Stage 2 deliverable: Compilation of an ecosystem services assessment toolkit

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Introduction

Coastal and marine ecosystems, including seagrass meadows, coral reefs, mangrove forests and saltwater marshes, collectively known as 'blue forests', are essential for coastal and island communities by supporting human wellbeing. The benefits blue forests provide include coastal protection, nursery and breeding grounds for fisheries, and carbon sequestration (a concept also termed 'blue carbon') (GRID-Arendal, 2016).

The Global Environment Facility (GEF) 'International Waters' focal area is enabling the Blue Forests Project to provide the first global-scale assessment of the values associated with coastal carbon ecosystem services. A central aim of the project is to achieve improved ecosystem management through the enhanced recognition of these values in decision-making. The project also seeks to improve knowledge for informed decision-making and raise awareness on blue forest ecosystems, as well as to foster cooperation among blue forest stakeholders.

Stage 2 of this project consists of the compilation of an ecosystem services assessment toolkit. This document describes the strengths and weaknesses of a range of methods best suited to blue forest ecosystem service valuation and assessment. It is not a comprehensive review of all ecosystem valuation and assessment methodologies. Six blue forest ecosystem services were chosen for the analysis:

- Fisheries including aquaculture;
- Coastal protection;
- Fuel (firewood, charcoal) and raw material (timber);
- Water purification;
- Cultural identity; and
- Recreation.

To highlight the applicability of different ecosystem service valuation and assessment methodologies to these 5 ecosystem services, a network chart was created (see Figure 1 below).

Relevant terminology and definitions:

There are many different definitions of ecosystems services and natural capital, however the ones used in this document are:

Ecosystem services: Benefits people obtain from ecosystems. These include provisioning services, such as food and water; regulating services, such as regulation of floods, drought, land degradation, and disease; cultural services, such as recreational, spiritual, religious and other non-material benefits; and supporting services, such as soil formation and nutrient cycling (Hassan *et al.*, 2005).

Natural capital: Natural assets in their role of providing natural resource inputs and environmental services for economic production. Natural capital includes land, minerals and fossil fuels, solar energy, water, living organisms, and the services provided by the interactions of all these elements in ecological systems (UNEP, 2012; OECD, 2007).

Blue forests: Coastal and marine habitats that support human wellbeing, such as seagrass meadows, mangrove forests, and saltwater marshes (GRID-Arendal, 2016).

Ecosystem services valuation and assessment: The valuation of ecosystem services is a way of evaluating what society is willing to trade off to conserve a particular ecosystem service by either quantitatively or qualitatively assessing its value (TEEB, 2010).

For further details on related terminology and definitions, please see the UN Environment World Conservation Monitoring Centre (UNEP-WCMC) Biodiversity A-Z: http://www.biodiversitya-z.org/.

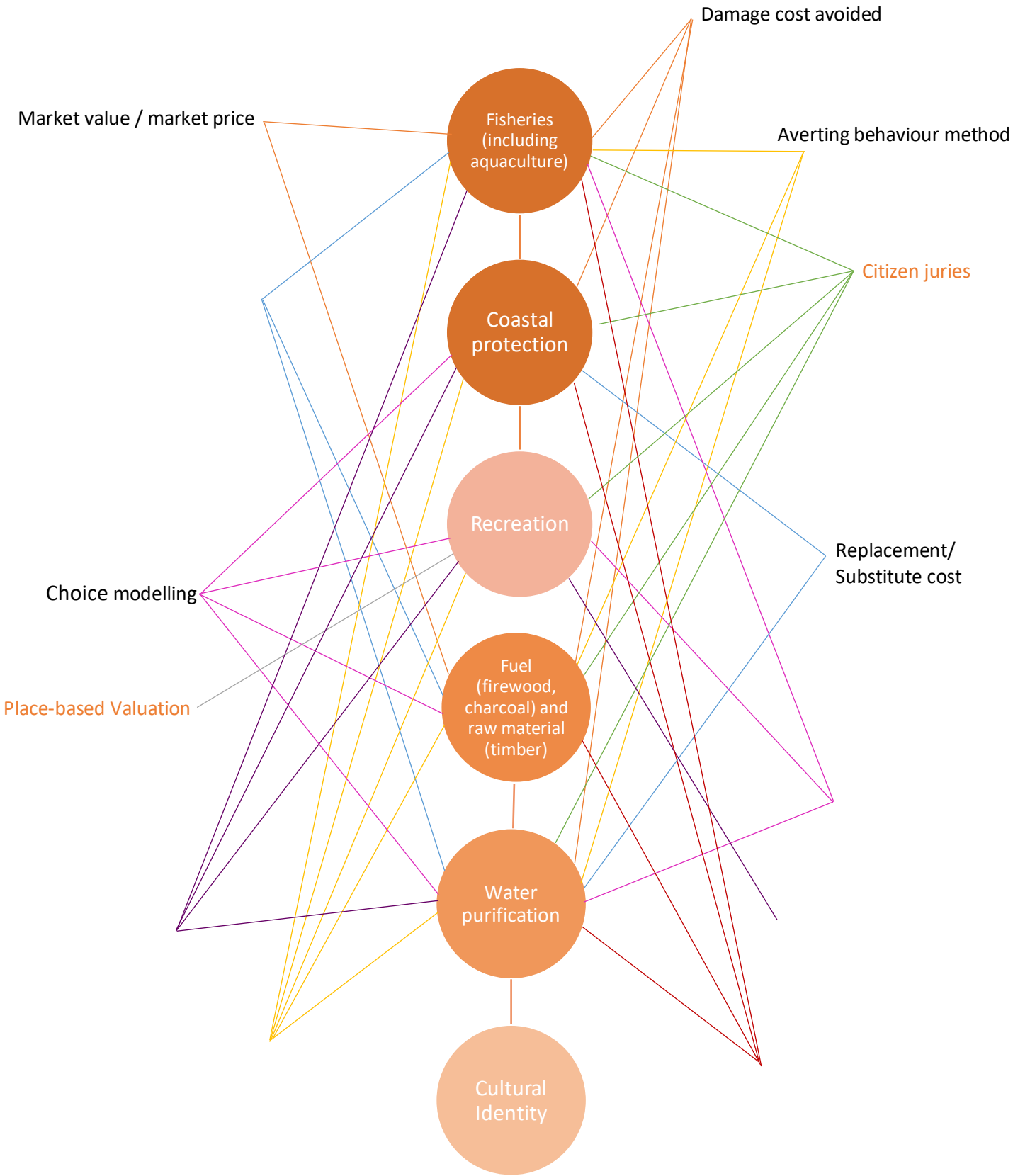

Figure 1: The monetary methods (black font) and non-monetary methods (orange font) that can be used for the valuation or assessment of blue forest ecosystem services (central circles)

Blue forest ecosystem service valuation and assessment methods

The following section briefly describes methods most suited to the valuation and assessment of blue forest ecosystem services based on Mongruel et al. (2015), Fletcher et al. (2014), Waite et al. (2014) and TEEB (2013). The methods are divided into those which are monetary and non-monetary in nature.

Monetary methodologies

Market value/Market price

This method considers the sale and purchase price of the ecosystem service in question, most commonly valuing provisioning ecosystem services. The market price method estimates the economic value of ecosystem services that are bought or sold on commercial markets. Valuation is based on the different market prices of ecosystem services and the quantity supplied at these prices. For more information on how to use this method, please refer to Table 1.

