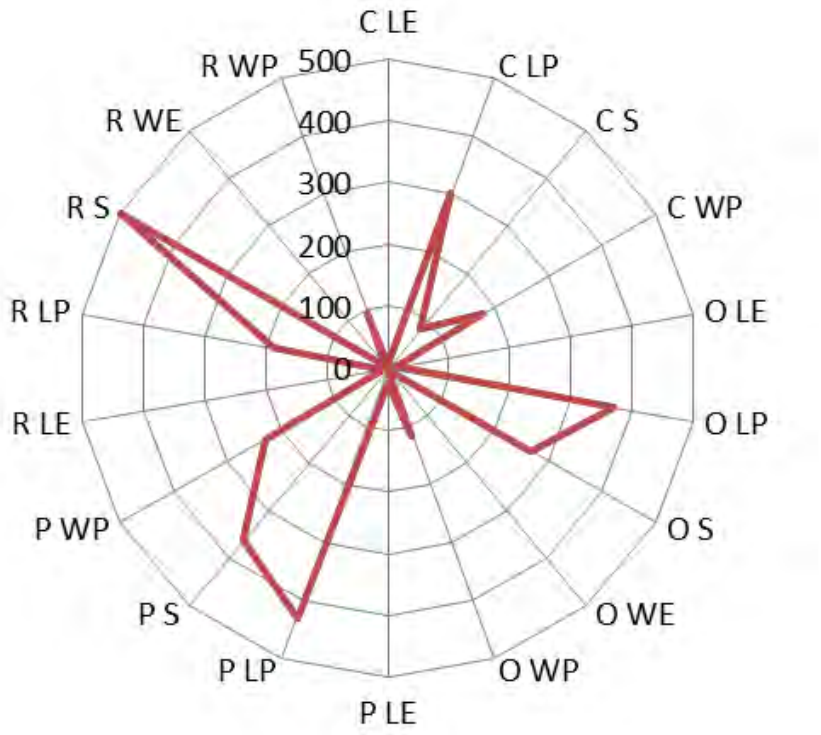
3. Interpretation then based on purpose

Can use initial outputs to explore different types of priority…

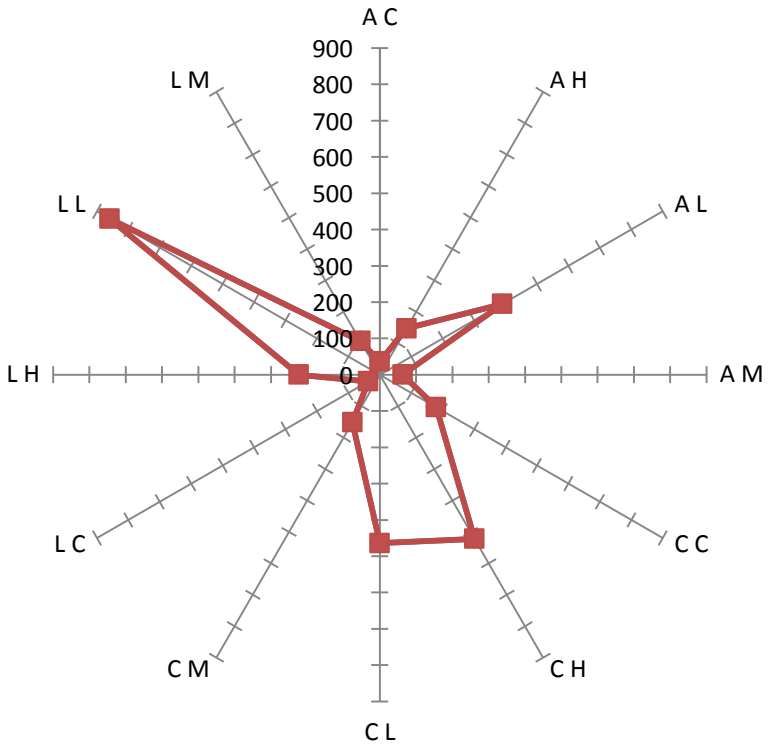


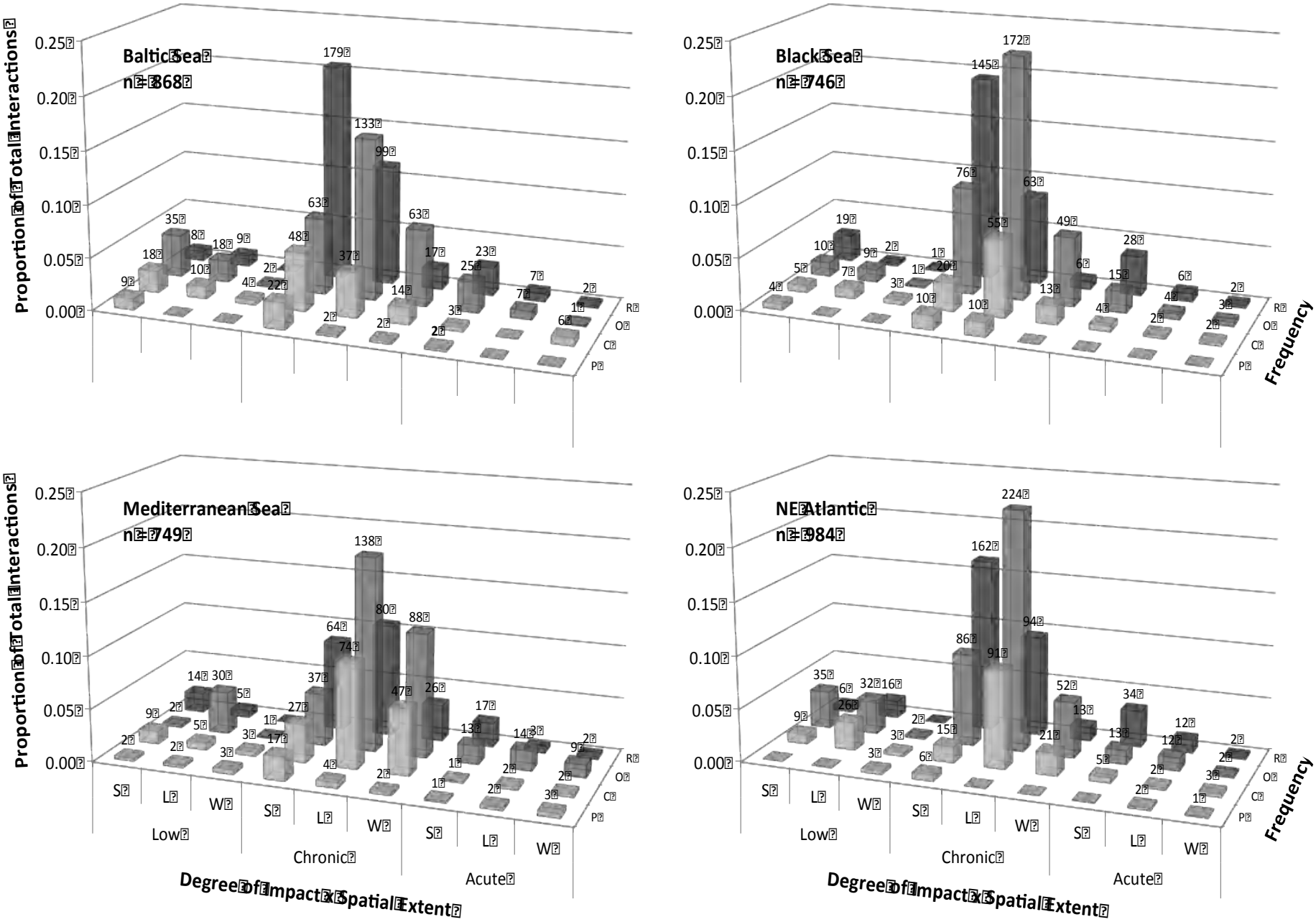
Type of results that can be explored…

Frequency and extent



Severity & Management Pot.




Baltic Sea
n = 3868
Black Sea
n = 7746
Mediterranean Sea
n = 7749
NE Atlantic
n = 3984
Proportion of Total Interactions
0.25
0.20
0.15
0.10
0.05
0.00
R
O
C
P
Frequency
S
L
W
Low
Chronic
Acute
Degree of Impact x Spatial Extent

High threat interactions (set criteria)…

Here – widespread, acute or chronic severity, long recovery and/or low management potential (Robinson et al. (2014), www.odemm.com)

