museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

Ecosystem changes associated with offshore wind farms: bridging the gap between biogeochemical effects and its repercussions for ecosystem functioning and services

Jan Vanaverbeke, Jennifer Dannheim, Silvana Birchenough, Arthur Capet, Paul Causon, Joop Coolen, Steven Degraer, Tara Hooper, Urszula Janas, Roland Krone, Han Lindeboom, Ninon Mavraki, Francis O' Beirn, Karline Soetaert, Elise Toussaint, Inge van der Knaap, Gert van Hoey, Helena Voet, Alexa Wrede

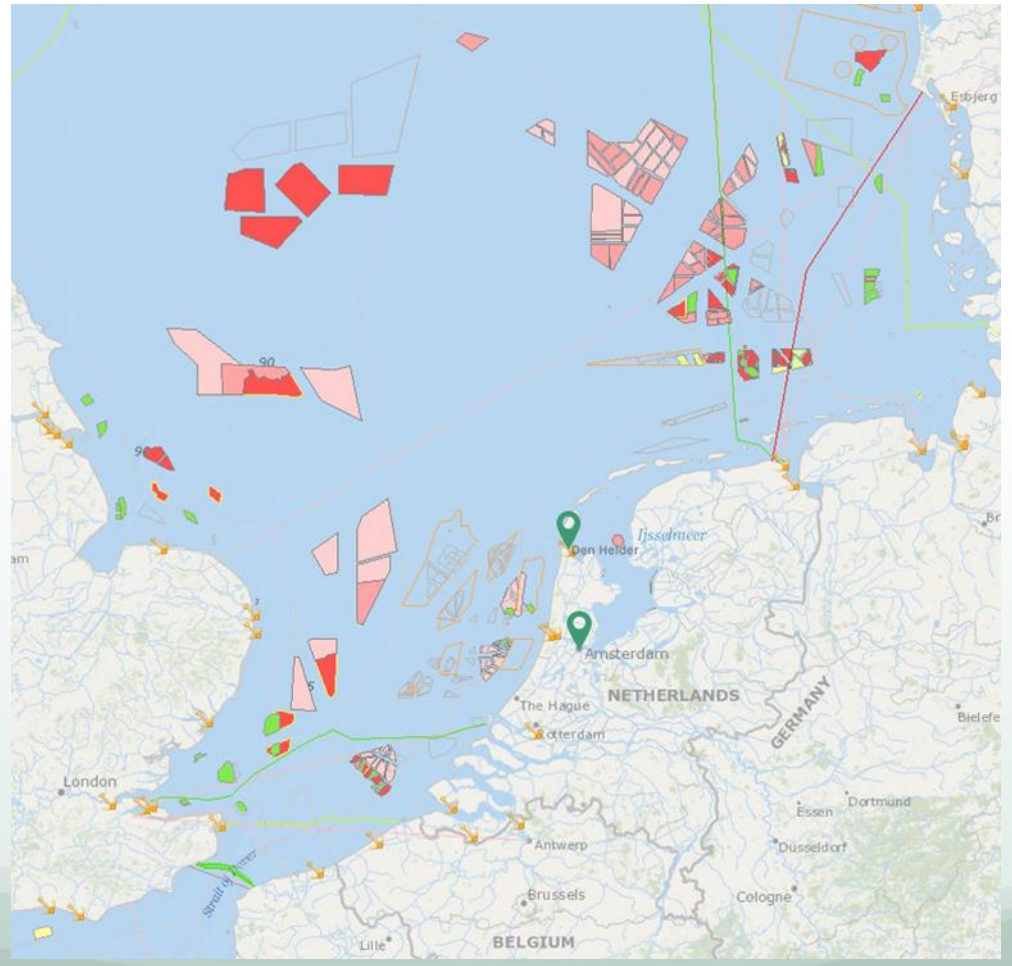
Europe: 2030 Energy Strategy

- 40% cut in greenhouse gass emissions compared to 1990
- At least a 27% share of renewable energy consumption
- At least a 27% energy savings compared with business-as-usual scenario

museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

Renewable energy: offshore wind in EU

- 4149 wind turbines
- 92 wind farms
- 11 European countries
- 18.84GW
- 25 GW by 2020



museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

Wind turbines – fouling fauna

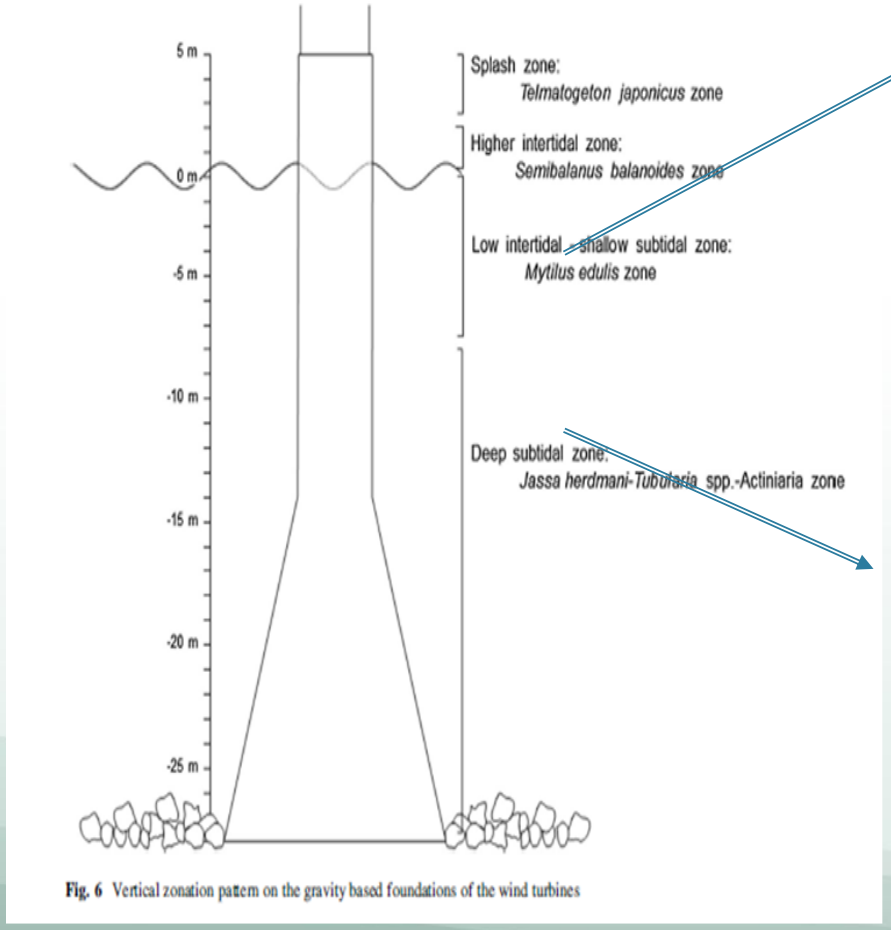


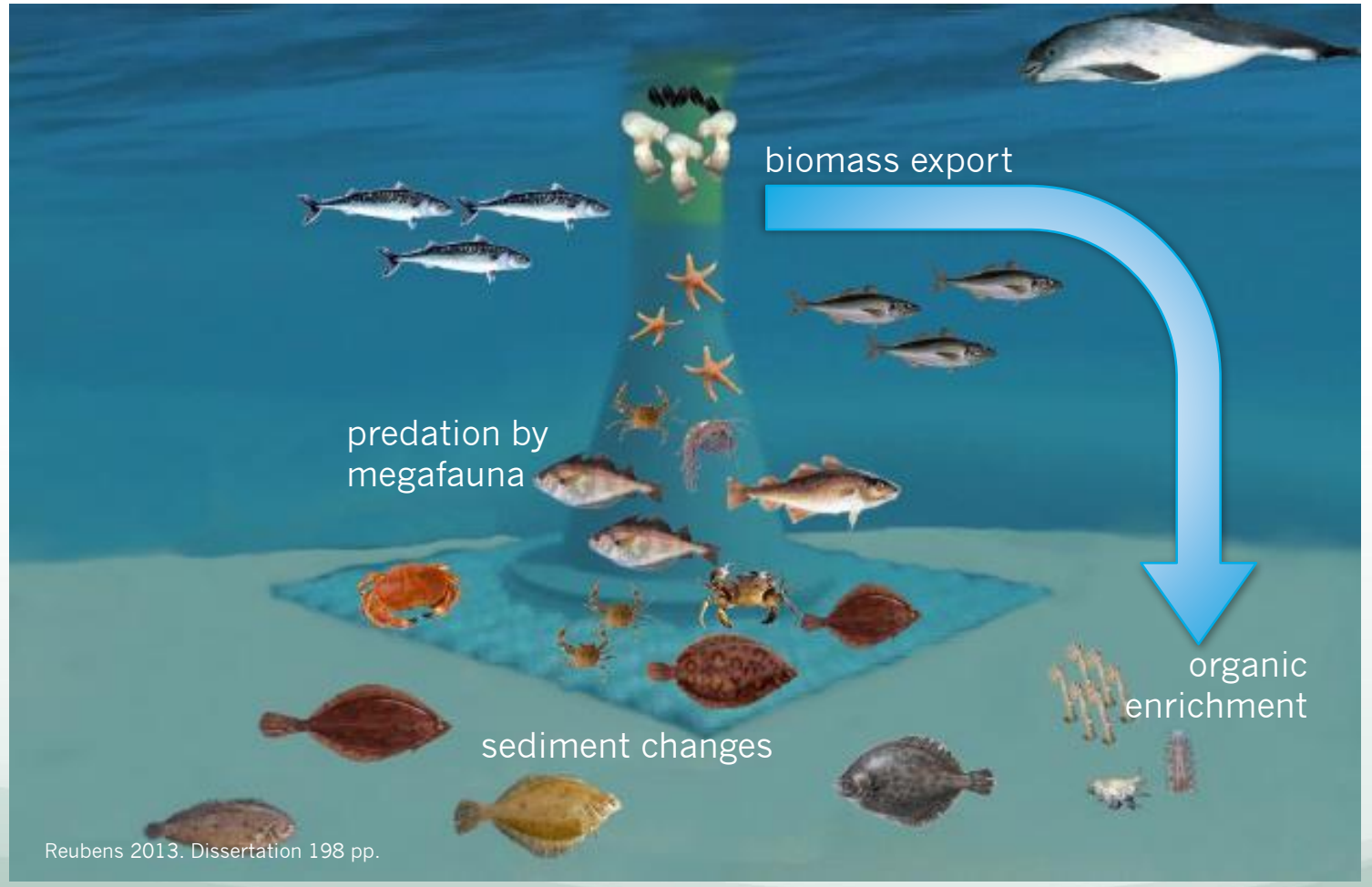
Fig. 6 Vertical zonation pattern on the gravity based foundations of the wind turbines

- *Mytilus edulis*: 18.8 – 38.7 kg m^{-2} Krone et al. 2013)

- *Jassa herdmani*: minimum 10^4 ind m^{-2} (De Mesel et al. 2015)

