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Corresponding Author:

Corinne Baulcomb
Land Economy Research Group
West Mains Road
Edinburgh EH9 3JG
Scotland UK

t: +44 (0)131 535 4031
f: +44 (0)131 667 2601
e: Corinne.Baulcomb@sruc.ac.uk
w: www.sruc.ac.uk

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**Number: 83 A Review of the Marine Economic Valuation
Literature 1975 – 2011: Classifying Existing Studies
by Service Type, Value Type, and Valuation
Methodology**

A Review of the Marine Economic Valuation Literature 1975 – 2011: Classifying Existing Studies by Service Type, Value Type, and Valuation Methodology

Corinne Baulcomb and Anne Böhnke-Henrichs

ABSTRACT

There is a long history of the application of economic valuation methods to marine environments, changes to marine environments, and changes to marine management. Increasingly, however, there is an interest in analyzing the economic consequences of changes in marine ecosystem service provision resulting from changes in marine management and marine ecosystem state. In turn, this requires either that researchers conduct new, primary valuation studies focused on particular marine ecosystem services, or that researchers use existing studies and transfer values from one research and policy context to another (also known as benefits transfer). This study presents the result of a review of the marine economic valuation literature that was conducted as a part of an EU-FP7 project with the goals of understanding 1) the state of the marine economic valuation literature in certain countries, 2) the potential for this literature to support benefits transfer-based analyses, and 3) gaps in the existing literature. The review was also intended to support the undertaking of new, gap-filling primary non-market valuation studies. The results indicate that there are many gaps in the existing marine valuation literature with respect to the individual ecosystem services valued, the valuation methodologies that have been utilized, and the types of economic value captured.

KEY WORDS: Marine Ecosystem Services; Economics Values; Non-Market Valuation

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Introduction

As a part of the EU FP7-funded project called ODEMM ('Options for Delivering Ecosystem-Based Marine Management'), a large review of the marine non-market valuation literature was conducted. This review was necessary because ODEMM was focused on understanding both the barriers to the implementation of the EU Marine Strategy Framework Directive (MSFD) and on economically assessing the hypothetical changes to marine ecosystem service provision that could plausibly result from efforts to implement the MSFD in Europe's regional seas.¹

Specifically, this review was motivated by a need to 1) assess the state of the marine² ecosystem service (ES) (economic) valuation literature, 2) identify candidate studies for use in benefits-transfer-supported cost benefit analyses (CBA), 3) understand the gaps in the existing marine non-market valuation literature, and 4) support the undertaking of primary non-market valuation studies targeting one or more of the identified gaps. This review focuses on motivations (1) and (3), where as motivations (2) and (4) were relevant in the wider context of ODEMM.

This review is, consequently, inherently focused on the economic valuation literature, and not on literature related to the concept of 'value' more broadly in the context of marine systems or the literature related to non-monetary approaches to analysing ecosystem service changes.

Methodology

Search Process

The search process occurred throughout 2011 (inclusive of December 2011), and the oldest article yielded was 1975, and so covers this full period. In conducting the review, the project team borrowed from the Systematic Review methodology (CEBC, 2006) in that we utilised clear and specific search terms in specific databases (i.e. ISI Web of Science) in order to locate relevant publications. The search protocol deployed was not, however, condensed into a compact search string as would be expected in a Systematic Review. Initially, it was anticipated that a fairly broad and simple topic-based³ search term (e.g. "Marine Ecosystem Services") would retrieve all the relevant literature (published in English). However, it was found that the literature was highly fragmented, and that a wide variety of key words have been applied to relevant studies over a number of decades. This meant that a thematically broad, yet simple search term missed quite a few relevant results, including publications already known to the authors as being relevant.

Consequently, the search process evolved to include a large number of simplistic, topic-focused search terms covering a very wide range of dimensions of the target English-

¹ ODEMM included partner organisations from the UK, Finland, the Netherlands, Denmark, Poland, Greece, Turkey, Israel, Ukraine, Romania, and Bulgaria. Further information on ODEMM is available here: <http://www.liv.ac.uk/odemmm/> or <http://odemmm.com/>

² Here we use the term 'marine' in its broadest sense

³ As opposed to a title-based or simply key word-based searches

language literature (Box 1).

Box 1 Initial search strings used to locate existing studies

"Benefit" AND "Ocean"	"Nonmarket Valuation" AND "Coastal Environment"
"Benefit" AND "Marine"	"Non-Market Valuation" AND "Coastal Environment"
"Benefit" AND "Coastal"	"Nonmarket Value" AND "Marine Services**"
"Coastal Ecosystem Services"	"Non-market Value" AND "Marine Services**"
"Coast*" AND "Service**"	"Nonmarket Value" AND "Coastal Services**"
"Choice" AND "Ocean"	"Non-market Value" AND "Coastal Services"
"Choice" AND "Marine"	"Nonmarket Value" AND "Ocean Services"
"Choice" AND "Coastal"	"Non-market Value" AND "Ocean Services"
"Choice" AND "Coast**"	"Non-Market" AND "Marine Service**"
"Choice" AND "Ocean**"	"Nonmarket" AND "Marine Services**"
"Contingent Valuation" AND "Ocean"	"Non-Market" AND "Coastal Service**"
"Contingent Valuation" AND "Marine"	"Nonmarket" AND "Coastal Services**"
"Contingent Valuation" AND "Coastal"	"Non-Market" AND "Ocean Service**"
"Contingent" AND "Marine"	"Nonmarket" AND "Ocean Services**"
"Contingent" AND "Coast**"	"Nonmarket" AND "Ocean"
"Contingent" AND "Ocean**"	"Non-Market" AND "Ocean"
"Ocean*" AND "Service**"	"Nonmarket" AND "Marine"
"Economic" AND "Marine"	"Non-Market" AND "Marine"
"Economic" AND "Coast"	"Nonmarket" AND "Coastal"
"Economic" AND "Ocean"	"Non-Market" AND "Coastal"
"Economic Benefit*" AND "Marine"	"Revealed Preference" AND Ocean
"Economic Benefit*" AND "Coastal"	"Revealed Preference" AND Marine
"Economic Benefit*" AND "Ocean"	"Revealed Preference" AND "Coastal"
"Economic Valuation" AND "Marine"	"Service Value" AND "Marine"
"Economic Valuation" AND "Coastal"	"Service Value" AND "Coastal"
"Economic Valuation" AND "Ocean"	"Stated Preference" AND "Ocean"
"Economic Valu*" AND "Marine Biodiversity"	"Stated Preference" AND "Marine"
"Economic Valu*" AND "Coastal Biodiversity"	"Stated Preference" AND "Coastal"
"Economic Valu*" AND "Ocean Biodiversity"	"Travel Cost" AND "Ocean"
"Economic Valuation" AND "Marine Biodiversity"	"Travel Cost" AND "Marine"
"Economic Valuation" AND "Coastal Biodiversity"	"Travel Cost" AND "Coastal"
"Economic Valuation" AND "Ocean Biodiversity"	"Travel Cost" AND "Coast**"
"Ecosystem Services" AND "Marine Biodiversity"	"Travel Cost" AND "Ocean**"
"Ecosystem Services" OR "Ecosystem Goods" AND "Coastal" "Ecosystem Services" OR "Ecosystem Goods" AND "Marine"	"Value" AND "Coastal Environment"
"Ecosystem Goods and Services" AND "Marine Biodiversity"	"Value" AND "Marine Environment"
"Ecosystem Goods and Services" AND "Coastal Biodiversity"	"Value" AND "Marine Service**"
"Hedonic" AND "Ocean"	"Value" AND "Coastal Service**"
"Hedonic" AND Marine	"Value" AND "Ocean Services"
"Hedonic" AND "Coastal"	"Valuation" AND "Marine Ecosystem"
"Hedonic" AND "Coast**"	"Valuation" AND "Marine Environment"
"Hedonic" AND "Ocean**"	"Valuation" AND "Coastal Ecosystem"
"Marine Ecosystem Services"	"Valuation" AND "Coastal Environment"
"Marine" AND "Service"	"Valuation" AND "Ocean"
"Nonmarket Valuation" AND "Ocean"	"Valuation*" AND "marine"
"Non-Market Valuation" AND "Ocean"	"Valuation*" AND "Coast**"
"Nonmarket Valuation" AND "Marine Ecosystem"	"Valuation*" AND "Ocean**"
"Non-Market Valuation" AND "Marine Ecosystem"	"Valuation" AND "Coastal Services**"
"Nonmarket Valuation" AND "Marine Environment"	"Valuation" AND "Marine Services**"
"Non-Market Valuation" AND "Marine Environment"	"Valuation" AND "Ocean Services**"
"Nonmarket Valuation" AND "Coastal Ecosystem"	"Willingness to Pay" AND "Ocean"
"Non-Market Valuation" AND "Coastal Ecosystem"	"Willingness to Pay" AND "Marine"
	"Willingness to Pay" AND "Coastal"

Adopting this approach did necessitate removing duplicate records from the search results, but also did facilitate the retrieval of records from a really wide range of sources over a wide time period featuring a wide variety of key words (albeit at the cost of search efficiency). Although one might expect a significant amount of overlap between the results stemming from such closely related search strings, and there was certainly overlap in the results obtained, it is worth noting that we often found relevant and unique results between even

seemingly (conceptually and technically) closely-related searches.⁴ We have taken this to be a further indication of the fragmentation of the literature presenting the results of non-market (economic) valuation methods applied in marine contexts.

Additionally, the phrase “Marine Ecosystem Service” was also entered into Google in February 2011, and the first 100 results viewed in order to identify relevant grey literature.

Finally, studies returned using these search strings were then compared with collections of marine economic valuation literature known to the authors at the time (i.e. the list of studies contained in the US National Ocean Economics Programme database (NOEP, 2011), the review contained in Wilson and Liu (2008), and the database assembled as a part of *The Economics of Ecosystems and Biodiversity* project (Van der Ploeg and de Groot, 2010). Consequently, although the search conducted was not formally exhaustive, it was nonetheless very thorough.

Filtering Process

This search process yielded more than 600 results from around the world. This pool of literature was then subject to a range of filtering. Firstly, only sources published in English were considered further. Secondly, only *primary* economic valuation studies were considered, meaning that studies that were theoretical, purely argument-based, literature reviews, meta-analyses, or benefits transfer studies were excluded from further consideration. Thirdly, studies were filtered based on location. This necessary for two reasons, both of which stem from the review being an input to ODEMM: 1) valuations conducted in certain marine systems were never going to be relevant in the context of ODEMM because those ecosystems do not exist within Europe’s regional seas; 2) it was decided that valuations derived from non-European developing country contexts could not justifiably be transferred to a European context, even if the ecosystem featured in a particular study was relevant to Europe. Consequently, studies conducted in (primarily equatorial/tropical) contexts that had no (ecological) parallel in Europe’s regional seas were excluded from further consideration, as were studies conducted non-European developing countries. Instead, the review focused on studies published in European countries, in non-European countries neighbouring Europe that were directly relevant to ODEMM (such as Turkey and Ukraine), and in non-European, non-Asian, non-Latin American OECD countries (Box 2). Collectively, the countries considered are henceforth referred to as ‘OECD+’ countries for the purposes of this review.

