

Assessment of Ecosystem Service Flows From Marine Protected Areas: The VNN Matrix Approach and Beyond!

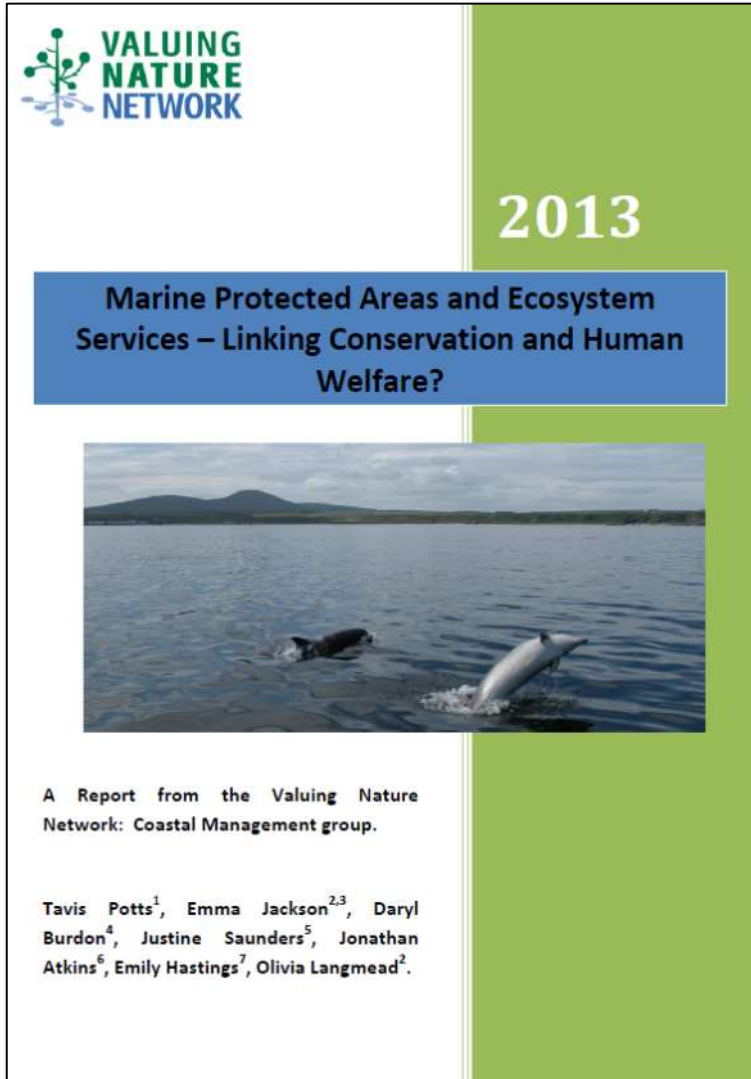
