

PML

Plymouth Marine
Laboratory

Listen to the ocean

Ecosystem Services

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Head of Science: Sea and Society



Marine Ecosystems
Research Programme

sweep



Outline

- Sea and Society group at PML
 - What we do and why
- Natural capital and ecosystem services
- Some interdisciplinary ecosystem service research examples
- An ecosystem service ‘tool’

Sea and Society (Socio-economics, Environment and Human Health, Resource management and support)

Integrate evidence from natural and social sciences to:

- Understand the consequences and benefits of the interactions between society and the marine environment,
- Improve the outcomes and benefits,
- Support sustainable and responsible ocean stewardship.



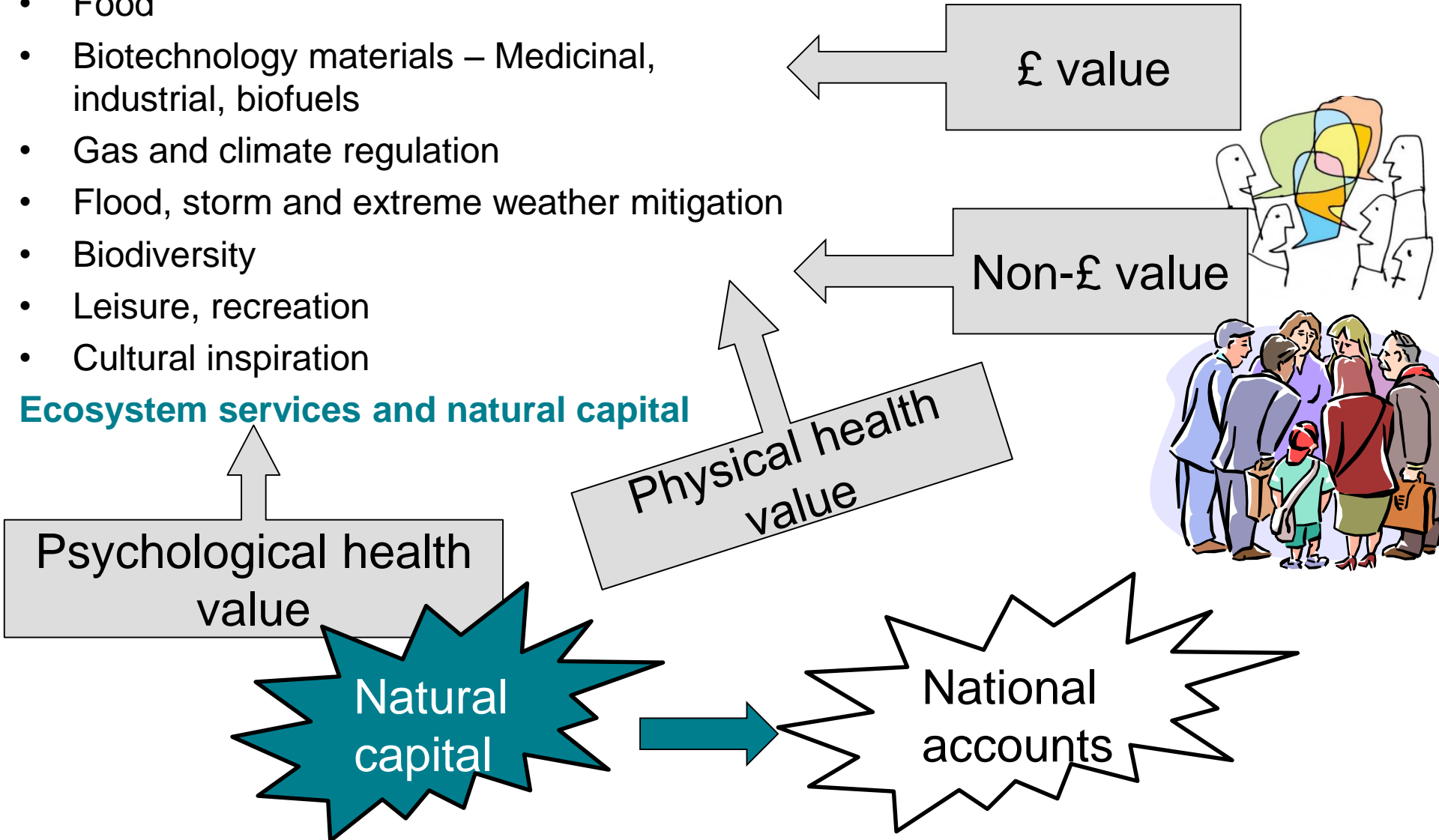
Sea and Society at PML

- ✓ Expertise in environmental economics and valuation, macroeconomics, economic modelling, environmental psychology, ecology and ecosystem services, health and wellbeing benefits, and knowledge exchange
- ✓ Research applications e.g. global change including ocean acidification, local change, International, EU and UK marine policy including SDGs in ODA countries, marine planning, marine renewable energy and environment, fisheries and aquaculture
- ✓ Publications >50 ISI papers (during 2010-2015); peer reviewed book chapters and reports; national and international policy reports and briefings; popular articles; internationally popular education materials for children
- ✓ Advice Researchers regularly provide strategic advice at national and international policy and science development arenas
- ✓ **Champions interdisciplinary thinking in marine science**

Why marine ecosystems matter to people

- e.g.
- Food
 - Biotechnology materials – Medicinal, industrial, biofuels
 - Gas and climate regulation
 - Flood, storm and extreme weather mitigation
 - Biodiversity
 - Leisure, recreation
 - Cultural inspiration