⁴ For example, “Economic Valu*” AND “Marine Biodiversity” yields a *fewer* results in Web of Knowledge than does “Economic Valuation” AND “Marine Biodiversity”, even though the truncation in the first should, in theory, ensure that it encompasses the results of the second.

Box 2 Countries included in the literature review process

Albania	Denmark	Lithuania	San Marino
Andorra	Estonia	Luxembourg	Serbia
Armenia	Finland	Macedonia	Slovakia
Australia	France	Malta	Slovenia
Austria	Georgia	Moldova	South Africa
Azerbaijan	Germany	Monaco	Spain
Belarus	Greece	Montenegro	Sweden
Belgium	Hungary	Netherlands	Switzerland
Bosnia-Herzegovina	Iceland	New Zealand	Turkey
Bulgaria	Ireland	Norway	Ukraine
Canada	Israel	Poland	United Kingdom
Croatia	Italy	Portugal	United States
Cyprus	Latvia	Romania	Vatican City
Czech Republic	Liechtenstein	Russia	

Study Classification

Post filtering, the resulting pool of literature (i.e. 187 unique studies) was then classified according to three dimensions: ES considered (or ES effectively considered),⁵ valuation methodology used, and value type estimated. In terms of ES type, studies were classified based on the definitions included in Boehnke-Henrichs et al (2013) (the marine ecosystem service typology designed in the context of ODEMM that was being finalised at the time of this review). When classifying studies according to the type of value estimated, the project team initially used a four-tiered break down of total economic value (TEV) (Figure 1). This four-tiered conceptualization of TEV was specified at the start of the review process in order to facilitate a more nuanced understanding both of the gaps in the marine ES economic valuation literature than would have otherwise been achievable.

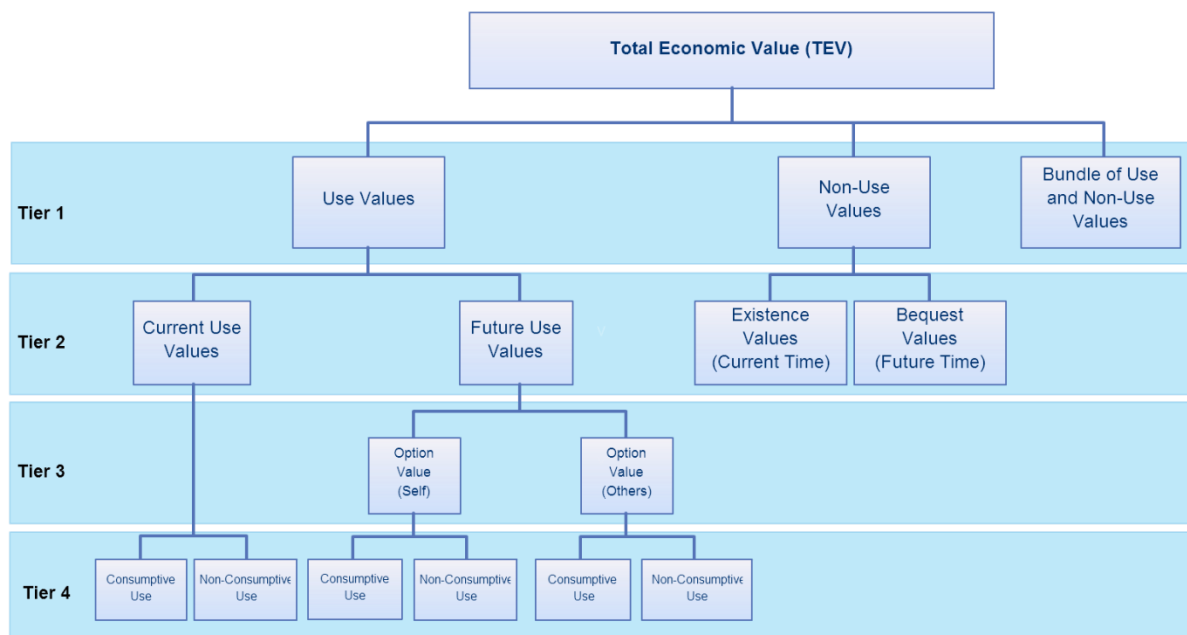
This four-tiered breakdown of TEV has several features worth noting. Firstly, it both explicitly and implicitly identifies ‘bundles’ of value. Bundles of value occur when a study elicits a single value estimate that includes elements of multiple, individual types of values but in such a way that the individual values cannot be distinguished separately from the overall, combined value. For example, a contingent valuation (CV) study may elicit a single willingness-to-pay (WTP) value that includes elements of recreation (a use value) in a certain ecosystem and existence values (a type of non-use value) related to species within that ecosystem. Such a value would not actually represent a *total* economic value for the ecosystem in question, but it is a mixture of use value and non-use value, and so would most appropriately be classified as a ‘Bundle of Use and Non-Use Values’.

Similarly, the value types of one tier can, depending on the nature of the ES in question, implicitly represent unspecified bundles of the more specific value types contained on

⁵ As many studies that contain the results of primary non-market marine valuation studies were conducted without reference to the concept of ecosystem services, let alone a particular ecosystem service typology, it was necessary to consider which ecosystem service the studies *effectively* valued based on the definitions used in the selected typology and the information available in the studies.

subsequent tiers (e.g. some studies may not differentiate between current and future use, but do maintain a distinction between use and non-use values).

Figure 1 Four-tiered TEV typology



Secondly, the TEV typology includes a distinction between option use values related to ones desire to use a particular service in the future, and option use values related to preferences for future use by others. It would be appropriate, for example, to make this distinction when a study endeavours to elicit a respondent's WTP specifically for giving his/her child the option of fishing for personal consumption in the future as opposed to eliciting a respondent's WTP for his/her own ability to fish in the future. Thirdly, a distinction is made between consumptive use (e.g. values associated with the harvesting of fish) and non-consumptive use (e.g. viewing a sea-scape).

It is also worth noting that not every ES-value type pairing is plausible. Some ESs may only be associated with use values, for example, while others may be primarily associated with non-use values. Given the definitions for individual ESs employed in Böhnke-Henrichs et al (2013), the team defined a certain set of plausible ES-value type pairings (Table 1).

This set of plausible ES-value pairs means that in the context of certain services, economic values contained in the literature could be classified according to a more specific tier of value than may have been reported in the study (e.g. current seafood harvest is always associated with a consumptive use value), whereas for other ESs, no such inferences could be made.

This particular review presents a higher-level summary of the literature, focusing on tier 1 value types (i.e. use values, non-use values, and bundles of use and non-use values that are still less than TEV), ES (or effective ES) valued, and the economic valuation methodology

used. As such, this review does not feature other attributes of the studies (e.g. the location of studies conducted, or even further information on the specific sub-services valued).

Table 1 Plausible economic value and ecosystem service pairs (based on Böhnke-Henrichs et al (2013))

TEV Typology									
		Direct Use Values						Direct Non-Use Values	
		Current Use		Future Use				Existence	Bequest
				Option (self)		Option (others)			
ESs*		C	NC	C	NC	C	NC		
Provisioning	1	✓		✓		✓			
	2	✓	✓	✓	✓	✓	✓		
	3	✓		✓		✓			
	4	✓		✓		✓			
	5	✓		✓		✓			
	6	✓		✓		✓			
Regulating	7		✓		✓		✓		
	8		✓		✓		✓		
	9		✓		✓		✓		
	10		✓		✓		✓	✓	✓
	11	✓		✓		✓			
	12		✓		✓		✓		
	13		✓		✓		✓	✓	✓
Habitat	14	✓		✓		✓			
	15							✓	✓
Cultural	16	✓	✓	✓	✓	✓	✓		
	17		✓		✓		✓	✓	✓
	18		✓		✓		✓		
	19		✓		✓		✓		
	20	✓	✓	✓	✓	✓	✓		
	21		✓		✓		✓	✓	✓

* ES1=Seafood; ES2=Sea Water; ES3=Raw Materials; ES4=Genetic Resources; ES5= Medicinal Resources; ES6=Ornamental Resources; ES7= Air Purification; ES8=Climate Regulation; ES9= Disturbance Prevention and Moderation; ES10=Regulation of Water Flows; ES11=Waste Treatment; ES12= Coastal Erosion Prevention; ES13=Biological Control; ES14=Lifecycle Maintenance (note: typically, this service would be considered to provide indirect value. However, depending on the scale of any particular analysis, there may be situations where it can be functionally considered to be contributing a direct use value, and so may be counted alongside the values associated with other ecosystem services); ES15=Gene Pool Protection; ES16=Recreation; ES17=Aesthetic Information; ES18=Inspiration for Culture, Art & Design; ES19=Spiritual Experience; ES20=Information for Cognitive Development; ES21=Cultural Heritage & Identity.

Results

At high-level summary of the pool of literature considered shows that the primary English-language, OECD+ marine valuation literature is extremely unbalanced across individual services (Table 1). For many ESs, fewer than 10 primary studies were found, whereas there

are 95 unique recreation studies (many of which actually contain multiple value estimates). There were also a range of studies found that were not easily classified with respect to particular ESs. These studies sometimes presented an explicit mix of named ESs (e.g. recreation and aesthetic information), but in many cases did not and instead implicitly bundled a range of unspecified ESs together. When considering the high-level break down by type of value, the literature found is heavily skewed towards a focus on use values rather than non-use values (Figure 3). A similarly high-level summary of the non-market valuation methodologies used shows an imbalance in that there are comparatively few choice experiment studies than travel cost, hedonic pricing, or contingent valuation studies (Figure 4).

Figure 2 High-level summary of primary marine non-market OCED+ valuation literature by ES. Number of studies per ES with at least one value. Note that some studies valued several ESs individually.

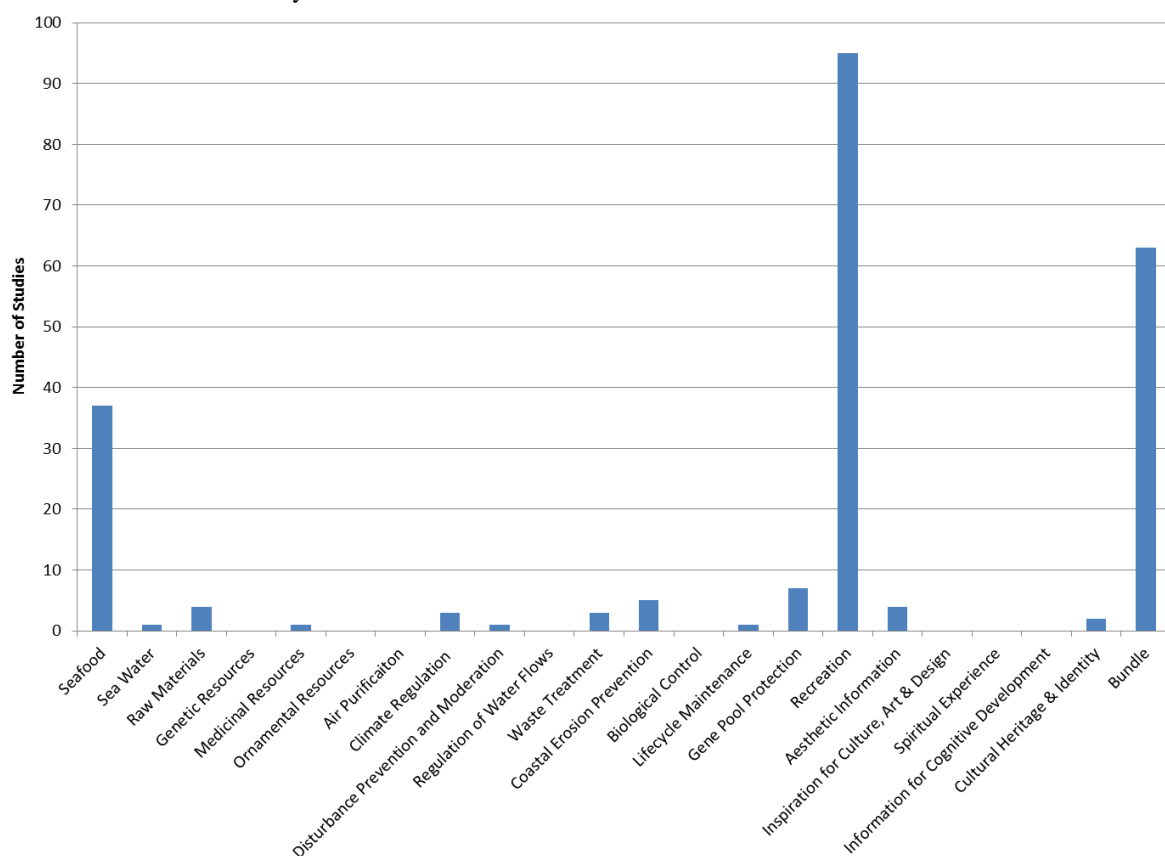


Figure 3 Distribution of studies by value type considered. Number of studies per ES with at least one value. Note: some studies estimated more than one type of value for multiple ESs.

