Chapter 6
Valuation of Coastal and Marine Ecosystem Services: A Literature Review

M. Schaafsma and R.K. Turner

6.1 Introduction

Valuation can be used to support the step of economic (and social) appraisal and valuation of options in the adaptive coastal management approach. This chapter aims to assess the availability of primary valuation studies providing economic value estimates for 'goods and benefits' generated from coastal and marine ecosystems. This overview reveals the main gaps in the literature with respect to primary (monetary) valuation studies addressing coastal and marine habitats and specific ecosystem services, globally and in particular for Great Britain (GB). We assess the extent to which monetary value estimates of the ecosystem goods and benefits and habitat types that are most important in GB are available from the literature.

The assessment and valuation of ecosystem stock and flow situations is not straightforward and some goods and benefits cannot be meaningfully valued in monetary terms (those related to cultural services in particular) (see Chap. 4). This chapter only covers monetary value estimates based on economic valuation methods to derive marginal *economic* values of changes in the flow of goods and benefits over time. Such marginal values can be used in support of decision making on trade off choices. A number of reports (Posford Duvivier Environment 1996; Pugh and Skinner 2002; Pugh 2008; Saunders et al. 2010; UKMMAS 2010) review the *financial* values (e.g. in terms of gross value added (GVA) to the UK economy) of marine-dependent industries, including fisheries and tourism.

M. Schaafsma (✉)
Geography and Environment and Centre for Biological Sciences, University of Southampton, University Road, Southampton SO17 1BJ, UK
e-mail: M.Schaafsma@soton.ac.uk

R.K. Turner
School of Environmental Sciences, University of East Anglia, Norwich, UK

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6.2 Methodology

6.2.1 Scope

The literature review is structured around a particular set of habitats and ecosystem goods and benefits. Many ecosystem services assessments aim to map values onto habitats or 'land cover- land use' maps. There are, however, multiple habitat classifications for coastal and marine areas, which are, for example, habitat, depth, salinity or sediment based. For the purpose of this valuation literature review, we aim to map the valuation studies onto the six coastal margin and six marine habitats identified in the UK NEA (2011), two tropical habitats (coral reefs and mangroves) and two complex habitats (estuaries – including fjords and bays – and intertidal wetlands). The latter are included because habitats covered by valuation studies are sometimes less precise or more pragmatically defined. For example, estuaries may encompass different intertidal (e.g. mud flats) and shallow subtidal areas (e.g. seagrass beds, kelp forest), as well as coastal margins (e.g. salt marshes) (Moss 2008). Because of this habitat complexity, valuation studies often do not or cannot assign ecosystem goods and benefits to specific habitat types within an estuary and broadly label the study area as an estuary. Similarly, valuation studies report to provide values for '(intertidal) wetlands', which may encompass other habitats, such as marshes and mudflats. Other valuation studies do not provide sufficient detail about the study area to assign values to either intertidal or subtidal areas.

Valuation studies included in the 'coastal shelf' category may include different coastal and marine habitat types, depending on the study area. Where possible, we allocated these studies to specific habitat types, but when this was impossible the study was included in the (therefore broad) coastal shelf category. In addition, we assigned economic values to the coastal shelf if the fisheries pertained to political Exclusive economic zones (EEZ).

This literature overview focuses on the following goods and benefit categories (see Fig. 2.6 in Chap. 2): products (food, bait and fish feed, fertiliser, etc.); 'healthy' climate; prevention of coastal erosion; sea defence; tourism and nature watching; spiritual and cultural wellbeing; aesthetic values; and education and research. The literature review excludes water purification services as sea water use for water supply is very limited (UKMMAS 2010), and benefits of improved water quality are captured in other categories, such as recreation and amenity, products or seascape values. Human health benefits are excluded as well, although they may partially be captured in recreational values (e.g. see Georgiou et al. 2000). Following the UK NEA ESF (see Chap. 2), we also excluded services that relate to abiotic components of the areas, and services with negative impacts related to off-shore wind farms, artificial reefs and pests or invasive species (see Chap. 12).

In valuation studies, the reported economic value may correspond to the benefits derived from a bundle of goods and benefits. This is especially the case for studies that aim at capturing values of tourism, nature watching and aesthetic benefits of meaningful seascapes. The value that people attach to certain wild species and natural habitats and seascapes values may reflect spiritual and cultural wellbeing, health benefits, and aesthetic values, and thus may contain an aspect of non-use (bequest, existence) values. In such cases, it is difficult to assign separate values to each of the ecosystem goods and benefits. For the purpose of this chapter, we have therefore created a category labelled "Spiritual and cultural well-being and aesthetic benefits of wild species and seascapes".

6.2.2 Study Selection and Quality Criteria

The overview covers primary valuation studies published since 2000 in academic journals and book chapters that have undergone peer-review. Papers published in grey literature (consultancy and non-governmental organisation reports, working papers) or before 2000 are excluded. Peer-revision is taken as a quality assessment of the analysis. Valuation estimates are subject to serious spatial and temporal bias constraints and in the latter context a period of more than a decade or so is a prudent limit. The selection process is based on web-searches in Science Direct and Google Scholar using the key-words 'ecosystem services', '(economic) valuation', 'coastal', 'marine', in various combinations. Primary studies referenced in the selected studies, available meta-analyses or other review papers (e.g. Beaumont et al. 2008, 2010) are included. Finally, a more targeted search on specific journals and authors is also performed to complete the list. The selection processes is limited to data available up to 1 May 2014.