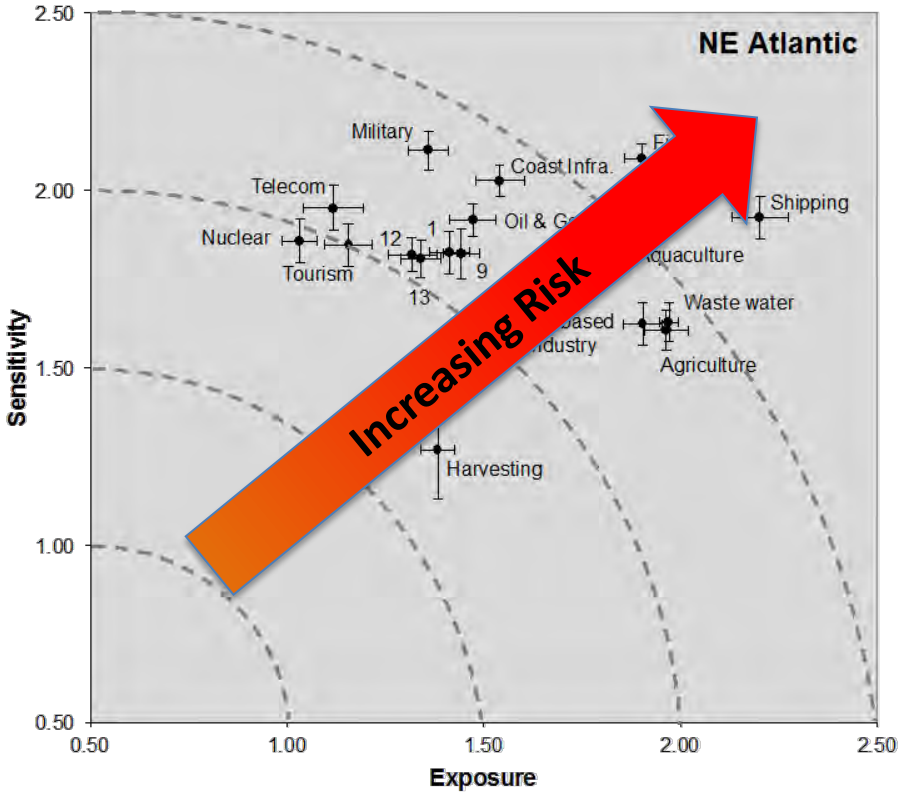
Table 4.2 Summary of high threat interactions by pressure type across the four regional seas: Baltic Sea, Black Sea, Mediterranean Sea (Med) and the Northeast Atlantic (NEA)

	Regional Sea				
Pressure	Baltic	Black	Med	NEA	Total
Abrasion	1		1	1	3
Changes in Siltation			6		6
Input of organic matter			7	2	9
Introduction of Non-Indigenous Species			4		4
Introduction of Non-synthetics				1	1
Marine Litter	9	9	16	9	43
Nitrogen and Phosphorus enrichment	2		5		7
Sealing	2	2	7	2	13
Selective extraction of species	6	2	8	5	21
Smothering			1		1
Underwater noise				1	1
Total	20	13	55	21	109