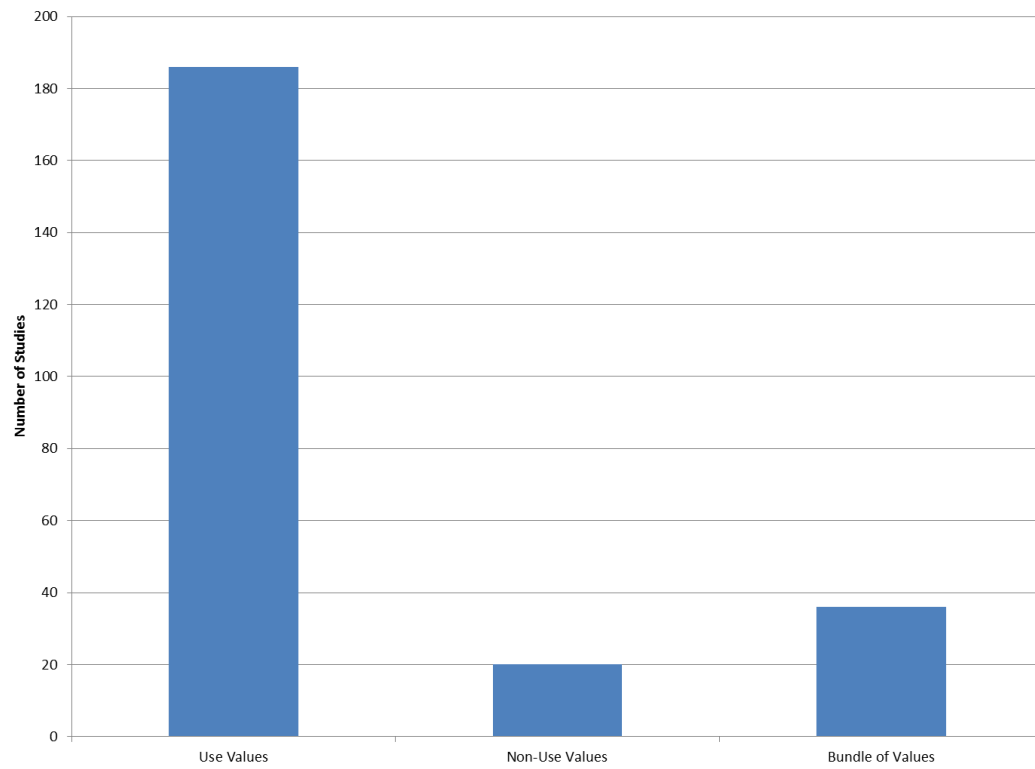
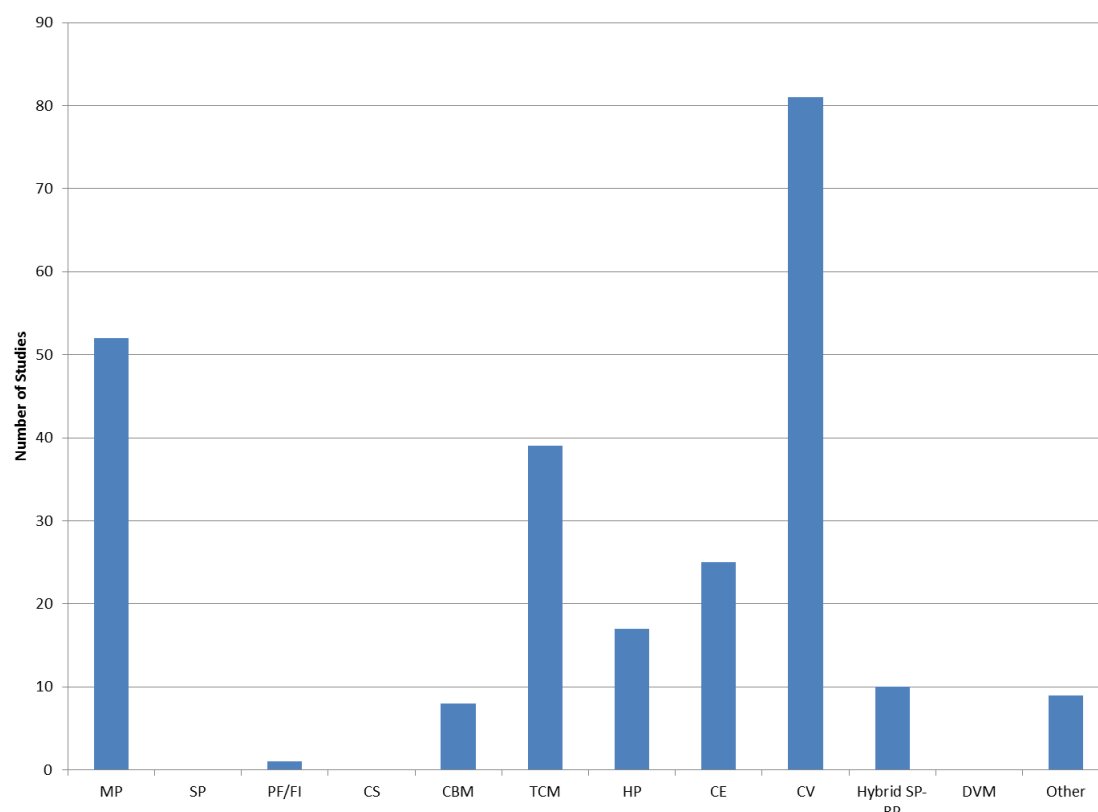


Figure 4 Distribution of studies by choice of valuation method.* Note: some studies utilised more than one method.



*MP=Market Price (e.g. ex-vessel prices; rents, expenditures, bioeconomic models using market data); SP=Shadow Price; PF/FI=Production Function/Factor Income; CS=Conservation Spending; CBM=Cost-Based Methods (e.g. replacement cost, avoided cost, damage cost); TCM=Travel Cost Methods (including site choice & random utility models); HP=Hedonic Pricing; CE= Choice Experiment & Choice Modelling; CV=Contingent Valuation; Hybrid SP-RP=Hybrid Stated Preference and Revealed Preference studies; DVM=Deliberative Valuation Methods; Other=any other approach; Grey filled cells represent ES-value combinations that are not expected to be plausible as per Table 1.

Combining these three dimensions yields the results shown in Tables 2-16. ESs for which no primary valuation studies were found are listed in Box 3. The specific studies that make up these tables are listed in Appendix 1. Readers should note that many of these studies included multiple values. This is especially true in studies that economically valued different kinds of recreation (e.g. diving and angling). For the purposes of this paper, however, studies are only listed multiple times in Tables 2-16 and the appendix if the various values were calculated using either a different method and/or elicited a different value type. For example, if a study valued three different kinds of recreational use value using market data, the study would appear a single time in Table 12 and in Appendix 1, whereas if a study valued aesthetic use value and aesthetic non-use value separately, it would appear twice within Table 13 and twice within Appendix 1. Similarly, if a study valued multiple, distinct ecosystem services, it will appear in the table associated with each service valued, as well as the corresponding parts of Appendix 1. A summary across all services, methods, and value types is shown in Table 16.

Box 3 Ecosystem services for which no primary economic valuations were found

<u>Provisioning</u>	<u>Regulating</u>	<u>Cultural</u>
• Genetic Resources	• Air Purification	• Inspiration for Culture, Art & Design
• Ornamental Resources	• Regulation of Water Flows	• Spiritual Experience
	• Biological Control	• Information for Cognitive Development

Table 2 Counts and distribution of studies containing by methodology and value type

ES 1: Seafood⁶ (# of studies*)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	27	0	1	0	1	0	0	4	2	0	0	2
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (37)	27	0	1	0	1	0	0	4	2	0	0	2

*MP=Market Price (e.g. ex-vessel prices; rents, expenditures, bioeconomic models using market data); SP=Shadow Price; PF/FI=Production Function/Factor Income; CS=Conservation Spending; CBM=Cost-Based Methods (e.g. replacement cost, avoided cost, damage cost); TCM=Travel Cost Methods (including site choice & random utility models); HP=Hedonic Pricing; CE= Choice Experiment & Choice Modelling; CV=Contingent Valuation; Hybrid SP-RP=Hybrid Stated Preference and Revealed Preference studies; DVM=Deliberative Valuation Methods; Other=any other approach; Grey filled cells represent ES-value combinations that are not expected to be plausible as per Table 1.

Table 3 Counts and distribution of studies containing by methodology and value type

ES 2: Sea Water (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	1	0	0	0	0	0	0	0	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (1)	1	0	0	0	0	0	0	0	0	0	0	0

⁶ The low number of seafood studies is somewhat to be expected given the focus on using market-based data and the search strings focus on non-market valuation. It does not indicate these are the only attempts that have been made to economically value seafood of course.