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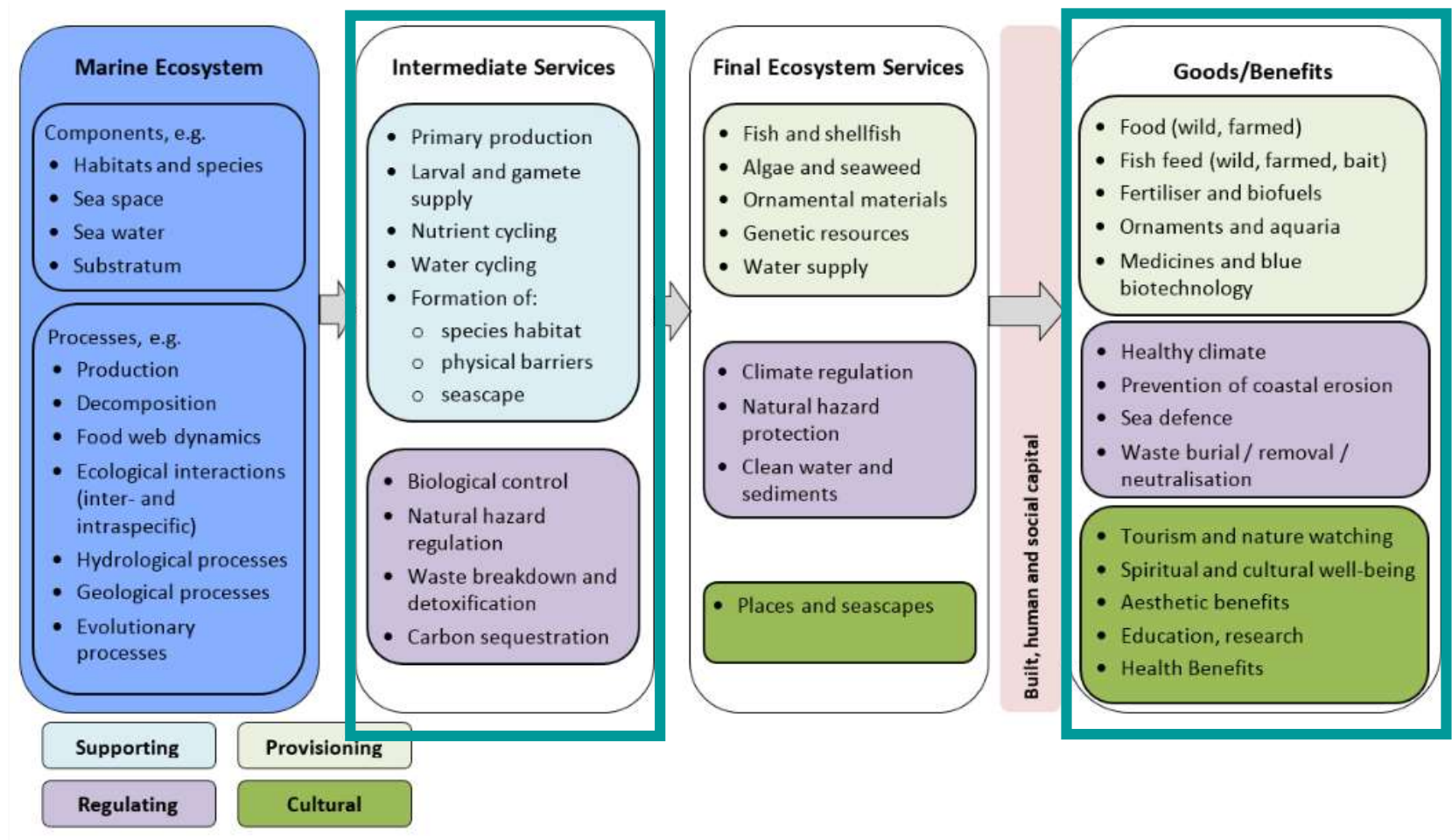
NERC-Funded Valuing Nature Network