Table 1: Guidance on market value/market price methods

Guidance document/resource	Type of guidance	Pages
EFFTEC (2006). Valuing our natural environment	Contains a section on market price proxies (3.1.1), including information on related value concepts, resource and policy contexts in which they can be applied, practical limitations and recommendations on use in combination with other methods (see also Table 3.1)	19-20
ValuES Methods Database (website): Direct market price method	Short online description and method profile factsheet (8 pages), containing information on: 1) information provided by the method, 2) ecosystem services assessed, 3) how, when and where the method can be applied, 4) how the method works, 5) resources required for applying the method, 6) strengths and challenges, 7) case study example, 8) further guidance and case study references	online
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Introduction to implementing the market price technique in small island developing states, including: Table 4.2: A step-by-step valuation of island ecosystem services using the market price technique Box 4.2: Examples of application	30-32

JNCC (2007). Valuing the environment in small islands. An environmental economics toolkit	Contains a section on market price methods (5.5), including a description of the approach, step by step guidance on using the method and an example case study	52-53

For additional descriptions of market price/market value approaches and further information about the type of values they capture and the ecosystem services they can be applied to, see also:
Defra (2007). An introductory guide to valuing ecosystem services (pp. 37; 60)
TEEB (2010). Chapter 5. The economics of valuing ecosystem services and biodiversity (pp. 17; 24; 25; 29)
World Bank (2016). Managing coasts with natural solutions: Guidelines for measuring and valuing the coastal protection services of mangroves and coral reefs (p. 113)

Production function

This valuation method evaluates how a change in an ecosystem service or good, which results from a change in the environmental resource, is reflected in the value of this service. The production function method is thus based on the contribution of ecosystem services to the enhancement of income or productivity. This means that to use this methodology, the physical effects of changes in a biological resource or ecosystem service on an economic activity need to be known, as well as the impact of these changes on the marketed output of the traded activity. For more information on how to use this method, please refer to Table 2.

Table 2: Guidance on the production function method

Guidance document/resource	Type of guidance	Pages
EFFTEC (2006). Valuing our natural environment	Contains a section on production function (3.1.2), including information on related value concepts, resource and policy contexts in which they can be applied, practical limitations and recommendations on use in combination with other methods	20
ValuES Methods Database (website): Effect on production method	Short online description and method profile factsheet (9 pages), containing information on 1) information provided by the method, 2) ecosystem services assessed, 3) how, when and where the method can be applied, 4) how the method works, 5) resources required for applying the method, 6) strengths and challenges, 7) case study example, 8) further guidance and case study references	online
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Introduction to implementing the production function technique in small island developing states, including: Table 4.1: A step-by-step valuation of island ecosystem services using the production function technique Box 4.1: Examples of application	29-30

JNCC (2007). Valuing the environment in small islands. An environmental economics toolkit	Contains a section on the production function method (5.9), including a description of the approach, step by step guidance on using the method and an example case study	57-59

For additional descriptions of the production function approach and further information about the type of values it captures and the ecosystem services it can be applied to, see also:
Defra (2007). An introductory guide to valuing ecosystem services (pp. 37; 60)
TEEB (2010). Chapter 5. The economics of valuing ecosystem services and biodiversity (pp. 17-18; 24; 25; 30)
World Bank (2016). Managing coasts with natural solutions: Guidelines for measuring and valuing the coastal protection services of mangroves and coral reefs (p. 115-116)

Travel cost method

This method is based on the premise that marine sites hold high value for tourists and residents for the purpose of recreation, leisure and tourism. It involves quantifying the amount of money spent travelling to a site. It is one of the most commonly applied methods for estimating the value of recreational sites. For more information on how to use this method, please refer to Table 3.

Table 3: Guidance on the travel cost method

Guidance document/resource	Type of guidance	Pages
EFFTEC (2006). Valuing our natural environment	Contains a section on the travel cost method (3.1.4), including information on related value concepts, resource and policy contexts in which they can be applied, practical limitations and recommendations on use in combination with other methods	21-22
ValuES Methods Database (website): Travel Cost Method (TCM)	Short online description and method profile factsheet (8 pages), containing information on 1) information provided by the method, 2) ecosystem services assessed, 3) how, when and where the method can be applied, 4) how the method works, 5) resources required for applying the method, 6) strengths and challenges, 7) case study example, 8) further guidance and case study references	online
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Introduction to implementing the production function technique in small island developing states, including: Table 4.3: A step-by-step valuation of island ecosystem services using the travel cost technique Box 4.3: Examples of application	32-34
JNCC (2007). Valuing the environment in small islands. An environmental economics toolkit	Contains a section on the travel cost method (5.11), including a description of the approach, step by step guidance on using the method and an example case study	61-64

For additional descriptions of the travel cost method and further information about the type of values it captures and the ecosystem services it can be applied to, see also:
Defra (2007). An introductory guide to valuing ecosystem services (pp. 37; 60)
TEEB (2010). Chapter 5. The economics of valuing ecosystem services and biodiversity (pp. 19; 24; 25; 30)
World Bank (2016). Managing coasts with natural solutions: Guidelines for measuring and valuing the coastal protection services of mangroves and coral reefs (p. 115-116)

Hedonic pricing

This method is based on the premise that the value of a good will be related to its characteristics or to the services it provides. Therefore, the service can be valued by assessing how the price people are willing to pay for a good changes as its characteristics change. It is used to estimate the economic value of ecosystem services that directly affect market prices. For example, the differences in house prices in an area close to the source of an ecosystem service will be higher than for similar houses in different areas. For more information on how to use this method, please refer to Table 4.

Table 4: Guidance on the hedonic pricing method

Guidance document/resource	Type of guidance	Pages
EFFTEC (2006). Valuing our natural environment	Contains a section on the hedonic property pricing method (3.1.3), including information on related value concepts, resource and policy contexts in which they can be applied, practical limitations and recommendations on use in combination with other methods	21
ValuES Methods Database (website): Hedonic valuation method	Short online description and method profile factsheet (6 pages), containing information on 1) information provided by the method, 2) ecosystem services assessed, 3) how, when and where the method can be applied, 4) how the method works, 5) resources required for applying the method, 6) strengths and challenges, 7) case study example, 8) further guidance and case study references	online
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Introduction to implementing the production function technique in small island developing states, including: Table 4.4: A step-by-step valuation of island ecosystem services using the hedonic pricing technique Box 4.4: Examples of application	34-35
JNCC (2007). Valuing the environment in small islands. An environmental economics toolkit	Contains a section on the hedonic pricing method (5.10), including a description of the approach, step by step guidance on using the method and an example case study	59-61

For additional descriptions of the hedonic pricing method and further information about the type of values it captures and the ecosystem services it can be applied to, see also:
Defra (2007). An introductory guide to valuing ecosystem services (pp. 37; 60)
TEEB (2010). Chapter 5. The economics of valuing ecosystem services and biodiversity (pp. 19; 24; 25; 30)
World Bank (2016). Managing coasts with natural solutions: Guidelines for measuring and valuing the coastal protection services of mangroves and coral reefs (p. 113-114)

Payment for ecosystem services (PES)

This method assumes that the payments made to undertake actions that protect or increase the quality and quantity of desired ecosystem services reflect the value of the service itself. It involves provision of incentives for people whose activities could, or do, cause damage or degradation to ecosystems. Direct but voluntary payments are given by beneficiaries to those providing ecosystem services to maintain or enhance service provision. However, this method can be considered a policy framework rather than a specific ecosystem service valuation methodology, since payment for ecosystem services schemes can take many different forms and need to be implemented by a local authority (Smith et al., 2015). For more information on how to use this approach, please refer to Table 5.