Table 4 Counts and distribution of studies containing by methodology and value type

ES 3: Raw Materials (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	3	0	0	0	0	0	0	0	0	0	0	1
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (4)	3	0	0	0	0	0	0	0	0	0	0	1

Table 5 Counts and distribution of studies containing by methodology and value type

ES 5: Medicinal Resources (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	1	0	0	0	0	0	0	0	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (1)	1	0	0	0	0	0	0	0	0	0	0	0

Table 6 Counts and distribution of studies containing by methodology and value type

ES 8: Climate Regulation (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	2	0	0	0	1	0	0	0	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (3)	2	0	0	0	1	0	0	0	0	0	0	0

Table 7 Counts and distribution of studies containing by methodology and value type

ES 9: Disturbance Prevention (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	0	0	0	0	1	0	0	0	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (1)	0	0	0	0	1	0	0	0	0	0	0	0

Table 8 Counts and distribution of studies containing by methodology and value type

ES 11: Waste Treatment (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	0	0	0	0	2	0	1	0	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (3)	0	0	0	0	2	0	1	0	0	0	0	0

Table 9 Counts and distribution of studies containing by methodology and value type

ES 12: Coastal Erosion Prevention (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	0	0	0	0	1	1	2	1	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (5)	0	0	0	0	1	1	2	1	0	0	0	0

Table 10 Counts and distribution of studies containing by methodology and value type

ES 14: Lifecycle Maintenance (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	1	0	0	0	0	0	0	0	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (1)	1	0	0	0	0	0	0	0	0	0	0	0

Table 11 Counts and distribution of studies containing by methodology and value type

ES 15: Gene Pool Protection (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	1	4	0	0	1
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	1	0	0	0
Total (7)	0	0	0	0	0	0	0	1	5	0	0	1

Table 12 Counts and distribution of studies containing by methodology and value type

ES 16: Recreation (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	15	0	0	0	2	38	1	10	28	9	0	3
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (106)	15	0	0	0	2	38	1	10	28	9	0	3

Table 13 Counts and distribution of studies containing by methodology and value type

ES 17: Aesthetic Information (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	0	0	0	0	0	0	3	0	0	1	0	0
Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Total (4)	0	0	0	0	0	0	3	0	0	1	0	0

Table 14 Counts and distribution of studies containing by methodology and value type

ES 21: Cultural Heritage & Identity (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	0	0	0	0	0	0	0	0	0	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	1	0	0	0
Bundled Use & Non-Use Values	0	0	0	0	0	0	0	0	1	0	0	0
Total (2)	0	0	0	0	0	0	0	0	2	0	0	0

Table 15 Counts and distribution of studies containing by methodology and value type

Bundle of Services* (# of studies)												
	MP	SP	PF/FI	CS	CBM	TCM	HP	CE	CV	Hybrid SP-RP	DVM	Other
Use Values	1	0	0	0	0	0	6	0	13	0	0	0
Non-Use Values	0	0	0	0	0	0	0	0	12	0	0	1
Bundled Use & Non-Use Values	1	0	0	0	0	0	4	9	19	0	0	1
Total (67)	2	0	0	0	0	0	10	9	44	0	0	2

*Bundle of services includes all those valuations that are not classified as single ecosystem services (e.g. bundles of services, values of full ecosystems, valuations that are unclear)

Table 16 Summary distribution of primary studies in OECD+ countries by ES type, methodology used, and value type.

ES	Valuation Method																	
	MP	SP	PF/FI	CBM	TCM	HP	CE			CV			Hybrid SP-RP			Other		
	(U)*	(U)	(U)	(U)	(U)	(U)	(U)	(NU)	(B)	(U)	(NU)	(B)	(U)	(NU)	(B)	(U)	(NU)	(B)
Seafood	27	0	1	1	0	0	4	0	0	2	0	0	0	0	0	2	0	0
Sea Water	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Raw Materials	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Genetic Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medicinal Resources	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ornamental Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Purification	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Climate Regulation	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disturbance Prevention & Moderation	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulation of Water Flows	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste Treatment	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Coastal Erosion Prevention	0	0	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0
Biological Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lifecycle Maintenance	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gene Pool Protection	0	0	0	0	0	0	0	1	0	0	4	1	0	0	0	0	1	0
Recreation	15	0	0	2	38	1	10	0	0	28	0	0	9	0	0	3	0	0
Aesthetic Information	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0
Inspiration for Culture, Art & Design	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiritual Experience	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Information for Cognitive Development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cultural Heritage & Identity	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0

* Value types indicated in parentheses: U=use value; NU=non-use value; B=bundle of use and non-use values; Orange-coloured cells indicate less than 5 studies were found; Yellow-coloured cells indicate that more than 5, but less than or equal to 10 studies were found; Green-coloured cells indicate that more than 10 studies were found. Note that methods that had no associated studies for any service (e.g. conservation spending and deliberative valuation) were removed from this table. Studies that valued bundles of services were also excluded from this table.

Discussion & Conclusion

In total, this review considered 187 unique, primary marine non-market studies conducted in the countries shown in Box 2 that were published between 1975 and 2011. This review classified them according to the methodology used, the ES (or effective ES) valued, and the value type estimated. The results did not contradict the anticipated set of plausible ES-value type combinations (Table 1). The results also highlight that there are many significant and sizeable gaps in the marine ES literature. In terms of ESs, the gaps are particularly noticeable in the context of the cultural ESs (other than recreation), though there are also notable gaps for a range of services that are associated with fewer than 5 primary valuation studies. There are also notable absences of value estimates with regards to ornamental resources and several regulating services. Particularly with regards to ornamental resources, this may reflect important underlying gaps in knowledge related to the supply of the service (e.g. aquarium species, sea shells, etc.). These gaps in knowledge regarding the nature and supply of this ES would need to be filled prior to eliciting an economic value associated with changes to the supply of this ES.

In terms of methods, it is clear that there is a long history of utilizing contingent valuation, travel cost models (including random utility site choice models), and hedonic pricing in the context of economically valuing different features of the marine environment (as well as changes to those features), but there are significantly fewer examples of CE studies being utilized, despite CE studies being the only non-market valuation method that is capable of evaluating economic preferences for the types of trade-offs that will inevitably be implied by marine environmental change and marine management change. There is significant scope, therefore, to conduct CE studies in marine contexts. Interestingly, the literature search conducted did not yield any examples of deliberative monetary valuation (DMV) being employed in marine contexts through the end of 2011. This may also be an important area for future research, especially in contexts with a strong community and/or community management focus.

The results also show a pool of literature that is primarily focused on use values (Figure 3). The choice of economic valuation methods may partly explain the strong focus on use values. Except for CE and CV, all other methods are capable only of eliciting use values, and as stated previously, of the methods available that can elicit both use and non-use values, only one (i.e. CV) has been applied frequently in the context of marine systems.

Finally, it is important to note that there are a nontrivial number of studies that either valued a bundle of marine ESs or elicited a bundle of economic values (or both), rather than eliciting single value types for single marine ESs. This has important implications in the context of conducting robust benefits transfer in the context of economically analysing the consequences of marine environmental change or marine management. It will be difficult (indeed if not impossible) to justify the transfer of a value from one context to another when the fundamental nature and object of that value cannot be clearly determined in the original study. For all intents and purposes, therefore, the pool of literature that has

the potential to support the valuation of marine ESs through benefits transfer is significantly smaller than the total number of studies considered in this review.

Given the results of this review, it is possible to suggest a number of areas that future research efforts focused on the economic valuation of changes in marine ES provision could target. These are as follows:

- Methodological gaps – future research should seek to improve the number and quality of CEs studies conducted in the context of marine environments in order to improve the available knowledge on preferences for the trade-offs associated with marine management. Research should also explore the application of DMV, particularly in community management contexts where group values may be more relevant to management decisions than individual values.
- Value type gaps – future research should seek to improve the extent to which economic valuation studies can target specific value types. Future research should also endeavour to expand the available pool of knowledge related to marine non-use values, as non-use values remain under-represented in the literature.
- Specific ES gaps – There is scant economic valuation data available for many of the identified marine ESs. As shown in Table 16, there are only a few marine ESs for which more than 10 primary studies conducted in the OECD+ country list could be found from more 35 years of research. Particular attention could be paid to regulating and cultural services, something that will likely require both data gathering related to ES supply, and the completion of new economic valuation studies.

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Appendix 1: List of studies featured in Tables 2-16

#	Ecosystem Service	Study	Value Type	Method*
1	Seafood	Anderson (1989) Economic Benefits of Habitat Restoration: Sea grass and the Virginia hard-shell blue crab fishery. North American Journal of Fisheries Management 9: 140-149	Use	Other (Simulation Model)
2	Seafood	Berman et al (1997) Estimating Net Benefits of Reallocation: Discrete Choice Models of Sport and Commercial Fishing. Marine Resource Economics 12:307-327	Use	Market
3	Seafood	Brown et al (1983) Assessing the Social Costs of Oil Spills: The Amoco Cadiz Case Study. National Oceanic and Atmospheric Administration Report NTIS PB84-100536, Washington, D.C.	Use	Market
4	Seafood	Cordier et al (2011) Quantification of interdependences between economic systems and ecosystem services: an input-output model applied to the Seine estuary. Ecological Economics 70(9):1660-1671	Use	Other (IO Model)
5	Seafood	Dolores et al (2009) Indirect assessment of economic damages from the Prestige oil spill: consequences for liability and risk prevention. Disasters 33(1): 95-109	Use	Market
6	Seafood	Eggert and Olsson (2009) Valuing multi-attribute marine water quality. Marine Policy 33: 201– 206	Use	CE
7	Seafood	Garza et al (2009) Indirect Assessment of Economic Damages from the Prestige Oil Spill: Consequences for Liability and Risk Prevention. Disasters 33(1):95-109	Use	Market
8	Seafood	Groeneveld (2011) Quantifying fishers' and citizens' support for Dutch flatfish management policy. ICES Journal of marine science 68(5):919-928	Use	CE
9	Seafood	Grozholz et al (2011) modelling the impacts of the European green crab on commercial shellfisheries. Ecological Applications 21(3): 915-924	Use	Market
10	Seafood	Hunsicker et al (2010) The Contribution of Cephalopods to Global Marine Fisheries: Can We Have Our Squid and Eat Them Too? Fish and Fisheries 11: 421-438	Use	Market
11	Seafood	Kasperski and Wieland (2009) When is it Optimal to Delay Harvesting? The Role of Ecological Services in the Northern Chesapeake Bay Oyster Fishery. Marine Resource Economics 24: 361-385	Use	Market
12	Seafood	Knowler et al (2002) An Open-Access Model of Fisheries and Nutrient Enrichment in the Black Sea. Marine Resource Economics 16(3): 195 - 217	Use	Market
13	Seafood	Knowler (2005) Re-assessing the costs of biological invasion: Mnemiopsis leidyi in the Black Sea. Ecological Economics 52: 187-199	Use	Market
14	Seafood	Leeworthy and Wiley (2003) Socioeconomic Impact Analysis of Marine Reserve Alternatives for the Channel Islands National Marine Sanctuary. US Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), Special Projects	Use	Market
15	Seafood	Lipton (2008) Economic benefits of a restored oyster fishery in Chesapeake Bay. Journal of Shellfish Research 27(3):619-623	Use	CV

