Natural capital accounts for marine areas – UK experience

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Introduction

This paper reports on the results of a project carried out for the Department for Environment Food and Rural Affairs by the Joint Nature Conservation Committee (JNCC) and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS)[2].

Ecosystem accounting for marine areas is a relatively unexplored area, raising a number of different issues to those encountered when compiling accounts for terrestrial areas. Marine accounts are particularly challenging because the areas are large (for the UK, over three times the land area), largely undifferentiated by remote sensing, much less studied, and more mobile and three-dimensional in nature.

This paper looks at some of the issues arising in compiling ecosystem accounts for marine areas, based on experience gained in the UK. It focuses on:

i) The need to use predictive modelling to determine the extent of different marine habitats
ii) The challenge of identifying appropriate condition indicators for the marine environment which are comprehensive and relevant to more than one service/ecosystem type
iii) The significance of two particular ecosystem services (waste mediation and coastal protection) which are currently not well covered in terrestrial ecosystem accounts
iv) The role of marine ecosystems in the storage and accumulation of carbon
v) The relationship between these services, other flows from the marine environment (such as energy from off-shore wind farms, wave and tidal power) and Blue Economy measures.

Background to the project

Natural capital accounting is an essential component of the natural capital approach advocated by the Natural Capital Committee (2017) and endorsed within the UK Government's 25 Year Environment plan (2018). Without understanding trends in the condition of marine and coastal habitats and the benefits

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[1] This paper presents the views of the author and does not necessarily represent the views of the Department for Environment, Food and Rural Affairs.

[2] Thornton, A., Luisetti, T., Grilli, G., Donovan, D., Phillips, R., and Hawker, J., 2019. *Initial natural capital accounts for the UK marine and coastal environment. Final Report.* Report prepared for the Department for Environment, Food and Rural Affairs.

we derive from the assets, it will be difficult to understand how changes in the state of these assets will affect economic growth and wellbeing in the future. Accounts for marine areas are expected to support the development of a systematic dataset on which to base better decisions about the marine environment particularly under the EU exit agenda.

The aim of the project was both to record existing data in the appropriate accounting tables, and to carry out development work by focusing on areas not well-covered by the existing terrestrial UK accounts. This meant that in addition to clarifying the extent and condition of marine habitats, a key part of the project was to incorporate measures of the volume and value of waste mediation and coastal protection services into the accounts.

Successes and lessons

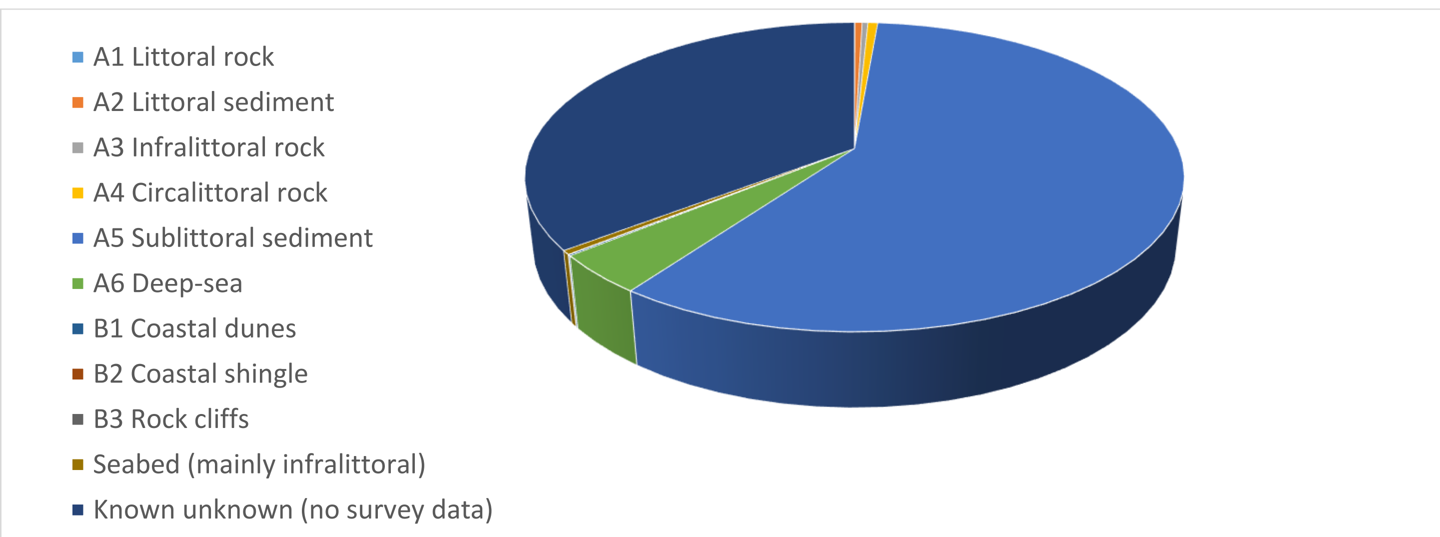
Collaborative working

The work was undertaken by in-house by colleagues with expertise in marine evidence but little or no experience of natural capital accounting practices. Hence an essential element of the project was the process of different disciplines working together, gaining a common understanding of concepts and terms, and bringing their own expertise to bear on the accounting issues which were encountered. We found that working through and developing logic chains for the services covered was an important part of this process.