Table 5: Guidance on Payment for ecosystem services

Guidance document/resource	Type of guidance	Pages
AECOM (2015). Payments for Ecosystem Services: A Best Practice Guide	A best practice guide on the payments for ecosystem services approach (90 pages)	all
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Technical guidance on how to design and structure a payment for ecosystem services scheme, including step-by-step guidance on various valuation methods that can be used to implement payment for ecosystem services (128 pages)	all

Natural capital mapping

Natural capital includes land, minerals and fossil fuels, solar energy, water, living organisms, and the services provided by the interactions of all these elements in ecological systems (UNEP, 2012; OECD, 2007). Natural capital mapping consists in representing natural capital on a map, thereby enabling the illustration of the spatial dimension of natural capital (Dickson et al., 2014). Mapping natural capital is particularly useful for land-use planning in national and sub-national contexts, i.e. for spatially explicit prioritization and problem identification. For more information on how to use this method, please refer to Table 6.

Table 6: Guidance on natural capital mapping

Guidance document/resource	Type of guidance	Pages

UNEP (2014). Towards a global map of natural capital: key ecosystem assets	Study on mapping of natural capital at a global scale (33 pages)	all

Contingent valuation

This method utilises questionnaires to ask survey respondents directly about their preferences regarding an ecosystem good or service. Respondents to the questionnaire are generally presented with a scenario (or series of scenarios) on a hypothetical change in policy where the good or service which they desire will be affected. Respondents are then asked what they would be willing to pay to obtain the good or service, or what they may be willing to accept in exchange for being deprived of it. Values are provided in monetary terms. For more information on how to use this method, please refer to Table 7.

Table 7: Guidance on the Contingent valuation method

Guidance document/resource	Type of guidance	Pages
EFFTEC (2006). Valuing our natural environment	Contains a section on the contingent valuation method (3.1.6), including information on related value concepts, resource and policy contexts in which they can be applied, practical limitations and recommendations on use in combination with other methods	23
ValuES Methods Database (website): CVM – Contingent valuation method	Short online description and method profile factsheet (9 pages), containing information on 1) information provided by the method, 2) ecosystem services assessed, 3) how, when and where the method can be applied, 4) how the method works, 5) resources required for applying the method, 6) strengths and challenges, 7) case study example, 8) further guidance and case study references	online
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Introduction to implementing the contingent valuation method in small island developing states, including: Table 4.6: A step-by-step valuation of island ecosystem services using contingent valuation and choice experiments Box 4.6: Examples of application	37-40
JNCC (2007). Valuing the environment in small islands. An environmental economics toolkit	Contains a section on the contingent valuation method (5.12), including a description of the approach, step by step guidance on using the method and an example case study	64-66
TEEB (2010). Chapter 5. The economics of valuing ecosystem services and biodiversity	Box 4: Steps for undertaking a contingent valuation study	21

For additional descriptions of the contingent valuation method and further information about the type of values it captures and the ecosystem services it can be applied to, see also:
Defra (2007). An introductory guide to valuing ecosystem services (pp. 37; 60)

Choice modelling

This method utilises surveys to present policy options grouped into scenarios. Respondents are invited to make a choice between different combinations of the options and attributes, or to rank their preference for different combinations. Each scenario has a price associated with it. The value of the scenarios are modelled following the choices made by respondents. Typically, this includes a 'business as usual' or no cost scenario as part of the set of scenarios that are presented. For more information on how to use this method, please refer to Table 8.

Table 8: Guidance on choice modelling

Guidance document/resource	Type of guidance	Pages
EFFTEC (2006). Valuing our natural environment	Contains a section on the choice modelling method (3.1.7), including information on related value concepts, resource and policy contexts in which they can be applied, practical limitations and recommendations on use in combination with other methods	23-24
ValuES Methods Database (website): Choice experiments – choice modelling	Short online description and method profile factsheet (9 pages), containing information on 1) information provided by the method, 2) ecosystem services assessed, 3) how, when and where the method can be applied, 4) how the method works, 5) resources required for applying the method, 6) strengths and challenges, 7) case study example, 8) further guidance and case study references	online
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Introduction to implementing choice experiment methods in small island developing states, including: Table 4.6: A step-by-step valuation of island ecosystem services using contingent valuation and choice experiments Box 4.7: Examples of application	37-38; 41
JNCC (2007). Valuing the environment in small islands. An environmental economics toolkit	Contains a section on choice modelling (5.13), including a description of the approach, step by step guidance on using the method and an example case study	67-70

For additional descriptions of the choice modelling method and further information about the type of values it captures and the ecosystem services it can be applied to, see also:
Defra (2007). An introductory guide to valuing ecosystem services (pp. 37; 60)

Benefits transfer

This is a group of valuation methods that consist of applying valuation results obtained from existing studies to different areas, making the assumption that the new area is comparable to the one that has already been assessed (e.g. estimating the value of a mangrove forest using the value calculated for a different mangrove forest of a similar size and type). For more information on how to use this method, please refer to Table 9.

Table 9: Guidance on the benefits transfer method

Guidance document/resource	Type of guidance	Pages
ValuES Methods Database (website): Benefits transfer method	Short online description and method profile factsheet (11 pages), containing information on 1) information provided by the method, 2) ecosystem services assessed, 3) how, when and where the method can be applied, 4) how the method works, 5) resources required for applying the method, 6) strengths and challenges, 7) case study example, 8) further guidance and case study references	online
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Introduction to implementing value transfer techniques tailored for small island developing states, including: Table 4.7: A step-by-step valuation of island ecosystem services using value transfer techniques	41-42
For additional descriptions of the benefits transfer method, see also: EFFTEC (2006). Valuing our natural environment (32; 39-40) Defra (2007). An introductory guide to valuing ecosystem services (entire document; in particular 38-39) World Bank (2016). Managing coasts with natural solutions: Guidelines for measuring and valuing the coastal protection services of mangroves and coral reefs (p. 116-117)		

Damage cost avoided

This method values the cost that was avoided by not allowing the ecosystem service to degrade. This method is frequently used to estimate the damages avoided by the presence of an ecosystem providing protection against natural disasters, such as hurricanes and floods. For more information on how to use this method and other cost-based methods, please refer to Table 10.

Replacement/Substitute cost

This method values the cost of replacing or providing substitutes for lost ecosystem services. This method relies on the presence of three conditions: (1) that the substitute provides the same ecosystem service, of the same quality and magnitude as that which is being replaced; (2) that the alternative is the cheapest method possible to replace the ecosystem service; and, (3) that society has demonstrated a willingness-to-pay for the services to be provided artificially. For

more information on how to use this method and other cost-based methods, please refer to Table 10.