- *Coastal ecosystem services: from science to values and decision-making* (2011-2013) led by Prof Kerry Turner (UEA).
- MPAs have historically focussed on protecting rare, threatened or endangered habitats and species.
- There is a recognition that MPAs also provide a range of societal benefits.
- Aim: to examine potential relationships between MPA designation and ecosystem service provision.
- The approach has important implications for MPA management, wider marine spatial planning and building public support.

Structural Framework for the Matrix Approach

Marine Ecosystem → Ecosystem Services → Societal Benefits



What is the Matrix Approach?

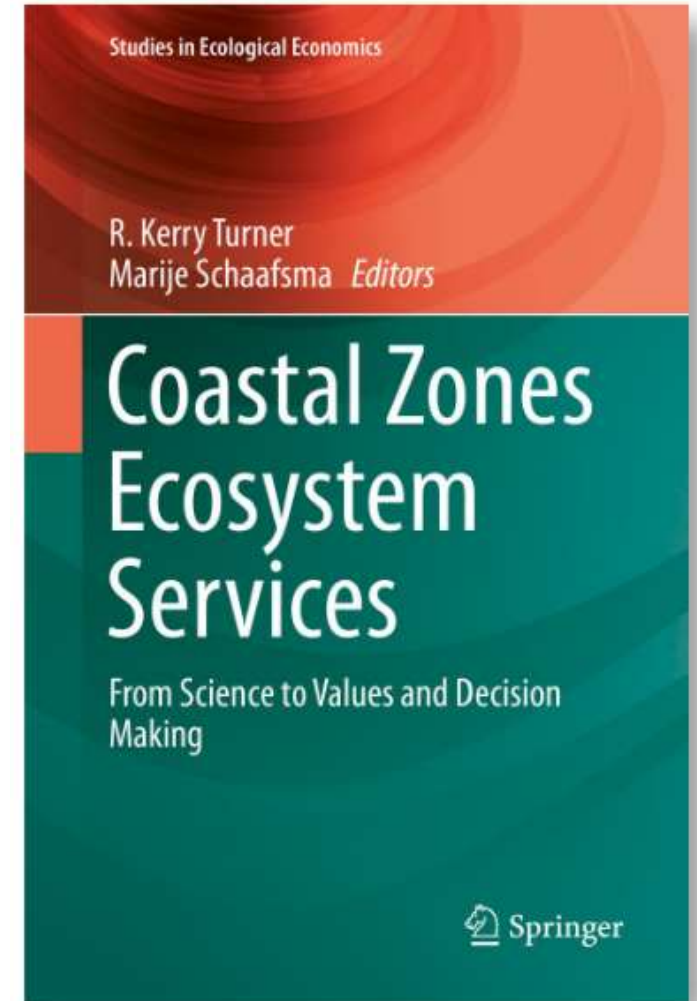
Features			Intermediate Services										Goods/Benefits																
Some habitats do not have a direct relationship to the EUNIS code and this column should only be used as a guide.																													
			Primary production	Larval and gamete supply	Nutrient cycling	Water cycling	Formation of species habitat	Formation of physical barriers	Formation of seascape	Biological control	Natural hazard regulation	Waste breakdown and detoxification	Carbon sequestration	Food (wild, farmed)	Fish feed (wild, farmed, bait)	Fertiliser and biofuels	Ornaments and aquaria	Medicines and blue biotechnology	Healthy climate	Prevention of coastal erosion	Sea defence	Waste burial / removal / neutralisation	Tourism and nature watching	Spiritual and cultural well-being	Aesthetic benefits	Education and Research	Physical health benefits	Psychological health benefits	
Existing Habitats protected under EU legislation																													
E,EU,W	A1.1	High energy intertidal rock																											
Assessment of Importance										Assessment of Confidence										Feature Type									
Scale of ecosystem service support relative to other features										Confidence in evidence										Feature type†									
<ul style="list-style-type: none"> # Significant contribution # Moderate contribution # Low contribution # No or negligible ESP Not assessed 										<ul style="list-style-type: none"> 3 UK-related, peer-reviewed literature 2 Grey or overseas literature 1 Expert opinion or Obvious Not assessed 										<ul style="list-style-type: none"> S Scottish MPA search feature E English MCZ feature W Welsh HP MCZ feature NI Northern Ireland MCZ feature EU EU Habitats Directive Annex 1 feature or sub-feature 									

Further Development of the Matrix Approach

UK National Ecosystem Assessment Follow-on

Work Package Report 4:
Coastal and marine ecosystem services: principles and practice

- National Ecosystem Assessment Follow-on Project (2012-2013).
- Marine ecosystem service framework was further refined (Turner et al., 2015).
- The matrices (habitats and species) were expanded and refined (Saunders et al., 2015).
- A practicable set of ecosystem service indicators were developed and UK data sources were identified (Atkins et al., 2015).



International Application of the Matrix Approach

- Joint Project between Aberdeen, Xiamen, Hull Universities.
- Co-funded by the Royal Society of Edinburgh (RSE) and the National Natural Science Foundation of China (NSFC).
- Project aims:
 1. Review & compare EU/Scottish and Chinese/Xiamen approaches to MPA policy and ES applications;
 2. Modify the matrix framework to include seabirds & Chinese protected features;
 3. Apply the framework to functionally similar species and MPAs in Scotland and China; and
 4. Conduct stakeholder workshops in both countries and explore valuation methods such as benefit transfer.