OWF change local community composition

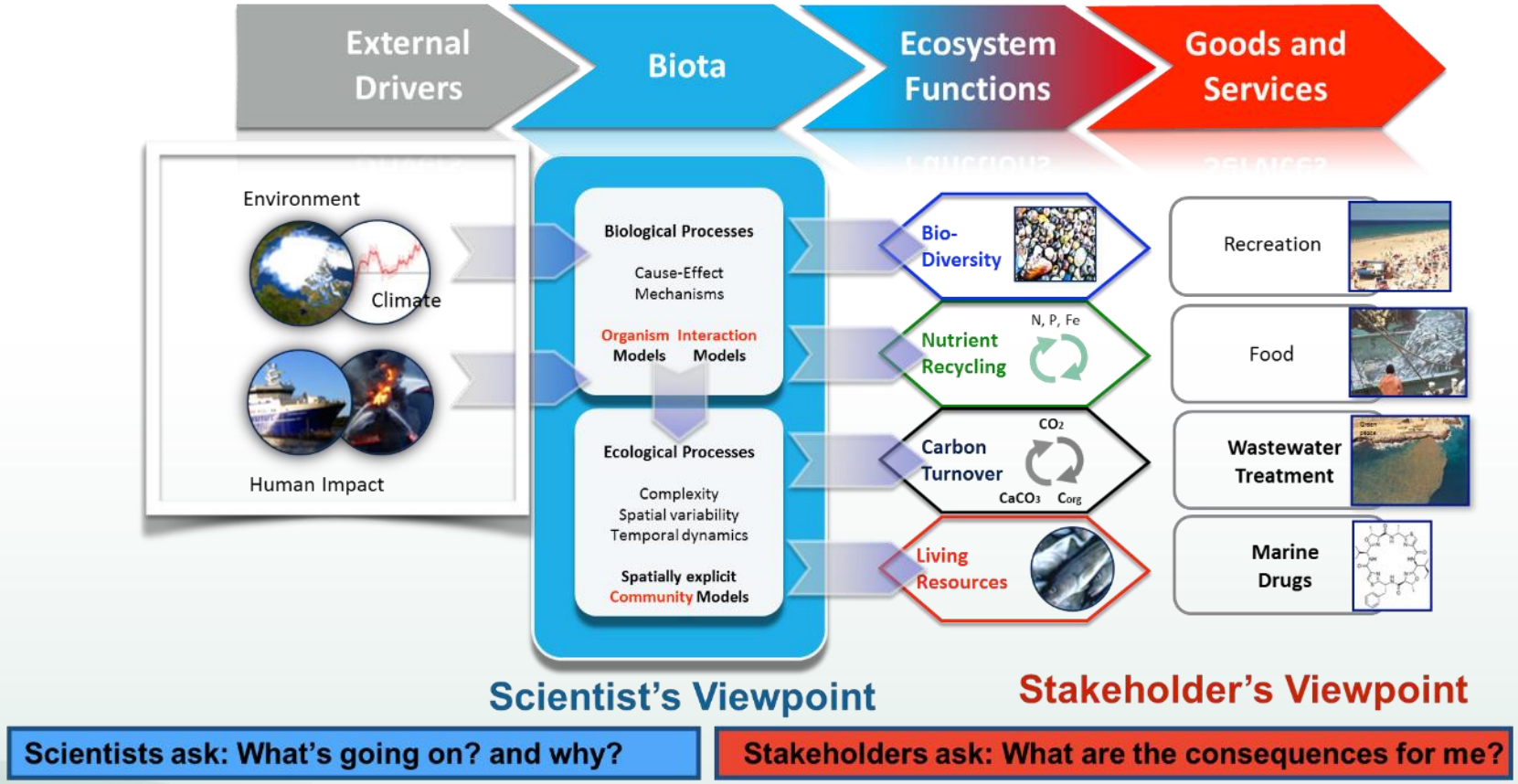
- Fouling fauna
  - Filter feeders
- Attraction of
  - Fish
  - Large crustaceans
- Export of organic matter



museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

So what?