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
16	Seafood	Liu et al (2011) Potential ecological and economic impacts of sea lice from farmed salmon on wild salmon fisheries. <i>Ecological Economics</i> 70(10): 1746-1755	Use	Market
17	Seafood	Loomis (1989) A Bioeconomic Approach to Estimating the Economic Effects of Watershed Disturbance on Recreational and Commercial Fisheries. <i>Journal of Soil and Water Conservation</i> 44(1):83-87	Use	Market
18	Seafood	Lovell and Drake (2009) Tiny Stowaways: Analyzing the economic benefits of a US Environmental Protection Agency Permit Regulating Ballast Water Discharges. <i>Environmental Management</i> 43(3):546-555	Use	CBM
19	Seafood	Merino et al (2009) Bioeconomic model for a three-zone marine protected area: a case study of Medes Islands (northwest Mediterranean). <i>ICES Journal of Marine Science</i> 66(1):147-154	Use	Market
20	Seafood	Morrissey et al (2011) Quantifying the value of multi-sectoral marine commercial activity in Ireland. <i>Marine Policy</i> 35(5): 721-72	Use	Market
21	Seafood	Murillas-Maza et al (2011) The value of open ocean ecosystem: A case study for the Spanish Exclusive economic zone. <i>Natural resources forum</i> 35(2):122-133	Use	Market
22	Seafood	Nobre (2009) An ecological and economic assessment methodology for coastal ecosystem management. <i>Environmental management</i> 44(1):185-204	Use	Market
23	Seafood	Noranarttragoon et al (2011) Value-per-recruit analysis of bighead thornyhead <i>Sebastolobus macrochire</i> caught off the Pacific coast of northern Honshu, Japan. <i>Fisheries Science</i> 77(4): 497-502	Use	Market
24	Seafood	Nunes et al (2003) Monetary Value Assessment of Clam Fishing Management Practices in the Venice Lagoon: Results from a Stated Choice Exercise. <i>Fondazione Eni Enrico Mattei Working Paper Series No. 67.</i>	Use	CE
25	Seafood	Nunes et al (2009) Decomposition of Warm Glow for Multiple Stakeholders: Stated Choice Valuation of Shellfishery Policy. <i>Land Economics</i> 85(3):485-499	Use	CE
26	Seafood	O'Higgins et al (2010) Habitat scale mapping of fisheries ecosystem service values in estuaries. <i>Ecology and Society</i> 15(4):7	Use	Market
27	Seafood	Palmer and Snowball (2009) The Willingness to Pay for Dusky Kob (<i>Argyrosomus Japonicus</i>) Restocking: Using Recreational Linefishing Licence Fees to Fund Stock Enhancement in South Africa. <i>ICES Journal of Marine Science</i> 66	Use	CV
28	Seafood	Pita et al (2008) How to assign a catch value to fishing grounds when fisheries statistics are not spatially explicit. <i>Scientia Marina</i> 4(2):759-770	Use	Market
29	Seafood	Roncin et al (2008) Uses of Ecosystem Services Provided by MPAs: How Much Do They Impact the Local Economy? A Southern Europe Perspective. <i>Journal for Nature Conservation</i> 16: 256-270	Use	Market

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
30	Seafood	Scholz et al (2011) Incorporation of Spatial and Economic Analyses of Human-Use Data in the design of marine protected areas. <i>Conservation Biology</i> 25(3): 485-492	Use	Market
31	Seafood	Smith and Crowder (2005) Valuing Ecosystem Services with Fishery Rents: A Lumped-Parameter Approach to Hypoxia in the Neuse River Estuary. <i>Sustainability</i> 3(11), 2229-2267	Use	Market
32	Seafood	Stal et al (2008) Coastal habitat support to fish and fisheries in Sweden: Integrating ecosystem functions into fisheries management. <i>Ocean and Coastal Management</i> 51(8-9):594-600	Use	PF/FI
33	Seafood	Strand and ASA Analysis & Communication, Inc. (2003) Estimation of Potential Economic Benefits of Cooling Tower Installation at the Diablo Canyon Power Plant. Final Draft Prepared for Pacific Gas and Electric Company, San Francisco, California	Use	Market
34	Seafood	Watson et al (2011) How much fish is being extracted from the oceans and what is it worth? IN: Christensen, M. And J. Maclean (eds) <i>Ecosystem approaches to fisheries: a global perspective</i> . 55-71	Use	Market
35	Seafood	Whitmarsh et al (2008) Marine habitat modification through artificial reefs off the Algarve (southern Portugal): An economic analysis of the fisheries and the prospects for management. <i>Ocean and Coastal Management</i> 51(6):463-468	Use	Market
36	Seafood	Whittington et al (1994) The Economic Value of Improving the Environmental Quality of Galveston Bay. Galveston Bay National estuary Program Publication CBNEP-38. Webster, Texas	Use	Market
37	Seafood	Wielgus et al (2008) Assessing the ecological and economic benefits of a no-take marine reserve. <i>Ecological Economics</i> 67(1):32-40	Use	Market
1	Sea Water	Murillas-Maza et al (2011) The value of open ocean ecosystem: A case study for the Spanish Exclusive economic zone. <i>Natural resources forum</i> 35(2):122-133	Use	Market
1	Raw Materials	Leeworthy and Wiley (2003) Socioeconomic Impact Analysis of Marine Reserve Alternatives for the Channel Islands National Marine Sanctuary. US Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), Special Projects	Use	Other (Unclear)
2	Raw Materials	Morrissey et al (2011) Quantifying the value of multi-sectoral marine commercial activity in Ireland. <i>Marine Policy</i> 35(5): 721-72	Use	Market
3	Raw Materials	Murillas-Maza et al (2011) The value of open ocean ecosystem: A case study for the Spanish Exclusive economic zone. <i>Natural resources forum</i> 35(2):122-133	Use	Market
4	Raw Materials	Nobre (2009) An ecological and economic assessment methodology for coastal ecosystem management. <i>Environmental management</i> 44(1):185-204	Use	Market
0	Genetic Resources			

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
1	Medicinal Resources	Erwin et al (2010) The pharmaceutical value of marine biodiversity for anti-cancer drug discovery. <i>Ecological Economics</i> 70(2):445-451	Use	Market
0	Ornamental Resources			
0	Air Purification			
1	Climate Regulation	Luisetti et al (2011) coastal and marine ecosystem services valuation for policy and management: managed realignment case studies in England. <i>Ocean and Coastal Management</i> 54(3):212-224	Use	CBM
2	Climate Regulation	Murillas-Maza et al (2011) The value of open ocean ecosystem: A case study for the Spanish Exclusive economic zone. <i>Natural resources forum</i> 35(2):122-133	Use	Market
3	Climate Regulation	Shepherd et al (2007) Modelling the effects and economics of managed realignment on the cycling and storage of nutrients, carbon, and sediments in the Blackwater estuary UK. <i>Estuarine Coastal and Shelf Science</i> 73(3-4): 355-367	Use	Market
1	Disturbance Prevention & Moderation	Costanza et al (2008) The Value of Coastal Wetlands for Hurricane Protection. <i>Ambio</i> 37: 241-248	Use	CBM
0	Regulation of Water Flows			
1	Waste Treatment	Breaux et al (1995) Using natural coastal wetlands systems for waste-water treatment - an economic benefit analysis. <i>Journal of Environmental Management</i> 44:285-291.	Use	CBM
2	Waste Treatment	Murillas-Maza et al (2011) The value of open ocean ecosystem: A case study for the Spanish Exclusive economic zone. <i>Natural resources forum</i> 35(2):122-133	Use	CBM
3	Waste Treatment	Poor et al (2007) Exploring the hedonic value of ambient water quality: A local watershed-based study. <i>Ecological Economics</i> 60(4):797-806	Use	HP
1	Erosion Control	Gopalakrishnan et al (2011) the value of disappearing beaches: a hedonic pricing model with endogenous beach width. <i>Journal of environmental economics and management</i> . 61(3): 297-310	Use	HP
2	Erosion Control	Huang and Poor (2004) Welfare Measurement with Individual Heterogeneity: Economic Valuation of Beach Erosion Control Programs Working paper, Department of Economics, University of New Hampshire	Use	CE

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
3	Erosion Control	Parsons and Powell (2001) Measuring the Cost of Beach Retreat. Coastal Management 29: 91-103	Use	HP
4	Erosion Control	Wakefield and Parsons (2003) A Comparison of Nourishment and Retreat Costs on Delaware's Ocean Beaches. NOAA Sea Grant	Use	CBM
5	Erosion Control	Whitehead et al (2009) Measuring the Economic Effects of Sea Level Rise on Beach Recreation. Mitig Adapt Strateg Glob Change (2009) 14:777-792	Use	TCM
0	Biological Control			
1	Lifecycle Maintenance	Luisetti et al (2011) coastal and marine ecosystem services valuation for policy and management: managed realignment case studies in England. Ocean and Coastal Management 54(3):212-224	Use	Market
1	Gene Pool Protection	Hannesson et al (2009) Ecological and Economic Considerations in the Conservation and Management of the Pacific Sardine (<i>Sardinops Sagax</i>). Canadian Journal of Fisheries and Aquatic Sciences 66(5):859-868	Non-Use	Other
2	Gene Pool Protection	Nunes et al (2009) Decomposition of Warm Glow for Multiple Stakeholders: Stated Choice Valuation of Shellfishery Policy. Land Economics 85 (3): 485-499	Non-Use	CE
3	Gene Pool Protection	Ressurreicao, Adriana, James Gibbons, Tomaz Ponce Dentinho, Michel Kaiswer, Ricardo S. Santos, and Gareth Edwards-Jones (2011) Economic valuation of species loss in the open sea. Economic economics 70(4):729-739	Non-Use	CV
4	Gene Pool Protection	Solomon et al (2004) The Florida manatee and eco-tourism: toward a safe minimum standard. Ecological Economics 50: 101- 115.	Non-Use	CV
5	Gene Pool Protection	Stithou (2009) Respondent Certainty and Payment Vehicle Effect in Contingent Valuation: an Empirical Study for the Conservation of Two Endangered Species in Zakynthos Island, Greece	Non-Use	CV
6	Gene Pool Protection	Scandizzo and Ventura (2010) Estimating the value of natural resources under legal constraints: an application to marine resources in Sicily. Applied Economics Letters. 17(4): 317-323	Bundle	CV
7	Gene Pool Protection	Tisdell et al (2005) Public Valuation and Attitudes towards the Conservation and Use of the Hawksbill Turtle: An Australian Case Study. Working Paper No. 124. Economics, Ecology, and the Environment. The University of Queensland	Non-Use	CV
1	Recreation	Agnello (1988) The Economic Value of Fishing Success: An Application of Socioeconomic Survey Data. Fishery Bulletin 87(1):223-233	Use	TCM
2	Recreation	Barry, Luke, van Rensburg, Tom M., Hynes, Stephen (2011) Improving the recreational value of Ireland's coastal resources: a contingent behavioural application. Marine Policy 35(6): 764-771	Use	TCM