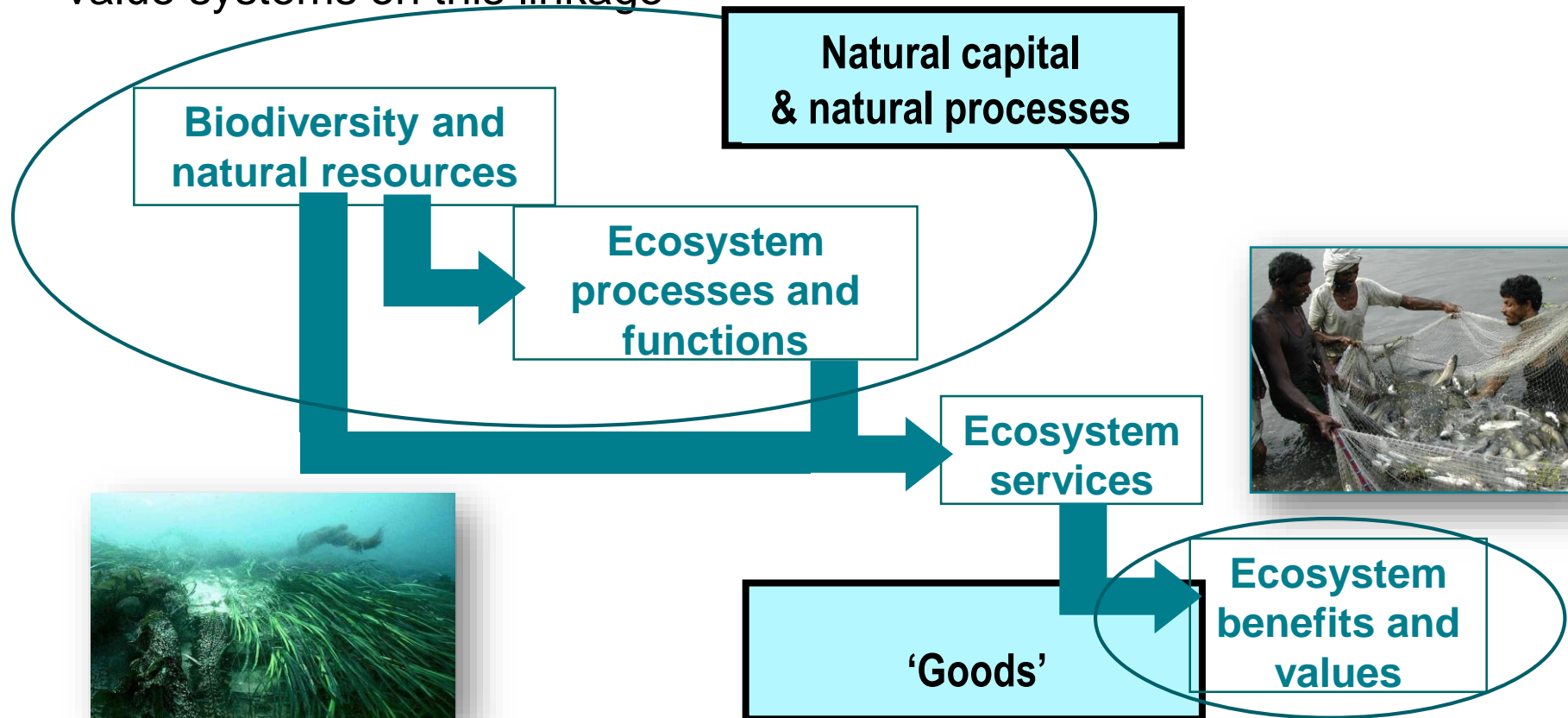
Ecosystem services and natural capital



SaS Aims

Elucidate how human and natural marine systems are linked including

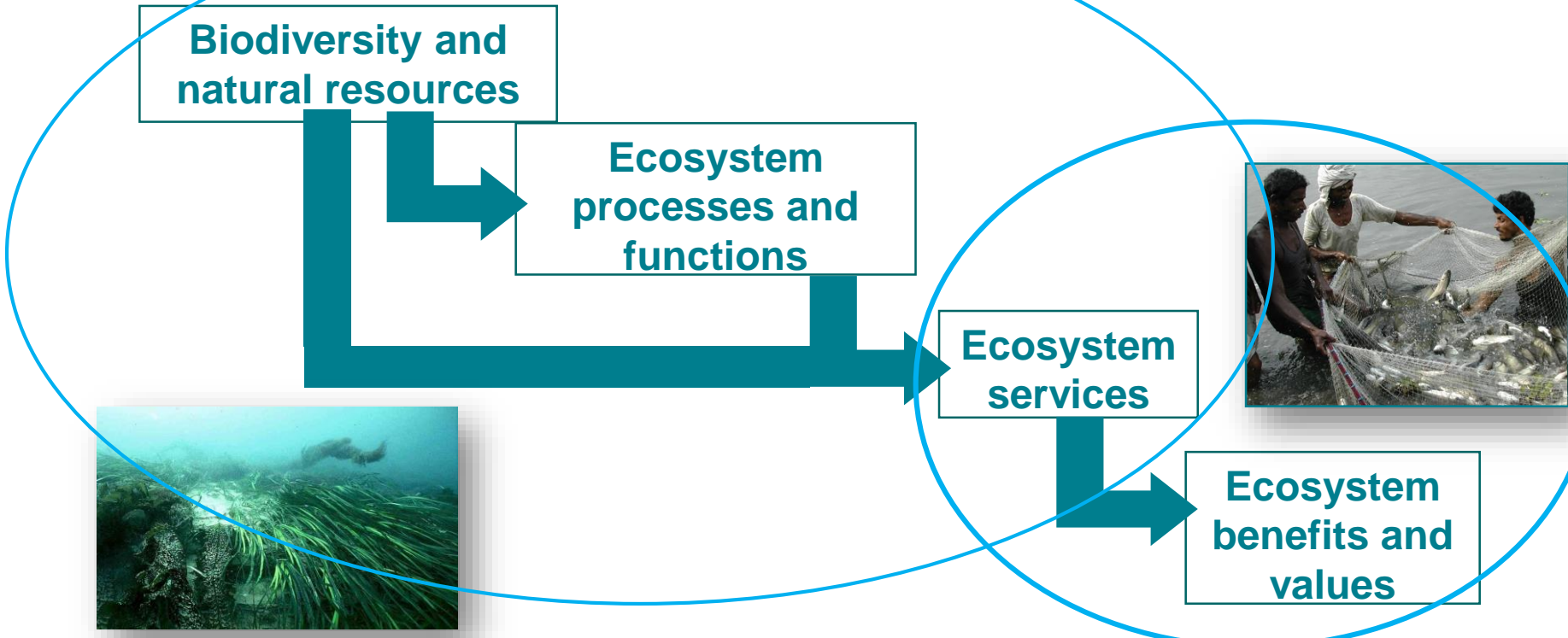
- key processes and pathways that sustain ecosystem services and their benefits,
- impacts of social and economic dimensions of human choices and value systems on this linkage



SaS Aims

Elucidate how human and natural marine systems are linked including

- key processes and pathways that sustain ecosystem services and their benefits,
- impacts of social and economic dimensions of human choices and value systems on this linkage



Decision making & the environment



**Natural capital
& natural processes**

e.g. nutrient cycling,
primary production,
supply of fish &
shellfish larvae,
carbon burial, etc.

**Ecosystem
services**

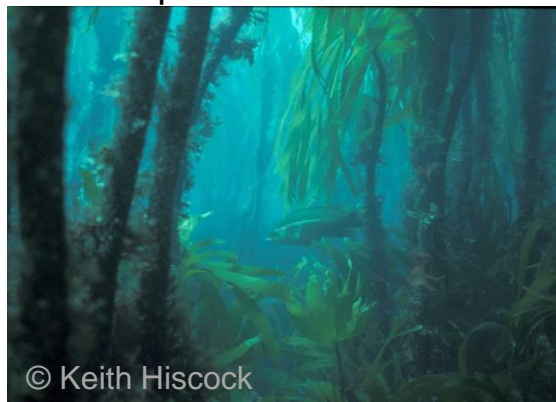
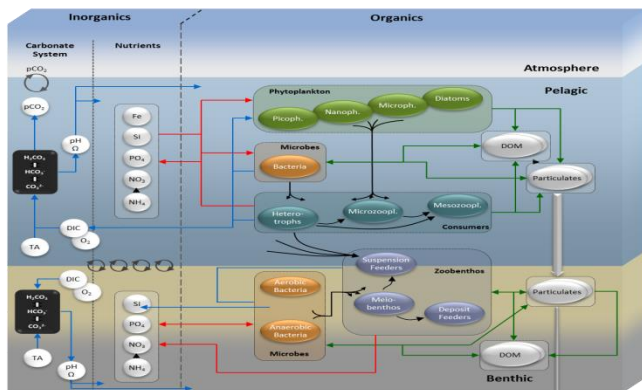
e.g. flows of fish,
birds, reefs &
saltmarsh, clean
seawater, carbon
sequestration etc.

Other capital

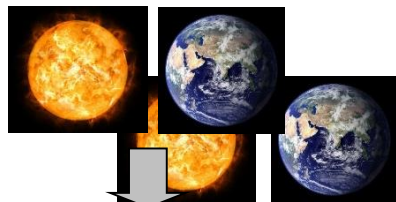


'Goods'

e.g. seafood, recreation,
tourism, renewable energy,
flood defences, climate
regulation etc.



Decision making & the environment



Other capital

Other capital

Natural capital & natural processes

Ecosystem services

Goods

'Goods'

- Primary production →
- Food web dynamics →
- Decomposition →
- Bioturbation →
- Nutrient cycling →
- Bioirrigation →
- Biogas regulation →
- Calcification →
- Evolutionary processes →
- Ecological interactions →

- Wild fish →
- Wild shellfish →
- Farmed fish →
- Farmed shellfish →
- Wild species diversity →
- Waste breakdown →
- Detoxification →
- Climate regulation →
- Sediment stabilisation →
- Stabilising vegetation →
- Natural enemies →
- Meaningful places →
- Wild species diversity →

- Food
- Clean seawater
- Timber
- Energy
- Equable climate
- Pollution control
- Flood control
- Disease control
- Nature watching
- Recreation
- Good health

e.g. seafood, recreation, tourism, renewable energy, flood defences, climate regulation etc.