Extent

Establishing basic data on the extent and condition of different marine habitats was the first challenge. We used the EUNIS classification at 2 to 3 digit level for categories A (marine habitats) and B (Coastal habitats). The information for marine habitats is largely determined by predictive modelling and even so the nature of some 30% of the area of UK waters is unknown. The unknown areas mainly relate to shallow sublittoral habitats which cannot be assessed using bathymetric or physical surveys.

Figure 1. EUNIS Level 2 marine and coastal habitats in the UK as a proportion of total area (ha)



Condition

Our approach to the identification of condition indicators was very much driven by reference to the capacity of the ecosystem(s) to deliver ecosystem services, and facilitated by detailed consideration of the relevant logic chains. There are potentially several key indicators for each habitat type for each service, so in addition to gaps in data availability, the challenge in keeping indicators down to a manageable level lies in judgements about the importance of the service, the extent of the habitat, the degree to which the indicator is likely to change in the near future and the significance of indicator in determining the capacity to deliver the service. Of course the choice is simplified if data availability is limited and one condition indicator is relevant to more than one service, and one of the key recommendations from the project was the need to improve the consistency between and fill the gaps in our evidence of the condition of the marine environment. Table 1 sets out the indicators selected for the marine accounts.

Table 1. Condition indicators by marine ecosystem service provision

	Condition indicator	**Service(s) to which it is relevant**
1	Primary production (biomass and extent of macroalgae) (littoral habitats)	Waste remediation Climate regulation
2	Primary production (other than littoral habitats)	Climate regulation
3	Habitat surveys of condition of coastal and littoral habitats	Waste remediation Coastal protection Climate regulation
4	Distance from land and configuration of habitat types	Waste remediation Coastal protection
5	Sediment type	Waste remediation Climate regulation Aggregates
6	Aspect / wind direction	Wind energy
7	Functioning marine food web	Biomass provisioning
8	Extent	Relevant to all services but most strongly associated with provision of recreation

Source: Thornton et al

Going forward, we will be looking to ensure consistency of reporting and messaging between the marine ecosystem accounts, the indicators used for the 25 Year Environment Plan, and the international indicators being developed under the OSPAR framework and the UN Sustainable Development Goal 14.

Marine ecosystem services

As can be seen from Table 1, the project covered seven different natural capital services:

1. Finfish and shellfish (biomass provisioning)
2. Carbon sequestration (climate regulation)
3. Natural hazard protection (coastal protection)
4. Waste (nutrient) remediation
5. Recreation
6. Renewable energy (wind energy)
7. Aggregates

The measurement and valuation of finfish and shellfish flows, recreation, renewable energy and aggregates relating to the marine environment are already implicit in the established UK natural capital accounts, so apart from work to identify the element relating to the marine environment, attention focused on the other three services.

Carbon sequestration

For carbon sequestration, the interest lies in the way that marine sediment absorbs carbon (known as carbon burial) and to a less significant degree the role of vegetated ecosystems (such as seagrasses and saltmarsh) in the sequestration of carbon. Neither of these sources of removals are currently recorded within the UK's Land Use, Land Use Change and Forestry (LULUCF) Inventory of greenhouse gases. For saltmarshes, estimates were based on above- and below-ground sequestration rate of 0.86 tonnes per hectare per year.

As the extent of saltmarsh in the UK is relatively limited, the more significant volumes were recorded for sublittoral sand and sublittoral mud, using conservative estimates of burial rates of 0.08 and 0.12 tonnes per hectare per year respectively. On this basis, the study estimated that some 10.5 million tonnes of CO2 equivalent were sequestered by the marine environment in 2017.

Our conclusion is that the marine environment makes a significant contribution to carbon sequestration and that these flows should be recorded in the ecosystem accounts.

Waste remediation

Waste remediation (breakdown, detoxification and burial/removal/neutralisation of pollutants) is an important process which involves different parts of the marine and coastal environment in different ways, depending upon the particular pollutant or nutrient being processed. For reasons of data availability, we focused on the remediation of wastewater from wastewater treatment plants into the coastal and marine environment of the UK. As a working assumption, it was assumed that the volumes of waste material were effectively processed by the marine environment, although it was recognised that in practice some deterioration in the condition of the ecosystem(s) would result from the discharges.