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
3	Recreation	Bell and Leeworthy (1986) An economic analysis of the importance of saltwater beaches in Florida. Sea Grant Project No. R/C-P-12. Department of Economics, Florida State University, Tallahassee	Use	Market
4	Recreation	Bell et al (1982) The Economic Impact and Valuation of Saltwater Recreational Fisheries in Florida. Report No. 47, Florida Sea Grant College	Use	CV
5	Recreation	Bell et al (2008) Assessing the marginal dollar value losses to an estuarine ecosystem from an aggressive alien invasive crab. A contributed paper to the AARES 52. Annual Conference 5-8 February 2008, Rydges Lakeside, Canberra, ACT	Use	CE
	Recreation	Ibid	Bundle	CE
6	Recreation	Bennear et al (2005) Using revealed preferences to infer environmental benefits: evidence from recreational fishing licenses. Journal of Regulatory Economics 28(2):157-179	Use	Other
7	Recreation	Bergstrom et al (2004) Estuary Management and Recreational Fishing Benefits. Coastal Management 32(4):417-432	Use	Hybrid RP-SP
8	Recreation	Bhat (2003) Application of non-market valuation to the Florida Keys marine reserve management. Journal of Environmental Management 67(4):315-325	Use	Hybrid RP-SP
9	Recreation	Bin et al (2005) Some Consumer Surplus Estimates for North Carolina Beaches. Marine Resource Economics 20:145-161	Use	TCM
10	Recreation	Bin et al (2007) Measuring the Impacts of Climate Change on North Carolina Coastal Resources. Final Report prepared for: National Commission on Energy Policy, Washington, DC.	Use	TCM
11	Recreation	Blackwell (2007) the value of a recreational beach visit: an application to mooloolaba beach and comparisons with other outdoor recreation sites. Economic Analysis & Policy. 37(1):77-98.	Use	TCM
12	Recreation	Bockstael et al (1987) Estimating the Value of Water Quality Improvements in a Recreational Demand Framework. Water Resources Research 23(5): 951-960	Use	TCM
	Recreation	Ibid	Use	CE
13	Recreation	Bockstael et al (1988) Benefits from Improvements in Chesapeake Bay Water Quality (Volume I-III). Office of Policy and Resource Management, US Environmental Protection Agency, Washington, DC	Non-Use	CV
	Recreation	Ibid	Bundle	CV
	Recreation	Ibid	Use	TCM
	Recreation	Ibid	Use	CV
14	Recreation	Bockstael et al (1989) A Random Utility Model for Sport fishing: Some Preliminary Results for Florida. Marine Resource Economics 6(3):245-260	Use	TCM
15	Recreation	Bockstael et al (1990) Sample Selection Bias in the Estimation of Recreation Demand Functions: An Application to Sport fishing. Land Economics 66(1):40-49	Use	TCM

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
16	Recreation	Brandolini (2006) Investing in biodiversity: The recreational value of a natural coastal area. <i>Chemistry and Ecology</i> . 22(S1):S443-S462	Use	CV
17	Recreation	Brandolini (2009) Recreational demand functions for different categories of beach visitor. <i>Tourism Economics</i> Volume 15(2):339-365	Use	CV
18	Recreation	Brau (2008) Demand-driven sustainable tourism? A choice modelling analysis. <i>Tourism Economics</i> 14(4): 691-708.	Use	CE
19	Recreation	Brown et al (1983) Assessing the Social Costs of Oil Spills: The Amoco Cadiz Case Study. National Oceanic and Atmospheric Administration Report NTIS PB84-100536, Washington, D.C.	Use	TCM
	Recreation	Ibid	Use	CBM
20	Recreation	Cameron (1988) Using the Basic "Auto-Validation" model to Assess the Effect of Environmental Quality on Texas Recreational Fishing Demand: Welfare Estimates. UCLA Working Paper No. 522 (September)	Use	Hybrid RP-SP
21	Recreation	Cameron and James (1987) Efficient Estimation Methods for "closed-ended" contingent valuation surveys. <i>The Review of Economics and Statistics</i> 69(2):269-276	Use	CV
22	Recreation	Cameron (1988) Empirical Discrete Continuous Choice Modeling for the Valuation of Non-market Resources or Public Goods. UCLA Working Paper No. 503 (September 1988)	Use	Hybrid RP-SP
23	Recreation	Cantrell et al (2004) Recreational anglers' willingness to pay for increased catch rates of Pacific Threadfin (<i>Polydactylus sexfilis</i>) in Hawaii. <i>Fisheries Research</i> 68:149 – 158 .	Use	CV
24	Recreation	Carson et al (2009) A Nested Logit Model of Recreational Fishing Demand in Alaska. <i>Marine Resource Economics</i> 24:101-129	Use	TCM
25	Recreation	Criddle et al (2003) Participation Decisions, Angler Welfare, and the Regional Economic Impact of Sportfishing. <i>Economic Research Institute Study Papers</i> . Paper 226. http://digitalcommons.usu.edu/eri/226	Use	Hybrid RP-SP
26	Recreation	Curtis (2003) Demand for Water-based Leisure Activity. <i>Journal of Environmental Planning and Management</i> 46(1): 65-77	Use	TCM
27	Recreation	Dicken (2010) Socio-economic aspects of boat-based ecotourism during the sardine run within the Pondoland Marine Protected Area, South Africa. <i>African Journal of Marine Science</i> 2010, 32(2): 405–411	Use	TCM
28	Recreation	Edwards and Anderson (1986) Protecting Rhode Island's Coastal Salt Ponds: An Economic Assessment of Downzoning. <i>Coastal Zone Management Journal</i> 14:67-91	Use	Hybrid RP-SP
29	Recreation	Edwards and Carlson (1989) On Estimating Compensation for Injury to Publicly Owned Marine Resources. <i>Marine Resource Economics</i> 6: 27-42	Use	TCM
30	Recreation	Eggert and Olsson (2009) Valuing multi-attribute marine water quality. <i>Marine Policy</i> 33: 201– 206	Use	CE

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
31	Recreation	Farr et al (2011) The efficiency of the environmental management charge in the Cairns management area of the Great Barrier Reef Marine Park. Australian journal of agricultural and resource economics. 55(3): 322-341	Use	TCM
32	Recreation	Font and Lloret (2011) Socioeconomic implications of recreational shore angling for the management of coastal resources in a Mediterranean marine protected area. Fisheries Research 108(1):214-217	Use	CV
33	Recreation	Gao and Hailu (2011) Evaluating the effects of area closure for recreational fishing in a coral reef ecosystem: the benefits of an integrated economic biophysical modeling. Ecological Economics 70: 1735-1745	Use	TCM
34	Recreation	Garza et al (2009) Indirect Assessment of Economic Damages from the Prestige Oil Spill: Consequences for Liability and Risk Prevention. Disasters 33(1) :95-109	Use	Market
35	Recreation	Gillig et al (2003) Joint Estimation of Revealed and Stated Preference Data: An Application to Recreational Red Snapper Valuation. Agricultural and Resource Economics Review 32(2):209-221	Use	Hybrid RP-SP
36	Recreation	Hagemann (1985) Valuing Marine Mammal Populations: Benefit Valuations in a Multi-Species Ecosystem. National Marine Fisheries Services, Southwest fisheries Center. http://creativecommons.org/publicdomain/zero/1.0/	Use	CV
37	Recreation	Halstead et al (1992) Factors Influencing the Willingness to Pay for Coastal Beach Protection. Coastal Management 20: 291-302	Use	CV
38	Recreation	Halstead and Tupper (1989) Demand for beach protection and use in Maine and New Hampshire: a contingent valuation approach. Proc. of Coastal Zone '89.	Use	CV
39	Recreation	Hanemann et al (2004) Southern California Beach Valuation Project	Use	TCM
40	Recreation	Hanley et al (2003) Valuing the Benefits of Coastal Water Quality Improvements Using Contingent and Real Behavior. Environmental and Resource Economics 24: 273–285.	Use	Hybrid RP-SP
41	Recreation	Hannesson et al (2009) Ecological and Economic Considerations in the Conservation and Management of the Pacific Sardine (<i>Sardinops Sagax</i>). Canadian Journal of Fisheries and Aquatic Sciences 66(5):859-868	Use	Other
42	Recreation	Hayes et al (1992) Estimating the Benefits of Water Quality Improvements in the Upper Narragansett Bay. Marine Resource Economics 7:75-85	Use	CV
43	Recreation	Hicks et al (2004) The Economic Benefits of Oyster Reef Restoration in Chesapeake Bay. Final Report Prepared for the Chesapeake Bay Foundation. Chesapeake Bay Foundation	Use	TCM
44	Recreation	Hindsley et al (2011) Addressing onsite sampling in recreational site choice models. Journal of Environmental Economics and management. 62(1):95-110	Use	TCM

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
45	Recreation	Hu et al (2009) Economic Values of Dolphin Exclusions in Hawaii: A Stated Choice Analysis. <i>Marine Resource Economics</i> 24: 61-76	Use	CE
46	Recreation	Hunt et al (2007) Accommodating Complex Substitution Patterns in a Random Utility Model of Recreational Fishing. <i>Marine Resource Economics</i> 22:155-172	Use	TCM
47	Recreation	Johns et al (2004) Socioeconomic Study of Reefs in Martin County, Florida. Hazen and Sawyer Environmental Engineers and Scientists. Available at: http://www.reefbase.org/resource_center/publication/pub_27476.aspx	Use	CV
48	Recreation	Johnston et al (2002) Valuing Estuarine Resource Services Using Economic and Ecological Models: The Peconic Estuary System Study. <i>Coastal Management</i> 30:47-65	Use	TCM
49	Recreation	Judge et al (1995) Valuing Beach Re-nourishment: Is it Preservation? Available at: http://ssrn.com/abstract=31985	Use	CV
50	Recreation	Kim et al (2006) The Distributional Impacts of Recreational Fees: A Discrete Choice Model with Incomplete Data. <i>Land Economics</i> 83(4):561-574	Use	TCM
51	Recreation	King and Potepan (1997) The Economic Value of California's Beaches. Public Research Institute, San Francisco State University	Use	Market
52	Recreation	Kragt et al (2009) Effects of Great Barrier Reef Degradation on Recreational Reef-Trip Demand: A Contingent Behaviour Approach. <i>Australian Journal of Agricultural and Resource Economics</i> 53(2): 213-229.	Use	Hybrid RP-SP
53	Recreation	Landry and Hindsley (2011) Valuing Beach Quality with Hedonic Property Models. <i>Land Economics</i> 87(1):92-108	Use	HP
54	Recreation	Lazarow (2009) Using observed marked expenditure to estimate the value of recreational surfing to the gold coast Australia. Queensland Coastal Conference, 12 – 15 May 2009, Gold Coast	Use	Market
55	Recreation	Lazarow (2007) The value of coastal recreational resources: a case study approach to examine the value of recreational surfing to specific locales. <i>Journal of Coastal Research</i> 50:12-20	Use	Market
56	Recreation	Leeworthy and Bowker (1997) Non-market Economic User Values of the Florida Keys/Key West. National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division, Silver Spring, MD	Use	TCM
57	Recreation	Leeworthy and Wiley (2003) Socioeconomic Impact Analysis of Marine Reserve Alternatives for the Channel Islands National Marine Sanctuary. National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects. 118 pp. plus Appendices	Use	Market
58	Recreation	Leeworthy et al (1989) A Socio-economic Profile of Recreationists at Public Outdoor Recreation Sites in Coastal Areas: Volume 2. National Oceanic and Atmospheric Administration, Rockville, Maryland	Use	CV

