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RESEARCH ARTICLE

Inter-country differences in the cultural ecosystem services provided by cockles

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Abstract

1. Coastal systems provide many cultural ecosystem services (CES) to humans. Fewer studies have focused solely on CES, while those comparing CES across countries are even rarer. In the case of shellfish, considerable ecosystem services focus has been placed on nutrient remediation, with relatively little on the cultural services provided, despite strong historical, cultural, social and economic links between shellfish and coastal communities. The ecosystem services provided by the common cockle, *Cerastoderma edule*, have recently been described, yet the cultural benefits from cockles remain mostly unknown.
2. Here, we documented the CES provided by *C. edule* in five maritime countries along the Atlantic coast of western Europe, classifying evidenced examples of services into an a priori framework. The high-level classes, adapted from the Millennium Assessment and the Common International Classification of Ecosystem Services, were: inspirational, sense of place, spiritual & religious, aesthetic, recreation & ecotourism, cultural heritage and educational. A further 19 sub-classes were defined. We followed a narrative approach to draw out commonalities and differences among countries using a semi-quantitative analysis.
3. Examples of CES provided by cockles were found for all classes in most countries. Cockles supply important and diverse cultural benefits to humans across Atlantic

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Europe, making it an ideal model species to study CES in coastal areas. Most examples were in cultural heritage, highlighting the importance of this class in comparison with classes which typically receive more attention in the literature like recreation or aesthetics. We also found that the cultural associations with cockles differed among countries, including between neighbouring countries that share a strong maritime heritage. The extent to which cultural associations were linked with the present or past also differed among countries, with stronger association with the present in southern countries and with the past in the north.

4. Understanding the wider benefits of cockles could deepen the recognition of this important coastal resource, and contribute to promoting sustainable management practices, through greater engagement with local communities. This study is an important step towards better integration of CES in coastal environments and could be used as a framework to study the CES of other species or ecosystems.

KEYWORDS

bivalves, *Cerastoderma edule*, cultural heritage, nature's contributions to people, non-material benefits, shellfish

1 | INTRODUCTION

Cultural ecosystem services (CES) encompass 'the non-material services of ecosystems that affect the physical and mental well-being of people' (Fish et al., 2016; Haines-Young & Potschin, 2017). Shaped by human–nature interactions (Jones et al., 2016), CES are obtained from the ecosystem through 'spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences' (Millenium Ecosystem Assessment (MEA), 2005). Despite the increasing number of studies addressing CES, these are some of the most challenging ecosystem services to characterise, quantify, integrate and link to specific ecosystem attributes (Blicharska et al., 2017; Daniel et al., 2012; Gould et al., 2019). CES differ from other ecosystem services as they are hard to define, mostly not observable, particularly difficult to link with changes in natural environmental processes and lack distinct measurement boundaries (Cooper et al., 2016; Fish et al., 2016). Research on CES is often limited to recreational and aesthetic indicators as these are more easily quantified (Hernández-Morcillo et al., 2013; Milcu et al., 2013), widening the division between what is perceived to be important to people and what is actually studied (Milcu et al., 2013). Useful alternatives exist for describing values associated with CES, such as linking biophysical attributes to experiential qualities of a landscape. However, these approaches predominantly focus on the landscape (Bieling & Plieninger, 2013; Norton et al., 2012) and rarely include the whole range of CES. There is thus a lack of quantitative assessment of the whole range of CES due to difficulties in adopting a suitable methodology and tangible indicators (but see Cabana et al., 2020). In addition, most of the research on CES remains largely focused on terrestrial ecosystems with little attention to the coastal environment (Drakou et al., 2017; Rodrigues et al., 2017).

Some 40% of the world's human population lives in coastal areas (UNEP, 2006) and coastal habitats provide the society with a range of goods and services that are both economically and socially important to human well-being (Costanza, 1999; van der Schatte Olivier et al., 2018). As well as provisioning, regulating and supporting services, marine and coastal ecosystems provide a number of CES that are greatly appreciated by the public and people who depend on them for their livelihood (Ahtiainen et al., 2019; Brookfield et al., 2005; Paracchini et al., 2014). Activities such as harvest and aquaculture production of finfish and shellfish provide economic, social and cultural goods especially in remote and economically disadvantaged coastal areas (Krause et al., 2018; Urquhart et al., 2014). As such, a strong cultural identity is often found within fishing communities and the practice of fishing is frequently characterised across multiple generations as a way of life rather than a means of earning a living (Brookfield et al., 2005; Urquhart et al., 2014; van Ginkel, 2001). Similarly, bivalve culture has been shown to act as a crucial activity for local 'meaning-making' shaping the cultural identities of place and ownership (Krause et al., 2018).

Universal classifications of CES such as the Millennium Ecosystem Assessment (2005) and the Common International Classification of Ecosystem Services (CICES; Haines-Young & Potschin, 2018) are useful tools for comparative studies, particularly beyond national scales. The relative importance of CES may vary across nations and individuals with diverse socio-economic backgrounds (Ahtiainen et al., 2019; Brown & Hausner, 2017; Czajkowski et al., 2015; Milcu et al., 2013; Paracchini et al., 2014). Cultural heritage, for instance, is intricately linked with history and human experiences and, as a result, heritage associations with the same ecosystem features are likely to vary across cultures (Daniel et al., 2012). For example, CES provided by the Baltic Sea marine environment were perceived differently across countries, and between users and nonusers of the Baltic Sea (Ahtiainen et al., 2019). Cross-country differences were attributed to the characteristics of the three countries (including

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size and population density) as well as cultural factors (Ahtiainen et al., 2019). Strong local anchoring of cultural traditions may also play a role. Recreational activity has received the most attention in cross-country comparisons in the literature, and there is a need to assess other types of CES, using a variety of approaches that take into account the complexity of definitions and interpretations of CES.

Comprehensive assessments of the suite of ecosystem services provided by shellfish for both cultured and wild-harvested bivalve species (see Carss et al., 2020; Smaal et al., 2019; van der Schatte Olivier et al., 2018) highlight that the importance of cultural services provided by bivalves is gaining increasing recognition. It has been suggested that knowledge of CES is more likely to motivate engagement from the public in restoration or new aquaculture initiatives than knowledge of provisioning, regulating or supporting services (Michaelis et al., 2020). Yet the CES associated with bivalves still remain poorly researched and quantified (Carss et al., 2020; van der Schatte Olivier et al., 2018).

The common cockle, *Cerastoderma edule*, is one of the dominant non-cultured bivalve species harvested along western European coastlines, and has a broad distribution extending from the coast of West Africa to Norway (Dabouineau & Ponsero, 2009; Malham et al., 2012). Related species are distributed world-wide and provide similar ecological roles. This cultural relevance to individuals and society is reflected in evidence of interactions passing down generations through historical, contemporary art and the folklore associated with them (Carss et al., 2020). It is clear, however, that further work is needed for a more holistic understanding of CES in cockles, especially beyond national borders.