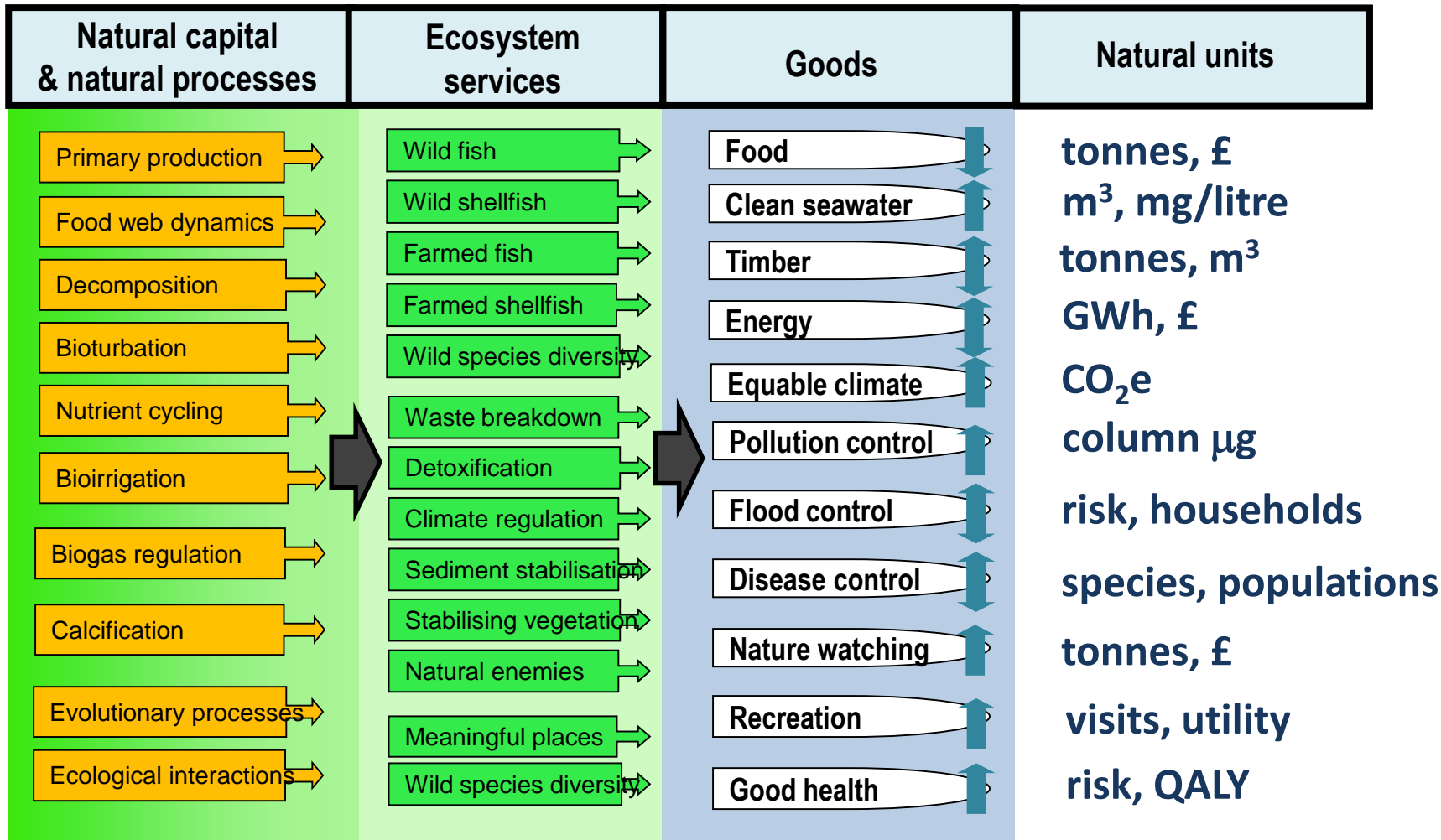
Decision making & the environment



Other capital



↑ Restoring marine mammal diversity



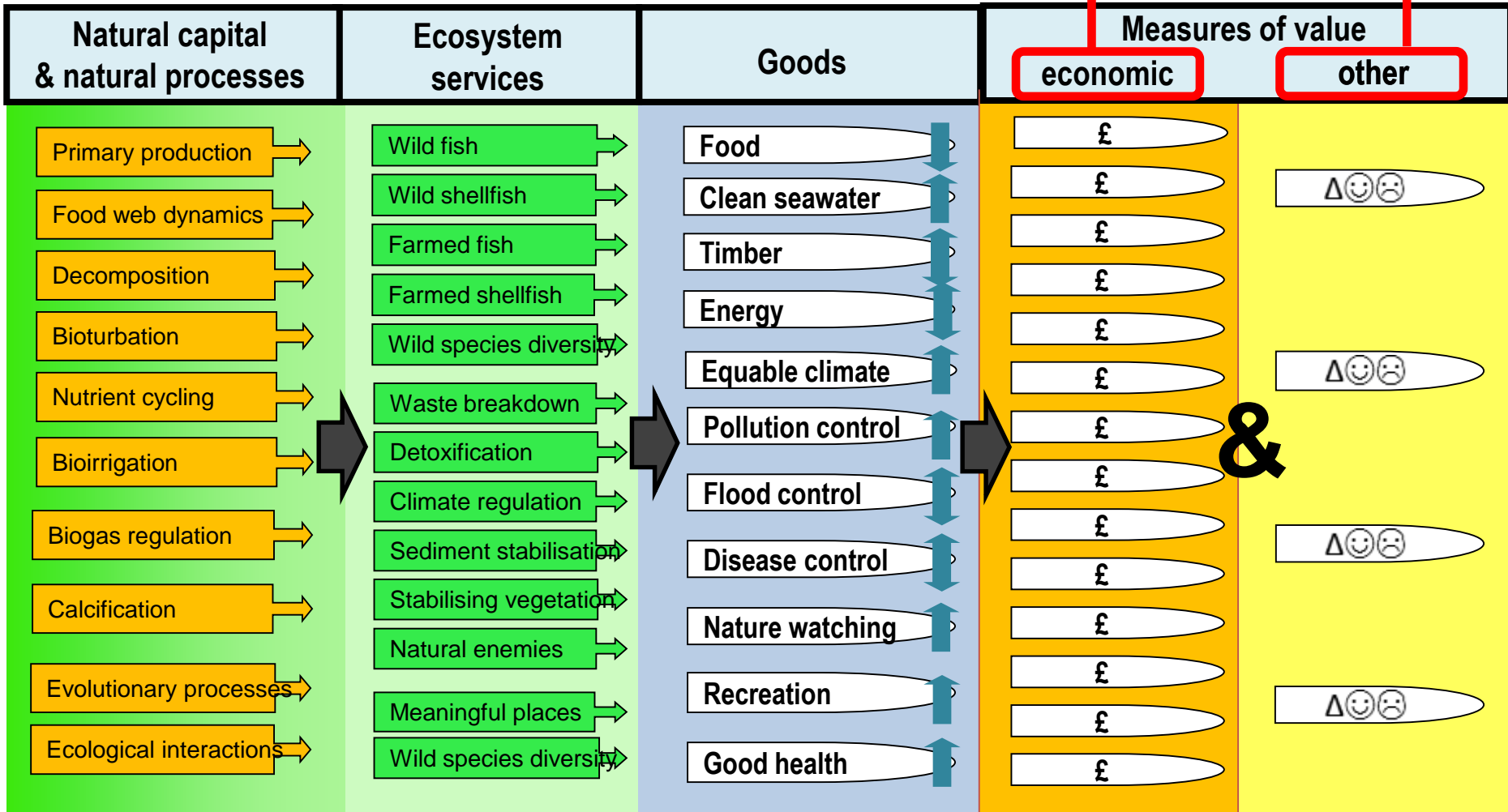
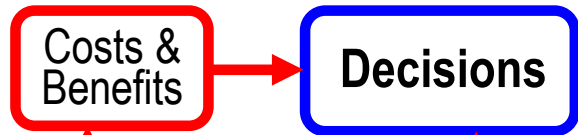
Decision making & the environment



Other capital



Restoring marine mammal diversity



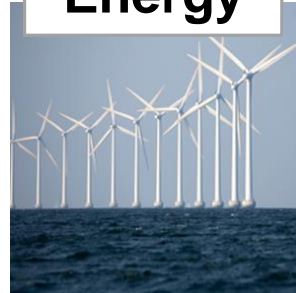
Incomes



Food



Energy



Market values



Social Value



Non-market values

Greenhouse gases



Biodiversity



Recreation & health



Flood defence



Added value from integrating methods for ecosystem service assessment and valuation

Ecological, economic and socio-cultural value of ecosystem services assessed using mixed methods under different scenarios in the Dogger Bank:

Implications of Vectors scenarios for Dogger Bank

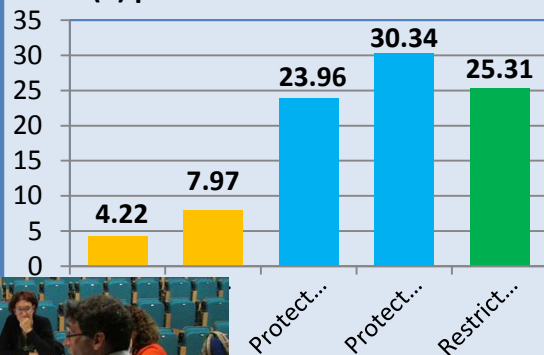


- A2**
- Abandonment of CFP: more destructive fishing practices
 - 15% cover of windfarms
 - Increased oil and gas exploration
 - 0.8°C SST increase