From each selected study, we extracted information on the authors, year of publication, continent and country of the case study, valuation method, habitat type and ecosystem goods and services under consideration. To evaluate the completeness of the valuation evidence base for GB, we extract value estimates from GB-based studies and converted these to 2012 GBP prices and review the studies based on a number of criteria that qualify studies for benefit transfer purposes (Brouwer 2000). We focused on the adequacy of the data, soundness of economic methods, quality of the empirical techniques, and validity of the model or WTP function.

6.3 Results

6.3.1 Descriptive Statistics

The selection process resulted in 233 primary valuation studies, including 30 GB-based studies, published between 2000 and May 2014 in peer-reviewed academic journals and books. In addition, we identified nine relevant meta-analyses (Brander et al. 2006, 2007, 2012; Martín-López et al. 2008; Enjolras and Boisson 2010; Latinopoulos 2010; Londoño and Johnston 2012; Salem and Mercer 2012; Ghermandi and Nunes 2013).

There is no obvious positive trend in the number of publications over time. Stated preference (SP) methods, including contingent valuation (CV) and choice experiments (CEs), are used most frequently, mainly to assess recreational and biodiversity values, followed by travel cost (TC) assessments for recreational values and estimation of gross or net revenues to assess benefits of raw materials (mainly fishing). The majority of studies address case study areas in Europe, North-America (mostly USA) and Asia. A third of the European case studies are for the UK, but this may reflect an upward biased due to our focus on GB-based valuation evidence for the UK NEA FO. Table 6.1 provides an overview of the number of studies that provide economic values for each of the habitat – goods/benefits combinations.

Globally, 'tourism and nature watching' is the most frequently valued ecosystem benefit (67 % of the studies), followed by biodiversity and cultural values of habitats (33 %). This corresponds to the high numbers of SP and TC studies. Most of the tourism studies are for tropical coral reefs, beaches and coastal areas more broadly. There are very few valuation studies for ecosystem benefits related to prevention of coastal erosion (2 %), and education and research (1 %: Samonte-Tan et al. 2007, Cesar and van Beukering 2004). Surprisingly, only a small number of studies (4 %) are available for the carbon sequestration potential of coastal and marine habitats.

The distribution of studies across the different habitats shows that for sea cliffs and small islands (Chae et al. 2012), open oceans (i.e. beyond EEZ zones, Murillas-Maza et al. 2011) and cold water corals (Wattage et al. 2011), only one study is available for each of these habitats, whilst no primary studies exist for machair. Dunes (e.g. Beaumont et al. 2010; Landry and Hindsley 2011), coastal lagoons (e.g. Alberini et al. 2007; O'Garra 2012), mudflats (e.g. Andrews et al. 2006; Shepherd et al. 2007), rocky bottoms (Stål et al. 2008; Kenter et al. 2013, 2014), and kelp forests (e.g. Smith and Wilen 2003; Turpie et al. 2003) have also received very little attention in the valuation literature. Reasonably well studied in the international literature are mangroves (e.g. Barbier et al. 2002; Das and Vincent 2009), intertidal wetlands (e.g. Samonte-Tan et al. 2007; Barbier et al. 2013), estuaries (e.g. Milon and Scrogin 2006; Zheng et al. 2009) and seagrasses (Unsworth et al. 2010; Tuya et al. 2014), for each of which at least 10 studies are available. The ecosystem goods and benefits provided by beaches (assessed in 26 % of the studies, e.g. Hynes et al. 2013; Windle and Rolfe 2013), tropical coral reefs (20 %, e.g. Farr et al. 2014; Pascoe et al. 2014) and the coastal shelf (26 %, e.g. Brouwer 2012; Doherty et al. 2014) have been most frequently valued in the academic literature.

Similar to other studies (e.g. Hynes et al. 2013), it is impossible to undertake a meta-regression analysis of all studies and ecosystem services together, because of the limited availability and distribution of value estimates across ecosystem goods and benefits and habitats of Northern European coastal zones. Such meta-analyses can be useful for benefit transfer purposes, with the necessary caution, because value estimates depend on the nature of the study, i.e. the policy context, the valuation method, the sample and the survey design.

Table 6.1 Overview of number of global studies for each combination of habitat and ecosystem service

	Products	Sea defence	Erosion prevention	Healthy climate	Tourism and nature watching	Education and research	Aesthetic: property	Spiritual/aesthetic: wild species, seascapes
Dunes	0	4	0	1	3	0	1	0
Beaches, shingles	0	3	1	0	47	0	11	9
Sea cliffs, small islands	0	0	0	0	1	0	0	0
Machair	0	0	0	0	0	0	0	0
Lagoons	2	0	0	0	2	0	0	1
Salt marshes	3	5	0	5	5	0	1	4
Mudflats	1	2	0	2	1	0	0	1
Mangroves	13	7	3	0	5	0	0	4
Inter. wetland	2	1	0	0	5	0	1	9
Seagrass beds	8	0	0	1	2	0	0	3
Kelp forest	3	0	0	0	0	0	0	0
Estuaries, bays, fjords	5	0	0	1	13	0	2	6
Tropical coral reefs	5	0	1	0	44	2	1	17
Cold water coral reefs	0	0	0	0	0	0	0	1
Rocky bottom	1	0	0	0	1	0	0	0
Coastal shelf	16	0	0	4	32	0	0	29
Open ocean	0	0	0	1	0	0	0	1