In this study, we aimed to collate evidence for the contribution of the common cockle *C. edule* to human well-being and society among countries along the European Atlantic Coast. The specific aims of this study were to: (a) develop a structured approach to quantifying CES; (b) use that structured approach to collate examples of the wider benefits of cockles to humans and (c) explore inter-country differences in the social and cultural benefits gained from cockles. The intention was to draw on the accumulated knowledge of experts and stakeholders with a strong understanding and experience of cockles, rather than a survey of public perceptions of cockles.

2 | METHODS

The study was performed through a face-to-face workshop, and a series of virtual meetings and follow-up activities with small in-country teams of experts and stakeholders from five countries: France, Ireland, Portugal, Spain and the UK. The study was co-ordinated as part of a research and industry collaboration, under the COCKLES project 'Co-operation for restoring cockle shellfisheries and its ecosystem services in the Atlantic Area', co-funded through the European Regional Development Fund (ERDF). The participating institutions comprise many of the main research, governmental and non-governmental organisations working on cockles in the five countries. Participants in the study included (numbers of participants in brackets): members of non-governmental organisations (3), representatives of regulatory bodies (7), representatives from eight different cockle fisheries co-operatives (11), social scientists (3), economists (3), natural scientists covering a range of expertise from ecology, biogeochemistry, hydrodynamic modelling to genetics and disease (22), and a few less easily classified stakeholders including a chef, archaeologists and an anthropologist (4). The first meeting comprised a face-to-face workshop held in Vigo in north-west Spain, 10 April 2018, with 28 participants from 11 organisations. Recognising that the terminology used in ecosystem services is not always clear (Norgaard, 2010), a presentation was given at the start to all participants illustrating examples visually and using everyday language to describe the different types of information being sought in the workshop. Participants were then split into three groups, each focusing on 2–3 sub-categories in the classification: Group 1: Aesthetic, Inspirational; Group 2: Sense of place, Recreation & Ecotourism; Group 3: Spiritual & Religious, Cultural heritage, Educational. Group membership was designed to ensure a diversity of country representatives and expertise in each, particularly balancing natural science and other perspectives, and each group had a facilitator to guide the discussion. After the group work, each group reported back followed by further discussion of ideas and examples among all participants in plenary. As described above, the aim was not to get independent information from different individuals or groups, but to achieve a common understanding of the task from many different perspectives, and to stimulate creative thinking about cultural benefits of the cockle. The collective view here aims for a better reflection of CES provided by cockles than could be gained from individual responses, as the deliberative process can help reveal shared values and the more elusive details of CES (Fish et al., 2011; Gould et al., 2019; Kenter, Bryce, et al., 2016). The workshop was followed up over the following months by smaller country-specific meetings, mostly held by teleconference call or video call and by email. Each country completed their entries in the template spreadsheet provided. Once this first draft was completed, it was circulated to all participants (again to stimulate missed ideas). This was followed up by a second round of smaller focused meetings with a representative from each country to check on potential information gaps. The role of the facilitators in both the initial workshop and subsequent follow-up meetings was to ensure balanced discussion, in order to minimise 'social desirability bias' emerging in the examples provided (Kaplowitz & Hoehn, 2001; Raymond et al., 2014).

An a priori framework defined the major classes and sub-classes of CES broadly based on the Common International Classification of Ecosystem Services and Millennium Ecosystem Assessment (CICES v5.1; Haines-Young & Potschin, 2017; MEA, 2005; Table 1). The CICES classification included Division, Groups, Class and Class type. CES were divided in two divisions, direct or indirect interactions. These were further categorised into groups (CICES codes in brackets), namely: 'Physical and Experiential (3.1.1)', 'Intellectual and Representative (3.1.2)' for direct interactions, and 'Spiritual or Symbolic (3.2.1)' and other 'non-use (3.2.2)' for indirect interactions.

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The groups were subsequently categorised into classes that we developed and adapted from the Millennium Assessment. From these classes, we then created the sub-classes with a more detailed specification for the CES provided by cockles (Table 1). The framework was tested with pilot data from one country, and revised to accommodate difficulties in assigning examples to classes. The framework was then distributed among participants with the request to document examples from their country, aligned within the framework wherever possible. Examples of CES were collated and checked for possible missing information during the face-to-face workshop and bi-lateral follow-up activities with in-country teams. Examples which did not easily fit the framework could also be suggested. Allocation of examples to classes and sub-classes was checked by the lead authors. At this stage, any un-allocated examples were also assigned to the closest class in the framework. Some specific examples were allocated to different classes depending on what they represented. So, statues and sculptures were assigned to 'symbolic' where they represented a cultural icon or theme, and to 'inspirational' where they were more abstract or artistic. For one sub-class (Education & Research), the method used differed slightly, due to the nature of the data and the most appropriate way to collate this. In order to quantify the scientific literature on cockles, literature searches were run in Web of Science on the 11th November 2020 using '*Cerastoderma edule*' as a search term. Publication records were allocated to the country of origin using the analysis result function of Web of Science. The scientific name was used for two reasons: to pick up the wider scientific literature published in languages other than English, and because the common name 'cockle' is frequently used for other related and un-related species world-wide.

Once collated, examples within each sub-class were then described using a narrative approach. To enable data visualisation, the information for each sub-class was summarised in quantitative form (Tashakkori & Teddlie, 1998), by assigning a score based on the number of examples, ranging from '0' for no cultural service example, '1' for one example, '2' for two examples, '3' for three examples, '4' for four or five examples and '5' for six or more examples. For one sub-class only (Education & Research), the number of publication records was re-scaled linearly from 0 to 5 to match the scale used for visualisation of other classes.

3 | RESULTS

Following the framework described above, all classes of CES were identified in all countries where the assessment was conducted, with one exception where no examples were provided for the *Spiritual & Religious* class in France and in Ireland. A total of 237 examples of CES were collected during the course of the study (Appendix I: Table S1). Across all countries (Figure 1), the CES class that comprised the greatest number of examples was *Cultural heritage* (n = 88) with many examples of *Imagery*, *Gastronomy* and *Cultural practices* associated with cockles. Both *Inspirational* and *Educational* were prominent classes (n = 44 and n = 42) while *Recreation & Ecotourism* was fourth (n = 28), followed by *Aesthetic* (n = 19) and *Sense of place* (n = 12). The CES class with the fewest examples was *Spiritual & Religious* with only four examples given across all five countries. In the following text, we describe the range of evidence found for each sub-class of CES, illustrating this with selected examples, and then draw out commonalities and differences among countries. All the evidence we collated is provided in Appendix I (Table S2), separated by country.