For more information on how to use this methodology, please see: (1) DEFRA guide, (2) TEEB report,

Averting behaviour method

This method considers the costs associated with changing behaviour to avoid or mitigate the effects of poor environmental quality. For example, this method could assess the cost of buying bottled water instead of drinking tap water that is polluted. For more information on how to use this method and other cost-based methods, please refer to Table 10.

Table 10: Guidance on cost-based methods, including damage cost avoided, replacement/substitute cost and averting behaviour method

Guidance document/resource	Type of guidance	Pages
ValuES Methods Database (website): Cost-based methods	Short online description and method profile factsheet (11 pages), containing information on 1) information provided by the method, 2) ecosystem services assessed, 3) how, when and where the method can be applied, 4) how the method works, 5) resources required for applying the method, 6) strengths and challenges, 7) case study example,) further guidance and case study references	online
UNEP (2014). Guidance manual on valuation and accounting of ecosystem services for small island developing states	Introduction to implementing cost based techniques tailored for small island developing states, including sections on avoided damage cost and replacement cost and: Table 4.5: A step-by-step valuation of island ecosystem services using the replacement cost technique Box 4.5: Examples of application of replacement cost and avoided damage cost	29-30
JNCC (2007). Valuing the environment in small islands. An environmental economics toolkit	Contains sections on replacement cost (5.6) and damage cost avoided (5.7), including a description of the approaches, step by step guidance on using the methods and an example case studies	53-56
World Bank (2016). Managing coasts with natural solutions: Guidelines for measuring and valuing the coastal protection services of mangroves and coral reefs	Short description of averting behaviour methods	114
For additional descriptions of cost-based approaches, see also: Defra (2007). An introductory guide to valuing ecosystem services (61)		

Non-monetary methodologies

Citizen juries
This method requires the involvement of the public in the decisions of public authorities. The jury is typically comprised of between 5-20 members of the public, selected to represent a cross-section of the community. The jury are provided with information about ecosystem service values, which they discuss and formally deliberate in a transparent process. This qualitative process aims to capture societal values. Examples of the kind of results citizen juries can produce include the compilation of a range of values, the ranking of options, or a consensus report.

For a short description of this method, see Defra (2007). An introductory guide to valuing ecosystem services (p. 61).

Place-based valuation
This method focuses specifically on identifying the value that communities place on features and areas within marine and coastal environments, taking into consideration cultural and social values as well as biological considerations. This method equally takes the form of a facilitated discussion, with many different possible types of results. For example, participants could be asked to discuss ecosystem service values before and after a human intervention.

For more information about the characteristics, advantages and disadvantages of place-based assessment approaches, see Haines-Young and Potschin (2009). Methodologies for defining and assessing ecosystem services (Table 3.5, p. 40)

Health valuation
This method aims to qualify and quantify the estimated increase in physical and mental health and quality of life related to the access to a protected area. Surveys, statistics and research on restorative effects are utilised to assess concepts such as decreased levels of stress and mental fatigue, increased levels of physical activity and lower levels of aggression. This method produces valuation results in the form of health based impacts, for example linking the use of an ecosystem service to health-year equivalents (i.e. the increase in life expectancy the use of the ecosystem service induced).

For a short description of health-based valuation approaches, see Defra (2007). An introductory guide to valuing ecosystem services (p. 61).

Indicator approach
Indicators are variables that estimate complex parameters that cannot be measured directly. Data can be translated from primary data, for example household surveys which produce mainly qualitative indicators, as well as from secondary data, which can save time and costs when compared to other methods. This method thus explicitly links the presence of an ecosystem

service (e.g. fish diversity) to socio-economic indicators (e.g. household income distribution). Socio-economic indicators include quality of human health, community infrastructure and business and distribution of formal knowledge to community.

For more information on how to use the indicator approach, see the ValuES methods database (online) and the method profile factsheet on 'Developing ecosystem services indicators' (6 pages).

Q-methodology

This method combines the benefits of both qualitative and quantitative research. Interviews are used to investigate the in-depth perspectives of stakeholders, allowing amenity values to be explored and the environments for which stakeholders have most affinity to be identified. This method assesses patterns of attitudes and shared perceptions and produces 'typical' sets of views by averaging out different individuals' views.

For a short description of the Q-methodology, see Defra (2007). An introductory guide to valuing ecosystem services (p. 61).

For more information on how to use the Q-methodology, see EFFTEC (2006). Valuing our natural environment (section 3.2.5, pp. 27-28).

Priority methods and approaches for ecosystem service valuation

Based on Figure 1, expert judgement and the reviewed assessments and guidelines mentioned above, a selection of the 3 most appropriate valuation methods was identified for each of the blue forest priority ecosystem services (table 1).

Table 11: Selection of the 3 most appropriate valuation methodologies for blue forest ecosystem services

Blue forest ecosystem service	Most appropriate valuation methodology
Fisheries including aquaculture	Market value/market price Production function Damage cost avoided
Coastal protection	Replacement/substitute cost Damage cost avoided Hedonic pricing
Fuel (firewood, charcoal) and raw material (timber)	Market value/market price Damage cost avoided Replacement/substitute cost
Water purification	Production function Averting behaviour method Replacement/substitute cost
Recreation	Contingent valuation Travel cost method Choice modelling
Cultural identity	Place-based valuation Indicator approach Q-methodology

Strengths and weaknesses of ecosystem service valuation methods

The following table summarises the strengths and weaknesses of the priority ecosystem valuation methodologies selected above, as well as more generic methodologies that could be used for several, if not all, of the five blue forest ecosystem services.

Table 12: Selection of the 3 most appropriate valuation methodologies for blue forest ecosystem services

Blue forest ecosystem service	Most appropriate ecosystem valuation methodology	Example of application	Strengths of the approach	Weaknesses and/or limitations of the approach
Fisheries including aquaculture	Market value/ market price	Calculating the monetary value of a particular fishery, for example in $/kg.	This method has the benefit to produce concrete and simple fishery valuation results, which are easy to understand for policy-makers. This methodology is also very straightforward to use, as the market value of different fisheries in any given place should be readily available (Defra, 2007).	This methodology can only be applied when a given market exists, or is accounted for (Defra, 2007). For example, this methodology will not capture illegal, unreported and unregulated (IUU) fisheries, or by-catch. Additionally, market values can be distorted, for example through subsidies, inflation and market fluctuations (UNEP, 2014). This method will also not capture all the values fisheries provide, such as their spawning or the food source they represent for their predators.
	Production function	Calculating the yield of a given fishery (for example in $/kg) based on several contributing factors, such as fishing effort required, seawater quality, and marine productivity.	By having a basis on concrete market values, this method produces tangible and simple results that are easy to interpret (Pagiola et al., 2004).	A large amount of data is required for this method, which makes its application difficult where there is poor data availability (Haines-Young & Potschin, 2009). This will particularly be the case in some developing countries, where fishery data might be scarce. Likewise, data are limited for IUU fisheries and fisheries occurring in areas beyond national jurisdiction, including deep sea fisheries (Ardron et al., 2014). Furthermore, the application of this method requires substantial technical knowledge due to its complexity (Pagiola et al., 2004).
	Damage cost avoided	Calculating the cost of establishing a fisheries	Being less data and resource intensive, this method is particularly useful when data on	This method assumes that the cost of avoiding damage to a fishery is equivalent to the benefit