Note: The numbers refer to the number of studies that provide at least one value for the ecosystem service in a particular habitat type

6.3.2 GB-Based Studies

The 30 primary GB valuation studies cover various habitats and goods and benefits. Recreational values are most frequently provided in the literature. Table 6.2 provides an overview of the available value estimates.[1] Unless stated otherwise, value estimates in this section are expressed in £, 2012 prices. Original values reported in the original studies have been corrected for inflation, using the National Accounts figures from ONS (last updated 27 March 2013). Two studies were excluded because of limited reliability and validity of the valuation methods (Mangi et al. 2011; Voke et al. 2013), whilst the study by Bateman et al. (2009) did not clearly present value estimate that could be used for benefit transfer purposes. The MPA study by Kenter et al. (2013, 2014) provides a number of generic habitat estimates, but for goods-habitat specific combinations further calculations using the model results are necessary, and therefore not presented here.

Products The first category includes goods and benefits of provisioning services. Coastal and marine ecosystems provide not only fish and shellfish for human consumption, fish feed and bait, fertiliser and biofuels, ornaments and aquaria, medicines and biotechnology, but coastal margins are also used for grazing, the collection of wild mushrooms and berries, other crops, reed, timber and seaweed (Jones et al. 2011).[2] Five studies provide primary data for GB. Luisetti et al. (2011) estimate the contribution of created salt marshes in the Blackwater estuary (through coastal realignment schemes) that act as a nursery for species relevant to commercial fisheries using estimates of juvenile bass abundance, average survival rates of fish up to commercial sizes and local market prices. However, fish production functions are highly site-specific and transferring the function from the Blackwater site to another salt marsh would not be reliable (Luisetti et al. 2014). Three studies look at coastal shelf areas (Crilly and Esteban 2013; Austen et al. 2010; Beaumont et al. 2010). These annual gross values cannot be split into values per unit area without data on vessels activities across the coastal waters. Moreover, current harvesting levels may not be sustainable so the current value estimates are of limited use for future projections and scenarios (Beaumont et al. 2010). Fisheries also have other negative externalities, which are not reflected in market prices (Crilly and Esteban 2013).

One study, the CE by Jobstvogt et al. (2014), assesses the WTP for protecting deep sea areas for their option values related to new medicinal products. Respondents were willing to contribute to the creating of deep sea MPAs in Scotland and protect animals with potential for new products if that potential was high.

'Healthy' Climate Typically, valuation studies use existing estimates of carbon sequestration rates of coastal and marine ecosystems and apply these to their case study area, combined with existing carbon value estimates. By using different sedimentation rates (Andrews et al. 2000; Adams et al. 2012) and carbon prices

[1] Tropical coral reefs and mangroves are of little importance to GB and therefore not included in Table 6.2.

[2] Recreational extraction of food and other products are included in the tourism category.

Table 6.2 Overview of UK valuation studies published since 2000 in the academic, peer-reviewed literature

Ecosystem service	Habitat	Case study and reference	Valuation method	Value in 2012 prices (£/year unless stated otherwise)
Products: fisheries (nursery)	Salt marshes	Blackwater: Luisetti et al. (2011)	Market prices	8.27–12.86/ha (after 5 years)
Products: fisheries	GB coast/open sea	UK cod fisheries in North Sea: Crilly and Esteban (2013)	Gross value	4.4 million
		Fisheries: Beaumont et al. (2010)	Gross value	Fisheries: 619 million
		Fish and shellfish farming: Austen et al. (2010)	Gross value	Fish farms: 364 million
				Shellfish farms: 26 million
		Option value of medicinal products: Jobstvogt et al. (2014)	CE	37.85
Healthy climate	Dunes	GB: Beaumont et al. (2010)	Abatement costs (2010 DECC)	33-251/ha
	Salt marsh and mudflats	Humber: Andrews et al. (2006)	SCC	14/ha
		Blackwater: Shepherd et al. (2007)	SCC	13–53/ha
	Salt marshes	Blackwater: Luisetti et al. (2011)	Market prices, SCC	1–865/ha
		GB: Beaumont et al. (2010)	Abatement costs (2010 DECC)	63–646/ha
	Sea grasses	GB: Luisetti et al. (2013)	Abatement costs (2012 DECC), SCC	103/ha (CI: 6.36–445/ha)
	Coastal shelf	GB: Beaumont et al. (2010)	Abatement costs (DECC)	7 billion (+/–50 %)
Coastal erosion prevention	Shingle bank (beach)	Protection of recreational values of Cley Marshes: Bateman et al. (2001)	TC CV	TC: 66/hh/visit CV: 2–81/hh

(continued)

Table 6.2 (continued)