3.1 | Cultural heritage

Cultural heritage yielded the most examples of CES linked to cockles. The largest sub-class within *Cultural heritage* was *Imagery* with 23 examples. Examples of this sub-class include the use of the word for 'cockle' in a wide variety of associations, including names of streets (Figure 2a), race horses, restaurants and place names. In France, many streets are named after the local names for cockle such as 'Rue du Rigadeau' in Britanny and 'Allée des Hénons' in Hauts-de France. Places such as Rooghan in Counties Antrim, Galway and Mayo (Ireland) are towns believed to be named after Ruacan, the Irish name for cockle, due to local presence of a hill or mound that is cockle-shaped. Names of beaches sometimes reflect their high abundance of cockles such as 'lagoa da Birbiricheira' in Carnota (Spain) and 'Praíña dos Croques' in San Cibrán (Spain). The coastal county and town name of Sligo in Ireland means 'abounding in shells' in Irish (*Sligeah*) and refers to the area's historic plenitude of shellfish, including cockles in the river and its estuary, as well as the shellfish middens common to the area. Some names are linked to people and cultural practices. In County Wexford (Ireland), there is a field known as the 'cockle field', named after the owner of the field, an old man who used to gather cockles. The small town of 'Coquebourg' in Normandie (France) is located closed to an old traditional cockle ('coque' in French) fishery. In Spain, the architect who built the 'Arcade of the Glory', in St. James Cathedral was known as 'O home dos croques' (= the man of the cockles) referring to his curly hair, similar to the shell of a cockle (Hodum, 2012).

The second largest sub-class in *Cultural heritage* class was *Cultural practices*, with 15 examples across the five countries. There is a considerable body of evidence around small-scale commercial cockle harvesting practices across Europe documented in books, articles and photography and archive documents from museums (Figure 2b). For instance, in Galicia (Spain), the harvesting of cockles as a livelihood in coastal communities has been widely documented through photography exhibitions and video documentaries. In Portugal, the practice of cockle harvesting has become assimilated into language, as illustrated by the proverb 'Ir a Aveiro sem sapatos' which means going to Aveiro without shoes, referring to the historical practice of landing cockles. In Ireland, an article from the Irish Times dated 1982 described cockle-shops as a type of shop in Dublin known for serving shellfish all day long. Certain seafood including cockles and dogfish (*Bia bocht*) were considered 'poor man's food' during the Great Famine in Ireland.

The sub-class *Gastronomy* comprised 13 examples. A wide range of cockle recipes exists along the Atlantic from traditional

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TABLE 1 Classification of the cultural services provided by cockles. Adapted from the Common International Classification of Ecosystem Services (CICES v5.1) and Millennium Ecological Assessment (MEA, 2005)

Division	Group	Class	Sub-class	Examples of evidence provided
Direct	Intellectual and representative	Educational	History & Archaeology	Shell midden, historical text
			Education & Research	Scientific journal, educational book
			Knowledge & Informal education	Outreach activity, educational website
		Cultural heritage	Cultural identity	Social group, military organisational unit (platoon)
			Cultural practices	Photography of traditional harvesting, eating/ selling cockle, book, archive
			Gastronomy	Regional food dish, food article
			Imagery	Street name, nickname, place, restaurant
			Language	Idiom, slang
			Folklore	Traditional song, dance, parade
			Symbolic	National/ regional monument, statue/sculpture, emblem, sign
	Physical and experiential	Aesthetic	Ornamental use	Decorative garden, grotto, wall, jewellery
		Recreation & Ecotourism	Recreational harvesting	Cockle harvesting activity
			Festival	Seafood festival
			Tourism	Hiking route, beach associated with cockles, foraging course, guided tour
Indirect	Other non-use interactions	Sense of place	Attachment to a special place	Meaningful location for people, anecdotal discussion with locals, blog
		Inspirational	Art	Sculpture, painting, photography, pottery
			Literature	Novel, poem, review
			Advertising	TV advert, promotional leaflet, advert for tourism
	Spiritual, symbolic and other interactions with the environment	Spiritual & Religious	Spiritual to cockles specifically	Pilgrimage, spiritual symbol

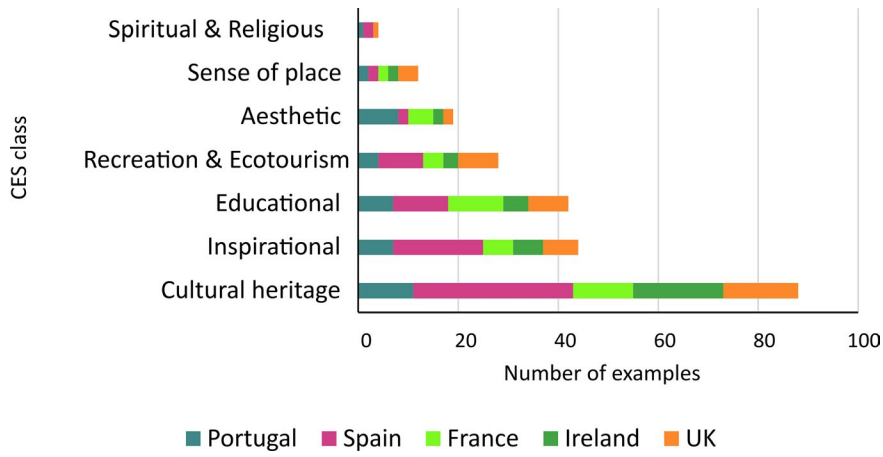

FIGURE 1 Total number of examples included in cultural ecosystem services (CES) class provided by the five partner countries

empanadas in Galicia, Spain (a pie typically containing fish or shellfish) (Figure 2c) to cockle soup in Ireland and Wales and snacks of pickled cockles served in British seaside towns. Various recipe books showcase cockles such as 'les coques de Cabourg' by Eric Rolland, which provides many recipes along with description of the old tradition of cockle shellfishery in Cabourg. The distinctive shape and cultural connotations associated with cockles have also influenced sweets such as the traditional 'Ovos Moles' from Portugal, the sugary 'Roudoudou' in France as well as the famous chocolates 'les coques de Cabourg' in Normandy. In the past decades in Galicia (Spain), the price of cockles has increased and their public image has become broader, evidenced by web articles expounding the appeal of empanadas.

Eleven examples were provided for the sub-class *Folklore*. As frequently found in fishing communities, folklore surrounding cockles was common in the form of songs in several countries. The song of

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FIGURE 2 Cultural heritage examples. From top left: (a) street named after cockle in Dundalk Bay, an important cockle harvesting area in Ireland © Kate Mahony; (b) Mrs Lettice Rees harvesting cockles on Cefn Sidan beach, Pembrey by Geoff Charles (1909–2002) ©Llyfrgell Genedlaethol Cymru—The National Library of Wales; (c) 'Empanada Gallega de Berberecho' ©CETMAR; (d) The statue of Molly Malone by Jeanne Rynhart in Dublin (Txemari, Flickr, Public domain); (f) A women selling cockles in Tramore Co. Waterford in the 1800s (JamesTebay81, Flickr, Public domain); (g) Women harvesting cockle in Ria de Noia © SAGA Pedro G. Losada

Molly Malone, a folk-tale of a young fishmonger who sold cockles on the streets of Dublin, is a vivid example of traditional folklore that has persisted through generations and is now sung during Irish football matches (Figure 2d). A version has even been recorded by U2 and Sinead O'Connor. Some songs contain double-meanings, including popular songs in Galicia (Spain) and pop-rock music from Algarve (Portugal), which use the word 'berberechiña' in Galician or 'Berbigão' in Portuguese in the lyrics to mean both cockle and female genitalia. Another example of folklore was the celebration day for Santo António in Estarreja in Portugal, where competitors in parade contests dress up to illustrate local themes. Shellfish harvesting is often chosen as a theme, for example in the 2012 parade.