Blue forest ecosystem service	Most appropriate ecosystem valuation methodology	Example of application	Strengths of the approach	Weaknesses and/or limitations of the approach
		closure area to avoid the collapse of, or damage to, a given fishing stock.	the assessed fishery are limited, or the fishery itself is not marketed (for example, this could be the case for artisanal fisheries or subsistence fisheries) (e.g. Hauck & Sweijd, 1999).	provided by it, which can be inaccurate (Mavsar et al., 2013). The cost of avoiding damage might actually exceed the monetary benefit the fishery provides to society because it does not take into account non-monetary benefits.
Fisheries including aquaculture	All three methodologies	n/a	All methods produce concrete, tangible values that are easy to understand by policy-makers and stakeholders. Furthermore, where secondary data are used, the valuation is time and cost efficient.	While the collapse of a fishery is likely to have wide ranging socio-economic effects on coastal communities' livelihoods (e.g. Pinnegar et al, 2016; Kronen et al., 2010), all three methods only focus on the economic impact of the fisheries' market value, with the risk to underestimate the actual value of a fishery.
Coastal protection	Replacement/ substitute cost	Calculating the cost of replacing the coastal protection provided by blue forest with man-made coastal protection, such as a seawall.	This method is frequently used for the valuation of natural coastal defences (World Bank, 2016). Furthermore, the costs of replacing natural ecosystems by man-made infrastructures are well documented and therefore readily available (e.g. Barbier et al., 2016; Moberg & Rönnbäck, 2003). Since the method is based on existing values, it is thought to be very accurate.	This method is only feasible when there is a concrete way of replacing the assessed ecosystem service. Additionally, artificial constructions are unlikely to provide the same protection as a blue forest ecosystem (Mavsar et al., 2013), and would only provide some of the goods and services of the assessed natural ecosystem. Furthermore, this method can unjustly suggest that an artificial structure can be an appropriate substitute for blue forest derived ecosystem services. While a seawall can protect a village from flooding, it will not provide the same nursery grounds for fish species as a mangrove forest.
	Damage cost avoided	Calculating the cost of repairing housing after extreme weather events.	This method does not require technical knowledge and uses secondary data that are readily available.	This method assumes that the cost of avoiding damage to a blue forest ecosystem is equivalent to the benefit provided by it, which as previously mentioned, can be inaccurate (Mavsar et al., 2013).

Blue forest ecosystem service	Most appropriate ecosystem valuation methodology	Example of application	Strengths of the approach	Weaknesses and/or limitations of the approach
	Hedonic pricing	Calculating the difference in housing prices in an area benefitting from natural coastal protection compared to a similar area where the ecosystem providing coastal protection is missing.	This method is straightforward and its concept is widely accessible to a range of different stakeholders. Natural coastal protection has been shown to increase housing prices (e.g. Hamilton, 2007; Jin et al., 2015), which makes hedonic pricing a useful option for assessing the benefits of coastal protection.	There is a risk of housing price differences being wrongly attributed to the coastal protection service of the assessed ecosystem. For example, the increase in housing prices could also be related to the recreational value of a blue forest. Local communities might also not be aware of the effect the assessed blue forest ecosystem has on coastal protection. Likewise, housing prices are likely to be influenced by a multitude of socio-ecological factors, therefore it can be hard to solely attribute housing price differences to coastal protection. Additionally, this method is numerically complex, usually requiring statistical analysis (Defra, 2007).
Coastal protection	All three methodologies		The coastal protection service of a blue forest is, in itself, difficult to assess. These methods therefore represent useful proxies for evaluating the benefits for coastal protection in a straightforward way. Since these methods are based on pre-existing data, they are not time, nor cost intensive (Fletcher et al., 2014). Additionally, by being cost-based, all three methods produce tangible results that are easily understandable to policy-makers and stakeholders.	None of the three methodologies capture socio-economic benefits of coastal protection or other non-monetary benefits.
Fuel (firewood, charcoal) and raw material (timber)	Market value/ market price	Calculating the monetary value of fuel or timber, for example in $/kg.	This method has the benefit of producing concrete and simple valuation results, which are easy to understand for policy-makers. This methodology is also very straightforward to use, as the market value of different blue forest products in a given	This methodology can only be applied when a given market exists, or is accounted for (Defra, 2007). For example, this methodology will not capture illegal harvesting of blue forest products. Additionally, market values can be distorted, for

Blue forest ecosystem service	Most appropriate ecosystem valuation methodology	Example of application	Strengths of the approach	Weaknesses and/or limitations of the approach
			place are readily available and can be based on existing markets.	example through subsidies, inflation and market fluctuations (UNEP, 2014).
Fuel (firewood, charcoal) and raw material (timber)	Replacement/ substitute cost	Calculating the cost of replanting a mangrove forest.	The costs of replacing blue forests, such as mangroves and saltmarshes, are well documented and therefore readily available (e.g. Primavera & Esteban, 2008; Sparks et al., 2013). Since it is based on existing values, this represents an accurate valuation method. Furthermore, replanting schemes often have socioeconomic impacts by engaging with coastal communities, raising awareness about blue forests and contributing to better informed decision-making (Walton et al., 2006).	Replanted or other substituted blue forests are unlikely to be as productive as a natural blue forest, with a generally low survival rate (e.g. Primavera & Esteban, 2008). Additionally, they are likely to only provide a fraction of the goods and services the natural blue forest ecosystem provided. Furthermore, this method can unjustly suggest that a replanted or otherwise substituted blue forest is equivalent to a natural blue forest in terms of its benefits and functions.
	Damage cost avoided	Calculating the cost of designating the blue forest as a protected area in order to restore or protect the fuel and raw material the ecosystem provides.	This method does not require technical knowledge, and uses secondary data that are readily available for many different types of protected areas. Additionally, the concept of protected areas has long been established and is likely to be familiar to most decision-makers.	This method assumes that the cost of avoiding damage to a blue forest ecosystem is equivalent to the benefits the ecosystem provides, which can be inaccurate (Mavsar et al., 2013).
	All three methodologies	n/a	All methods produce concrete, tangible values that are easy to understand by policy-makers and stakeholders. Furthermore, where secondary data are used, the valuation is time and cost efficient.	The applicability of each methodology greatly varies depending on which blue forest the assessed raw material stems from. Different blue forests are characterised by varying levels of data availability, replacement possibilities and existing case studies.

Blue forest ecosystem service	Most appropriate ecosystem valuation methodology	Example of application	Strengths of the approach	Weaknesses and/or limitations of the approach
Water purification	Production function	Calculating the price of drinking water produced (for example in $/L) based on several contributing factors, such as the ecosystem's ability to remove contaminants and water turbidity.	Through being based on concrete market values, this method produces tangible and simple results that are easy to interpret (Pagiola et al., 2004).	A large amount of data is required for this method, which makes its application difficult where there is poor data availability (Haines-Young & Potschin, 2009). This will particularly be the case in developing countries. Furthermore, the application of this method requires technical knowledge due to its complexity (Pagiola et al., 2004).
	Averting behaviour method	Calculating the cost of buying bottled water due to poor quality water.	This method is based on concrete and readily assessable data on consumers' expenditures.	The averting behaviour will often not be equivalent to the ecosystem service lost (e.g. natural water might contain more nutrients than bottled water).
	Replacement/ substitute cost	Calculating the cost of water treatment facilities.	The costs of building water treatment and water filtration facilities are concrete figures that are readily available. Since the method is based on existing values, it is an accurate method.	This method is only feasible when there is a concrete way of replacing the assessed ecosystem service. Additionally, chemically treated water and filtrated water is unlikely to provide the same health benefits as untreated, clean water (Beaumont et al., 2008).
	All three methodologies	n/a	All methods can use existing data and are therefore time and cost efficient. All methods are price or cost based, meaning that they produce tangible results.	These methods do not consider social preferences for ecosystem services. Additionally, drinking water often being a common and free resource, it can be difficult to attribute a price or cost to it in certain contexts.