- B1**
- Precautionary approach to MSY
 - 50% cover of windfarms = no take zone
 - Reduced oil and gas exploration

WTP (£) per UK household

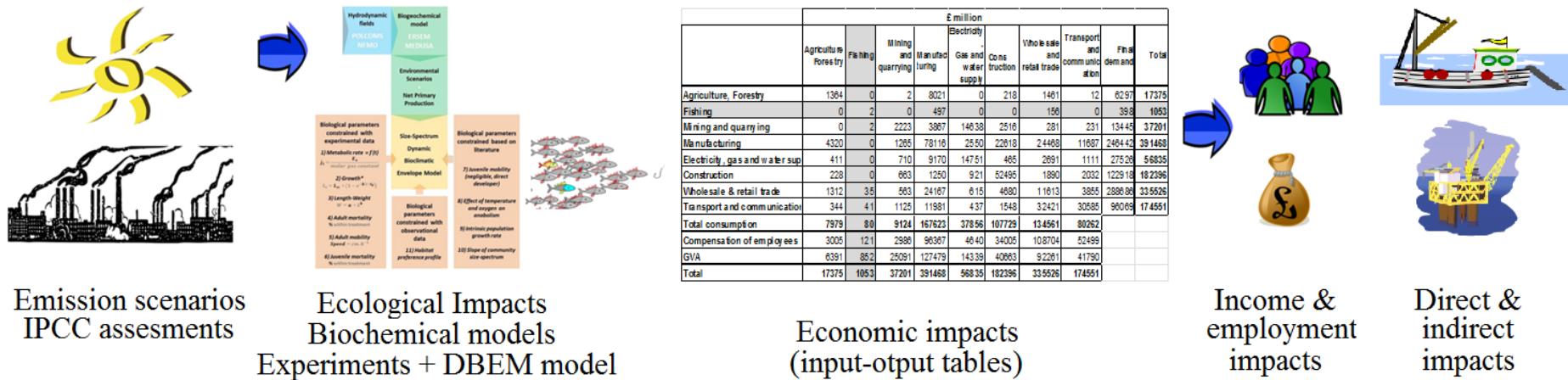


- Ecological modelling and empirical data;
- Choice experiments for non-market monetary values;
- Deliberative valuation with citizen's jury

- Mixed methods identify mixed messages but bring greater understanding
- Highlights complexities relating to management outcomes that would not become apparent using a single method approach
- Combination of approaches identified areas where mismatches may occur between ecosystem service supply and demand in the future



Modelling ecological and economic impacts of ocean warming and acidification in fish and shellfish species



Emission scenarios
IPCC assessments

Ecological Impacts
Biochemical models
Experiments + DBEM model

Economic impacts
(input-output tables)

Income & employment
impacts

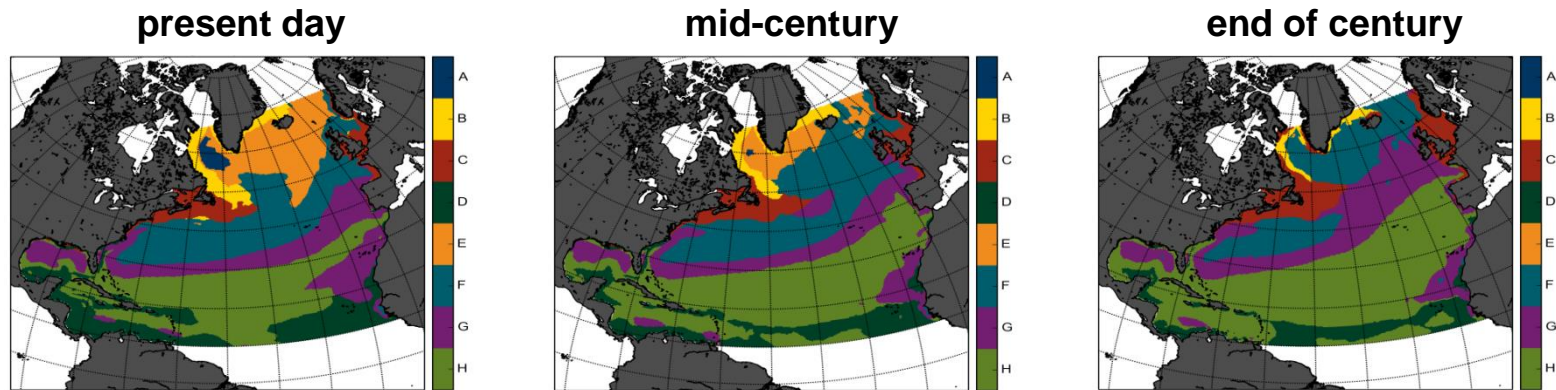
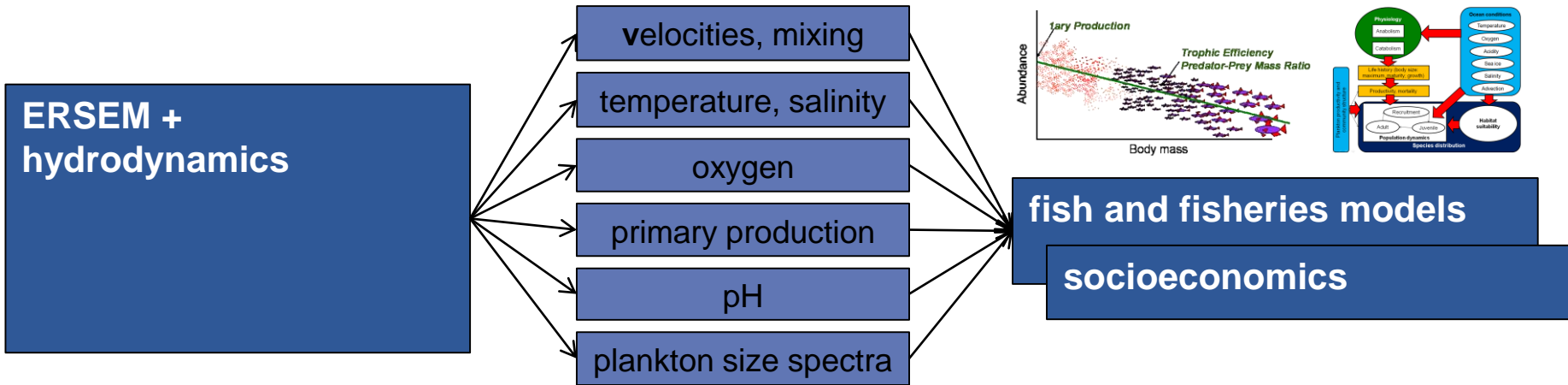
Direct & indirect
impacts

Fernandes, J. A., et al., (2013). Modelling the effects of climate change on the distribution and production of marine fishes: accounting for trophic interactions in a dynamic bioclimate envelope model. *Global change biology*, 19(8), 2596-2607.