The sub-class *Symbolic* includes cockles as a symbol or emblem of identity, for example, in monuments or sculptures, or with other symbolic meanings. This sub-class comprised 10 examples. In Galicia (Spain), tourist t-shirts can be purchased with the slogan 'Beach boys: Good Berberechos' illustrating the extent to which cockles are emblematic of the region. In Ireland, the statue of Molly Malone represents an important symbol for the city of Dublin (Figure 2d). On International Women's Day 2019, a Heritage Blue Plaque was unveiled in Waterford, Ireland to commemorate the Cockle Women who for generations sold cockles on the streets. Another sculpture was the 'Mariscador', part of the 'Giants' series exhibition by the Galician sculpture Francisco Leiro in Valladolid, Spain. The sculpture represents a fisherman holding a traditional 'raño' which is a tool used to collect clams and cockles. There were additional examples of statues of fishermen in various Spanish cities including Poio, Argoñas, Arcade and O Grove. At Morecambe Bay in the UK, the commemorative plaque 'the Bay of Words' is a reminder of the tragedy of the Chinese cockle harvesters who died there when overtaken by the tides while out cockling. Lastly, in the British film Casino Royale, James Bond found a cockle shell in Vesper's purse, which represented the special time shared together at the beach and a symbol of their love, as suggested by some critics (Becker et al., 2011).

Language was also grouped under the *Cultural heritage* class since many words originated from cultural traditions. This sub-class provided eight examples. Alternatives meanings of cockles in slang and vernacular language are common in several countries. In Portuguese, the word for cockle 'Berbigão' has a double-meaning and is synonym for part of the female genitalia in vernacular language. After the civil war in Spain, 'birbicheiros' was used to refer to extremely poor people with nothing to eat but the cockles they gathered. Today, 'berberecho' is often used to describe 'a very simple person' in some part of Spain. In Cornwall, UK, cockle harvesting can also be referred as 'trigging' in the local dialect and this word also has sexual connotations (Carss et al., 2020). Cockles have many regionally differing names in France. Although 'la coque' is currently the French word for cockle, it varied in the early 19th century depending on the region. For instance, in the Finistère 'Rigadel' was sometimes used for cockle; while in Haute-Normandie cockle was named 'Hénon' but 'Bucarde' was preferred in Basse-Normandie. Table 2 collates the many regional names for cockle in the five countries. Another evidence of using cockle in language is the proverb 'warm the cockles of one's heart' meaning to make one feel good. It is thought to date from the second half of 17th century and may have derived from the Latin name of the heart ventricles 'cochleae cordis' (Oxford University Press, 2004).

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TABLE 2 Variation in the names commonly used for cockle across countries and regions

Name	Country	Region
Cockle	UK	All
Cocos, gith, ller, ydig	UK	Wales
Cockle, Ruacan	Ireland	All
Berbigão	Portugal	All
Berberecho	Spain	All
Birbiricho, croque, carneiro, chícaro	Spain	Galicia
Berberetxo	Spain/France	Basque Country
Verdigón	Spain	Andalusia
Coque commune	France	All
Hénon	France	Hauts-de-France
Bucarde, sourdon, rigadeau, rigadel, maillot	France	Atlantic French coast
Bourdos, besourde, bigour, mourgue	France	Mediterranean French coast

Strong examples of *Cultural identity* associated with cockles were also provided (n = 8). During the Civil War in Spain, platoons from Galicia were known as 'Mariscos' (= shellfish) and they had their own symbols and songs (Seixas, 2006). Many historical photographs showcase women harvesting cockles. Cockle harvesting was primarily carried out by women, perhaps due to men out fishing at sea for the day. Cockle harvesting in the Welsh communities of Penclawdd gave the women a valuable source of income (Watkins, 2020). As far back as 1901 in Ireland, women, often widowed or single mother and daughter, considered their principal occupation to be cockle pickers or sellers (Figure 2e). Cockles were also an important source of income for French women in coastal communities during the inter-war period. Another evidence of *Cultural identity* was the fight of fishers' guilds against intermediaries in Galicia (Spain), their icon was the cockle due to its high abundance along the Galician coast (Broullón Acuña, 2010). A socio-economic study on the high mortality of cockles in South Wales (UK) (Murray & Tarrant, 2015), identified that '*it was readily apparent that there remains a strong cultural attachment and sense of identity associated with life-long participation in this iconic fishery in its stunning setting*'. The practice of cockle picking has dramatically decreased in the UK and Ireland, and cockle picking there is more often carried out by men now. However, it remains a major livelihood for women in Galicia. The cultural linkages around cockle harvesting as an activity primarily carried out by women in Spain features strongly in the recent candidature application to World Heritage UNESCO as an essential feature of the cultural landscape for Ría de Muros and Ria de Noia, since both beaches are renowned for the harvesting of cockles by women (Figure 2f). A recent initiative in Spain 'Marenfeminino', which roughly translates as 'the sea from the perspective of women' aimed to highlight the role of women in the sustainability of marine activities including shellfisheries.

3.2 | Inspirational

This class, with three sub-classes, was the second most abundant with 44 examples identified. The sub-class *Art* comprised the most examples (n = 20). Paintings were the most expressed form of cockle-related art with several paintings depicting cockle gatherers. The oldest form of art known so far to be associated with cockles is Cardium Pottery (Figure 3a), which dates from the Neolithic (6,400 BC–5,500 BC). This was a decorative style of pottery from the Mediterranean region using shell impressions of the cockle (likely using two cockle species, depending on the region: *C. glaucum* and *C. edule*). Today, cockles remain a source of inspiration as evidenced by many paintings, photography exhibitions and films made around cockles and its association with people. Cockles are represented in sculpture form, for instance in Carlingford (Ireland; Figure 3b) or sculptures of the traditional cockle-shaped sweet in Aveiro (Portugal), illustrating the close links these cities share with cockles.