- important for society?
- provisioning of ecosystem services?



Bridging the gap between two seperated research fields

museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

‘Bridging the gap’

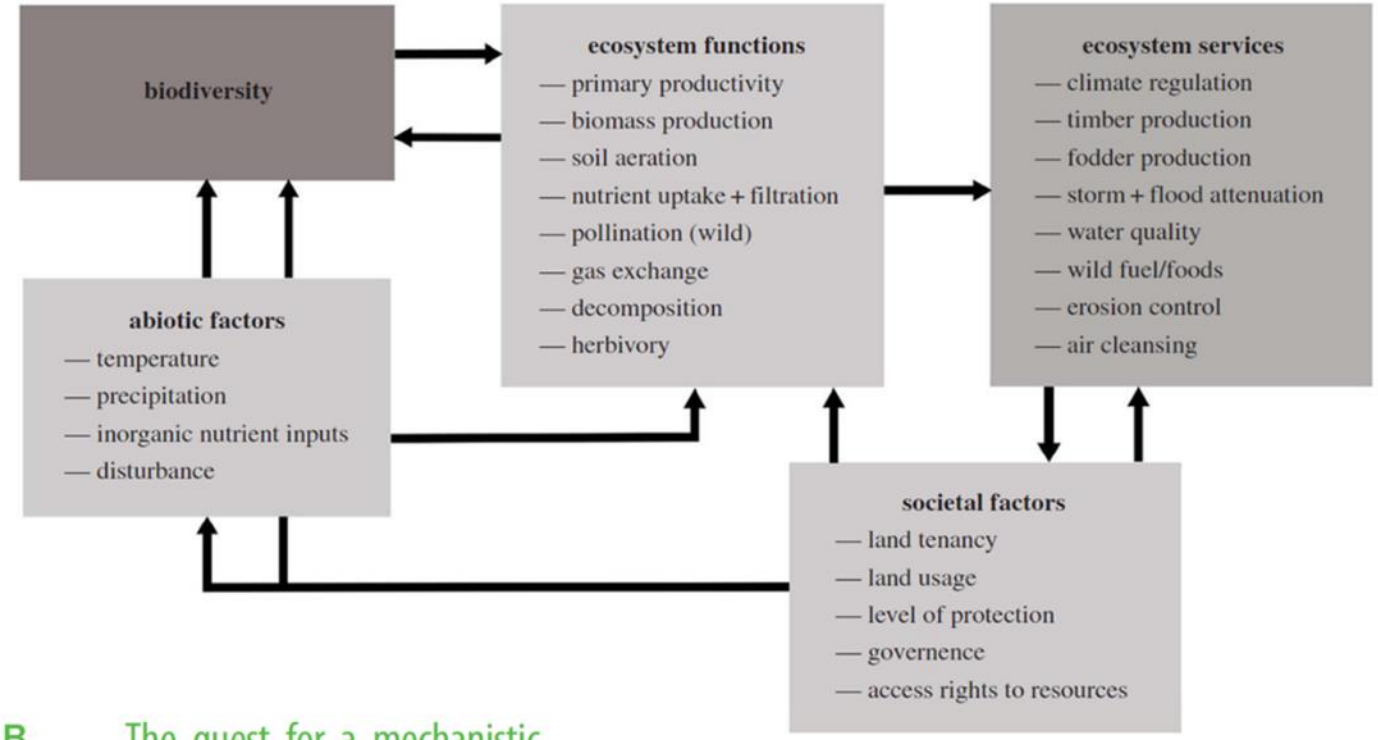
EUROMARINE
EUROPEAN MARINE RESEARCH NETWORK