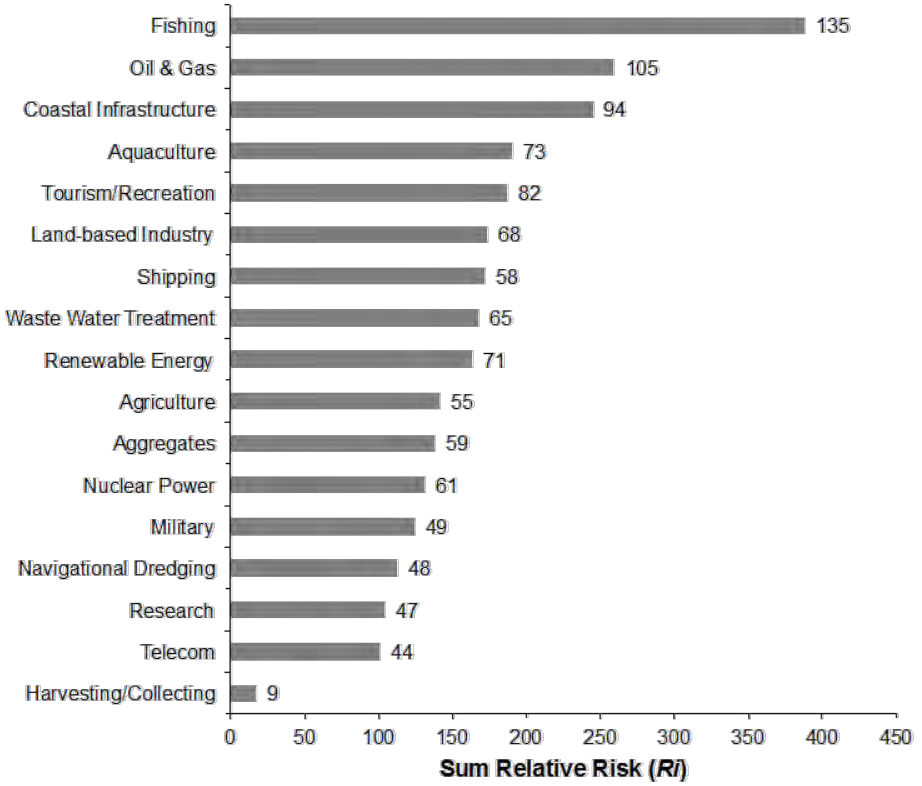
Numerical risk assessment since developed

(Knights et al. (2015) ICES J Mar Sci – final approach)