Queirós A., Fernandes JA, ..., Cheung WWL, Barange M, Widdicombe S. (2014). Scaling up experimental ocean acidification and warming research: from individuals to the ecosystem. *Global change biology*, DOI: 10.1111/gcb.12675

Fernandes, J. A., Papathanasopoulou E., Queirós A.M., Cheung W.W.W.L., Yool A., Artioli Y., Pope E.C., Flynn K.J., Merino G., Calosi P., Beaumont N., Austen M., Widdicombe S., Hattam C., Barange M. (2016) Ocean acidification and warming add to vulnerability to UK fisheries-dependent communities. *Fish and Fisheries* 18 (3). 389-411

Physics to food

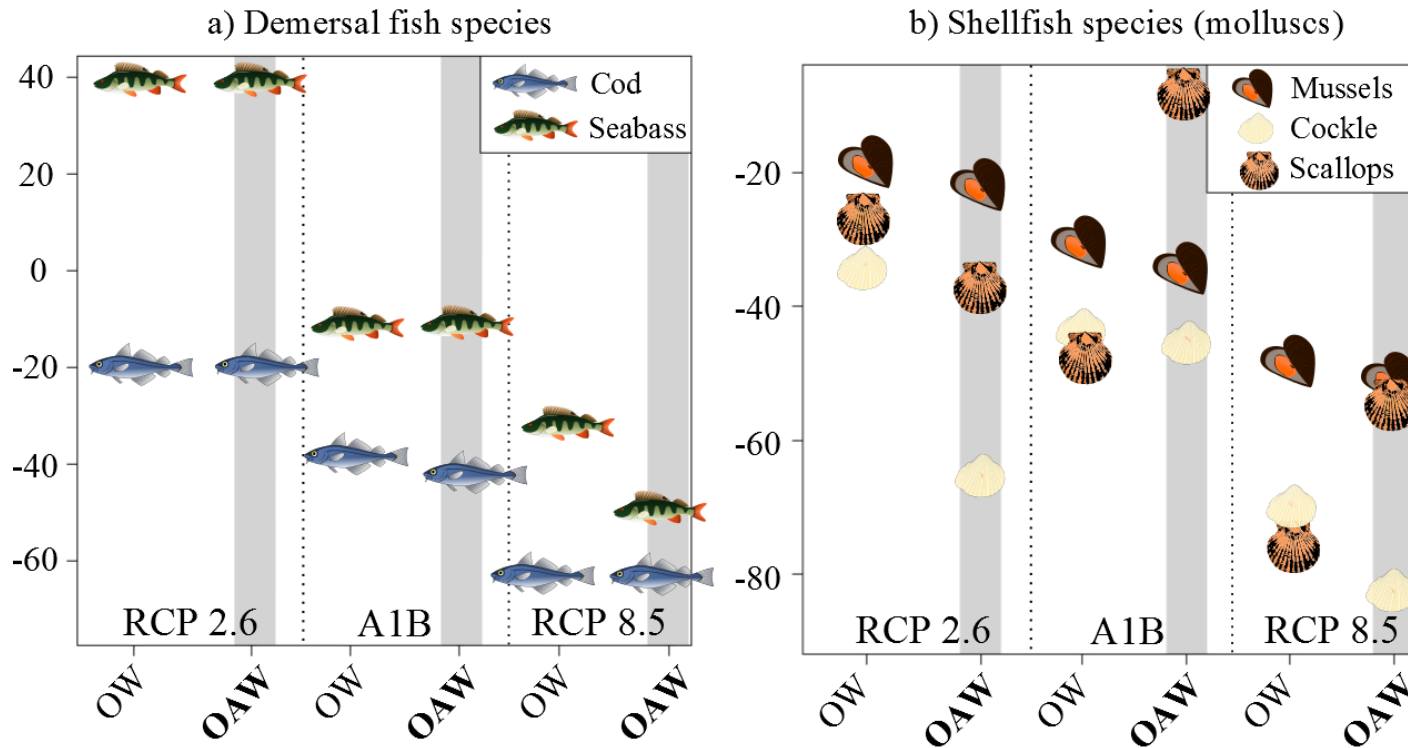


Changes in pelagic fish habitat under climate change in the North Atlantic.
 Note the disappearance of high-latitude habitats by 2100 (Butenschön et al. 2015 ICES ASC)

Fish and shellfish projections and implications

Independent experiments combined with modelling lead to **similar trends** across different emission scenarios, but with different levels of impact. Most dramatic impacts were observed on **shellfish species**, with **decreases in potential catches between 20% and 80%**.

% change between present (1990-2000) and future (2090-2099)

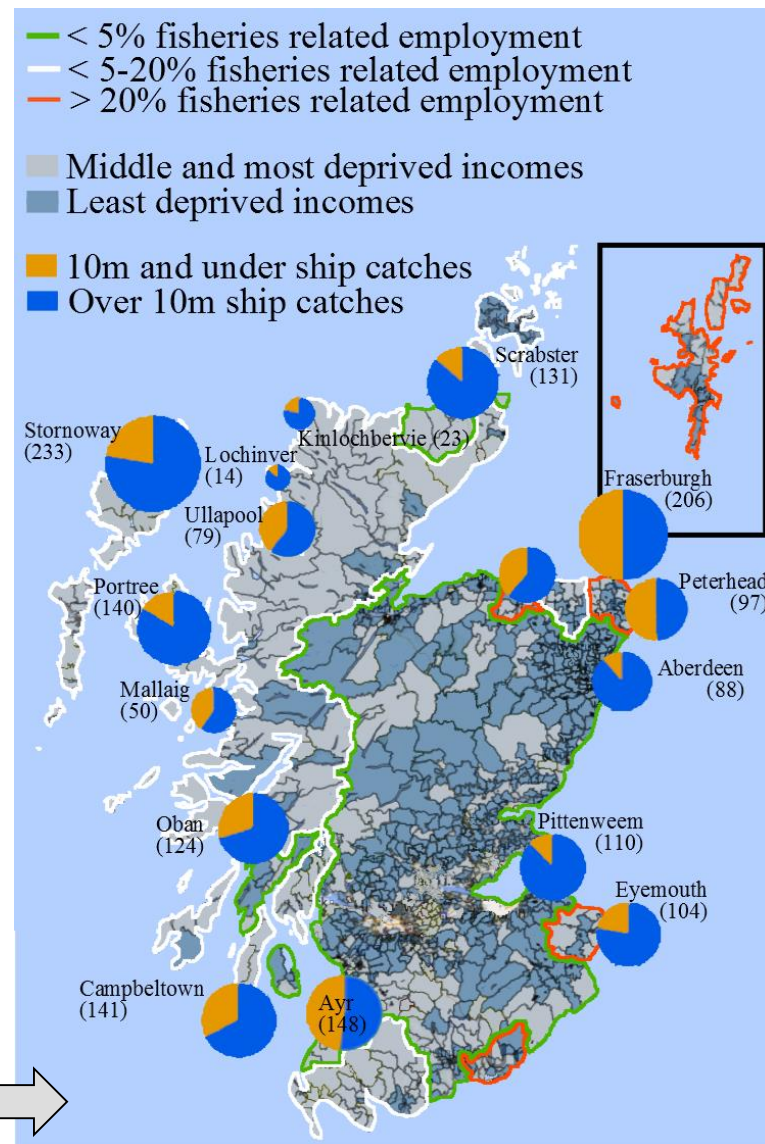


Using Input-output tables

- Largest value loss due to the reduction of catch from larger **Scottish vessels by 2050s (£57 million across Scottish economy),**
- Largest **employment** impacts in **England** from catch reduction of **smaller vessels** - loss of **944** full time jobs.

Impact on →	Value of catch (£m)	Jobs (FTE)
England		
Vessels <10m	- 52.54	- 944
Vessels >10m	- 17.75	- 319
Scotland		
Vessels <10m	- 11.60	- 123
Vessels >10m	- 56.77	- 595
Wales		
Vessels <10m	- 6.01	- 92
Vessels >10m	- 0.53	- 8
Northern Ireland		
Vessels <10m	- 3.38	- 36
Vessels >10m	- 5.92	- 63

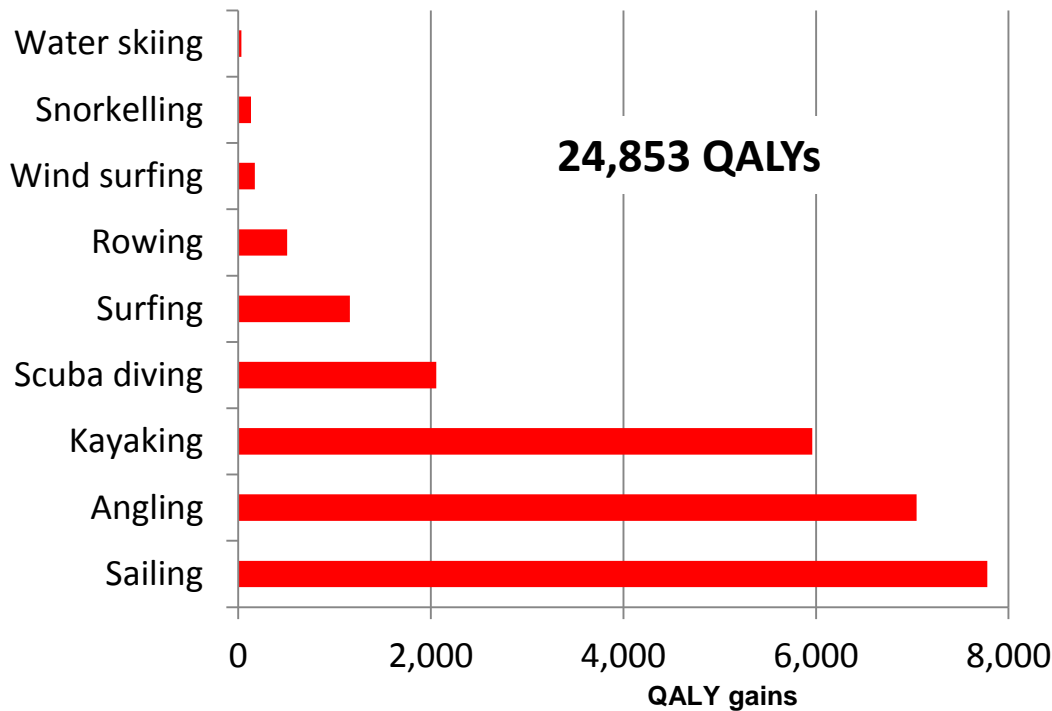
Are lower income areas more dependant on fisheries and the most impacted in terms of employment and income losses? →