Bremerhaven, 20-23 February 2018

- Bridging the gap between benthic ecologists, ecosystem modellers, oceanographic modellers, social scientists
- Briding the gap between scenior scientists and early career researchers

museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

Inspiration



PROCEEDINGS B

rspb.royalsocietypublishing.org

Review

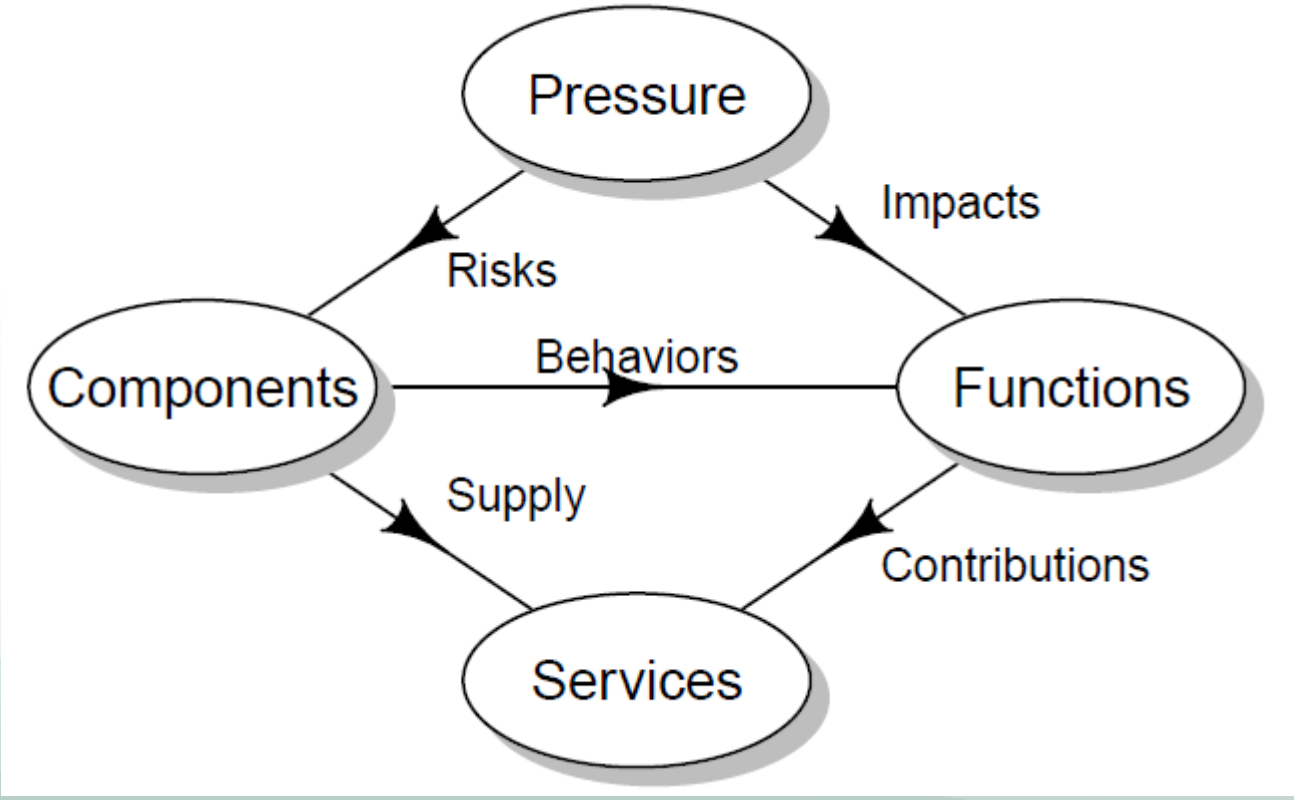
Cite this article: Duncan C, Thompson JR,