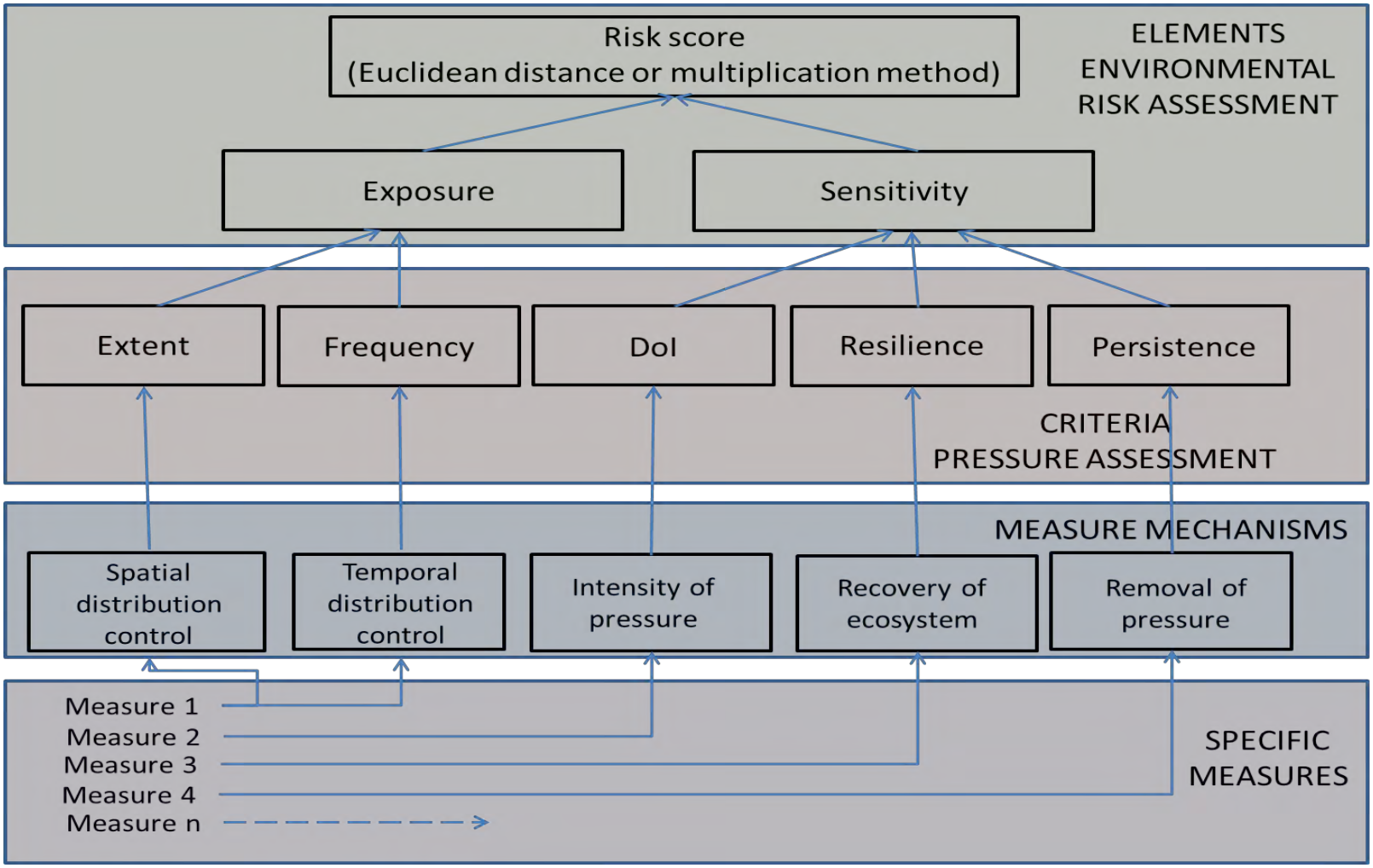
Sector



Cumulative threat



Applying management measures



Effectiveness of management options – risk reduction

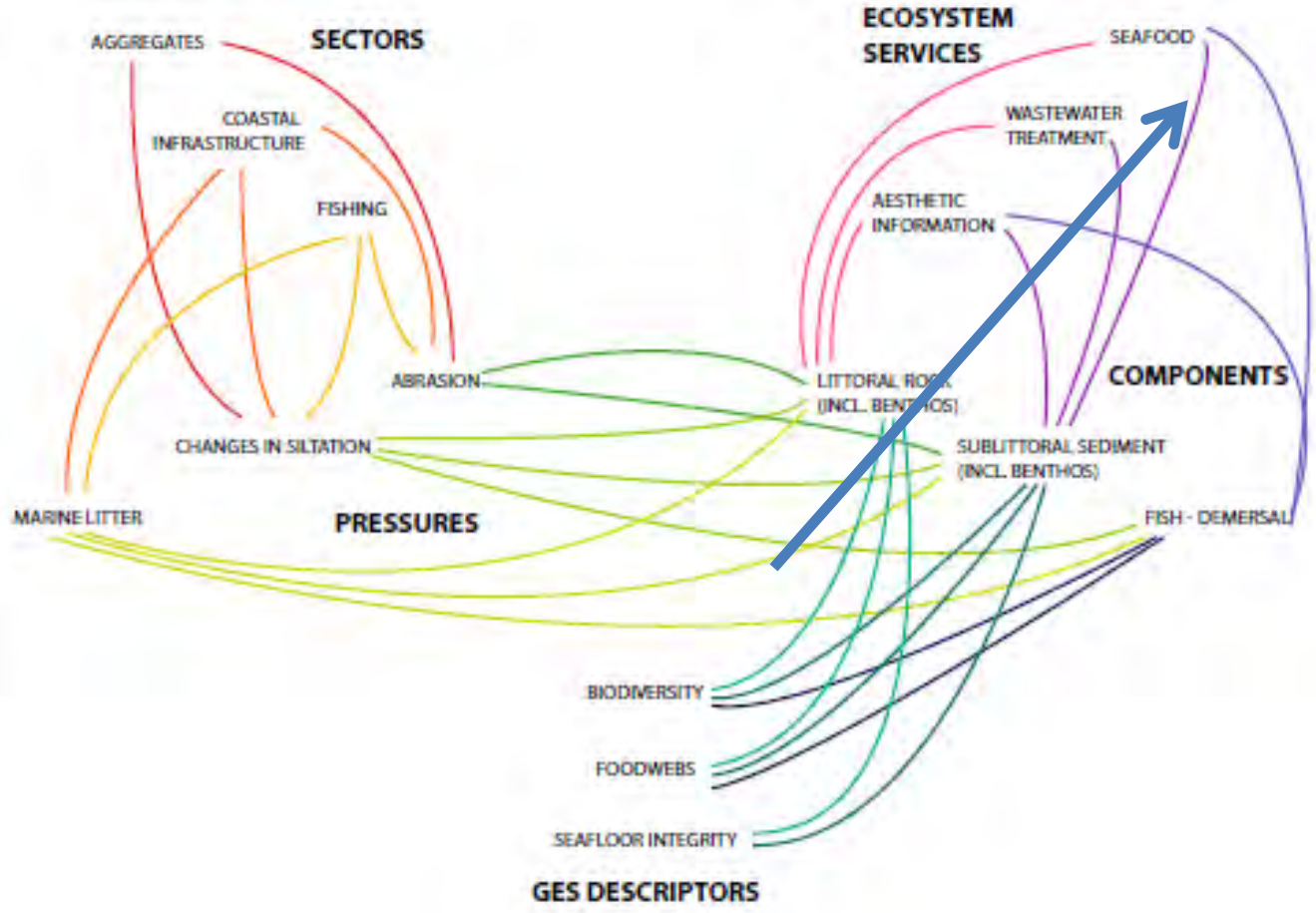
- Every impact chain has a total score
- These can be summed to explore total current risk to any ecological component
- By applying management options to some impact chains (e.g. removing or reducing key pressures or sectors) can evaluate how overall risk reduces

Effectiveness of MOs– risk reduction

Piet et al. (2015) Biol Cons

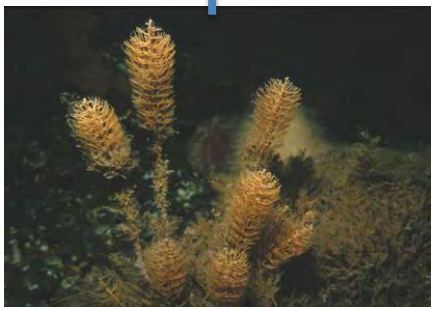
No.	Management option	Focus	# Impact Chains	Potential reduction (%)		
				RL	IR	TR
1	Spatio-temporal closures of the pelagic fishery	D (Fisheries) P (All pressures related to this type of fishery) S (Pelagic fish)	30	-	13	7
2	Spatio-temporal closures of the demersal fishery	D (Fisheries) P (All pressures related to this type of fishery) S (Demersal fish and all seafloor habitats)	70	-	30	11
3	Spatio-temporal restrictions to the discharge of ballast water	D (Shipping, Military) P (Non-indigenous species)	38	-	5	11
4	No take zone(s)	P (Selective extraction of species and non-living resources) S (may be applied, e.g. a specific seafloor habitat but was not in this assessment)	38	-	29	1
5	Closed areas for deepwater coral or seamounts	S (Deep sea bed)	28	-	3	3
6	Decommissioning fishing vessels	D (Fisheries)	81	-	31	14
7	System for identification of oil spills from offshore installations	D (Oil & Gas) P (Non-synthetic compounds)	11	-	1	1
8	Biodegradable fishing gear	D (Fisheries) P (Marine Litter)	12	-	2	7
9	Ban on littering	P (Marine Litter)	84	-	10	33

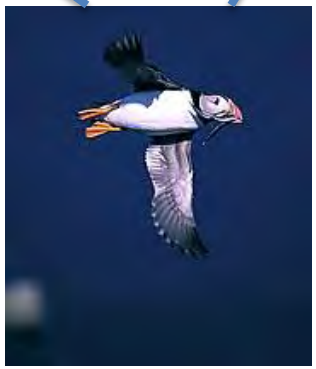
3. Weighting of linkages (EC to ES)