Blue forest ecosystem service	Most appropriate ecosystem valuation methodology	Example of application	Strengths of the approach	Weaknesses and/or limitations of the approach
	Contingent valuation	Asking coastal community members how much they would be willing to pay to preserve a blue forest linked to recreational activities.	This method takes into account social preferences for the recreational use of blue forests without being restricted to use-values.	Willingness-to-pay is not always an accurate reflection of the value of an ecosystem service, as it represents a hypothetical market. This method is also technically difficult to implement.
	Travel cost method	Examining the cost of visits to a blue forest, for example through the petrol costs incurred.	This is a straightforward and simple method for assessing non-market values such as recreation.	Travel cost might be difficult to estimate in certain scenarios (e.g. if the blue forest was a stop-over, if the respondents have multiple destinations).
Recreation	Choice modelling	Using individuals' responses to preferences between scenarios to estimate their willingness-to-pay.	This method allows the assessment of coastal communities' socio-economic preferences and the ecosystem service trade-offs they are willing to make. There is also a high level of flexibility in the survey design, allowing different aspects of recreation uses to be assessed.	Results generated through this method are harder and more time consuming to interpret. The values obtained through this method are also based on hypothetical markets. This method is also technically difficult to implement.
	All three methodologies	n/a	These methods can capture use- and non-use values.	These methods are subject to biases in people's views and responses. This means that if respondents are not willing to pay for this service, it will be underestimated. Additionally, all methods have high data requirements to yield representative results.

Blue forest ecosystem service	Most appropriate ecosystem valuation methodology	Example of application	Strengths of the approach	Weaknesses and/or limitations of the approach
Cultural identity	Place-based valuation	Holding a facilitated discussion aiming to identify the cultural identity value that communities place on features and areas within blue forests.	This method is very flexible and can be adapted to many different situations or ecosystem services. This method can moreover be tailored to the objectives and expected outcomes of the ecosystem valuation. Additionally, its results can take many different forms depending on the intended use of the evaluation's results.	Surveys need to be well designed to produce meaningful results. Additionally, the design of the survey and interpretation of its result can be complex and time consuming. Cultural identity being a subjective and sometimes intangible concept, it might be difficult for respondents to describe the feeling of cultural identity they associate with a blue forest, and they might not be aware of associating cultural identity with the a given ecosystem.
	Q-methodology	Using a survey to ask different stakeholders about their perceptions concerning the cultural identity value a blue forest ecosystem provides.	This method allows the empirical investigation of different stakeholders' perceptions regarding the cultural identity a blue forest might provide. Being flexible in its design and the questions that stakeholders are asked, it is therefore particularly useful for identifying benefits provided by less tangible ecosystem services, such as cultural identity. It is also useful to identify conflicts or discourses (e.g. Hagan et al., 2016). Additionally, this method only requires a relatively small sample size.	Surveys need to be well designed to produce meaningful results. Additionally, their design and interpretation can be complex and time consuming due to the complex nature of cultural identity (Fletcher et al., 2016). Additionally, respondents might not be aware of the cultural identity value they associate with a given blue forest.
	Indicator approach	Using household surveys to link sociological indicators (e.g. income bracket) to the presence of a specific blue forest ecosystem service that people associate with cultural identity.	This method combines social, economic, legal, and ecological aspects of ecosystem services, and can measure services that are hard or impossible, such as cultural identity, to measure directly. Since it is based on existing data, this method is not time and effort intensive.	It can be difficult to link indicator effects to non-use blue forest ecosystem services (Fletcher et al., 2016).

Blue forest ecosystem service	Most appropriate ecosystem valuation methodology	Example of application	Strengths of the approach	Weaknesses and/or limitations of the approach
Various blue forest ecosystem services	Health valuation	Examining a blue forest's contribution to mental wellbeing.	This method enables the link between a blue forest ecosystem service and mental health to be made explicit, for which there is no existing market.	This method is subject to human biases, and assumes that respondents are aware of the effect a blue forest ecosystem service has on their mental health and wellbeing.
	Benefits transfer	Extrapolating the known ecosystem service value of a seagrass meadow site to another seagrass meadow that is similar in size and other characteristics.	This method is applicable to many different ecosystem services. Since it is based on existing data, this method is not time and effort intensive.	It is unlikely that two sites would be entirely comparable due to the myriad of ecological and biochemical properties of a site.

Communication of ecosystem service assessment results

The effective communication of ecosystem service assessment results is critical for their uptake in decision-making and management of blue forest ecosystems. Effective communication firstly involves the development of synthesis products derived from the ecosystem service assessment. These products can take many different forms, including policy briefs, technical reports, brochures, newsletters, posters, maps, infographics and websites.
It is important to keep in mind that different ecosystem service assessment methods will produce various types of results. For example, while monetary assessment methods have the benefit to produce very tangible results that are easier to communicate to a non-technical audience, they can sometimes fail to capture underlying cultural and sociological dimensions of ecosystem services which can be inferred from non-monetary methods.

When choosing the right communication product, it is important to take into account the target audience of the results, including the metrics that are the most suitable for this audience (see table 3). It is also vital to take into consideration the current awareness and understanding of the assessed blue forest ecosystem service. Ideally, decision makers should be engaged in as many stages of the ecosystem service assessment result production and interpretation.

Once results have been effectively synthetized, these should ideally be communicated to decision makers in an iterative way in order to reflect the potentially changing circumstances of the assessed site. They furthermore need to be shared with the wider marine and coastal valuation community, for example using online databases (see table 2, deliverable 4). It is also critical for any communication to consider windows of opportunity for the ecosystem service valuation results. These include the current political landscape of a site, such as impending legislation and investment decisions). Results can be disseminated using various options, including websites, social and other media, launch events, workshops and other meetings.