The quest for a mechanistic understanding of biodiversity–ecosystem services relationships

Clare Duncan[1,2], Julian R. Thompson[2] and Nathalie Pettorelli[1]

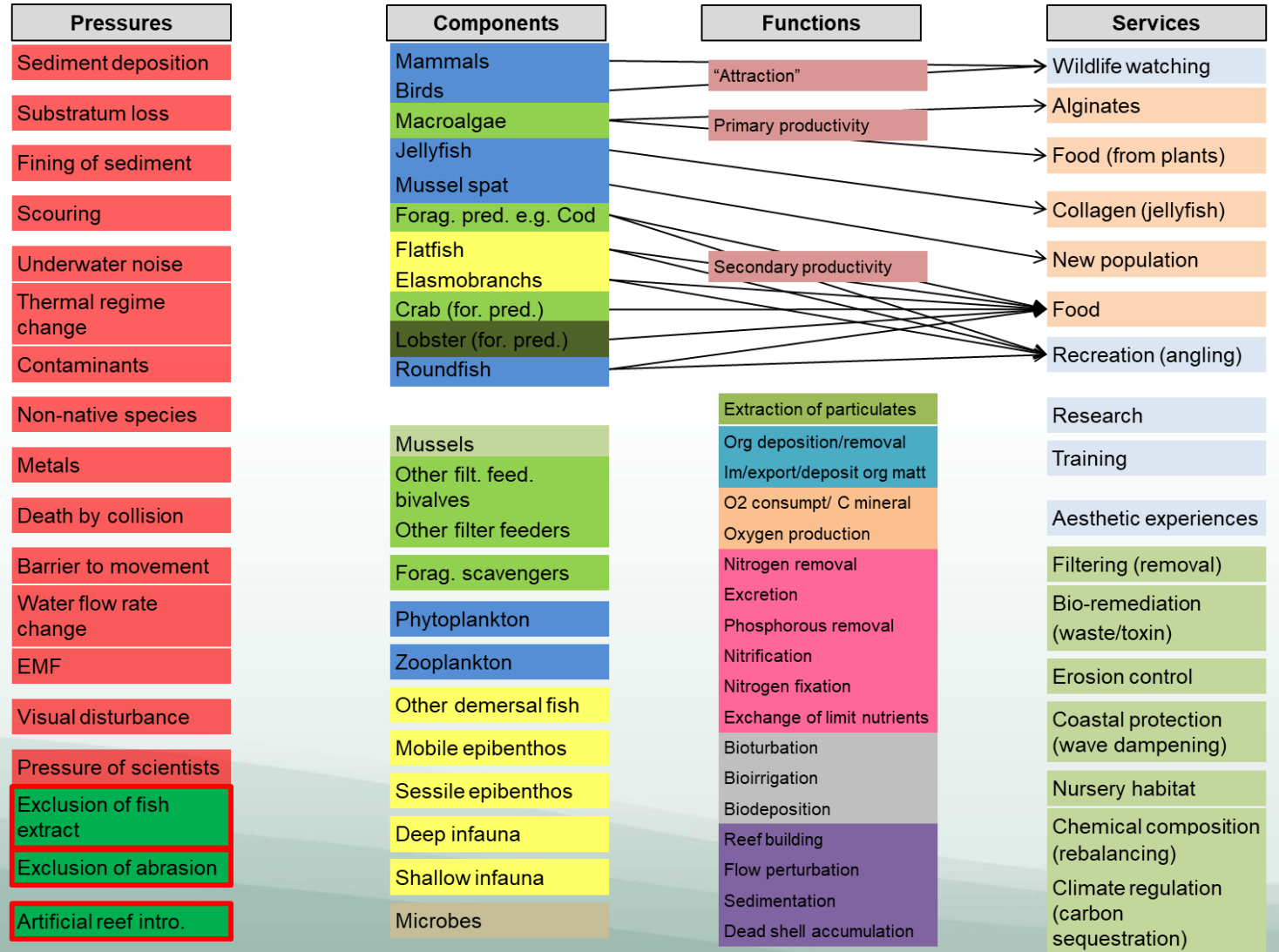
[1]Institute of Zoology, Zoological Society of London, Regent's Park, London NW1 4RY, UK
[2]Department of Geography, University College London, Gower Street, London WC1E 6BT, UK