Ecosystem service	Habitat	Case study and reference	Valuation method	Value in 2012 prices (£/year unless stated otherwise)
Sea defence	Dunes	England and Wales: Beaumont et al. (2010, 2014)	Replacement costs	England: 181–540 million; Wales: 56 billion
		Sefton Coast: Van der Meulen et al. (2004)	Management costs	309–1,949/ha
	Shingle beaches	England: Beaumont et al. (2010)	Replacement costs	0.82 billion
	Salt marshes and mudflats	Humber: Andrews et al. (2006)	Replacement costs, avoided costs, opportunity costs	Capital costs: 1,033,420/km Opportunity costs: 2,685–3,031/ha Replacement costs savings: 786,623/km Maintenance costs savings: 3,730–4,189/km
		Blackwater: Shepherd et al. (2007)	Avoided costs	Maintenance costs savings: 4,950/km
	Salt marshes	GB: Beaumont et al. (2010, 2014)	Replacement costs	Total savings: 5.5–9.7 billion 2,225–5,191/m wall for 6 m wide marsh; 3,856–6,822/m wall for 80 m wide marsh.
		England: Beaumont et al. (2010)	Net replacement costs	2.25 billion
Tourism and nature watching	All	Coastal recreation: Palmieri et al. this book	Meta-analysis	4/trip England: 39 million
	Beaches	Norfolk EC Bathing Water Directive: Georgiou et al. (2000)	CV	49/hh
		Norfolk beach replenishment Bateman et al. (2001)	CV	34–41/hh (local – holiday) Total: 971,640
		Coastal water quality in Scotland: Hanley et al. (2003)	TC, Contingent behaviour	0.63/trip (7.66/pp) Total: 1.65 million
		Beach protection: Christie and Gibbons (2011)	CE	Beach safety: 38/hh; Surfing conditions: 16.5/hh

	Cliffs, small islands	Lundy Island Marine Nature Reserve: Chae et al. (2012)	TC	420–672/trip
	Salt marshes	Blackwater managed realignment: Luisetti et al. (2011)	CE	Access: 4.91/hh Access (ln(ha)): 1.36/hh
	Estuary	Conservation and regeneration in the inner Firth of Forth: Kenter et al. (2014)[a]	CE	Water quality: 15.28/pp Hide (South of river): 34.77/pp Woodland (South of river): 33.61/pp Woodland (Stirling): 27.28
	Coastal shelf	Seal conservation in England: Bosetti and Pearce (2003)	CV	10–12/view
		Whale-tourism in West-Scotland: Parsons et al. (2003)	Gross value	Whale-tourism: 2.3 million Total: 7.9 million
		Sea angling in England: Lawrence (2005)	CE	Per day-trip: 6.72–14.93
		Lyme Bay, England: Rees et al. (2010)	Gross value	Total: 19.8 million Angling: 14.8 million Diving: 1.1 million Wildlife watching: 3.8 million
		Biodiversity related recreation in Wales: Ruiz Frau et al. (2013)	Gross value (financial revenues)	Diving: 8.4 million Kayaking: 2.7 million Boating: 14.5 million Seabird watching: 3.9 million
Spiritual and cultural wellbeing and aesthetic benefits of wild species and seascapes	Salt marshes	Blackwater: Luisetti et al. (2011)	CE	Additional bird species: 2.09–4.06/hh
	Intertidal wetlands	Otter and bird protection: Birol and Cox (2007)	CE	Otter hold creation: 37.19/pp Protection birds: 1.41/pp
	Estuary	Conservation in the inner Firth of Forth: Kenter et al. (2014)[a]		Bird population +1,000: 3.25/pp Prevention 1 local bird species: 17.60 pp

(continued)

Table 6.2 (continued)

Ecosystem service	Habitat	Case study and reference	Valuation method	Value in 2012 prices (£/year unless stated otherwise)
	Coastal shelf	MPAs in the UK: McVittie and Moran (2010)	CE	Halting loss of biodiversity and ES: England: 75/hh Wales: 116/hh Scotland: 23/hh, Northern Ireland: 37/hh Increasing biodiversity England: 75/hh Wales: 66/hh Scotland: 26/hh Northern Ireland: 41/hh
		Marine species conservation: Ressurreicao et al. (2011, 2012)	CE	All one-off payments Mammals: 43–49/hh Birds: 39–44/hh Fish 38–43/hh Invertebrates: 36–41/hh Algae: 46–53/hh
		Seal conservation in England: Bosetti and Pearce (2003)	CV	Total: 689,239
		Species protection in Scottish deep sea: Jobstvogt et al. (2014)	CE	Intermediate level (+300 species): 26.28 High level (+600 species): 38.70

[a]Values included here for Kenter et al. (2013, 2014) are individual non-deliberative values

ranging from £4 to £230/tC, Luisetti et al. (2011) show that the value of the carbon storage capacity by salt marsh re-creation projects may vary from £1 to £865/ha/year. A similarly wide range is presented in Beaumont et al. (2010, 2014): from £63 to £646/ha/year. Two studies (Andrews et al. 2006; Shepherd et al. 2007) look at the carbon sequestration by salt marshes and mudflats in the Blackwater and Humber catchments using the average concentrations of particulate C, N and P from Andrews et al. (2000) and Jickells et al. (2003). Estimates are also available for dunes (Beaumont et al. 2010, 2014) based on a carbon sequestration study by Jones et al. (2008) and carbon prices from UK DECC; and sea grass (*Zostera marina* species) (Luisetti et al. 2013). Beaumont et al. (2014) provide a figure for machair but since this estimate is based on sand dune grasslands and not on primary biophysical research in machair areas, this is excluded from our overview in Table 6.2. The sequestration rates for dunes, sea grasses, salt marshes and mudflats used in the studies are comparable to other studies elsewhere and are considered to be transferable across space and time (Luisetti et al. 2014).