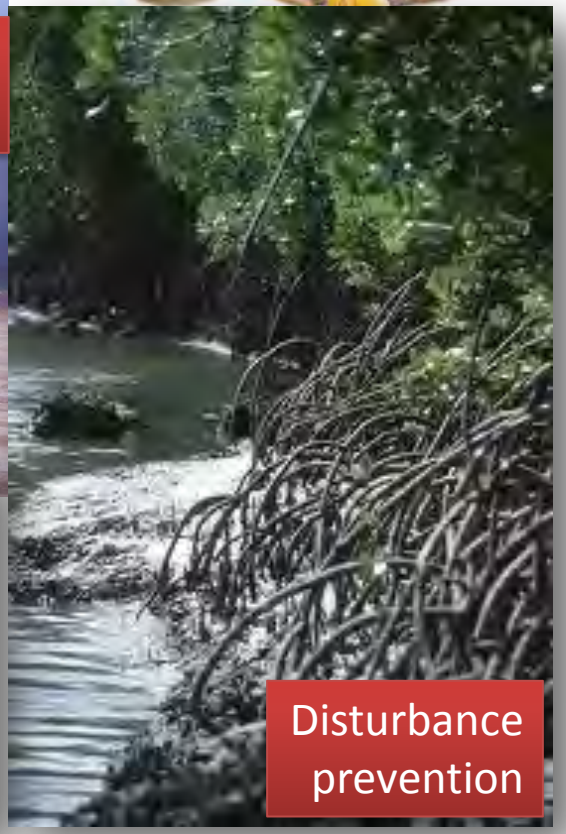


Robinson et al. (2014) www.odemm.com

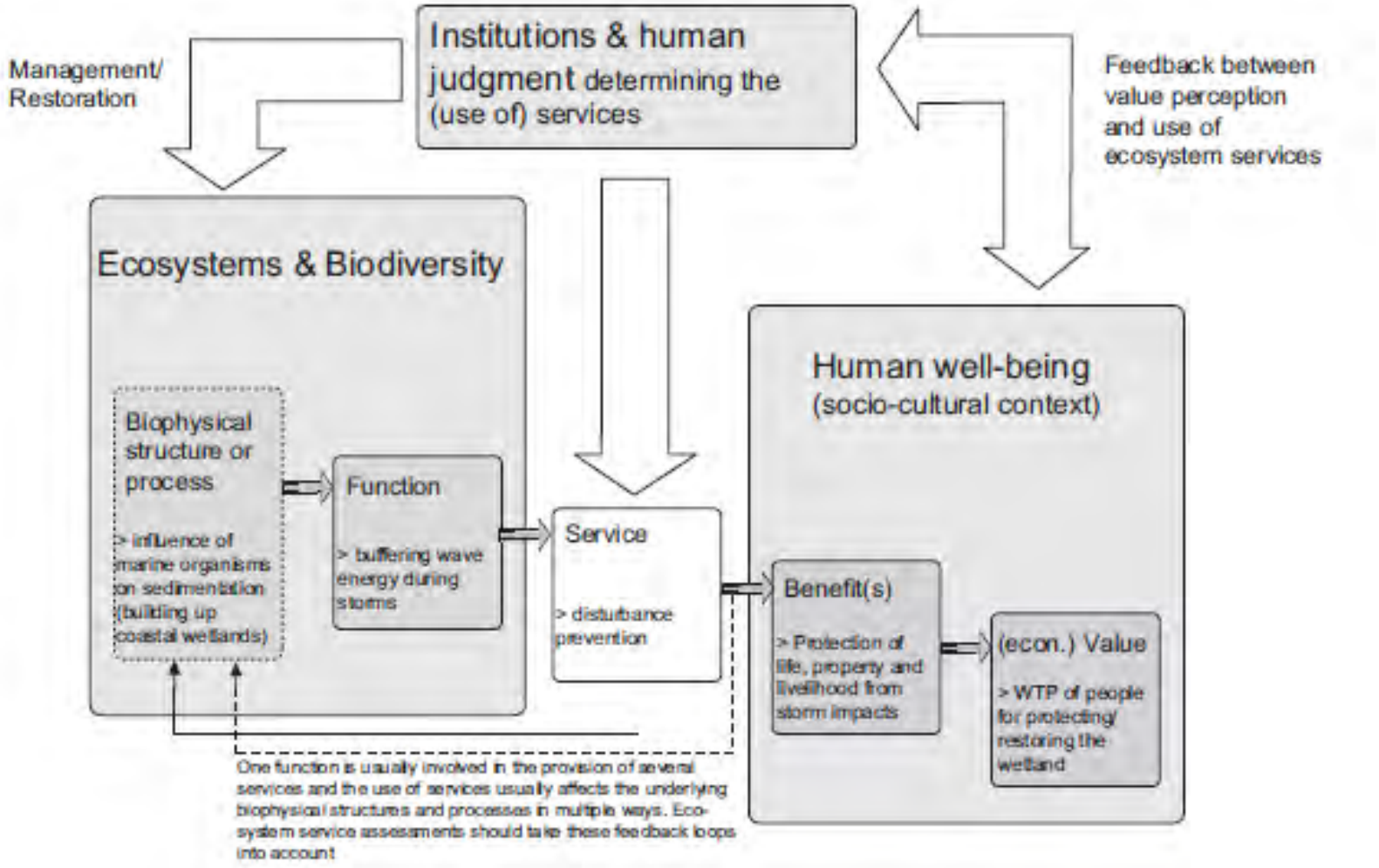
How does change in ecosystems affect human wellbeing?
IEA that can tell us about ESs (and wellbeing)







Bohenke-Henrichs et al. (2013) J Env. Man.; also see Cost:Benefits page at www.odemm.com



Bohenke-Henrichs et al. (2013) J Env. Man.

Supply (capacity) versus Demand of ESs?