QALY gains and health service savings from engaging with the marine environment

Quality-adjusted life year or quality-adjusted life-year (QALY) - a generic measure of disease burden, including both the quality and the quantity of life lived. Used in economic evaluation to assess the value for money of medical interventions. One QALY equates to one year in perfect health.

National QALY gains (per year)



Health Savings (£ million/year)

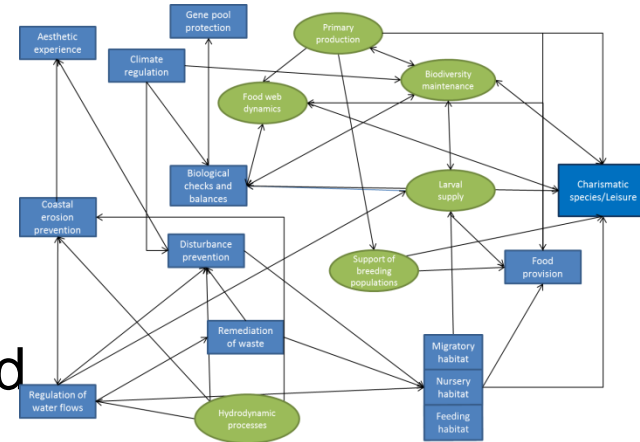
0.2	Water skiing
0.9	Snorkelling
1.2	Wind surfing
3.6	Rowing
8.2	Surfing
14.6	Scuba diving
42.3	Kayaking
50.1	Angling
55.3	Sailing
176.7	Total

NERC MERP - Marine Ecosystems Research Programme

Ecosystem services: Developing the 'Tool'

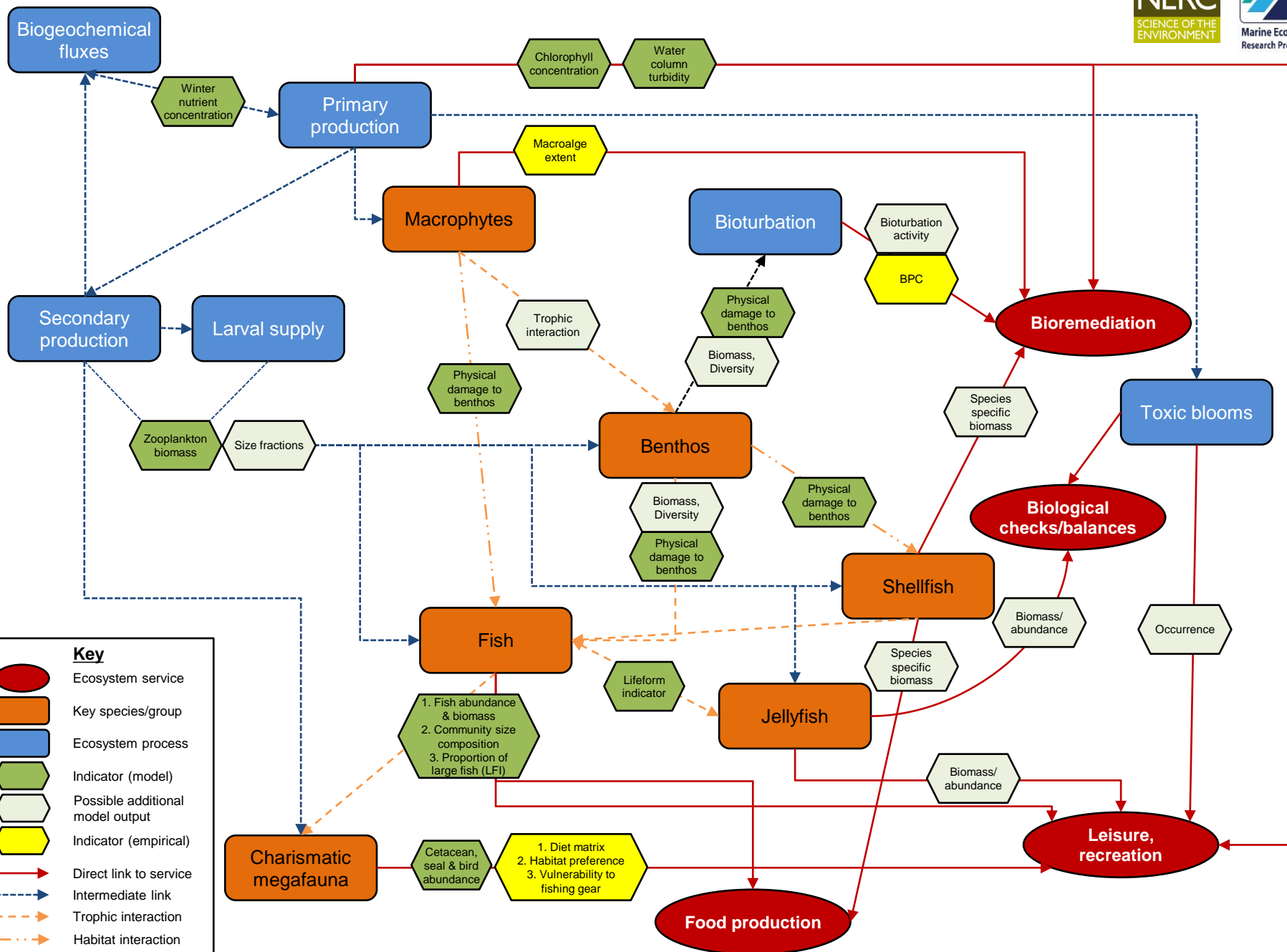
Approach

- Using existing and new MERP data, understanding and models to develop and test conceptual models of ecosystem services