The carbon sequestration of marine habitats through primary production of phytoplankton has been assessed, but its net contribution to the reduction of atmospheric CO_2 levels depends on the transportation of carbon to deep oceans where carbon is stored permanently (see Heckbert et al. 2011). In GB (coastal) shelf seas it is unlikely that this carbon will be transported to the deep ocean. Nevertheless, Beaumont et al. (2010) estimate that in 2004, the value of carbon sequestration in marine habitat by phytoplankton based on primary production was £7 billion/year.

Prevention of Coastal Erosion Natural habitats play an important role in coastal protection policies in GB. Coastal protection can be provided in terms of the prevention of coastal erosion when the gradual loss of land is mitigated by coastal habitats, or in terms of sea defence that reduce the risk of sea flooding and inundation related to natural hazards (see also Section 11.3.2.1 in Jones et al. 2011). Coastal protection values include benefits of ecosystem services provided by areas that are prevented from being lost through the protection provided by coastal margins.

The value of coastal erosion prevention includes avoided losses of property, agriculture, recreational uses etc. that take place without erosion. Bateman et al. (2001) report on the only GB-based study on benefits of coastal erosion prevention published since 2000. They address the recreational values of the freshwater Cley Marshes Natural Reserve that are protected from saltwater inundation by a shingle bank, using a combined TC-CV survey. The results of the study show that the aggregate annual recreational benefits are around £786,000 – £1,970,000, depending on the welfare estimate used (TC or CV) and the estimated number of visitors to the site, and much higher than the maintenance cost of £30,000–£50,000/year. Limitations of this study include the small sample size, the limited detail on TC and CV WTP functions or analysis, and the imprecise CV scenario description. The usefulness of this study for benefit transfer (BT) may be limited to cases where shingle beaches protect freshwater marshes.

Sea Defence Sea defence values relate to a risk reduction of flood, storm or tidal surge events that would damage infrastructure, business, the natural and historic environment, and other property, and also the risk of life. This risk reduction benefit depends on the location, depth and flow rate of the potential flood event. Two existing meta-analyses have not found significantly higher values for storm protection provided by wetlands (Brander et al. 2006) or lagoons (Enjolras and Boisson 2010), but these results do not necessarily imply that these habitats do not provide sea defence services. The benefits of sea defence have been assessed for several ecosystems in GB: marshes, mudflats, mangroves, beaches and dunes. All studies use cost-based valuation methods. The main limitation of these cost-based estimates is that they do not reflect the value of the goods and benefits protected by ecosystem sea defence, including values of commercial and residential properties, agriculture and recreation. They are typically a lower bound estimate of society's willingness-to-pay. Moreover, the costs of managed realignment vary widely across sites (Tinch and Ledoux 2006).

Salt marshes allow for building lower man-made sea walls, or no walls at all. Andrews et al. (2006) and Shepherd et al. (2007) estimate that replacing hard defences by salt marshes and mudflats would provide savings on replacement costs of unsatisfactory hard defence and maintenance costs. Since salt marshes and mudflats also provide societal benefits through carbon sequestration, recreational opportunities and their nursery function, the overall cost-benefit ratio supports the implementation of this soft approach to coastal defence when viewed over >25 year time scales. The resulting cost savings vary depending on the width of the salt marsh beside the sea wall. The GB-wide figures presented in Beaumont et al. (2010), based on cost-data from King and Lester (1995), for replacing salt marshes with man-made sea defences ignore the width of the salt marsh.

The total replacement cost of shingle shores in England are estimated at £0.82 billion, whilst sand dunes defence services are worth £0.54 billion (see Beaumont et al. 2010, also for limitations) and lower when using an alternative approach based on Pye et al. (2007): £181 million in England and £56 million in Wales. However, the latter are very conservative estimates and only apply to dunes without any additional artificial defence structures near high value land. The study by Van der Meulen et al. (2004) addresses the management costs of two dune sites on the Sefton Coast, one which is managed as a Nature Reserve and a busier one managed as a semi-park. However, these costs are not only for sea defence, as these dunes are also managed for their recreational use and cultural, spiritual, and aesthetic (biodiversity, non-use) benefits, but it is not possible to assign separate values to each of these benefit categories.

Tourism and Nature Watching There are many international studies on the benefits of tourism for beaches, tropical coral reefs and coastal shelf areas, yet no value estimates for open oceans, machair and cold coral reefs. Palmieri et al. (Chap. 12) use the results of Sen et al. (2014) to estimate the recreational values of coastal areas in the England. Based on an estimated £4 per trip, the total benefits amount to £39 million. However, these values cannot be assigned to specific habitats and the value per trip is based on an international recreation meta-analysis. Habitat-specific studies are available for beaches, small islands, salt marshes and the coastal shelf in

GB. Three studies are available that assess values associated with beach recreation more locally. Georgiou et al. (2000) use an open-ended CV survey to estimate public WTP for achieving compliance with the EC Bathing Water Directive to ensure safe bathing conditions at beaches in East Anglia. Hanley et al. (2003) combine TC and Contingent Behaviour data to estimate the WTP for better coastal water quality at seven different beaches in Scotland. The results suggest that the number of trips would increase should water quality improve to 'very good' standards, with associated aggregate benefits of £1.65 million/year. Bateman et al. (2001) assess the benefits of beach replenishment to avoid coastal erosion – and thereby obtain extra recreational possibilities in Caister-on-Sea, Norfolk, using an open-ended CV survey. The resulting aggregate benefits of £971,640/year would outweigh the cost of beach replenishment. Although these three primary studies fulfil most standard reliability and validity criteria, the surveys were executed prior to 2000 and the use of these values in BT may produce less reliable results. A more recent, but rather specific CE study on beach amenities assessed WTP for a change in coastal defences in Borth, North Wales (Christie and Gibbons 2011). These results could be applied to similar interventions that improve beach safety and surfing conditions.