The study estimated the quantities of nitrogen, phosphorus and organic compounds (Biological Oxygen Demand) discharged and hence the monetary value of the remediation service, based on estimates of the avoided cost of treating the selected pollutants. Although the estimates didn't cover all pollutants or all sources of wastewater entering the marine environment, the value of the service was found to be significant, at 1.7 billion Great Britain Pounds (GBP). Further work is clearly needed to refine and extend the estimates.

Natural hazard protection

The study also made a first attempt to measure the value of natural hazard protection provided by UK coastal and marine habitats. This relates to the moderating effect that coastal habitats have on moderating storm surges and coastal flooding. Different marine habitats contribute differently to this service depending largely upon location.

Due to a lack of data, the project only looked at the role of saltmarshes in providing protection from recurrent (e.g. waves and tides) and infrequent (e.g. storms) natural disturbances. Some simplifying assumptions needed to be made about the nature of the saltmarshes and their role in the provision of the service, the replacement costs of the protection provided, and the likelihood of those costs being incurred. The resulting valuation suggests that the service is significant but much more work is needed to refine the assumptions and extend the estimates.

Potential policy applications

Once more fully developed, we see the accounts for marine areas as contributing to:

i) The identification and management of protected and unprotected areas. As the accounts are spatially disaggregated (albeit currently to varying degrees), it should be possible to use the accounts to inform decisions about those areas which are important resources in terms of the services provided

ii) Measurement and understanding of the 'Blue economy'. The Blue economy has various definitions, many of which do not currently take into account the non-market services provided by marine ecosystems, but it seems likely that the emerging guidance on oceans accounting under the banner of the Global Ocean Accounts Partnership will take a broader view of the importance of the marine environment to economic and social development. In this respect it will also be important to record abiotic flows within the accounting framework

iii) Understanding the social context of users and beneficiaries of marine ecosystem services. This is a theme emphasised within the UN Sustainable Development Goals and one that can be explored by linking ecosystem service use accounts with information about the social characteristics of users and beneficiaries

What might a combined 'Blue Economy'/Marine ecosystem account look like? Table 2 sets out how marine natural capital service flows might relate to the economic values recorded in measures of the Blue Economy.

Table 2. Potential relationships between the UK Blue Economy GVA, valuations of market-based flows from the marine area (SNA benefits), and non-market flows from the UK marine ecosystem

Illustrative/ Provisional	Marine ecosystem supply of services	Additive to /contributes to	GBP million Blue economy GVA
Provisioning services			
Fish, aquaculture	292	=>	2,416
Carrier services? (maritime transport)			2,595
Ports			6,492
Shipbuilding			2,529
Abiotic flows			
Oil and gas	1,157	=>	9,784
Minerals and aggregates	14	=>	529
Wind power	1,345	=>	?
Regulating Services			
Air pollution removal		+	
Carbon sequestration	384	+	
Storm buffering	5,590	+	
Temperature regulation		+	
Waste mediation	1,692	+	
Cultural Services			
Enabling recreation	1,299	+	
Enabling physical activity		+	
Settings for mental health		+	
Enabling educational interactions		+	
Amenity (and other non-use?) values		+	
Nature-based tourism	800	=>	7,056

Source: Thornton et al, European Union

Summary of challenges and unresolved issues

1. The need to use models to determine the extent of different habitats, and the difficulty of verifying the accuracy of the resulting estimates.
2. How to record the interface between marine and coastal within an accounting framework. This is especially relevant to cultural services such as recreation, where visits to the coastal environment involve interaction with the marine environment, but is also relevant to other services, such as the use of saltmarshes for grazing.
3. The need to have a better understanding of the relationship between ecosystem condition and the capacity to deliver services in the future, if the condition indicators are to inform decisions.
4. Optimising the degree of spatial resolution, given the challenges of disaggregating some estimates to the level which would be needed for analysis and use of the accounts in local decision-making.
5. Estimation and treatment of unmediated waste flows within the accounting framework.
6. The need to linking the modelling of coastal protection services with socio-economic data about the nature of the assets which are thereby protected (and some assumption about the likelihood of replacement costs being incurred if the protection wasn't provided).
7. The inclusion of carbon burial in sediment and the treatment of carbon storage within the accounts.
8. Distinguishing between users and beneficiaries of ecosystem services, with a view to recording the social characteristics of the beneficiaries. This is especially relevant in respect of non-use values, given the deep cultural significance of the marine environment to the UK as a 'maritime nation'.

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