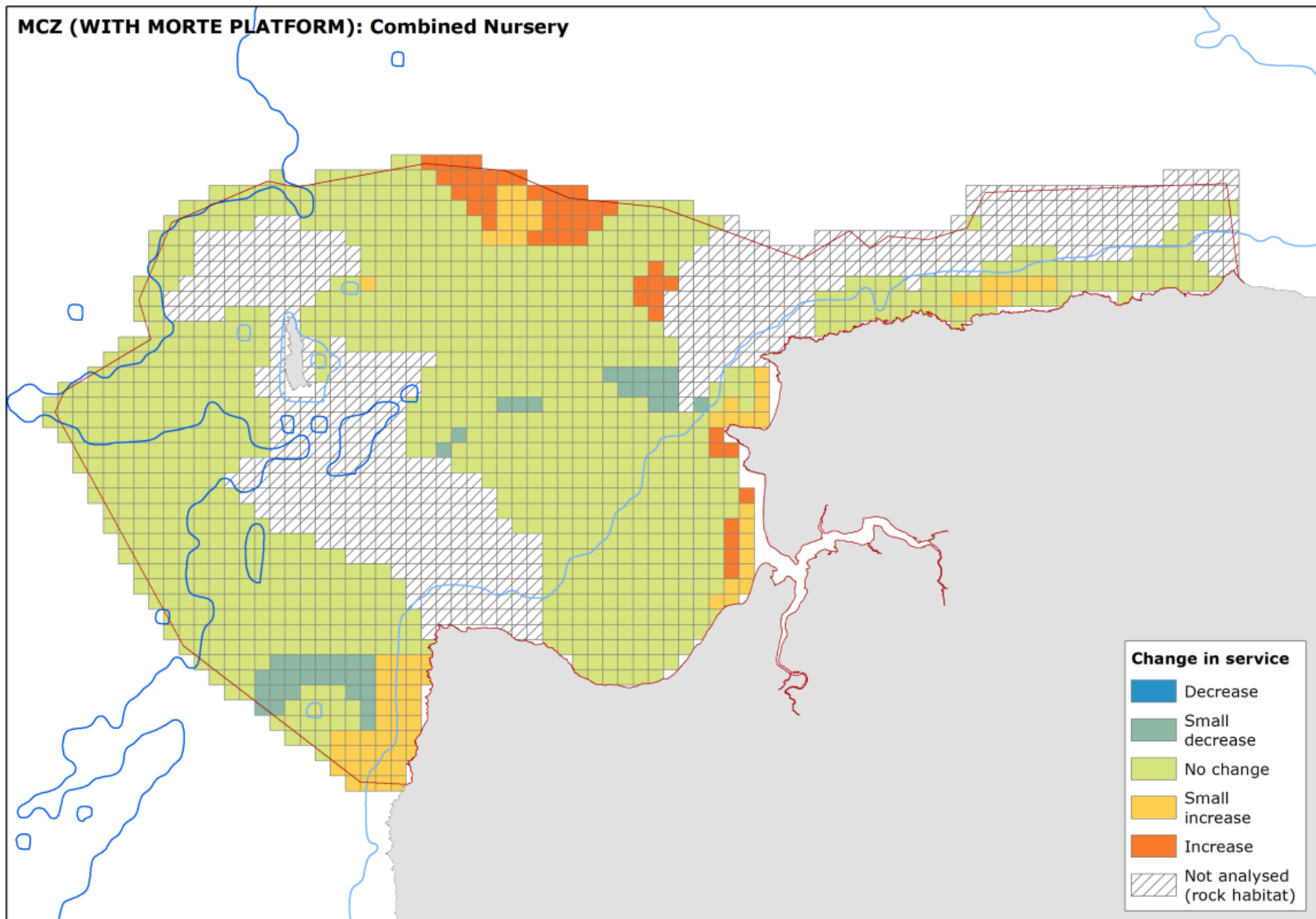


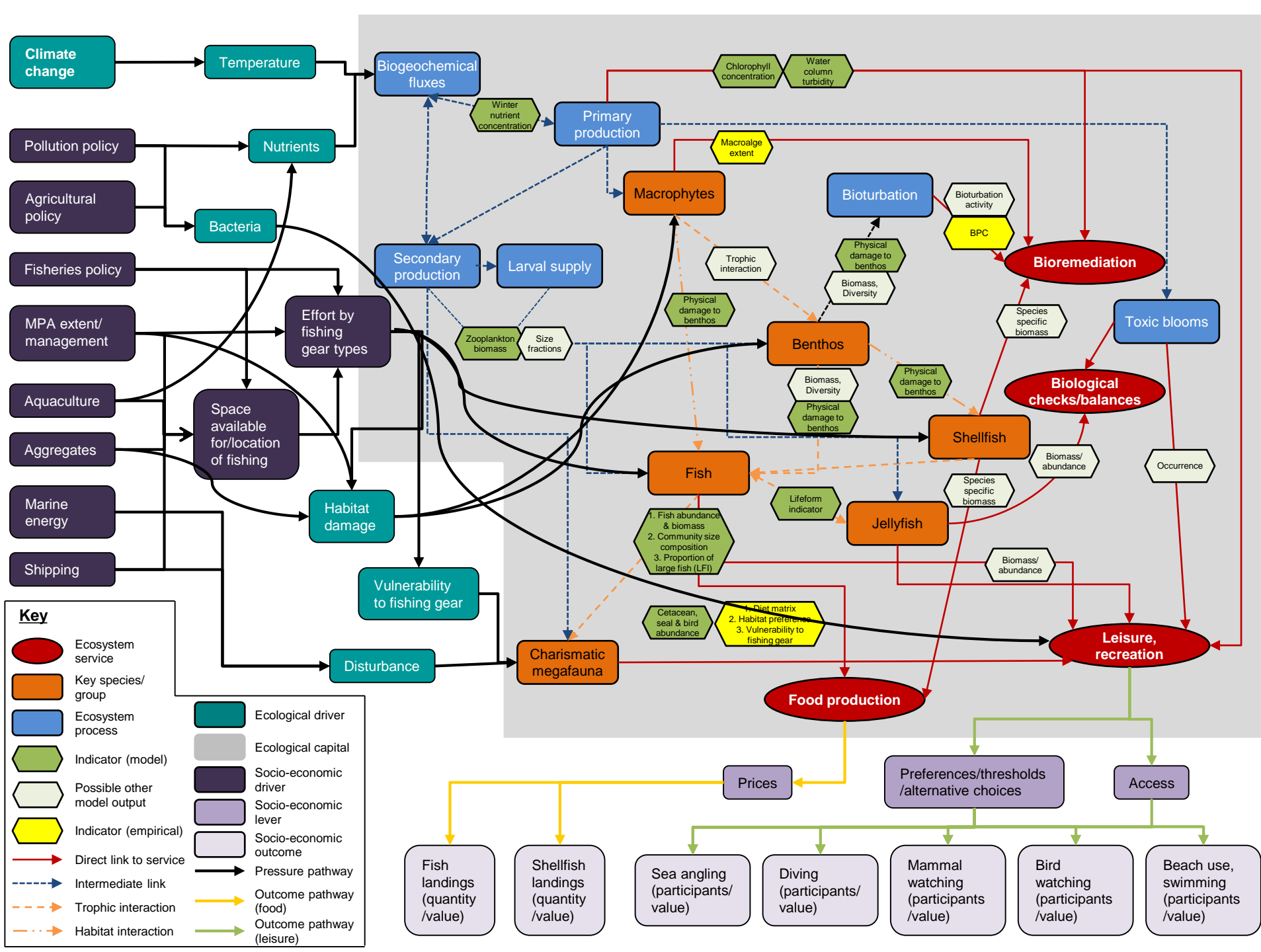
Interests

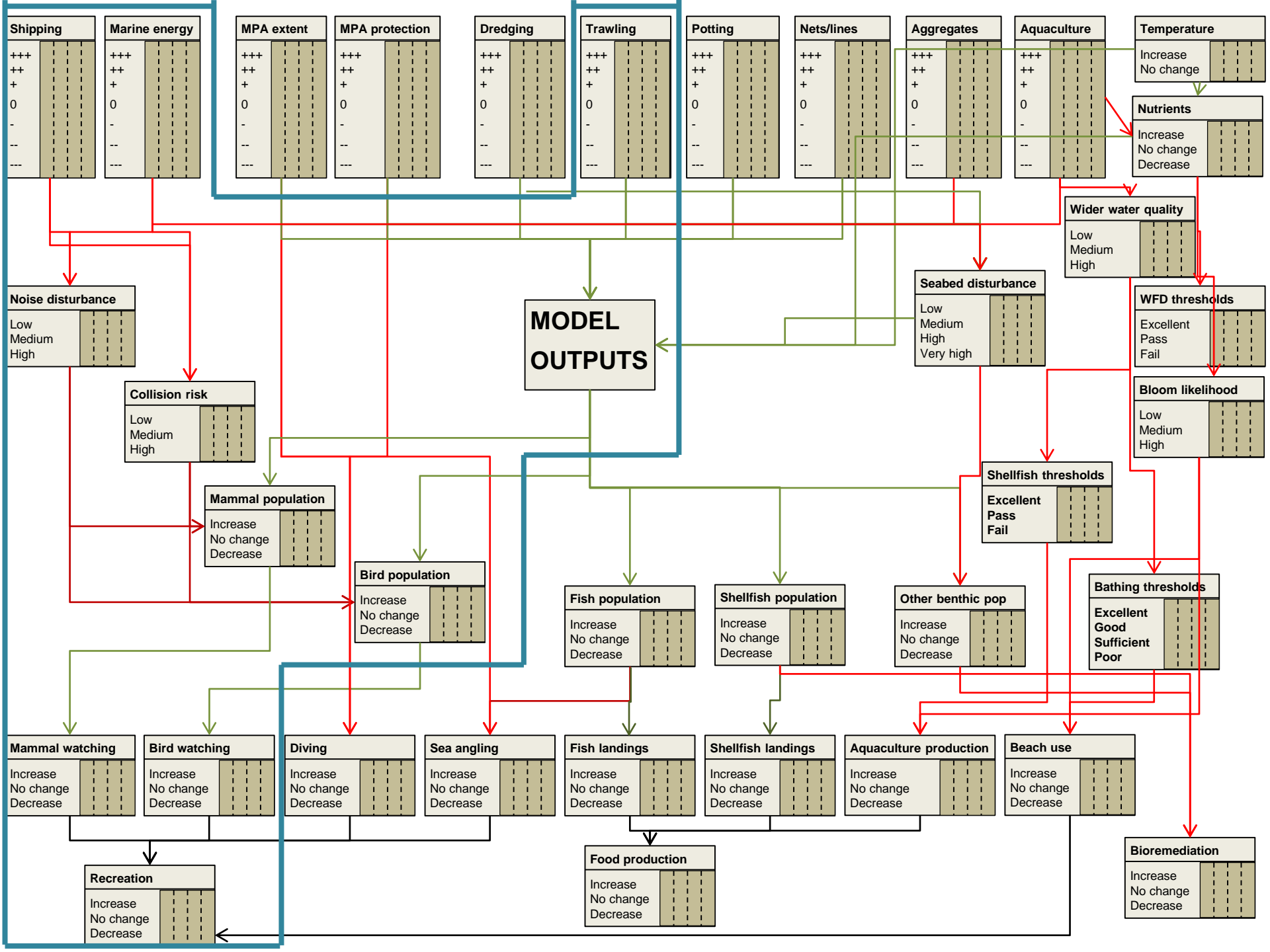
- Investigating how regulation of ecosystem services affected by food webs, 'top down' and 'bottom up' processes
- Spatial/temporal scales of processes/services
- Impact of environmental change
- Impact of management measures