One GB-based study falls into the small islands category. Chae et al. (2012) use TC to estimate the non-market recreational benefits arising from the Lundy Island Marine Nature Reserve. The estimated mean WTP for visiting Lundy is high compared to other studies. This may be because of the protected and unique status of Lundy, but also because of the inclusion of multipurpose trips or the small sample. The CE presented in Luisetti et al. (2011) of salt marshes shows that respondents attribute higher welfare to salt marshes that are accessible for recreation. WTP estimates decrease with distance and increase with the size of the marsh in a non-linear way. Two studies assess marginal values for recreational activities at the coastal shelf. Bosetti and Pearce (2003) use a CV study to assess the use value of seal conservation in southwest England, but the resulting values are difficult to relate to marginal increases in seal populations. The results of the CE about recreational coastal angling in southwest England presented in Lawrence (2005) show that WTP values per fishing trip varied by species. The relationship between catch size and WTP is non-linear (declining), and increasing the size of individual fish would have a larger impact on WTP than increasing the catch per day in this study. These results can be used in scenarios of change, as they reflect the values associated with specific changes in biophysical parameters.

Tourism values are were assessed within the UK NEA FO on the benefits of Marine Protected Areas by Kenter et al. (2013, 2014) for a range of substrate/ habitats, including rocky seafloors with shell beds, large kelp, seaweeds and sea-pens, and sandy and muddy sea floors with different types of plant growth, including soft corals and sponges, as well as estuarine areas. These habitats cover a range of features of conservation interest (FOCI, see Chap. 8). The combined CE-CV study provided positive WTP estimates for MPA development, which vary across habitats. Positive WTP values are also found for sites where seals, octopus and birds may be encountered. WTP was also higher in both the CV and CE exercise for sites that were accessible by shore, boat and pier, whilst access out at sea or where boat use is prohibited were associated with negative effects. Size did not have any impact on recreational values, but distance was significant and negative. A limitation of the study is the use of a voluntary donation as payment vehicle, which is generally considered not to be incentive compatible. The study compared individual and deliberative approaches to valuation, and found that values would generally decrease after deliberation, which may be because the deliberative results were based on a 'fair price' whilst the individual WTP questions aim to elicit maximum individual WTP.

Kenter et al. (2014) also present the results of a CE study in the Firth of Forth, an estuary in Scotland. The results show significant positive WTP for improvement of water quality, an increase of the bird populations, the presence of a hide (but only South of Forth) and new woodland planted (but only South of Forth and near Stirling – there are many woodland North of the river). Again, this study found that deliberation resulted in lower WTP values, both at individual level as well as when WTP was expressed by the group as a fair price.

Three studies assess the direct income earned in the coastal shelf from tourism and recreation (Parsons et al. 2003; Rees et al. 2010, Ruiz Frau et al. 2013). Although these values indicate the economic importance of coastal recreation, the estimates are not directly related to changes in environmental quality or habitat extent and their use in scenario analysis would require additional assumptions. Moreover, they do not reflect consumer surplus, i.e. the welfare that people derive from coastal and marine tourism on top of what they have to pay on accommodation, transport, excursions, entrance fees, etc.

Aesthetic Values as Reflected in Property Prices Cultural values range from use values related to tourism and nature watching, aesthetic values, education and research, to goods and benefits of spiritual and cultural wellbeing. Aesthetic benefits are sometimes reflected in property values when people are willing to pay an additional price in the housing market that can be attributed to the presence of nearby environmental amenities. The only GB-based study has been developed for the UK NEA 2011. Mourato et al. (2010) find that house prices in England are not significantly associated with distance to the coastline or the availability of marine and coastal margins in the km^2 in which a house is located. However, it may be that the effect of seascape aesthetics on housing prices could not picked up at the coarse scale of this analysis and should not be considered conclusive evidence for the absence of aesthetic benefits reflected in GB housing prices. International studies (n = 17), mostly from the USA, find evidence of the added value of nearby ecosystem services in house prices. Given the large differences in housing markets between countries, transferring values to GB is expected to generate large errors in value estimates (see Sect. 6.4).

Spiritual and Cultural Well-Being and Aesthetic Benefits of Wild Species and Seascapes There are over 60 international valuation studies that address the economic welfare that people derive from biodiversity, species, habitat and/or landscape conservation. These reflect both spiritual and cultural wellbeing and aesthetic values. Seven SP studies provide primary value estimates for GB.

The study by Luisetti et al. (2011) on the WTP for salt marsh creation along the English coast also assessed WTP per observable protected bird species which, at least in part, non-use values. Marginal WTP is declining as the number of species increases, from £2.09/hh/year for three additional species to £4.06/hh/year for five additional species. The study also shows that people are willing to pay for salt marsh creation even when they won't be allowed access to the site. Birol and Cox (2007) use a CE to assess the WTP for otter hold creation and protected bird species in wetlands. The sample contained both users and non-users, and was small, and the models relatively simple. Hence, reliable extraction of pure non-use values from these studies is not possible. The results of the CE in the estuary Firth of Forth by Kenter et al. (2014) reveal a positive WTP for preventing a local species from extinction, in addition to the value of increasing the bird population in general.