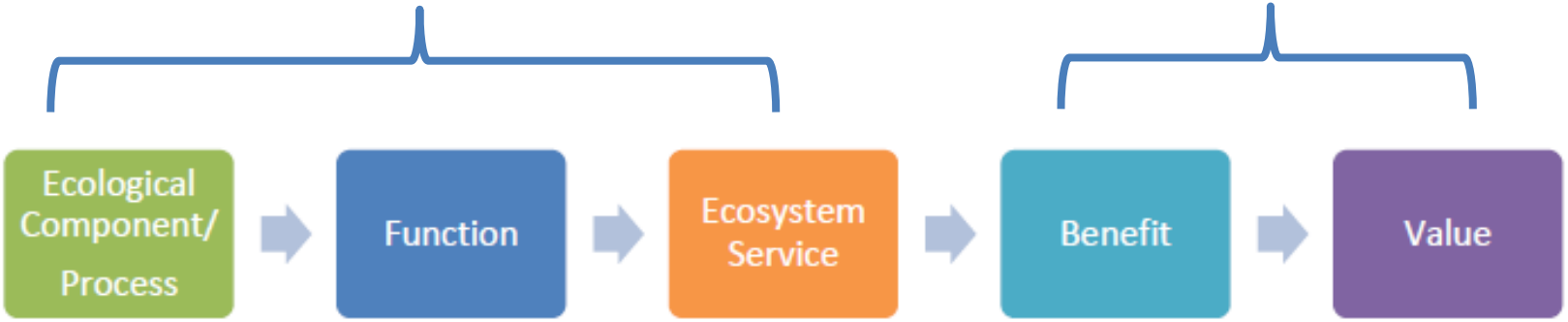


Figure 1.3 Example of a service flow cascade from the ecosystem through to economic value (adpated from Böhnke-Henrichs et al. 2013; Liquete et al. 2013a).

Culhane et al. (2014) for the EEA [State of European Seas, 2014]

How does supply in Ecosystem Services relate to state of Ecological Components?

1. Typology of Ecosystem Services (ESs) linked to Ecological Components (ECs)

2. Relative contributions of ECs to ESs

From tight coupling/quantitative (sea food) to weak coupling/proxies (cultural services)

3. Relationship state change in contributing ECs to ESs

Robinson et al. (2014) www.odemm.com
Culhane et al. (2014) for the EEA, State of European Seas

Eg. Relative contributions of ECs to waste nutrient removal (quantitative, but proxy)

Table 5.6 Primary production of biotope types and contribution of each biotope type to total primary production in the Irish Sea. Taken from Table AIII.4

Broadscale Habitat (dominant primary producer)	Primary Productivity of Biotope Type (kg m^{-2} yr^{-1} dry weight)	Contribution to primary productivity in the Irish Sea (10^6 kg yr^{-1} dry weight)^
EUNIS A1.1 (Fucoid)	0.19	3.22
EUNIS A1.2 (Fucoid)	0.75	81.03
EUNIS A1.3 (Fucoid)	1.50	116.40
EUNIS A3.1 (Kelp)	7.50	4307.30
EUNIS A3.2 (Kelp)	11.25	2518.13
EUNIS A3.3 (Kelp)	7.50	6.04
EUNIS A2.5 (Saltmarsh Macrophytes)	0.48	148.03
Water Column: Irish Sea (Phytoplankton)	0.19	19665.50
Irish Sea Total Primary Productivity		**26845.65**
Macroalgae Proportional Contribution		**26%**
Macrophyte Proportional Contribution		**<1%**
Phytoplankton Proportional Contribution		**73%**

^Productivity was estimated based on primary productivity of the biotope type and the area of each biotope

Culhane et al. (2014) for the EEA, State of European Seas

Eg. Relative contributions of ECs to cultural value (qualitative, proxies)

Table 5.9 Habitats assigned to categories of distance (taken from Table AII.3 in Annex II)

Distance from Shore: Category (Score)	Description of Category
Zero (4)	Included in this category are some low/reduced salinity habitats (a lagoon may be surrounded almost fully by land); littoral habitats; ice
Low (3) – easy to reach with low effort	Included in this are some low/reduced salinity habitats, some variable salinity, some coastal waters and shallow sublittoral habitats
Moderate (2) – still easy to reach but requires some more effort	Included in this are some coastal waters, some shelf waters, some shelf sublittoral habitats
High (1) – requires considerable effort to reach	Included in this are some shelf waters, oceanic waters, some shelf sublittoral habitats

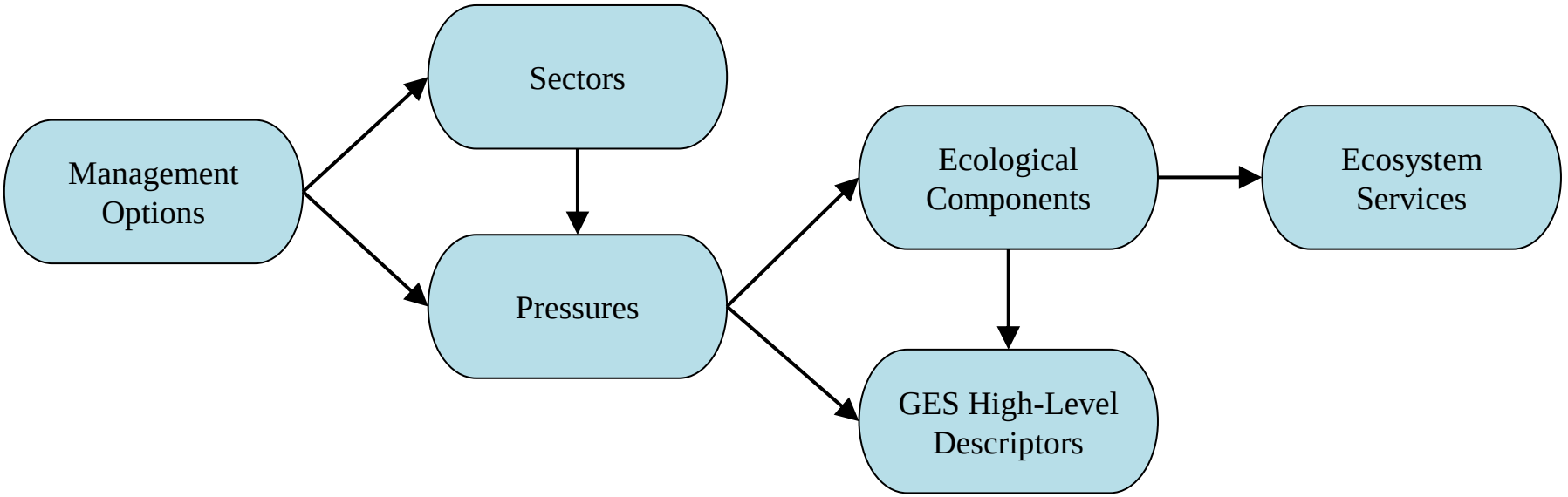
Culhane et al. (2014) for the EEA, State of European Seas