Table 13: Examples of metrics produced by different ecosystem service valuation methods that can be communicated to stakeholders, and their main target audience

Ecosystem service assessment methodology	Example of metric	Main target audience
Replacement/ substitute cost	Cost of building a seawall	Local governments, government policy analysts
Damage cost avoided	Cost of repairing damage to housing from coastal hazards	Estate agents, property owners, government officials and politicians, government policy analysts, local residents
Production function	Gross or net revenue	Local governments, government policy analysts, intergovernmental agencies, tax collectors, local residents
Choice modelling	Willingness to pay to access the assessed site	Site managers, tour operators, people employed by the tourism sector
Travel cost method	Bus ticket price to reach the assessed site	Site managers, tour operators, people employed by the tourism sector
Health valuation	Number of hospital visits	Local governments, government policy analysts, intergovernmental agencies, local residents
Market value/Market price	Consumer or producer surplus	Local governments, government policy analysts, intergovernmental agencies
Contingent valuation	Entry fee to the assessed site	Site managers, tour operators, people employed by the tourism sector
Hedonic pricing	Price difference in housing	Estate agencies, property owners, local residents
Payment for ecosystem services	Gross or net revenue	Fishermen, farmers and landowners, local residents
Averting behaviour method	Price of bottled water	Local governments, government policy analysts, intergovernmental agencies, local residents
Benefits transfer	Fisheries landings	Fishermen, farmers and landowners
Citizen juries	Ranking of options for ecosystem management	Local governments, NGOs, conservation organisations, site managers, government policy analysts, intergovernmental agencies, local residents

Place-based valuation	List of priority ecosystem values	Local governments, NGOs, conservation organisations, site managers, government policy analysts, intergovernmental agencies, local residents
Indicator approach	Number of jobs created	Local governments, government policy analysts, intergovernmental agencies, tax collector, local residents

Integration into planning and management

Ecosystem service assessment and valuation can be integrated into priority planning and management instruments such as mangrove and seagrass conservation strategies and action plans, spatial planning instruments (such as Marine Spatial Planning, Integrated Coastal Zone Management, Locally Managed Marine Areas, Managed Marine Areas and Marine Protected Areas) and PES schemes. There are four main ways in which ecosystem service assessment results and values can support these planning and management processes.

1) Ecosystem service assessment and valuation can help identify and understand conflicts and synergies between social, economic and ecological interests, or key questions that need to be addressed to achieve specific objectives, such as for example sustainable development goals.

   - Assessment and valuation of ecosystem services in the management area helps identify and understand the links and interactions between different ecological features and functions, human activities, economic and social interests. Understanding these links provides policy makers and managers with a comprehensive view on their site and helps identify potential areas of conflict or opportunity.

   - Ecosystem service valuation outputs can highlight where important ecosystem services, economic or social values are being lost due to destructive resource extraction or use practices. Understanding the implication of losing ecosystem services can encourage governments or responsible authorities to take action against these destructive practices, and it provides them with evidence to justify that action. For example, in the Philippines, valuation of ecosystem services provided by mangrove forests led to bans of mangrove logging and shrimp aquaculture in mangrove areas (Kushner et al. 2012).

2) Ecosystem service assessment and valuation can provide evidence to support policy formulation, management and planning decisions.

   - Ecosystem service assessment and valuation outputs contribute to the evidence base for policy, management and planning decisions by integrating ecological information with social and economic values.

   - Ecosystem service assessment and valuation helps compare different policy options or management alternatives by linking each option to the ecological changes it is likely to cause and to the changes in social or economic benefits that would result from this. This helps make trade-off decisions more transparent. It helps decision makers choose the policy or management option that is most appropriate for meeting a specific objective.
   - By providing an improved evidence baseline against which to measure changes resulting from management measures, ecosystem service assessment and valuation also supports monitoring and review of management effectiveness.

- In combination with scenario exercises, ecosystem service assessment and valuation allows decision makers to explore alternative future management options and their socio-ecological implications and trade-offs. This can inform future policies and management strategy decisions.

- Ecosystem service values can be used in environmental impact assessments for policies, plans or projects, for example by integrating social, economic and ecological considerations in cost-benefit analysis. For example, ecosystem service valuation was part of the environmental impact assessment for gas exploitation in the Dutch Wadden Sea (Slootweg and van Beukering 2008).

- Ecosystem service valuation can inform coastal risk management strategies. For example, ecosystem service values could be calculated for different management strategies, such as managed realignment or protection of existing coastline, and these values could then be integrated into the cost-benefit analysis of these different strategies. Valuation methods that could be useful for this include replacement cost, damage cost avoided or benefit transfer methods.

3) Ecosystem service valuation results can provide technical support for the delivery of policies by informing the design of implementation tools, such as taxes or user fees.

    - Monetary valuation of ecosystem services for example from coral reefs can help determine and implement user fees for marine parks by providing an estimate of people's willingness to pay to visit the park. For example, ecosystem service valuation was used to determine and introduce a user fee system in the Bonaire National Marine Park (Slootweg and van Beukering 2008). Useful valuation methods for this include contingent valuation, choice experiments and travel cost method.

    - Similarly, monetary ecosystem service valuation can also help determine fine systems for marine ecosystem damage. For example, monetary valuation studies provided the basis for the introduction of an escalating penalty system for reef damage in Hawaii (Kushner et al. 2012).

    - Ecosystem service assessment and valuation also provides basic information for setting up market based mechanisms such as emissions trading schemes or Payment for Ecosystem Service (PES) schemes.

4) Lastly, ecosystem service assessment and valuation can facilitate good stakeholder dialogue, constructive engagement and collaborative management processes.

    - Engagement of stakeholders in the ecosystem service assessment and valuation process can help facilitate good dialogue and improved relationships between stakeholders and decision makers, as well as among different stakeholder groups, and support collaborative management processes. Ways this can be done is by providing

opportunities to contribute local and expert knowledge and to validate the information that is used in the valuation, by involving the stakeholders in different assessment and valuation exercises, or by conducting scenario building with the stakeholders.

Experience from different case studies and projects has shown that ecosystem service assessment and valuation can most effectively support management and planning processes if it is a coproduction between policy makers, managers and planners, stakeholders, technical experts and in some cases wider user communities and the public. This ensures that the assessment and valuation is based on the best available information, including local and expert knowledge, and improves support, buy-in and trust among all involved parties.

Finally, which assessment and valuation method to use, and which ecosystem services or types of value to focus on, depends on the specific management and planning context to which it is being applied. Determining factors for this include:

- The objective of the assessment or valuation (to identify or raise awareness of issues, to inform a specific policy or management decision, to design an implementation instrument, or to support stakeholder engagement),
- The available data and expertise.

Relevant guidance documents and resources

Useful resources for natural capital and ecosystem services valuation[1]

'The Ocean and Us' – This publication highlights how healthy marine and coastal ecosystems contribute to achieving sustainable development goals and describes the role of credible and accessible data, well communicated knowledge generated through dialogue with users, in supporting informed decision making.

'Advice note for using ecosystem service assessment to support marine governance' – A short guide on how ecosystem service assessment can be used in marine management and planning, based on experience from six case studies.
Reference: Dodds W, Philippe M., Friedrich L., Fletcher S., Glegg G. and Bailly D. 2015. Advice note for using ecosystem service assessment to support marine governance, VALMER project.

'Improving stakeholder engagement in marine management through ecosystem service assessment' – A short guide on how to use ecosystem service assessment as a tool for improved marine stakeholder engagement, based on experience from six case studies.
Reference: Friedrich L.A., Dodds W., Philippe M., Glegg G., Fletcher S. and Bailly D. 2015. Improving stakeholder engagement in marine management through ecosystem service assessment. A guide for practitioners based on experience from the VALMER project.

'International review of the application of Ecosystem Service Valuation in marine governance' – A working paper presenting a literature review of case studies in which monetary ecosystem service valuation was applied to marine governance.
Reference: Friedrich, L.A., Dodds, W., Glegg, G. and Fletcher, S. 2013. International review of the application Ecosystem Service Valuation of in marine governance. Working paper. VALMER project.