Many examples of cockles were found in *Literature*. With 15 examples, this represented the second largest sub-class within *Inspirational*. Famous writers have been inspired by cockles, as evidenced by numerous poems and novels referring to cockles or the activity of picking cockles in several countries (Figure 3c). For instance, cockles were mentioned in a poem about Carbally Hill in Waterford, Ireland from 1956. Another example is the poem 'Os birbirichos e os Birbiricheiros' by Xoán Manuel Pintos, roughly translated as 'The cockles and the cockle pickers', which paid tribute to the humble shellfish gatherers in the Ría of Arousa in Galicia (Spain). It has additional cultural resonance since it was part of the first book to be edited in the Galician language (A Gaita Gallega, 1853) at a time of cultural renaissance (i.e. O Rexurdimento) aiming to recover the language. Other examples include cockles mentioned in non-fiction magazines describing how to collect cockles, and featuring in a British nursery rhyme '*Mary, Mary, Quite contrary*'. [Correction added on 31 October 2021, after first online publication: The text in section 3.2, poem name 'Os birbirichiños e os Birbiricheiros', author name 'Xosé Manuel Pintos' and translated title 'The little cockles and the cockle pickers' has corrected to 'Os birbirichos e os Birbiricheiros' by Xoán Manuel Pintos, roughly translated as 'The cockles and the cockle pickers'. The year in the reference (A Gaita Gallega, 1953) has updated as (A Gaita Gallega, 1853)].

The *Advertising* sub-class included nine examples. Cockles frequently feature in tourist information leaflets highlighting the key aspect of a region, such as in Ílhavo, Portugal where shellfish and cockle harvesting were mentioned as an important economic activity for the region. The activity of picking cockles and clams is advertised as part of the cultural landscape where a guidebook for walking trails in the Algarve in Portugal describes 'During low tide you can see dozens of curved shellfish gatherers over the dark earth in search of molluscs like clams or cockles'. In Ireland, tourist brochures promote the Wild Atlantic Way with activities including cockle gathering. Other examples included promotional videos for local brands. For instance, the Spanish winery showcases the Atlantic region and its strong links with cockle harvesting through the testimony of a chef and cockle pickers. Similarly, a seafood restaurant and fishmongers hall in the UK made a short film showcasing a day in the life

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FIGURE 3 Inspirational examples: (a) Cardium pottery of Tajos de Cacín cave, Granada, Spain (José-Manuel Benito Álvarez (Locutus Borg), Wikimedia Commons, Public Domain); (b) Sculpture of cockles in Carlingford ©Kate Mahony; (c) Book titled 'Fabulas Y Leyendas de la mar' by Alvaro Cunqueiro

of a cockle business, from cockle harvesting on the boat to serving cockles at their restaurant, and Victorian tourism adverts for British seaside towns often mention cockles. Another interesting manifestation of cockles in advertising can be seen in the association between a reputable Galician porcelain brand 'Sargadelos' and a shellfish company. They created a bowl decorated with the iconic cockle canning brand.

3.3 | Educational

This class included 42 examples of which *History & Archaeology* represented the vast majority ($n = 18$). Evidence of cockles in *History & Archaeology* included examples of five archaeological research manuscripts (Figure 4a), seven books, three archaeological reports, one doctoral thesis and two web articles. These provided information on the use of cockles and their associated cultural significance along the Atlantic coast in history.

Education & Research was rich in evidence including scientific articles, books, meeting abstracts and reviews. From the past 30 years, the database search of ISI Web of Science showed that France contributed 243 articles, the UK 226, Spain 217, Portugal 177 and Ireland 45 articles.

Knowledge & Informal education had the lowest number of examples ($n = 5$). Examples from France included a marine park in the Baie de Somme, where staff visit local primary schools to educate on cockle biology. Day trips are also organised with children to visit cockle beds and explain the best-practice of managing cockle beds while respecting the environment. Lectures organised by a French NGO GEMEL (Groupe d'étude des milieux estuariens et littoraux) are also available for fishermen interested in cockles. In Ireland, the Marine Institute, which also engages with primary schools through its Explorers Education Programme, has recently showcased the common cockle. An example of locally held knowledge is that cockle pickers consider it a bad omen when they observe cockle shells accumulating on the beach since it is related to high cockle mortality (Figure 4b). Lastly, in Spain, the Region of Murcia produced a webpage which documents the cultural importance of cockles in Spain from the Palaeolithic to the modern age.

3.4 | Recreational & Ecotourism

Recreation & Ecotourism with 28 examples covered *Seafood festivals* ($n = 11$), *Tourism* ($n = 11$) and *Recreational harvesting* ($n = 6$). The dominant sub-class was *Seafood festivals*, with festivals dedicated specifically to cockles in Spain, Portugal, Ireland and the UK (Figure 5a). These promote cockles with tasting menus, organised cooking contests with famous chefs and innovative recipes.

The appreciation for coastal foraging has increased in the last decade, supporting a growing tourism sector, for example, with courses showing where and how to find and eat cockles in Ireland, France and the UK. A provincial council in Spain also organised routes for people to learn about the activity of the shellfish harvesters and to have the chance of a real harvesting experience. Also in Spain, a shellfish gatherers association created by women runs tourism activities focused on shellfish gathering, providing guided tours of the shore, shellfishery and cannery. Other evidence of tourism associated with cockles included tourism websites and on-line reviews of foraging courses. Cockles on the beach are sometimes so abundant that it becomes a distinctive tourism feature. For instance, Cockleshell Beach in Crookhaven, Ireland, is famous for its shells (Figure 5b). In the UK, the Isle of Barra is described as a good spot for picking cockles whilst Bradwell Cockle spit nature reserve is special for its 30 acres of shell bank. In Spain, the 'Ruta del berberecho' is a well-known hiking route along the cockle harvesting sites.

Examples for *Recreational harvesting* are revealed in various web articles including descriptions of the family tradition of gathering and eating cockles during summer holidays (Figure 5c). Other evidence included government advice and legislation governing recreational harvesting such as in the Magna Carta, which allows anyone to pick up to eight pounds of cockles in the UK for their own use without a licence.

3.5 | Sense of place

Sense of place comprised a single sub-class *Attachment to a special place*, with 12 examples provided. Memories of cockle harvesting, cooking and eating were reported across all five nations through

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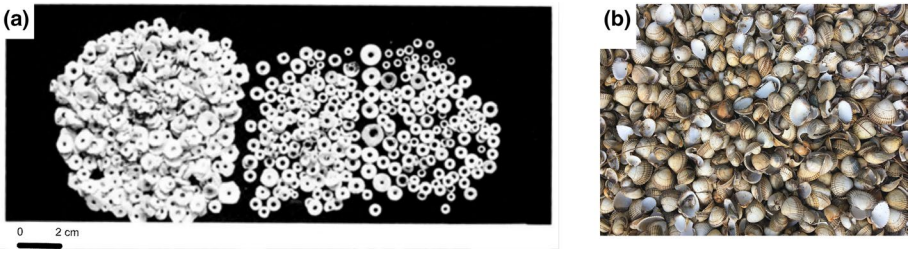

FIGURE 4 Educational examples: (a) Pearls made of cockle shell collected in the archaeological sites of Ponthezière and la Perroche, France, image adapted from Ricou and Esnard (2000) and (b) Cockle shell debris, a bad omen for cockle pickers ©Mathilde Jackson-Bué

FIGURE 5 Recreational & Ecotourism examples: (a) A poster of the 17th cockles festival in Foz, Spain (https://www.paxinasgalegas.es/fiestas/festa-do-berberecho-foz-6296.html); (b) Cockleshell Beach in Crookhaven, Ireland ©Kate Mahony and (c) Collecting cockles as family activity ©Ilse Orsel on Unsplash

several online blogs, emphasising people's strong personal connections with the coast. Similar evidence came from direct exchanges with locals who remember doing these activities as a child or seeing their grandparents collecting cockles. Buying cockles locally from a place known for cockle harvesting can also be an important cultural reference point for people. Further examples of human attachment to place were provided through anecdotal exchanges with local fishermen.