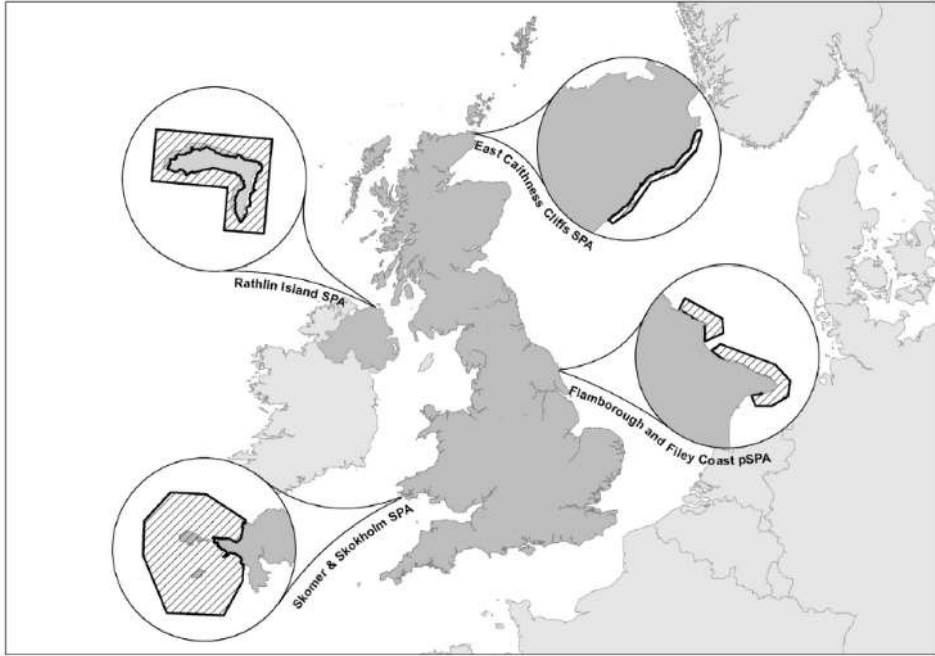


Fig. 3. Case study sites used for application of the UK seabird matrix.

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The matrix revisited: A bird's-eye view of marine ecosystem service provision

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Feature Type †	Species Names	Scientific Name	Intermediate Services										Goods/Benefits																					
			Supporting services					Regulating services					from Provisioning services			from Regulating services			from Cultural services															
			Primary production	Larval and gamete supply	Nutrient cycling	Water cycling	Formation of species habitat	Formation of physical barriers	Formation of seascape	Biological control	Natural hazard regulation	Waste breakdown and detoxification	Carbon sequestration	Food (wild, farmed)	Fish feed (wild, farmed, bait)	Fertiliser and biofuels	Ornaments and aquaria	Medicines and blue biotechnology	Healthy climate	Prevention of coastal erosion	Sea defence	Waste burial / removal / neutralisation	Tourism and nature watching	Spiritual and cultural well-being	Aesthetic benefits	Education	Physical health benefits	Psychological health benefits						
Seabirds - 'True Marine Seabirds which depend on the UK marine environment for their breeding and survival and occur in numbers greater than 50 per year'																																		
EU	Northern fulmar	<i>Fulmarus glacialis</i>	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1
EU	Manx shearwater	<i>Puffinus puffinus</i>	1	1	3	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1
EU	European storm-petrel	<i>Hydrobates pelagicus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Leach's storm-petrel	<i>Oceanodroma leucorhoa</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Northern gannet	<i>Morus bassanus</i>	1	1	3	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Great cormorant	<i>Phalacrocorax carbo</i>	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	European shag	<i>Phalacrocorax aristotelis</i>	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Arctic skua	<i>Stercorarius parasiticus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Great skua	<i>Catharacta skua</i>	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Black-legged kittiwake	<i>Rissa tridactyla</i>	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Black-headed gull	<i>Chroicocephalus ridibundus</i>	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	
EU	Mediterranean gull	<i>Larus melanocephalus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	
EU	Mew gull	<i>Larus canus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	
EU	Lesser black-backed gull	<i>Larus fuscus</i>	1	1	3	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Herring gull	<i>Larus argentatus</i>	1	1	3	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Great black-backed gull	<i>Larus marinus</i>	1	1	3	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Little tern	<i>Sterna albifrons</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Sandwich tern	<i>Sterna sandvicensis</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Common tern	<i>Sterna hirundo</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Roseate tern	<i>Sterna dougallii</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Arctic tern	<i>Sterna paradisaea</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Common guillemot	<i>Uria aalge</i>	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Razorbill	<i>Alca torda</i>	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
S, NI	Black guillemot	<i>Cephus grylle</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	
EU	Atlantic puffin	<i>Fratercula arctica</i>	1	1	3	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	

Scale of ecosystem service supplied relative to other features

- # Significant contribution
- # Moderate contribution
- # Low contribution
- # No or negligible ESP
- Not assessed

Confidence in evidence

- 3 UK-related, peer-reviewed literature
- 2 Grey or overseas literature
- 1 Expert opinion or Obvious

Feature type †

- S Scottish MPA search feature
- NI Northern Ireland MCZ feature
- EU EU Habitats Wild Birds Directive

Fig. 2. Relative importance of protected UK breeding seabirds in providing intermediate ecosystem services and goods/benefits.