'Valuation of Ecosystem Services and Strategic Environmental Assessment' – This reports presents findings from case studies in which ecosystem service assessment and valuation was integrated into strategic environmental assessments.
Reference: Slootweg, R. and van Beukering, P. 2008. Valuation of Ecosystem Services and Strategic Environmental Assessment. Lessons from influential cases. Netherlands Commission for Environmental Assessment.

'Influence of coastal economic valuations in the Caribbean: enabling conditions and lessons learned' - A review of the application and influence of economic ecosystem service valuation in marine governance in the Caribbean.
Reference: Kushner, B., Waite, R., Jungwiwattanaporn, M. and Burke, L. 2012. Influence of

[1] Please note, this is not an exhaustive list.

coastal economic valuations in the Caribbean: enabling conditions and lessons learned. World Resources Institute working paper.

Further helpful resources include:

- The Economics of Ecosystems and Biodiversity (TEEB) (http://www.teebweb.org/)
- Wealth Accounting and the Valuation of Ecosystem Services (WAVES) (http://www.wavespartnership.org/)
- InVEST: Integrated Valuation of Environmental Services and Tradeoffs (InVEST) (http://www.naturalcapitalproject.org/invest/)
- The Natural Capital Project (http://www.naturalcapitalproject.org/)
- ValueES: Methods for integrating ecosystem services into policy, planning and practice (http://aboutvalues.net/)
- Valuing ecosystem services as productive inputs (Barbier et al., 2007) (http://earthtek.org/EVPP524/ProdFunc_Barbier2007EP.pdf)
- Coastal Capital - Ecosystem Valuation for Decision Making in the Caribbean (http://www.wri.org/publication/coastal-capital-guidebook#)
  Understanding and valuing the marine ecosystem services of the Northern Mozambique Channel (Ghermani & Nunes, 2016) (http://www.bioecon-dnetwork.org/pages/18th_2016/Nunes.pdf)
- Valuing Nature Network (VNN) (www.valuing-nature.net)
- The Environmental Valuation Reference Inventory (https://www.evri.ca/Global/Splash.aspx)
- Valuing Ecosystem Services in the Western Channel (VALMER) project (http://www.valmer.eu/)
- The Marine Ecosystem Services (MES) Partnership (http://www.marineecosystemservices.org/)

Best practice guidelines for ecosystem valuation

For this analysis, various best practice guidelines for conducting ecosystem service assessments and valuations were reviewed; a summary of which is presented below.

Eftec's (2006) report 'Valuing our Natural Environment' for the Department for Environment, Food and Rural Affairs (Defra) evaluates the choice of methods that can be used for ecosystem service valuations.

Similarly, Defra's (2007) guide to valuing ecosystem services provides advice on the valuation of ecosystem services, partially building on Eftec's (2006) report taking a systematic approach to the assessment of impacts on the environment.

The Centre for Environmental Management's 'Report 14' by Haines-Young and Potschin (2009) also describes methodologies for defining and assessing ecosystem services by reviewing key national and international initiatives, such as The Economics of Ecosystems and Biodiversity (TEEB) and the UK National Ecosystem Assessment.

The German Federal Enterprise for International Cooperation's (GIZ) ValuES Methods Database is an online tool through which practitioners can identify the most appropriate valuation methodology for the ecosystem service they want to assess. It contains profiles of a diverse range of methods, tools and sources of ecosystem valuations and assessments.

Defra's best practice guide on Payments for Ecosystem Services by Smith et al. (2015) provides guidance on assessing ecosystem services through Payments for Ecosystem Services schemes. It contains step-by-step advice for people designing and implementing such schemes.

TEEB's (2010) Chapter 5 on valuing ecosystem services and biodiversity is also of relevance for this review. The chapter mainly describes the Total Economic Value (TEV) framework. As such, it describes the different valuation tools that can be used to estimate the components of a TEV for different types of ecosystem services.

For marine and coastal ecosystem service valuation, UN Environment's guidance manual (2014) for Small Island Developing States (SIDS) is of relevance. The manual presents case studies and examples of marine and coastal ecosystem valuations that were undertaken where are of relevance for SIDS.

Additionally, Torres and Hanley's (2016) review of coastal and marine ecosystem services provides and inventory of different coastal and marine ecosystem services, their policy implications, and challenges in their assessment and protection.

Finally, the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) technical report (World Bank, 2016) provides guidelines for measuring and valuing the coastal protection services of mangroves and coral reefs.

Guidance documents and resources mentioned in expert interviews

Video: Benefits Transfer - Steven King

'Benefits transfer and the aquatic environment: An investigation into the context of fish passage improvement'

This paper presents findings from a choice experiment which investigated the improvements in the aquatic environment that result from mitigating barriers to fish passage. The paper can be found here.

Reference: King, S., Fraser, I. and O'Hanley, J. R. (2016) 'Benefits transfer and the aquatic environment: An investigation into the context of fish passage improvement', Journal of Environmental Management. Elsevier, 183(2016), pp. 1079-1087. doi.org/10.1016/j.jenvman.2016.09.041.

'Divestment of the English Forestry Estate: An economically sound choice?'

This paper evaluates the economic rationality of the proposed divestment of the English Forestry Commission Estate in 2010. The paper can be found here.

Reference: King, S. and Fraser, I. (2013) 'Divestment of the English Forestry Estate: An economically sound choice?', Ecological Economics. Elsevier, 88(2013), pp. 25-31. doi.org/10.1016/j.ecolecon.2012.12.021.

Video: Benefits Transfer James Vause

'Guidance for policy and decision makers on using an ecosystems approach and valuing ecosystem services.'

Guidance for policy and decision makers on using the ecosystem services approach and ecosystem service valuation provided by the Department for Environment, Food and Rural Affairs, UK Government. The site can be accessed here.

Reference: Defra (2014) 'Guidance for policy and decision makers on using an ecosystems approach and valuing ecosystem services.', Department for Environment, Food and Rural Affairs, London. https://www.gov.uk/guidance/ecosystems-services#using-an-ecosystems-approach [accessed on 19/05/17].

Video: Ecosystem Service Indicators

'Measuring ecosystem services: Guidance on developing ecosystem service indicators.'

Guidelines document to support the development of ecosystem service indicators at the national and regional level for use in reporting, assessments, policy making, biodiversity conservation, ecosystem management, environmental management, development planning and education. The guideline document is available: https://www.unep-wcmc.org/system/dataset_file_fields/files/000/000/303/original/1850_ESI_Guidance_A4_WEB.pdf?1424707843 or here.

Reference: Brown, C., Reyers, B., Ingwall-King, L., Mapendembe, A., Nel, J., O'Farrell, P., Dixon, M. and Bowles-Newark, N. J. (2014) 'Measuring ecosystem services: Guidance on developing ecosystem service indicators', UNEP-WCMC, Cambridge, UK.

Video: Payment for Ecosystem Services Matthew Ling

'Payments for Ecosystem Services: A Best Practice Guide'

A best practice guide to assist with the design and implementation of Payments for Ecosystem Services schemes. The best practice guide is available here.

Reference: Smith, S., Rowcroft, P., Everard, M., Couldrick, L., Reed, M., Rogers, H., Quick, T., Eves, C. and White, C. (2013) 'Payments for Ecosystem Services: A Best Practice Guide', Defra, London.

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