3.6 | Aesthetic

Only one sub-class was included in *Aesthetic*, namely *Ornamental uses*, which covered 19 examples. There were many historic as well as modern examples of cockles used as decorative features on buildings across the five countries. Examples provided included walls, a shell tower, grottoes, churches, houses and gardens covered with cockles (Figure 6a–c). Items of jewellery inspired by or made from cockles were given as examples in Portugal and Spain where it is very common. There were also examples of figurines or decorations made with cockle shells either as a tourist gift, Christmas decorations (Figure 6d) or as part of creative activities for children.

3.7 | Spiritual & Religious

Spiritual & Religious had the lowest number of examples with only four provided. Some bell pottery decorated with cockles and clam shells but also entire cockle shells were found in the megalithic remains of the Dolmen of Dombate in Galicia (Spain). According to archaeologists, it is believed that shells placed at the entrance of funerary monuments were used to deter wicked spirits and keep the place free of misfortune. Further evidence of likely spiritual association with cockles was the graves of San Pedro de Eume's cemetery in northern Galicia (Spain), which are covered with cockle, clam and scallops shells. While the original reason for this display is unknown, the local community continues to clean and replace the shells every year during All Saints Eve. In a more recent example, cockles were used to predict the future in a Portuguese TV show «A Tarde é Sua» on TVI channel in May 2020 indicating some kind of spiritual association with cockles. Lastly, a pierced cockle shell was found in the grave of the 'Worcester pilgrim' in the UK. While the cockle shell was sometimes represented in religious pictures (Figure 7), a different species, the scallop shell is a widely recognised emblem carried by pilgrims on their way to the shrine of Santiago de Compostela in Galicia. Therefore this pierced cockle may have had similar symbolism to the wearer.

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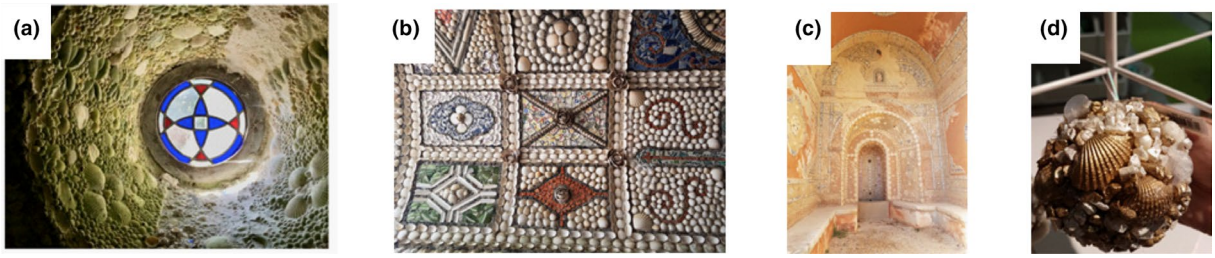

FIGURE 6 Aesthetic examples: (a) 'Cockle shell tower' at Larchill House, Co. Kildare, Ireland ©Finola Finlay; (b) Walls made of various shells including cockles in a historical farm, Quinta da Filgada, Seixal, Portugal ©Sara Cabral; (c) Cockle and other shells are used to decorate the walls of Capela do Convento de Nossa Sra. da Arrábida, Portugal ©Sara Cabral and (d) Christmas decoration made with cockle shells ©Sara Cabral

FIGURE 7 Spiritual & Religious example: Miniature from a Choirbook showing St James of Compostella with pilgrim's staff, cockle shells and rosary and a landscape background; Spanish; 17th century © Victoria and Albert Museum, London

3.8 | Commonalities and differences among countries

There were some commonalities across countries in that *Cultural heritage* consistently contained the most CES examples in every country. More obvious were the differences. For some of the classes, a number of countries provided no examples at all (Figure 8; Appendix I: Table S1): CES examples of *Folklore* were not identified in either France or the UK. No evidence was found for *Recreational harvesting* in Spain and Ireland, while *Informal education* did not include any examples for Portugal and the UK. In Ireland, there was no evidence for *Language* and there were no examples of *Cultural identity* for Portugal. Surprisingly, France lacked any examples of *Seafood festivals*, *Advertising*, *Folklore* and *Symbol*. For the overall spread of examples, Spain had the highest number (n = 76), followed by the UK (n = 45) and Portugal (n = 40), France (n = 40) and lastly Ireland (n = 36) (Figures 8 and 9).

Spain dominated the examples for *Cultural heritage* (n = 32), *Inspirational* (n = 18) and *Recreation & Ecotourism* (n = 9), while Portugal provided the most evidence under the *Aesthetic* class (n = 8) and the UK provided the most examples for *Sense of place* (n = 4, Figure 8).

In terms of the relative importance of sub-classes (Figure 9; Table S1), for *Cultural heritage* classes, Spain dominated the *Symbolic* and *Cultural* sub-classes with strong evidence of cultural identity associated with cockles in Spain, which contrasted with the other countries. Spain and Ireland shared the greatest number of examples for *Imagery* and, with France, provided several examples of *Imagery*, notably streets named after cockles. Only one example was given for the UK and Portugal, perhaps due to the rudeness often associated with the alternative meanings of the word cockle. Folklore was particularly important in Portugal and Spain, but less so in Ireland. By contrast, there were no examples for the UK or France suggesting a weak influence of the cockle on British and French folklore.

For the *Inspirational class*, Spain dominated most examples, with France and Ireland having the fewest examples (n = 6). For most of the countries, there were more examples of *Art* than for *Literature* with the exception of Portugal, which provided more examples of *Literature* than *Art* (n = 3 and n = 2, respectively; Table S1).

In terms of *Recreation & Ecotourism*, many examples of tourism such as coastal foraging courses and guided tours were given by all nations with the exception of Portugal; suggesting that these activities might be less recognised as potential touristic activities there. Spain stood out from other nations by having a large number of examples of festivals dedicated to cockles, while the highest evidence of recreational harvesting came from the UK suggesting an enthusiasm for foraging in recent years. All countries had broadly similar scores for *Tourism*.

Aesthetic was led by Portugal which provided the most evidence of ornamental uses of cockle. There were only a few examples for *Aesthetic* provided by the UK and Ireland (n = 2) contrasting with more examples from the southern countries (Portugal: n = 8, France: n = 5 and Spain: n = 2; Figure 8).

Sense of place was well-represented in the UK compared to other countries. Given that cockle harvesting has decreased in the UK, there is perhaps a kind of nostalgia around the cockle industry.