From concept to operationalisation and quantification

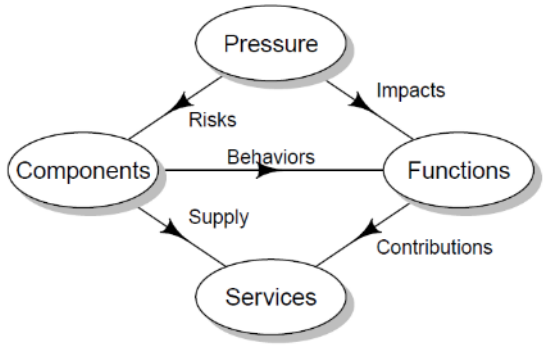


- Pressures: relevanant to MSFD
- Components:
  - species/functional groups
  - Turbine/EPL/sediment/water
- Ecosystem functions: De Groot et al (2012)
- Services: CICES

From concept to operationalisation and quantification



From concept to operationalisation and quantification



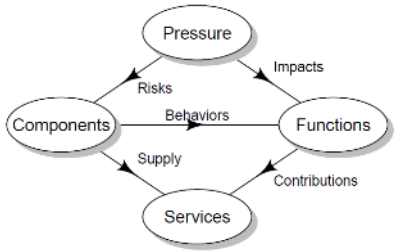
		Blue Mussel				other calcifying filter feeders				non calcifying filter feeders (i.e. Jassa)				
		Effect Size	Effect Are	Reference	Certainty	Effect Size	Effect Are	Reference	Certainty	Effect Size	Effect Are	Reference	Certainty	E
ECOSYSTEM PROCESS	ECOSYSTEM FUNCTION													
Biomass production	Primary productivity													
Biomass production	Secondary productivity													
Biomass production	Attraction													
Organic Matter Transformation	OM decomposition and removal													
Organic Matter Transformation	import/export OM													
Organic Matter Transformation	deposition of OM													
Inorganic Matter Transformation	Extraction of inorganic particles													
Ecoystem metabolism	O2 consumption													
Ecoystem metabolism	C mineralisation													
Nutrient Cycling	nitrogen removal													
Nutrient Cycling	nutrient excretion													
Nutrient Cycling	phosporous removal													
Nutrient Cycling	nitrification													
Nutrient Cycling	denitrification													
Nutrient Cycling	nitrogen fixation													
Nutrient Cycling	exchange of limiting nutrients (i.e. silicate)													
Allogenic engineering	bioturbation													
Allogenic engineering	bioirrigation													
Allogenic engineering	biodeposition													
Habitat Creation	reef building													
Habitat Creation	flow perturbation													
Habitat Creation	sedimentation													
Habitat Creation	dead shell accumulation													

Magnitude score (Code)	EFFECT SIZE: Magnitude of effect or change definition
+2	Moderate to large positive effect on ecological component, process or function
+1	Slight to small positive effect on ecological component, process or function
0	No effect/neutral effect on ecological component, process or function
-1	Slight to small negative on ecological component, process or function
-2	Moderate to large negative on ecological component, process or function

Effect area (Code)	Spatial scale
1	Local: turbine + Erosion protection layer
2	OWF scale: within the OWF array
3	Regional (outside the OWF, incl. multiple arrays)

From concept to operationalisation and quantification

- How much stress is put on service ‘s’ by the presence of operational OWF?