In their CV study on seal conservation in southwest England, Bosetti and Pearce (2003) found respondents willing to pay to mitigate conflicts between fishermen and seals and conserve seals in the wild. However, besides the relatively small sample, the payment vehicle employed for non-use values in this study (voluntary donation) is not considered to be incentive compatible, because they could avoid actual payments would the proposed donation request be implemented.

McVittie and Moran (2010) use a CE to ask respondents for their WTP to install Marine Protected Areas (MPAs) in the coastal waters of England, Wales, Northern Ireland and Scotland. Part of the WTP values reflect use values. The levels of the attributes were defined as 'increase biodiversity' and 'halt loss of biodiversity', hence the change in ecosystem service provision is not described quantitatively (mainly because a lack of such information), which may limit the possibilities for BT. Ressurreicao et al. (2011, 2012) implemented a CV survey to assess the WTP for marine species among residents and visitors in three European coastal areas, including the Isles of Scilly. The results show that the absolute WTP for the prevention of species loss are around 2–3 % of monthly household income. The results did not show significant sensitivity to scope, i.e. losing fewer species was not associated with significantly higher WTP, which may be due to warm glow effects or limited understanding about the implications of species loss and ecological uncertainty about the effects of species loss on other communities. Kenter et al. (2013, 2014) also find a positive WTP for protection of various marine landscapes under MPA regulations, symbolic sealife species, and for the protection of vulnerable marine species that anglers or divers would normally not encounter.

The CE by Jobstvogt et al. (2014) to assess the WTP for the conservation of deep sea organisms in Scotland shows that, despite limited knowledge about deep sea biodiversity, respondents were willing to contribute to MPAs in deep sea areas.

Education and Research No academic papers present values of education and research. Financial values are available from UKMMAS (2010) and Pugh and Skinner (2002), as reported in Beaumont et al. (2008). There are only two other, non-GB, academic studies that meet our study selection criteria and assess the economic value of education and research (Cesar and van Beukering 2004; Samonte Tan et al. 2007). While these studies are not directly applicable to GB they do provide some notion of the magnitude of this category of benefit.

6.4 Prioritisation of Future Research Resources

The gaps in the primary GB-based valuation literature limit the possibilities to inform management, especially for ecosystem goods and benefits and habitats that are considered to be important. There are no GB valuation studies for a number of the habitats (machair, coastal lagoons, cold water corals and open oceans) published in the academic literature since 2000. There are also no value estimates for amenity effects on property values and education and research, only one study on the benefits of prevention of coastal erosion, and only values for product provisioning in salt marshes and the coastal zone. Moreover, the available studies use different valuation methods, and the results are not necessarily comparable and vary in terms of their reliability and validity.

We compare the availability of existing valuation studies to expert-based judgements on the importance of coastal and marine habitats and the ecosystem goods and benefits they provide. The UK NEA 2011 provides an assessment of the importance of the different types of coastal margins in terms of their contribution to human wellbeing of the various goods and benefits (or the amount of good/benefit delivery per unit area) that these habitats provide (Jones et al. 2011). We complement this with a comparable importance matrix for marine habitats in GB, developed in an expert-workshop during the UK NEA Follow-On project.

Table 6.3 presents the results: the number in each cell reflects the number of studies that are available for that particular good/benefit in the habitat, and the colour coding reflects the availability-importance score.

As the many red and orange cells in Table 6.3 indicate, there are considerable gaps in the GB valuation literature related to ecosystem goods and benefits provided by coastal ecosystems deemed important by experts. Cultural values (here under education, research, spiritual and aesthetic values of wild species and seascapes) are poorly represented in the monetary valuation studies literature despite the service-habitat combination being deemed important, and this holds to a lesser extent for cultural use values related to recreation. Sea defence and carbon sequestration benefits of coastal habitats have received little recent attention despite the significant risks that climate change and sea level rise may pose. No carbon sequestration valuation studies are available for sea cliffs and small islands, machair, lagoons, intertidal wetlands, estuaries, kelp forests and cold water coral reefs, whilst studies for the coastal shelf and the open ocean are associated with large uncertainties about the longer-term storage.

Provisioning services related to land-based activities on coastal margins, including the production of crops, meat, wild food, wool, reed, grasses, timber and turf, require more attention. No GB studies on products are available other than those on (shell-) fisheries and aquaculture and no studies exist for dunes, machair, mudflats, seagrass beds, kelp forest, estuaries, cold water corals, rocky bottoms and the open ocean. The studies in our global valuation dataset also do not provide value estimates for these goods and benefits from coastal habitats in countries like the UK. Future studies should also provide more insight into sustainable harvesting

Table 6.3 Importance of ecosystem services per coastal habitat and the availability of UK-based valuation studies