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
	Recreation	Ibid	Use	TCM
	Recreation	Ibid	Use	Market
59	Recreation	Lew and Larson (2005) Valuing Recreation and Amenities at San Diego County Beaches. Coastal Management 33(1):71-86	Use	TCM
60	Recreation	Lew and Larson (2008) Valuing a Beach Day with a Repeated Nested Logit Model of Participation, Site Choice, and Stochastic Time Value. Marine Resource Economics 23:233-252	Use	TCM
61	Recreation	Lipton (2003) The Value of Improved Water Quality to Chesapeake Bay Boaters. WP03-16 University of Maryland. Available at: https://www.arec.umd.edu/sites/default/files/_docs/03-16.pdf	Use	CV
62	Recreation	Magnussen and Navrud (1992) Valuing Reduced Pollution of the North Sea. Report B-015-92. Norwegian Agricultural Economics Research Institute	Use	CV
63	Recreation	Merino et al (2009) Bioeconomic model for a three-zone Marine Protected Area - a case study of Medes Islands (northwest Mediterranean). ICES Journal of Marine Science 66(1):147-154	Use	Market
64	Recreation	Moksness et al (2011) Effects of fishing tourism in a coastal municipality: a case study from Risør, Norway. Ecology and Society 16(3):11	Use	Market
65	Recreation	Morrissey et al (2011) Quantifying the value of multi-sectoral marine commercial activity in Ireland. Marine Policy 35(5): 721-727	Use	Market
66	Recreation	Murphy and Bernal (2008) The Impact of Surfing on the Local Economy of Mundaka, Spain. Report for Save the Waves Coalition. Available at: http://www.limmatwave.com/Presse/SurfonomicsStudieMundaka.pdf	Use	Market
67	Recreation	Nunes and van den Bergh (2004) Can People Value Protection against Invasive Marine Species? Evidence from a Joint TC-CV Survey in the Netherlands. Environmental and Resource Economics 28(4): 517-532	Use	TCM
68	Recreation	Nunes et al (2009) Decomposition of Warm Glow for Multiple Stakeholders: Stated Choice Valuation of Shellfishery Policy. Land Economics 85(3):485-499	Use	CE
69	Recreation	Oh et al (2005) A stated preference choice approach to understanding angler preferences for management options. Human Dimensions of Wildlife 10(3): 173-186	Use	CE
70	Recreation	Oh et al (2008) The Economic Value of Scuba-Diving Use of Natural and Artificial Reef Habitats. Society & Natural Resources: An International Journal 21(6): 455-468	Use	CV
71	Recreation	Oh et al (2008) Valuing Visitors' Economic Benefits of Public Beach Access Points. Ocean & Coastal Management 51(12):847-853	Use	CV

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
72	Recreation	O'Higgins et al (2010) habitat scale mapping of fisheries ecosystem service values in estuaries. Ecology and Society 15(4): 7	Use	TCM
73	Recreation	Opaluch et al (1999) Recreational and Resource Economic Values for the Peconic Estuary System. Final Report. Available at: http://www.peconicestuary.org/reports/f53c82ee382e1c988058ee2ae8e47db855b1517e.PDF	Use	TCM
74	Recreation	Parsons et al (2003) Measuring the Economic Benefits of Water Quality Improvements to Recreational Users in Six Northeastern States: An Application of the Random Utility Maximization Model. USEPA, Office of Policy, Economics, and Innovation through Cooperative Agreement	Use	TCM
75	Recreation	Parsons et al (2008) Valuing Beach Closures on the Padre Island National Seashore. Marine Resource Economics 24: 213-235	Use	TCM
76	Recreation	Paudel et al (2005) Opening a Public Recreation Area to Revitalize Coastal Communities and Preserve Natural Resources in Louisiana: The Case of Elmer's Island. Journal of Agricultural and Applied Economics (32(2):475-484	Use	TCM
	Recreation	Ibid	Use	CV
	Recreation	Ibid	Non-Use	CV
77	Recreation	Pendleton et al (2011). Estimating the potential economic impacts of climate change on Southern California beaches. Climatic Change 109(1): 277-298.	Use	TCM
78	Recreation	Rees et al (2010) The value of marine biodiversity to the leisure and recreation industry and its application to marine spatial planning. Marine Policy 34: 868-875	Use	Market
79	Recreation	Rein (1999) An Economic Analysis of Vegetative Buffer Strip Implementation- Case Study: Elkhorn Slough, Monterey Bay, California	Use	CBM
80	Recreation	Roncin et al (2008) Uses of Ecosystem Services Provided by MPAs: How Much Do They Impact the Local Economy? A Southern Europe Perspective. Journal for Nature Conservation 16: 256-270	Use	Market
81	Recreation	Scholz et al (2011) Incorporation of Spatial and 3Economic Analyses of Human-Use Data in the design of marine protected areas. Conservation Biology 25(3): 485-492	Use	Market
82	Recreation	Schuhmann and Schwabe (2004) An Analysis of Congestion Measures and Heterogeneous Angler Preferences in a Random Utility Model of Recreational Fishing. Environmental & Resource Economics 27(4):429-450	Use	TC
83	Recreation	Shivlani et al (2003) Visitor Preferences for Public Beach Amenities and Beach Restoration in South Florida. Coastal Management 31(4):367 - 385	Use	CV

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
84	Recreation	Silberman et al (1992) Estimating Existence Value for Users and Nonusers of New Jersey Beaches. Land Economics. 68(2):225-236	Use	CV
85	Recreation	Smith et al (1997) Marine Debris, Beach Quality and Non-Market Values. Environmental & Resource Economics 10: 223–247	Use	CV
86	Recreation	Swallow and McGonagle (2006) Public Funding of Environmental Amenities: Contingent Choices Using New Taxes or Existing Revenues for Coastal Land Conservation. Land Economics 82(1):56-67	Use	CV
87	Recreation	Tisdell et al (2005) Public Valuation and Attitudes towards the Conservation and Use of the Hawksbill Turtle: An Australian Case Study. Working Paper No. 124. Economics, Ecology, and the Environment. The University of Queensland	Use	CV
88	Recreation	von Haefen et al (2004) Estimation and Welfare Analysis with Large Demand Systems. Journal of Business and Economics Statistics 22(2):194-205	Use	Other
89	Recreation	Whitehead et al (1997) Economic Analysis of Estuarine Quality Improvement: The Albemarle-Pamlico System. Coastal Management 25(1): p. 43-57	Use	TCM
90	Recreation	Whitehead et al (2006) Valuing Beach Access and Width with Revealed and Stated Preference Data. Available at: http://www.wcu.edu/WebFiles/PDFs/Valuing_Beach_Access_and_Width_with_Revealed_and_Stated_Preference_Data_2006.pdf	Use	TCM
91	Recreation	Whitehead et al (2007) Convergent Validity of Revealed and Stated Recreation Behavior with Quality Change: A Comparison of Multiple and Single Site Demands. Working Paper Appalachian State University. Available at: http://www.ncsu.edu/cenrep/research/documents/Whitehead_P_haneuf_July09.pdf	Use	CE
	Recreation	Ibid.	Use	TCM
92	Recreation	Whitehead et al (2009) Measuring the Economic Effects of Sea Level Rise on Beach Recreation. Mitig Adapt Strateg Glob Change (2009) 14:777–792	Use	TCM
93	Recreation	Whitmarsh et al (1999) Recreational Benefits of Coastal Protection: a case study. Marine Policy 23(4):453-464	Use	CV
94	Recreation	Wielgus et al (2003) Effects of Coral Reef Attribute Damage on Recreational Welfare. Marine Resource Economics 18:225-237	Use	CE
95	Recreation	Wielgus et al (2008) Assessing the ecological and economic benefits of a no-take marine reserve. Ecological Economics 67(1):32-40	Use	Market
1	Aesthetic Information	Benson (1998) Pricing Residential Amenities: The Value of a View. Journal of Real Estate Finance and Economics 16(1):55-73.	Use	HP
2	Aesthetic Information	Benson et al (2000) Water Views and Residential Property Values. Appraisal Journal 68:260-271	Use	HP

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
3	Aesthetic Information	Earnhart (2001) Combining Revealed and Stated Preference Methods to Value Environmental Amenities at Residential Locations. Available at: http://www2.ku.edu/~kuwpaper/Archive/papers/Pre1999/wp1998_1.pdf	Use	Hybrid RP-SP
4	Aesthetic Information	Bin et al (2006) Valuing Spatially Integrated Amenities and Risks in Coastal Housing Markets. The Center for Natural Hazards Research. Thomas Harriot College of Arts and Sciences East Carolina University. Available at: http://0-www.wcu.edu.wncln.wncln.org/WebFiles/PDFs/Valuing_Spatially_Integrated_Amenities_and_Risks_in_Coastal_Housing_Markets.pdf	Use	HP
0	Inspiration for Culture, Art & Design			
1	Cultural Heritage & Identity	Tisdell et al (2005) Public Valuation and Attitudes towards the Conservation and Use of the Hawksbill Turtle: An Australian Case Study. Working Paper No. 124. Economics, Ecology, and the Environment. The University of Queensland	Non-Use	CV
2		Whitehead and Finney (2003) Willingness to Pay for Submerged Maritime Cultural Resources. Journal of Cultural Economics 27:231-240.	Bundle	CV
0	Spiritual Experience			
0	Information for Cognitive Development			
1	Bundle of Services**	Bell (1986) Economic policy issues associated with beach renourishment. Policy Studies Review. 6(2):374-381	Use	CV
2	Bundle of Services	Bell and Leeworthy (1986) An economic analysis fo the importance of saltwater beaches in Florida. Sea Grant Project No. R/C-P-12. Department of Economics, Florida State University, Tallahassee	Use	CV
3	Bundle of Services	Bell and Leeworthy (1986) An economic analysis of the importance of saltwater beaches in Florida. Sea Grant Project No. R/C-P-12. Department of Economics, Florida State University, Tallahassee	Use	CV
4	Bundle of Services	Bell et al (2008) Assessing the marginal dollar value losses to an estuarine ecosystem from an aggressive alien invasive crab. A contributed paper to the AARES 52 Annual Conference 5-8 February 2008, Rydges Lakeside, Canberra, ACT	Unclear	CE
5	Bundle of Services	Bin and Polasky (2002) Valuing Coastal Wetlands: A Hedonic Property Price Approach. Working Paper, East Carolina University	Use	HP
6	Bundle of Services	Bin and Polasky (2005) Evidence on the Amenity Value of Wetlands in a Rural Setting. Journal of Agricultural and Applied Economics 37(3):589-602	Bundle	HP

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
7	Bundle of Services	Carson et al (1994) Prospective Interim Lost Use Value due to DDT and PCB Contamination in the Southern California Bight. A report of Natural Resource Damage Assessment, Inc. and Industrial Economics, Inc. to the National Oceanic and Atmospheric Administration pursuant to Task Order 56-DGNC-3-50070 of NOAA Contract No. 50-DGNC-1-00007	Bundle	CV
8	Bundle of Services	Carson et al (1995) Temporal Reliability of Estimates from Contingent Valuation. Duke Economics Working Paper #95-05. Available at: http://public.econ.duke.edu/Papers//Abstracts/abstract.95.05.html	Bundle	CV
9	Bundle of Services	Carson et al (2003) Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill. Environmental & Resource Economics 25: 257–286	Bundle	CV
10	Bundle of Services	Conroy and Milosch (2011) an estimation of the coastal premium for residential housing prices in San Diego County. Journal of real estate finance and economics 42(2):211-228	Bundle	HP
11	Bundle of Services	Edwards-Jones et al (1995) A Comparison of Contingent Valuation Methodology and Ecological Assessment as Techniques for Incorporating Ecological Goods into Land-Use Decisions. Journal of Environmental Planning and Management. 38(2): 215-230	Use	CV
12	Bundle of Services	Eggert and Olsson (2009) Valuing multi-attribute marine water quality. Marine Policy 33: 201– 206	Bundle	CE
13	Bundle of Services	Giraud et al (2002) Economic benefit of the protection program for the Steller sea lion. Marine Policy 26:451-458	Non-Use	CV
14	Bundle of Services	Groeneveld, Rolf A. (2011) Quantifying fishers' and citizens' support for Dutch flatfish management policy. ICES Journal of marine science 68(5):919-928	Bundle	CE
15	Bundle of Services	Hagemann (1985) Valuing Marine Mammal Populations: Benefit Valuations in a Multi-Species Ecosystem. National Marine Fisheries Services, Southwest fisheries Center. Available at: http://creativecommons.org/publicdomain/zero/1.0/	Non-Use	CV
16	Bundle of Services	Hall et al (2002) Contingent Valuation of Marine Protected Areas: Southern California Rocky Intertidal Ecosystems. Coastal Management 30(2):47-65	Use	CV
17	Bundle of Services	Hicks et al (2004) The Economic Benefits of Oyster Reef Restoration in Chesapeake Bay. Final Report Prepared for the Chesapeake Bay Foundation. Chesapeake Bay Foundation	Bundle	CV
18	Bundle of Services	Jorgensen (2010) Ecosystem Services, Sustainability and Thermodynamic Indicators. Ecological Complexity 7 (2010) 311–313	Bundle	Market
19	Bundle of Services	Kotchen and Reiling (2000) Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species. Ecological Economics 32:93-107	Non-Use	CV