Local Application of the Matrix Approach

- Project funded by Uni. Aberdeen (Impact Knowledge Exchange and Commercialisation Award)
- Local application to features of Aberdeen Bay & East Caithness.
- Produced site specific matrices for:
 - Annex II species
 - Seabirds
 - Habitats
- Formed the basis of discussion within a workshop setting:
 - Sense check of local application
 - Identified suitable indicators
 - Identification of local data sets

Annex II species not designated in local MPAs

Feature Type	Species Names	Scientific Name	Intermediate Services		Goods/Benefits		
			Supporting services	Regulating services	from Provisioning services	from Regulating services	from Cultural services
Existing Species protected under EU legislation	EU Grey seal	<i>Halichoerus grypus</i>					
	EU Common seal	<i>Phoca vitulina</i>					
	EU S Bottlenose dolphin	<i>Tursiops truncatus</i>					
	EU S, NI Harbour porpoise	<i>Phocoena phocoena</i>					
	EU Otter	<i>Lutra lutra</i>					
	EU Atlantic salmon	<i>Salmo salar</i>					
	EU Sea lamprey	<i>Petromyzon marinus</i>					
	EU River lamprey	<i>Lampetra fluviatilis</i>					

Designated habitats not included in existing matrices

Feature Type	Species Names	Scientific Name	Intermediate Services		Goods/Benefits		
			Supporting services	Regulating services	from Provisioning services	from Regulating services	from Cultural services
Existing Species protected under EU legislation	EU Atlantic salmon	<i>Salmo salar</i>					
	EU Sea lamprey	<i>Petromyzon marinus</i>					
	EU River lamprey	<i>Lampetra fluviatilis</i>					

Designated habitats not included in existing matrices

Feature Type	Species Names	Scientific Name	Intermediate Services		Goods/Benefits		
			Supporting services	Regulating services	from Provisioning services	from Regulating services	from Cultural services
Existing Species protected under EU legislation	EU Atlantic salmon	<i>Salmo salar</i>					
	EU Sea lamprey	<i>Petromyzon marinus</i>					
	EU River lamprey	<i>Lampetra fluviatilis</i>					

Legend:

- Significant contribution
- Major contribution
- Low contribution
- No or negligible COP
- Not assessed

Guidance on evidence:

- UK national, peer-reviewed literature
- Only UK national literature
- Expert opinion or other

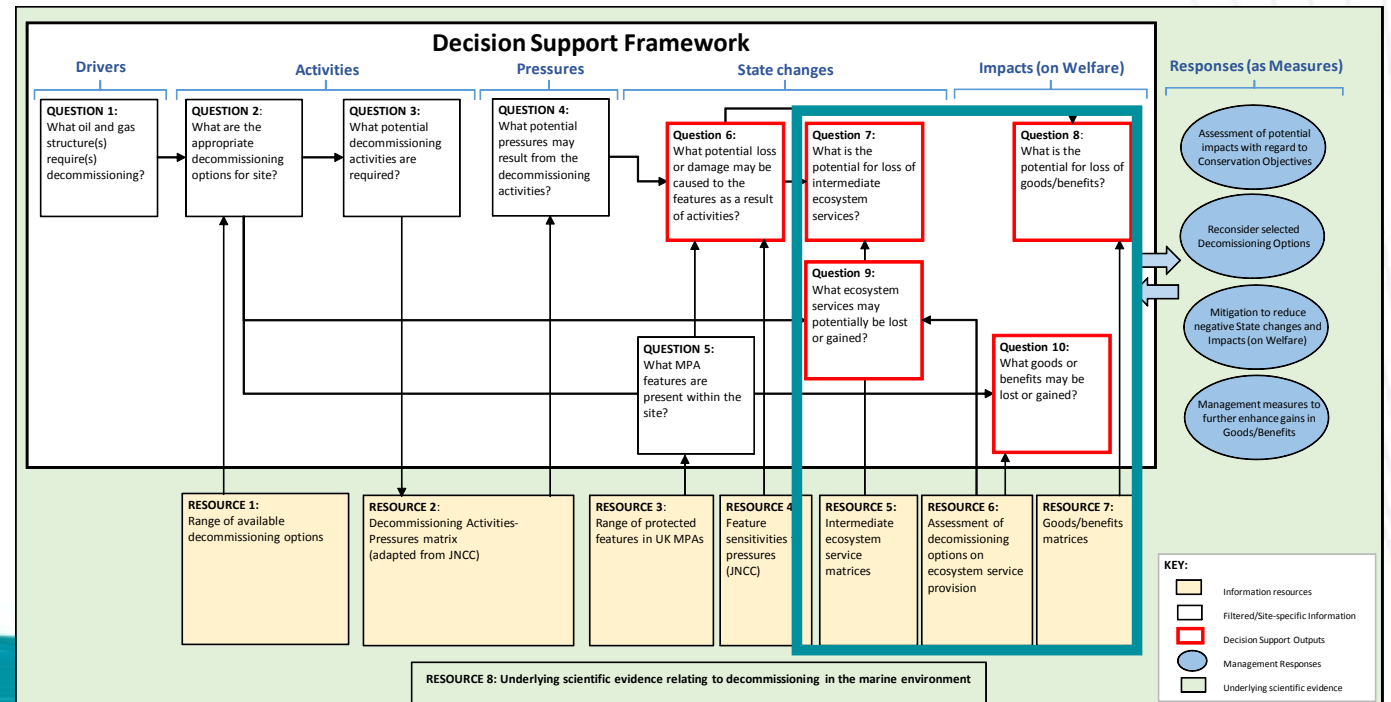
Feature type:

- Substrate with Leontide habitat
- Substrate with Leontide habitat
- Substrate with Leontide habitat



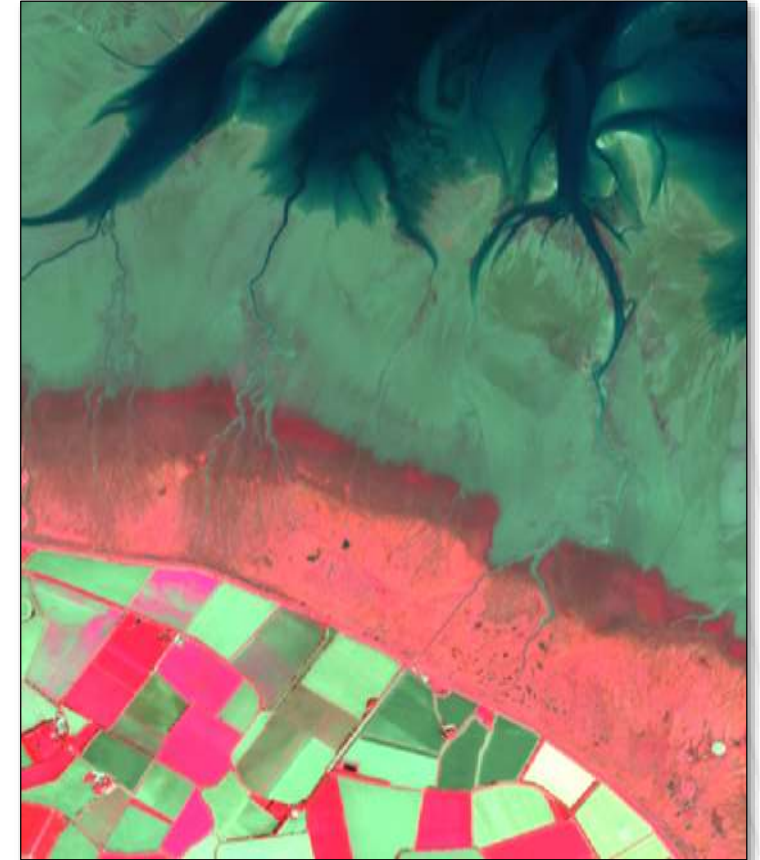
Industrial Application of the Matrix Approach

- NERC-funded DECOM-MPA project.
- The project will:
 1. Develop a Decision Support Document;
 2. Gather and Assess Best Available Scientific Evidence;
 3. Engage End-Users Throughout the Project;
 4. Use Industry-Led Case Studies to Test the DSD; and
 5. Disseminate Findings to a Wide Range of Stakeholders.
- Incorporate an innovative natural capital approach which builds on the VN matrices.