	Products	Sea defence	Erosion prevention	Healthy climate	Tourism and nature watching	Education research	Aesthetic: property[a]	Spiritual/ aesthetic: wild species, seascapes
Dunes	0	2	0	1	1	0	0	0
Beaches	0	1	1	0	3	0	0	0
Sea cliffs	0	0	0	0	1	0	0	0
Machair	0	0	0	0	0	0	0	0
Lagoons	0	0	0	0	0	0	0	0
Salt marshes	1	3	0	4	1	0	0	1
Mudflats	0	2	0	2	1	0	0	0
Inter. wetland	0	0	0	0	0	0	0	1
Seagrass beds	0	0	0	1	1	0	0	1
Kelp forest	0	0	0	0	1	0	0	1
Estuaries	0	0	0	0	2	0	0	2
Cold water coral reefs	0	0	0	0	0	0	0	0
Rocky bottom	0	0	0	0	1	0	0	1
Coastal shelf	3	0	0	1	6	0	0	5
Open ocean	0	0	0	0	0	0	0	0

Red: services of high importance with no relevant UK valuation studies
Orange: services of high importance with one UK valuation study, or services of medium importance with no UK valuation studies
Yellow: services of high importance with two or more UK valuation studies, or services of medium importance with one UK valuation study
White: services of low importance or services of medium importance with two or more UK valuation studies
[a]Property related aesthetic values are not included in Table 11.3 of UK NEA 2011

levels, analyse the value of fisheries net of other capital inputs, and include the economic value of other raw materials, including seaweed and pharmaceuticals.

It is also remarkable that are no studies for the (flow of) goods and services provided by machair, even though this is a unique type of habitat and only found in the UK and Ireland, and considered to be very important for sea defence, recreation, education, cultural wellbeing, aesthetics and biodiversity. Cold water coral reefs have not been addressed in the UK yet; the study by Jobstvogt et al. (2014) assesses the option and biodiversity values of deep seas in the Scottish EEZ.

More valuation efforts should be directed towards intertidal wetlands and estuaries. Their provision of products and different cultural services (tourism, education and research, aesthetic values of species and seascapes) are considered to be important in terms of their contribution to human wellbeing. For estuaries, intertidal wetlands and other ‘habitat complexes’ or ‘habitat mosaics’, it may be possible to use valuation studies for the habitat types that are present in the estuary (or habitat mosaic) of interest. However, the biophysical ecosystem service provision level as well as the economic values for the associated benefits may not be independent from the adjacent habitats within a habitat mosaic. In the presence of synergistic or antagonistic effects of one habitat type, fragmented within the mosaic, on the delivery of any particular service from another interspersed habitat type may not have the same value as a single block of habitat of equivalent overall size.

Benefit transfer approaches could help to fill some of the gaps. Table 6.1 shows that for some of the goods and benefits for which there exist no primary GB studies, value estimates from other countries may be available. As a rule of thumb, we suggest that for benefit transfer to the UK using international studies, studies from North- and West-Europe could be applied with the necessary caution, then studies from South- and East-Europe with more caution, followed by Australian and North-American studies with further increased caution, and studies from elsewhere should probably not be applied due to large differences in cultural, economic and ecological differences. There are four North- and West-Europe studies published that provide values for habitat/good and benefit combination for which no UK studies are available, which we will mention here but not evaluate. Nunes and Van den Bergh (2004) present a TC-CV study on the WTP to protect beaches in the Netherlands against algae blooms. Meyerhoff (2004) presents a CV study in Germany on the tourism benefits of the Wadden Sea. Stål et al. (2008) present a study on fisheries and the nursery function supporting commercial fisheries provided by seagrass beds and rocky bottom areas in Sweden. These studies may provide an initial figure of the order of magnitude of values of the goods and benefits but are likely to arise in high errors given the differences in social and ecological characteristics and are probably insufficiently reliable for socially efficient and equitable decision making.

It is difficult to prioritise research efforts based on national or international policy needs based on habitats or ecosystem goods and benefits, such as the OSPAR convention, the WFD and MSFD, and Strategic Environmental Assessments and Environmental Assessment regulations (see Chap. 1). The WFD and MSFD together cover all coastal and marine habitats and therefore economic value estimates are required for all types of habitats for impact assessments of measures. Similarly, the UK Biodiversity Action Plan (UKBAP) has defined 24 priority habitats and valuation information may be useful for all of these.

6.5 Concluding Remarks

Clear gaps have been identified in this review exercise for both the international and the UK coastal and marine ecosystem valuation data. A number of important habitats, ecosystem services and related goods and benefits have few or no valuation estimates assigned to them. While benefits transfer may offer some pragmatic assistance to cover a limited number of the gaps, this procedure is unlikely to be any sort of panacea. Both temporal and cultural bias constraints remain formidable challenges for any benefits transfer exercise using data more than a decade old and spatially more distant than a rough boundary around Northern Europe. The only real exceptions to this rule are global benefits such as those related to carbon sequestration and storage.

The obvious conclusion form this review analysis is that more primary valuation research needs to be undertaken. Table 6.3 offer some guidance on the foci for this possible new research programme for the UK. Highlighted gaps include the sea defence and coastal erosion prevention benefits, as well as climate benefits and provisioning services (products) provided by coastal habitats. For marine ecosystem services, more valuation studies may be required for aesthetic values and spiritual and cultural wellbeing from seascapes and wild species diversity, as well as products and other raw materials, education and research. Finally, the complexity of 'mosaic' habitats, such as intertidal wetlands and estuaries, may require valuation studies that consider these in aggregate terms, rather than trying to disentangle the values goods and benefits provided by sub-habitat types independently and at the same time avoiding double counting.

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