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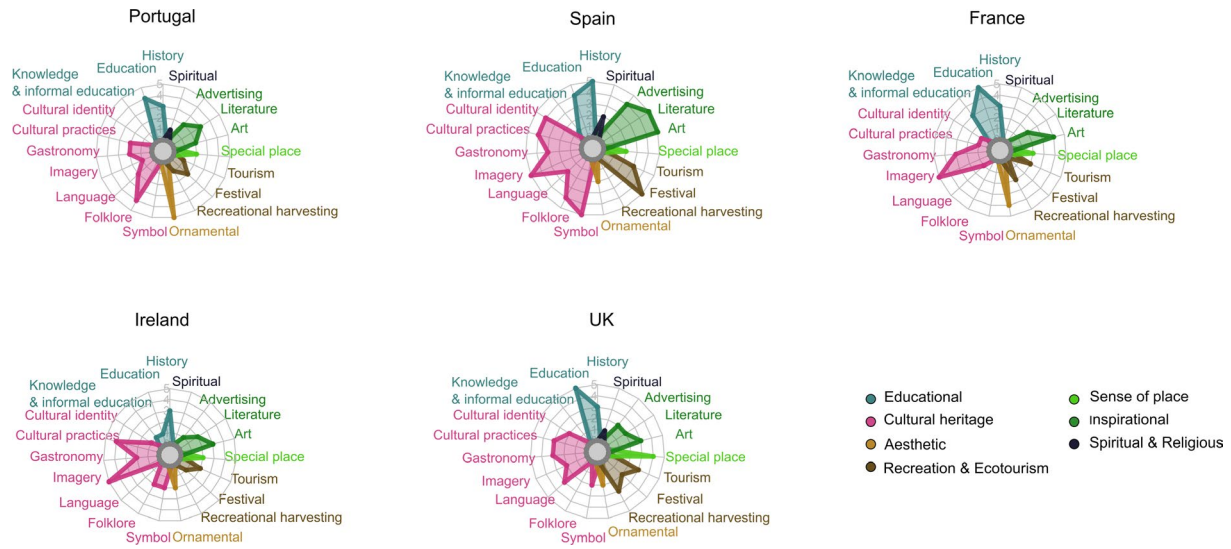

FIGURE 8 Cultural ecosystem services provided by cockles for each partner countries of the Atlantic Area. Cultural ecosystem services are grouped following the modified classification of CICES. Nonlinear scaling from 0 (no example), 2 (2 examples), 3 (3 examples), 4 (4 or 5 examples) to 5 (6 or more examples provided). For Education & Research the number of publications was re-scaled from 0 to 5 to match the other sub-classes

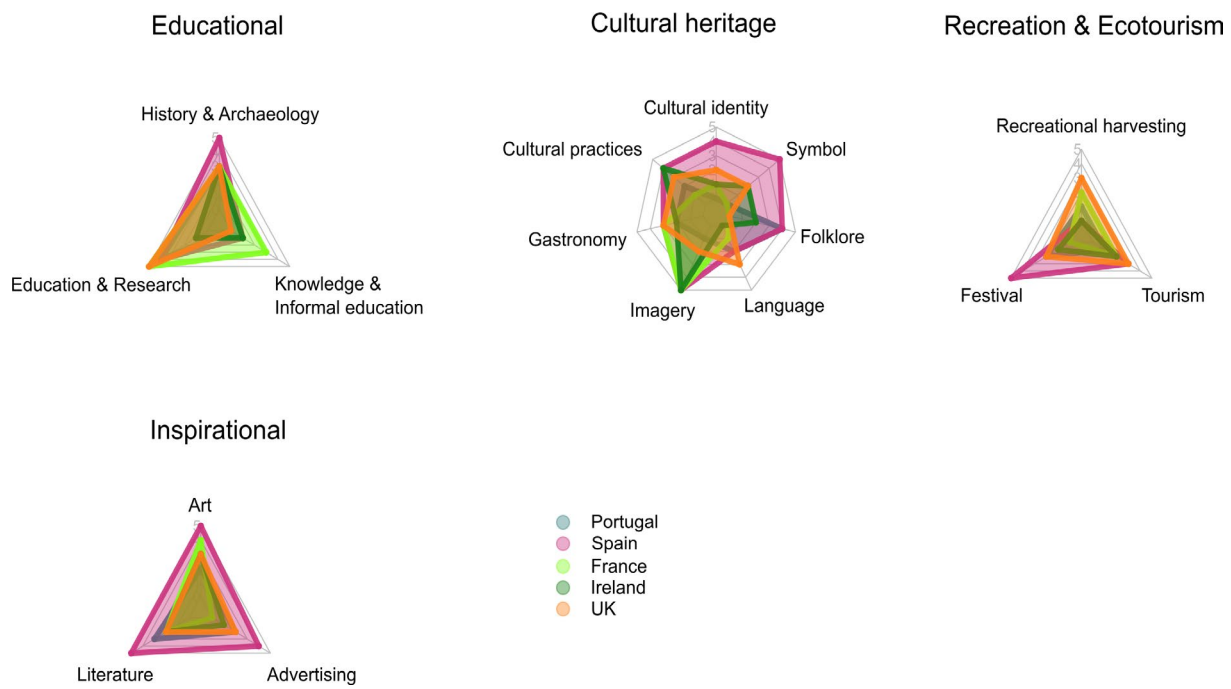

FIGURE 9 Cultural ecosystem services provided by cockles among countries of the Atlantic Area. Cultural ecosystem services are grouped following the modified classification of CICES. Note that the class Aesthetic and Spiritual & Religious are omitted since they include only two sub-classes. Nonlinear scaling from 0 (no example), 2 (2 examples), 3 (3 examples), 4 (4 or 5 examples) to 5 (6 or more examples provided). For Education & Research the number of publications was re-scaled from 0 to 5 to match the other sub-classes

Lastly, for *Educational*, France had noticeably more examples of *Informal education* and informally expressed *Knowledge* than other countries. France was also the leading country in cockle research with the highest number of published research originating from authors in France, showing a strong scientific record.

4 | DISCUSSION

The cockle is an important cultural species that provides many benefits not only to the people whose livelihoods depend on it but also to the wider society. Previous research highlighted the need

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for a deeper understanding of CES provided by cockles (Carss et al., 2020). In this study, we collated evidence across five countries along the Atlantic coast on how cockles contribute to 7 classes and 19 sub-classes of cultural services. Of the main class, *Cultural heritage* provided the most examples followed by *Inspirational*; suggesting that these classes are important and should receive more attention in studies on CES. We also found strong differences between countries, both in the numbers of examples, and the distribution of examples among sub-classes.

The predominance of *Cultural heritage* examples makes sense, given the high dependency of many coastal communities on natural systems for their livelihood. Traditional rural communities such as in Galicia (Spain) often share longstanding associations with particular ecosystems and the associated features are inherent to their cultural identity (Comberti et al., 2015). As such, for many cockle gatherers, harvesting goes far beyond the activity of collecting cockles and is part of a way of life in a similar fashion to fisheries (Brookfield et al., 2005; Urquhart et al., 2014; van Ginkel, 2001).