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
20	Bundle of Services	Kriesel et al (2000) Costs of Coastal Hazards: Evidence from the Property Market. Paper presented at the American Agricultural Economics Association Annual Meeting, Orlando, Florida. Available at: http://ageconsearch.umn.edu/bitstream/21745/1/sp00kr01.pdf	Use	HP
21	Bundle of Services	Kriesel et al (2004) Financing Beach Improvements: Comparing Two Approaches on the Georgia Coast. Coastal Management 32(4): 433-447	Use	CV
22	Bundle of Services	Kriesel et al (2005) Coastal Erosion Management from a Community Economics Perspective: The Feasibility and Efficiency of User Fees. Journal of Agricultural and Applied Economics 37(2): 451-461	Use	CV
23	Bundle of Services	Krueger et al (2011) valuing the visual disamenity of offshore wind power projects at varying distances from the shore: an application on the Delaware shoreline. Land economics 87(2): 268-283	Bundle	CE
24	Bundle of Services	Landry et al (2003) An Economic Evaluation of Beach Erosion Management Alternative. Marine Resource Economics 18:105-127	Use	HP
25	Bundle of Services	Landry and Hindsley (2011) Valuing Beach Quality with Hedonic Property Models. Land Economics 87(1):92-108	Use	HP
26	Bundle of Services	Le Goffe (1995) The Benefits of Improvements in Coastal Water Quality: A Contingent Approach. Journal of Environmental Management 45(4):305-317	Bundle	CV
27	Bundle of Services	Liu and Wirtz (2010) Managing coastal area resources by stated choice experiments. Estuarine, Coastal and Shelf Science 86 (2010) 512–517	Unclear	CE
28	Bundle of Services	Loomis and Larson (1994) Total Economic Values of Increasing Gray Whale Populations: Results from a Contingent Valuation Survey of Visitors and Households. Marine Resource Economics 9:275-286	Bundle	CV
29	Bundle of Services	Luisetti et al (2011) coastal and marine ecosystem services valuation for policy and management: managed realignment case studies in England. Ocean and Coastal Management 54(3):212-224	Bundle	CE
30	Bundle of Services	Major and Lusht (2004) Beach Proximity and the Distribution of Property Values in Shore Communities. The Appraisal Journal 72(4):333	Bundle	HP
31	Bundle of Services	Markowska and Zyliez (1999) Costing an international public good: the case of the Baltic Sea. Ecological Economics 30:301-3016	Bundle	CV
32	Bundle of Services	McVittie and Moran (2010) Valuing the non-use benefits of marine conservation zones: An application to the UK Marine Bill. Ecological Economics 70 (2010) 413–424	Bundle	CE
33	Bundle of Services	Milon and Scrogin (2006) Latent preferences and valuation of wetland ecosystem restoration. Ecological Economics 56(2):162-175	Bundle	CE

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method*
34	Bundle of Services	Mortimer et al (1996) Assessing the conservation value of New Zealand's Offshore Islands. <i>Conservation Biology</i> 10(1): 25-29	Bundle	CV
35	Bundle of Services	Nunes (2002) Using factor analysis to identify consumer preferences for the protection of a natural area in Portugal. <i>European Journal of Operational Research</i> 140(2):499-516.	Use	CV
	Bundle of Services	Ibid	Bundle	CV
	Bundle of Services	Ibid	Non-Use	CV
36	Bundle of Services	Nunes and van den Bergh (2004) Can People Value Protection against Invasive Marine Species? Evidence from a Joint TC-CV Survey in the Netherlands <i>Environmental and Resource Economics</i> 28(4): 517-532	Bundle	CV
	Bundle of Services	Ibid	Bundle	CV
37	Bundle of Services	Parsons et al (2003) The value of conserving whales: the impacts of cetacean-related tourism on the economy of rural west Scotland. <i>Aquatic Conservation: Marine and Freshwater Ecosystems</i> 13(5):397-415	Use	Market
38	Bundle of Services	Pate and Loomis (1997) The effect of distance on willingness to pay values: a case study of wetlands and salmon in California. <i>Ecological Economics</i> 20:199 -207	Bundle	CV
39	Bundle of Services	Perni et al (2011) Economic valuation of coastal lagoon environmental restoration: Mar Menor (SE Spain). <i>Ciencias marinas</i> 37(2):175-190	Use	CV
	Bundle of Services	Ibid	Non-Use	CV
40	Bundle of Services	Petrolia, Daniel R. And Tae-Guon Kim (2011) preventing land loss in coastal Louisiana: estimates of WTP and WTA. <i>Journal of environmental management</i> 92(3): 859-865	Bundle	CV
41	Bundle of Services	Pompe and Rinehart (1994) Estimating the effect of wider beaches on coastal housing prices. <i>Ocean and Coastal Management</i> 22: 141-152.	Use	HP
42	Bundle of Services	Punt et al (2009) Spatial planning of offshore wind farms: a windfall to marine environmental protection? <i>Ecological Economics</i> 69(1):93-103	Bundle	Other
43	Bundle of Services	Rowe et al (1992) Contingent Valuation of Natural Resource Damage due to the Nestucca Oil Spill. Final report, Boulder, CO. In: Ward, K. and J. Duffield (eds). <i>Natural Resource Damages</i> , New York: Wiley and Sons	Use	CV
	Bundle of Services	Ibid	Non-Use	CV
44	Bundle of Services	Rush and Bruggink (2000) The Value of Ocean Proximity on Barrier Island Houses. <i>Appraisal Journal</i> 68(2):142	Bundle	HP

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method *
45	Bundle of Services	Samples et al (1986) Information Disclosure and Endangered Species Valuation. Land Economics 62(3): 306–312	Non-Use	CV
46	Bundle of Services	Silberman et al (1992) Estimating Existence Value for Users and Nonusers of New Jersey Beaches. Land Economics. 68(2):225-236	Use	CV
47	Bundle of Services	Smith et al (1997) Marine Debris, Beach Quality and Non-Market Values. Environmental & Resource Economics 10: 223–247	Non-Use	CV
48	Bundle of Services	Stevens et al (1991) Measuring the Existence Value of Wildlife: What do CVM estimates really show? Land Economics 67(4): 390-400	Non-Use	CV
49	Bundle of Services	Strand and ASA Analysis & Communication, Inc. (2003) Estimation of Potential Economic Benefits of Cooling Tower Installation at the Diablo Canyon Power Plant. Report for Pacific Gas and Electric Company	Non-Use	Other
50	Bundle of Services	Togridou et al (2006) Determinants of visitors' willingness to pay for the National Marine Park of Zakynthos, Greece Netherlands. Ecological Economics 60:308–319	Bundle	CV
51	Bundle of Services	van Biervliet et al (2006) An Accidental Oil Spill Along the Belgian Coast: Results from a CV Study. FEEM working paper 2006.041	Bundle	CV
52	Bundle of Services	Wang (1997) Treatment of 'Don't-Know' Responses in Contingent Valuation Surveys: A Random Valuation Model. Journal of Environmental Economics and Management 32:219-232.	Use	CV
53	Bundle of Services	Wang (1997) Treatment of 'Don't-Know' Responses in Contingent Valuation Surveys: A Random Valuation Model. Journal of Environmental Economics and Management 32:219-232.	Non-Use	CV
54	Bundle of Services	Wattage et al (2011) Economic value of conserving deep sea corals in Irish waters: a choice experiment study on marine protected areas. Fisheries Research 107: 59-67	Bundle	CE
55	Bundle of Services	White et al (1997) Economic Values of Threatened Mammals in Britain: A Case Study of the Otter Lutra lutra and the Water Vole Arvicola terrestris. Biological Conservation 82:345-354	Non-Use	CV
56	Bundle of Services	Whitehead (1992) Ex ante willingness to pay with supply and demand uncertainty: implications for valuing a sea turtle protection programme. Applied Economics 24(9):981-988	Bundle	CV
57	Bundle of Services	Whitehead (1993) Total economic values for coastal and marine wildlife: Specification, validity, and valuation issues. Marine Economics 8(2):119-132	Bundle	CV
58	Bundle of Services	Whitehead et al (1995) Assessing the Validity and Reliability of Contingent Values: A Comparison of On-Site Users, Off-Site Users, and Non-users. Journal of Environmental Economics and Management 29:238-251	Use	CV
	Bundle of Services	Ibid	Non-Use	CV
59	Bundle of Services	Whitehead et al (1997) Economic Analysis of Estuarine Quality Improvement: The Albemarle-Pamlico System. Coastal Management 25(1): p. 43-57	Bundle	CV

Appendix 1 Continued: List of studies reviewed

#	Ecosystem Service	Study	Value Type	Method *
60	Bundle of Services	Whitehead et al (1998) Construct validity of dichotomous and polychotomous choice contingent valuation questions. Environmental and Resource Economics 11(1):107-116.	Bundle	CV
61	Bundle of Services	Whittington et al (1994) The Economic Value of Improving the Environmental Quality of Galveston Bay. Galveston Bay National estuary Program Publication CBNEP-38. Webster, Texas	Use	CV
	Bundle of Services	Ibid	Non-Use	CV
62	Bundle of Services	Woglom (2003) The Dynamics of Shoreline Management: An Approach Using Renewable Resource Economics. Master's Thesis for the Master of Environmental Management degree in the Nicholas School of the Environment and Earth Sciences of Duke University. http://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/275/Woglom%20MP%202003.pdf?sequence=1	Use	HP

* MP=Market Price (e.g. ex-vessel prices; rents, bioeconomic models using market data); SP=Shadow Price; PF/FI=Production Function/Factor Income; CS=Conservation Spending; CBM=Cost-Based Methods (e.g. replacement cost, avoided cost, damage cost); TCM=Travel Cost Methods (including site choice & random utility models); HP=Hedonic Pricing; CE/CM = Choice Experiment & Choice Modelling; CV=Contingent Valuation; Hybrid SP-RP=Hybrid Stated Preference and Revealed Preference studies; DVM=Deliberative Valuation Methods; Other=any other approach; Grey filled cells represent ES-value combinations that are not expected to be plausible as per Table 1. **Bundle of services includes all those valuations that are not classified as single ecosystem services (e.g. bundles of services, values of full ecosystems, valuations that are unclear)