Eg. Relative contributions of ECs to cultural value (qualitative, proxies)

	Oceanic waters		
Scuba-diving	Low/reduced salinity water Variable salinity water Coastal waters Ice Shallow sublittoral habitats Shelf sublittoral habitats	Moderate – High: scuba diving can be carried out regardless of biotic elements (e.g. wreck diving), but is enhanced by biotic elements and in areas with no wrecks is greatly enhanced by biotic elements	Scuba-diving can be carried out in any type of water body and ice diving can also be carried out. Recreational divers dive to a maximum of around 40m (e.g. PADI). Divers can benefit from both pelagic and benthic elements of the ecosystem.
Visiting scenic areas (where the ecological components contribute to the scenery)	Low/reduced salinity water Variable salinity water Coastal waters Shelf waters Oceanic waters Ice habitats Littoral habitats	Moderate: abiotic scenery (e.g. a sandy beach, sea cliffs)could be enjoyed as much as biotic elements but is enhanced by ecosystem components e.g. the presence of wildlife in the scenery	In this case, the activity occurs in the littoral habitat (or further inland) but all habitats within site can contribute to the experience. It can also occur in other habitats from a boat.
Other sports/water sports (where the	Low/reduced salinity water	Low: these activities could be carried out completely	Water sports such swimming, surfing and kayaking take

Culhane et al. (2014) for the EEA, State of European Seas

Can consider the potential for supply of ESs to change given management options applied…..?

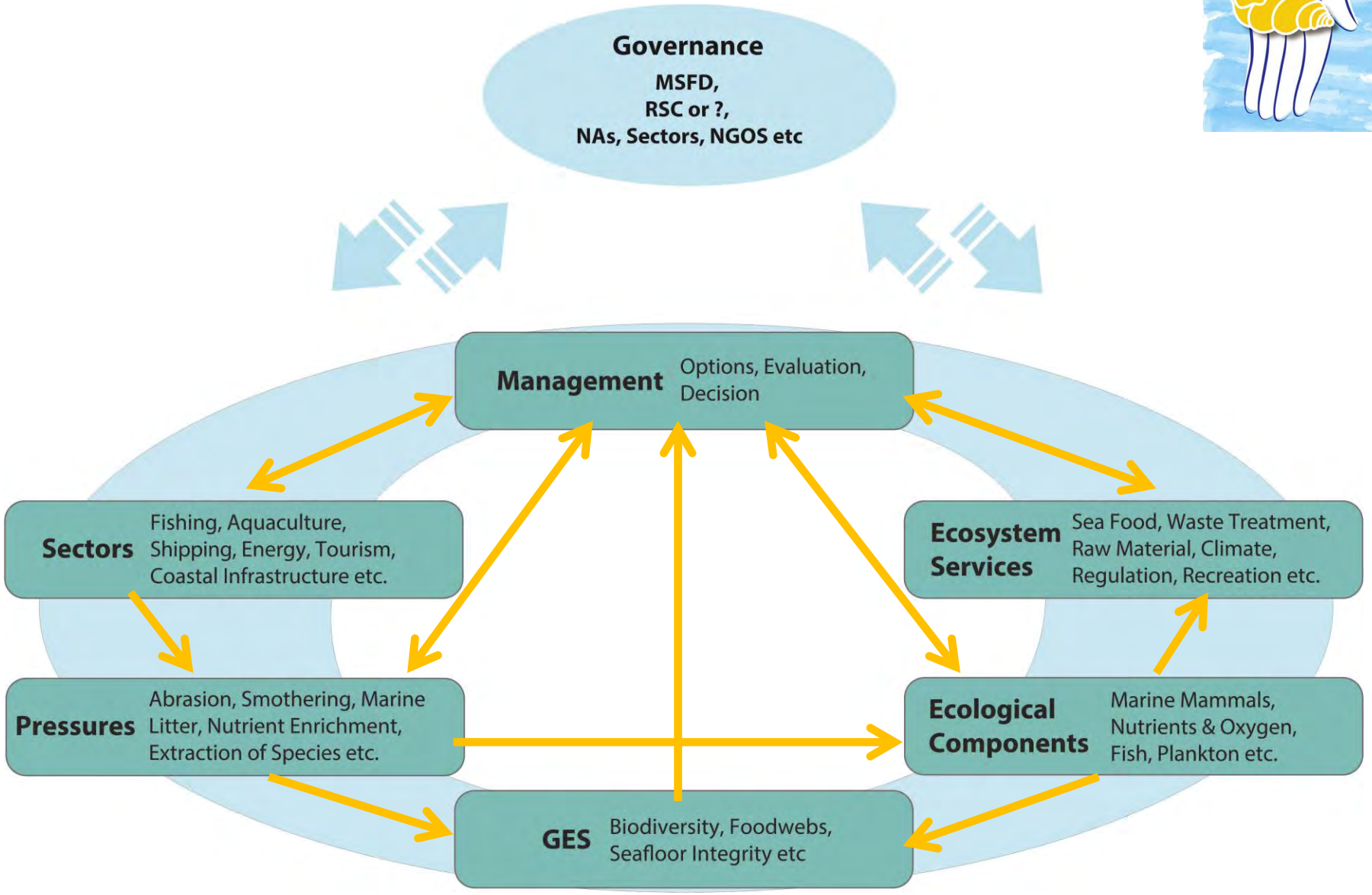


Trade off analysis using all aspects…..