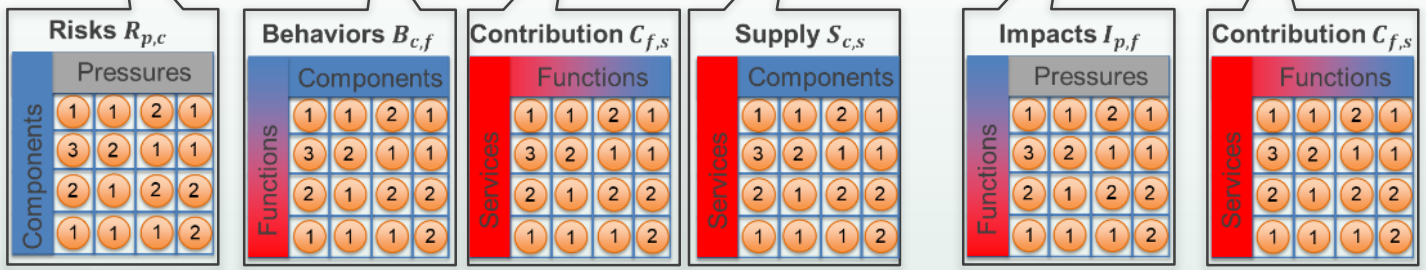
through organisms

through functions

direct supply

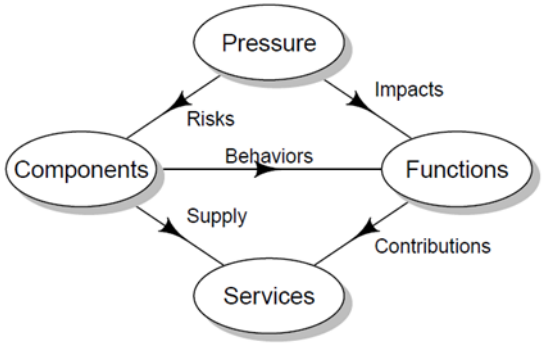
direct impact

$$Stress_s = \sum_{f \in P} \sum_{l \in scales} s_{p,l} \left[\sum_{c \in C} f_{l,c} \; R_{p,c} \left(\sum_{f \in F} B_{c,f} \; * \; C_{f,s} + \sum_{c \in C} S_{c,s} \right) + \sum_{f \in F} I_{p,f} \; * \; C_{f,s} \right]$$



From concept to operationalisation and quantification

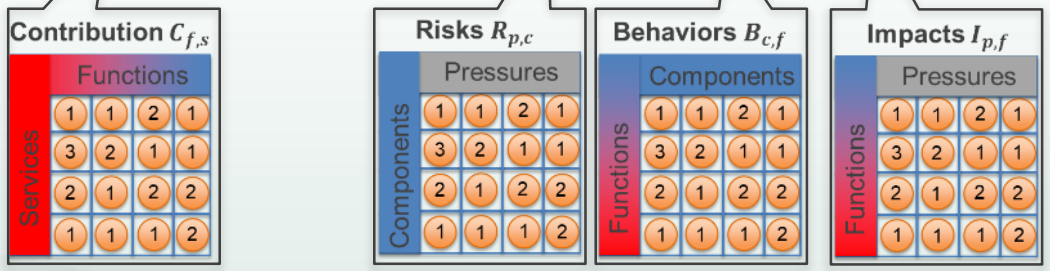
- Which key functions should be monitored?



$$Monitoring\ importance_f = \sum_{s \in S} C_{f,s} \left[\sum_{p \in P} \left(\sum_{c \in C} f_{l,c} \quad R_{p,c} \quad B_{c,f} \quad + \quad I_{p,f} \right) \right]$$

exposure to pressure

relevance — *organisms* — *direct impact*



museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

Work (to be) done

- R script for numerical analysis: finalised
- Tables completed
  - To be reviewed by ICES WGMBRED experts
  - 12-15 february 2019
- Numerical analysis (spring 2019)
- Writing and submitting manuscript (end 2019)

museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

Thank you!