MCZ (WITH MORTE PLATFORM): Combined Nursery







**MODEL
OUTPUTS**

Shipping	
+++	
++	
+	
0	
-	
--	

Marine energy	
+++	
++	
+	
0	
-	
--	

MPA extent	
+++	
++	
+	
0	
-	
--	

MPA protection	
+++	
++	
+	
0	
-	
--	

Dredging	
+++	
++	
+	
0	
-	
--	

Trawling	
+++	
++	
+	
0	
-	
--	

Potting	
+++	
++	
+	
0	
-	
--	

Nets/lines	
+++	
++	
+	
0	
-	
--	

Aggregates	
+++	
++	
+	
0	
-	
--	

Aquaculture	
+++	
++	
+	
0	
-	
--	

Temperature	
Increase	
No change	

Nutrients	
Increase	
No change	
Decrease	

Noise disturbance	
Low	
Medium	
High	

Collision risk	
Low	
Medium	
High	

Mammal population	
Increase	
No change	
Decrease	

Bird population	
Increase	
No change	
Decrease	

Fish population	
Increase	
No change	
Decrease	

Shellfish population	
Increase	
No change	
Decrease	

Other benthic pop	
Increase	
No change	
Decrease	

Wider water quality	
Low	
Medium	
High	

Seabed disturbance	
Low	
Medium	
High	
Very high	

WFD thresholds	
Excellent	
Pass	
Fail	

Bloom likelihood	
Low	
Medium	
High	

Shellfish thresholds	
Excellent	
Pass	
Fail	

Bathing thresholds	
Excellent	
Good	
Sufficient	
Poor	

Mammal watching	
Increase	
No change	
Decrease	

Bird watching	
Increase	
No change	
Decrease	

Diving	
Increase	
No change	
Decrease	

Sea angling	
Increase	
No change	
Decrease	

Fish landings	
Increase	
No change	
Decrease	

Shellfish landings	
Increase	
No change	
Decrease	

Aquaculture production	
Increase	
No change	
Decrease	

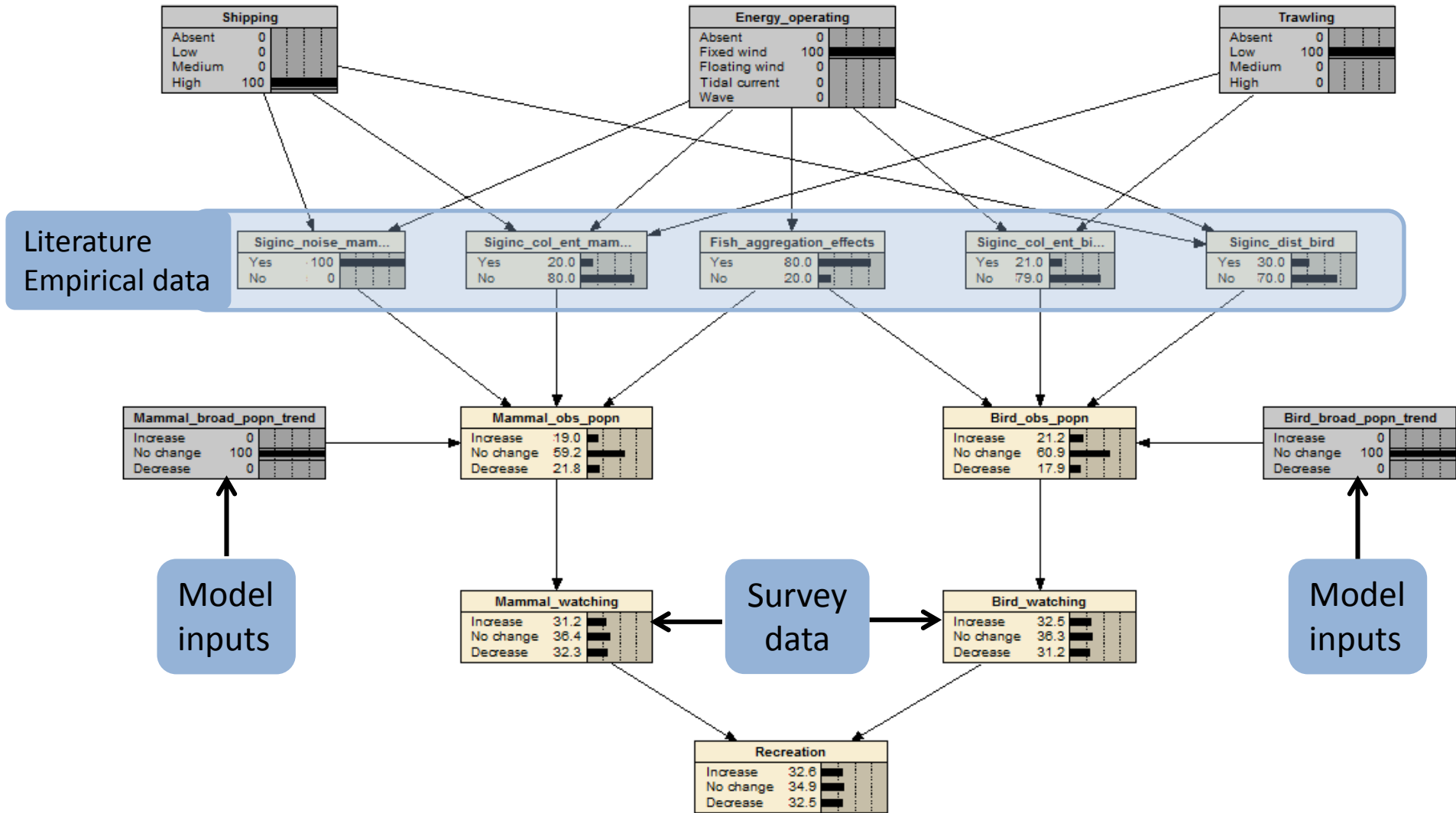
Beach use	
Increase	
No change	
Decrease	

Recreation	
Increase	
No change	
Decrease	

Food production	
Increase	
No change	
Decrease	

Bioremediation	
Increase	
No change	
Decrease	

Trial framework (Netica)



Incomes & jobs



Thank you for listening!

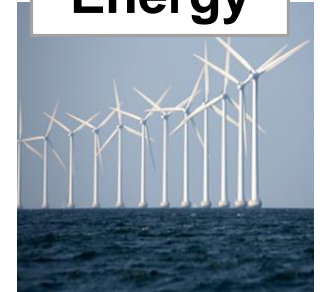
Biodiversity



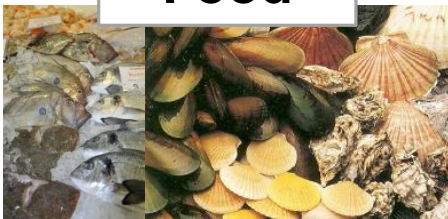
Greenhouse gases



Energy



Food



Recreation & health



Flood defence