Valuing Nature Placement Scheme 2017-18

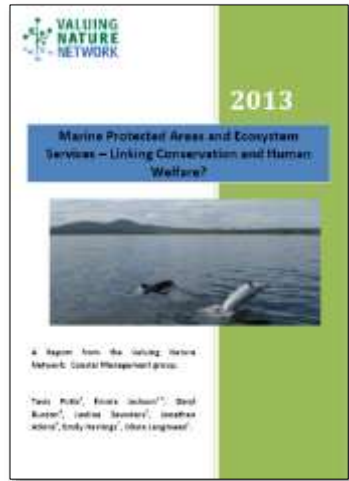
- ***Valuing ecosystem services and societal benefits provided by MPAs using space-based imaging of the coastal zone***
- Using The Wash and North Norfolk Coast SAC saltmarsh as a case study site:
 - I. Create saltmarsh type and extent maps using Sentinel-2 satellite derived data and visualise using GIS software.
 - II. Use established VNN matrices to identify the importance of ecosystem services provided by saltmarsh.
 - III. Interrogate local stakeholder opinion data collated through a state-of-the-art process: Community Voice.
 - IV. Conduct stakeholder workshops to identify region specific saltmarsh valuations.
 - V. Draft a peer-reviewed methods paper on the novel approach.



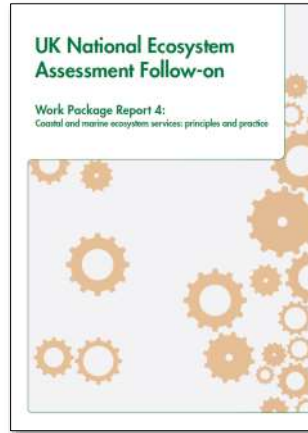
The Wash and
North Norfolk
Marine Partnership

Protecting Nature and Culture

Marine Protected Areas and Ecosystem Services – Linking Conservation and Human Welfare?
(Potts et al., 2013)



Ecosystem Service Framework for UK Coastal Waters
(Turner et al., 2014)



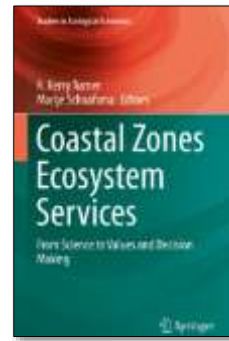
Ecosystem Service Matrix for Protected UK Coastal Habitats and Species
(Potts et al., 2014)



Revised Ecosystem Service Framework for UK Coastal Waters
(Turner et al., 2015)

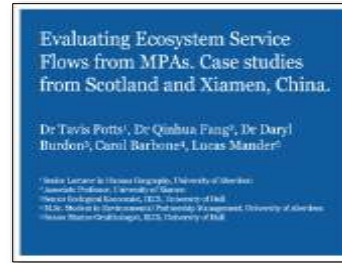
Identification of a Practicable Set of Ecosystem Service Indicators
(Atkins et al., 2015)

Expanded Ecosystem Service Matrix for Habitats and Species
(Saunders et al., 2015)



Ecosystem Service Matrix Scientific Workshop #1
(Xiamen, China)

Ecosystem Service Matrix Scientific Workshop #2
(Aberdeen, Scotland)



Ecosystem Service Matrix Workshop #3
(Aberdeen, Scotland)

Ecosystem Service Matrix Workshop #4
(Xiamen, China)

Ecosystem Service Matrix for UK Seabirds
(Burdon et al., 2017)



Ecosystem Service Stakeholder Mapping Workshop: Pilot #1
(Aberdeen Bay, Scotland)

Ecosystem Service Stakeholder Mapping Workshop: Pilot #2
(Moray Firth, Scotland)

Valuing Nature Placement Scheme:
Dr Sam Lew
E-IFCA to UHULL

Ecosystem Service Flows from MPAs in the UK and China: Shared Learning for Improved Site Design and Management
(Potts et al., in prep.)

Development and Application of Ecosystem Service Indicators for MPA Designation and Management
(Burdon et al., in prep.)

Navigating Coastal Change in NE Scotland. Expanding the Role of Participatory Mapping and Deliberation for the Management of MPAs and Coastal Developments
(Potts et al., in prep.)



2011-2013

2014

2015

2016

2017

2018

Timescale for the development and application of ecosystem service framework, indicators and matrices



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Thank you

For more information
visit www.hull.ac.uk

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