- **A.** Spatio-temporal restrictions on ballast water exchange
- **B.** No take zones for fishing
- **C.** Introduction of biodegradable fishing gear
- **D**. Beach cleaning

ODEMM tools allow exploration of how to prioritise threats and then how to evaluate management options in terms of effectiveness , benefits (later cost/benefit) and governance complexity

4. Underlying governance structures

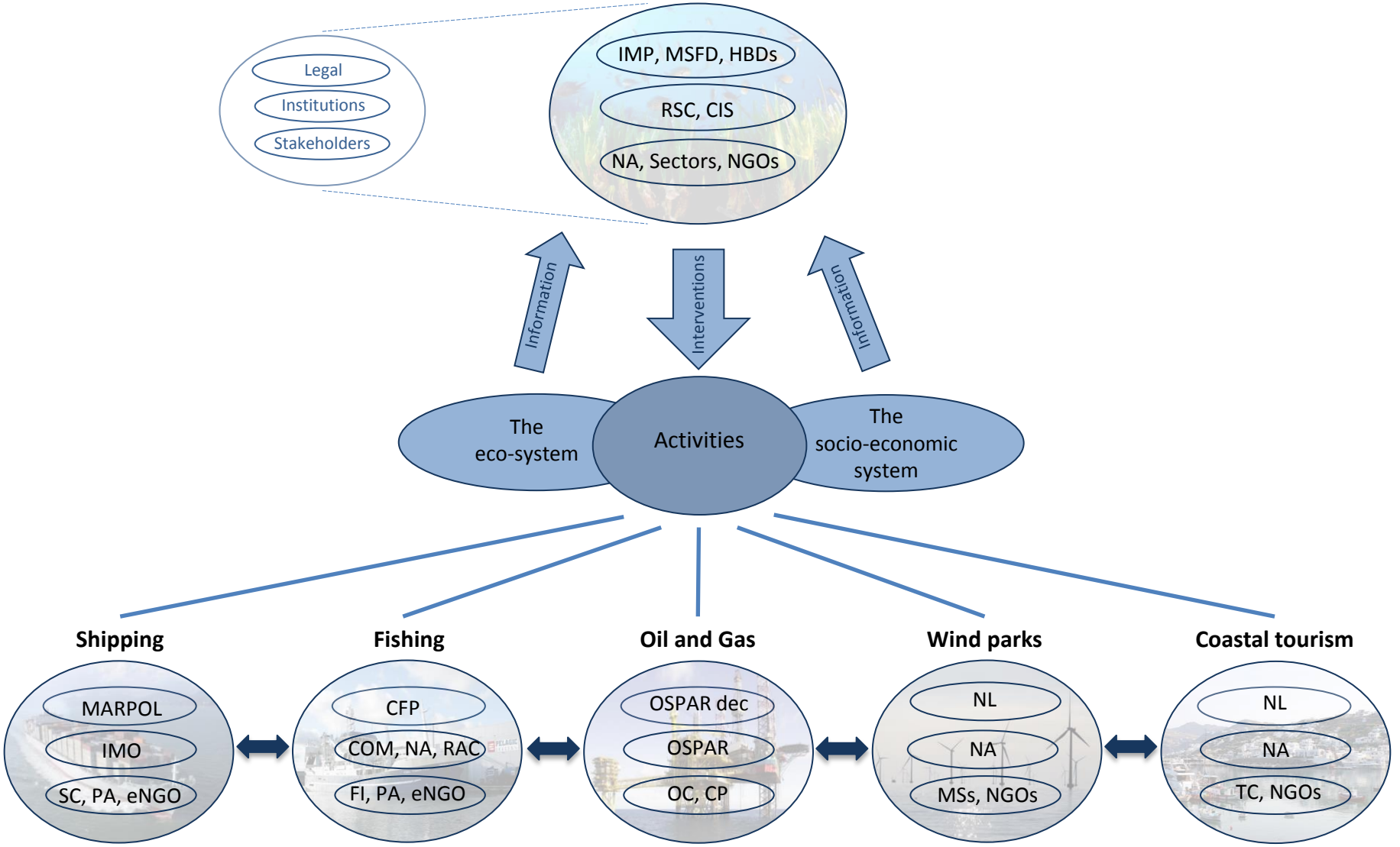


Alternative Regional Sea Governance Models

	Non-binding decisions	Binding decisions
No stakeholder involvement	Cross-border Platforms	Regional Sea Convention +
Stakeholders involved	Advisory Alliance	Regional Sea Assembly

- **Raakjaer et al. (2014) and Van Tatenhove et al. (2014) Marine Policy**
- **www.odemm.com Governance pages…**

Marine Governance System for EBM in European Seas



- **Raakjaer et al. (2014) and Van Tatenhove et al. (2014) Marine Policy**

IEA and the ODEMM approach

What it does/is:

- It is not data driven and can use expert judgement
- It is holistic in approach and can be tailored to any scale and any issue
- Humans are a key focus in the approach
- Highlights priorities for further investigation
- Approach is structured but does require careful cross-checking and quality control following expert assessments (takes time and expertise!)

IEA and the ODEMM approach

Future work:

- Cumulative and combined effects considered further
- Linking through measures to instruments for regulation and overlying governance
- Explore different methods for network and trade-off analysis (e.g. BBNs, bow-tie approach, graph analysis)
- Link in key environmental drivers/climate forcing (Env in SEES)
- Improving understanding and inclusion of human dimension (ES demand side; variability in socio-economic conditions)
- Other major macro-drivers (e.g. economics, political/security)

Thanks to the core ODEMM team…

Fiona Culhane, Antony Knights,
Corinne Baulcomb, Helen Bloomfield, Anne Bohnke-Henrichs, Patricia Breen, Tanya Churilova, Bella Galil, Freya Goodsir, Menachem Goren, Salman Hussain, Rebecca Koss, Judith van Leeuwen, Juha-Markhu Leppanen, Ronan Long, Piotr Margonski, Snejana Moncheva, Temel Oguz, Nadia Papadopoulou, Gerjan Piet, Jesper Raakjaer, Stuart Rogers, Chris Smith, Jan van Tatenhove, Florin Timofte, Lydia White and Chris Frid

Also to…Chris Frid, Jake Rice, Eva Gelabert, John Steele, Tony Smith, Anastasias Eleftheriou and Virginie Hart

www.odemm.com

Easy entry point to overall concepts and all major approaches – also cites key papers