Our study also draws attention to differences in cultural services provided by cockles among countries along the Atlantic coast. Culture plays a crucial role in defining nature's contributions to people (Díaz et al., 2018) and given that *Cultural heritage* is tightly linked with history and human experiences (Daniel et al., 2012), differences in *Cultural heritage* among countries are perhaps to be expected. As such, the CES examples which were collated over five culturally and socio-economically different countries translate into important differences in the way nature's contribution to people can be experienced. For instance, Spain provided rich *Cultural heritage* examples with a strong evidence of *Cultural identity*, *Folklore* and *Symbol* associated with cockles. One surprise was the extent to which cultural heritage and other CES differed between Spain and Portugal, neighbouring countries which both have a strong maritime heritage. Divergences in tradition and symbolic values have been found between other fishing nations, for example, between Finland and Estonia in relation to salmon fishing in the Baltic (Ignatius et al., 2019). Similarly, beaches in rural Ireland and Portugal were also perceived and valued differently (MacLeod et al., 2002), although in this case the differences in cultural and climatic settings may contribute substantially to this situation.

One less tangible aspect of inter-country differences is the extent to which cultural references are grounded in the present or in the past. In the northern countries of our study, UK and Ireland, cockle gathering is now less of a community activity and the strong coastal connections with cockles tend to exist more in the past than the present. By contrast, in the southern countries of our study, particularly Spain and Portugal but also to a lesser extent France, traditional cockle harvesting is still ongoing and embedded within its coastal communities. Traditions are passed along from one generation to the other and folklore surrounding cockles is maintained. The differences in the CES examples given by each nation support the point that cultural, political-economic and social dynamics influence CES over time (Gould et al., 2020).

Evaluation of CES classes in the ES literature are often directed towards *Recreation & Ecotourism* with little attention given to other CES, and studies which evaluate more than five CES are very rare (Cheng et al., 2019). Here, we produced data on 19 sub-classes of CES, allowing us to focus in more detail on how representation of these cultural elements differs among countries, and particularly those aspects of a more intangible nature (Chan, Guerry, et al., 2012; Milcu et al., 2013). Many cultural services provide indirect benefit to humans but are generally hard to identify and are therefore often disregarded from assessments, leading to a risk of excluding important cultural values in policy-making (Chan, Guerry, et al., 2012; Fletcher et al., 2014; Laband, 2013). Among the extensive suite of CES identified in our study, many examples belonged to *Inspirational*, which is generally the least investigated class in other studies (Hernández-Morcillo et al., 2013). This confirms its importance to humans and that it forms a larger part of cultural services than previously suggested. A strong place-based identity also emerges clearly from these examples, despite few concrete examples in this sub-class. Examples which were more simply categorised into other sub-classes allude to this place-based identity. These include the wide variation of local names for cockle which have a strong regional focus, the 'Mariscos' name (meaning shellfish) for the Spanish platoons from Galicia in the Civil War, and imagery used in advertising to trigger feelings of affinity with the coast and personal memories of previous coastal visits. Thus, cockles support a strong place-specific identity which, like in other areas, is built up around the history, heritage and culture associated with the region (Ma & Lew, 2012).

The structured approach using an a priori framework had a number of advantages. Firstly, it allowed us to provide guidance, and clear examples, to stakeholders when eliciting responses during the evidence gathering, which can help reduce biases (Cheng et al., 2019; Hernández-Morcillo et al., 2013). It also served as an aid to classification of examples (Cheng et al., 2019; Hernández-Morcillo et al., 2013). The use of a structured approach encourages consideration of every class of CES, increasing the representation of less conspicuous CES. Lastly, the structured classes facilitate comparisons among countries, or groups of participants. Despite the lack of maps and situational questions used by Gould et al. (2015) to elicit CES, our a-priori framework and the additional benefits of the deliberative process prompted many examples of CES.

In particular, the deliberative approach through group activities among stakeholders with a wide range of knowledge and expertise allowed participants to exchange ideas and stimulate new lines of thinking in a more reactive way, guided by the facilitator. Confidence in outcomes from deliberated group activity is generally higher than from individuals who have not participated in a deliberative process (Kenter, Jobstvogt, et al., 2016). Deliberated groups provide more opportunities for diverse voices to be heard with often different perspectives and interests (Elstub, 2010; Kenter, Bryce, et al., 2016). In our study the focus was on stimulating creative thinking and developing a shared understanding of the task, rather than adopting positions on an issue, and the deliberative process helped achieve this. Deliberative process are increasingly recognised as a valuable approach in the evaluation of ecosystem services (Kenter, Bryce, et al., 2016) as ecosystem assessment requires consideration of shared values (Fish et al., 2011). Additionally,

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place-based and indigenous values like cultural identity, spiritual and heritage, are often overlooked in ecosystem assessment (Pascua et al., 2017), and in our study, this provided a mechanism to gather this information. Given the shared understanding of the task, and the longer duration follow-on work which allowed participants time to gather further examples, we can be reasonably confident that the differences observed between countries are likely to reflect reality rather than being a result of sampling effort or inherent bias in participant selection. However, differences in the background knowledge or the degree of engagement of the participants may still lead to some influence on the outcomes. Another potential disadvantage of deliberative methods can be the power dynamics, both with respect to those invited to participate and through the dynamics of the process. The deliberative process may not adequately neutralise or may even exaggerate the unequal distribution of power amongst participants (Williams, 2000; Young, 1996). However, if conducted sensitively, deliberative processes can also help marginalised groups to get their voice heard and thus help address inequalities, and be a positive and creative energy in collective thinking (Hendriks, 2009).

As a minor disadvantage of this approach, the large number of CES classes compared with the number of groups in the comparison (i.e. five countries) precluded any multi-variate analysis of differences among respondents. Separate surveys of individuals would have provided greater flexibility in quantitative analysis, but would have lost the balanced participatory approach, and lost the shared values, richness and stimulation that comes with discussion in a group context. By counting the number of CES examples given in each sub-class, aggregating into class and ranking them, we were able to compare CES that are difficult to quantify in economic terms (Daniel et al., 2012). Overall, the methodological approach used in this study starts to address some of the challenges faced in assessing CES in a systematic way (Cheng et al., 2019).

Setting up the a priori framework required some iteration after testing with pilot data. This revealed some challenges in assessing CES where an example could be assigned to more than one class, which can lead to difficulties in interpretation (Hernández-Morcillo et al., 2013). Sculptures, for instance, could be interpreted as *Art* but also *Symbolic* if they hold significant meaning which itself may be linked to *Folklore* or *Cultural identity*. Other examples with potential ambiguity in the classification included the folk song about Molly Malone. In this study, the song was classified under *Folklore* since it is associated with cockle harvesting tradition. However, it could also have been placed under *Cultural identity* or *Symbolic* since it has become a cultural symbol of Irish people, and is sung during football matches. Another category which provided challenges in classification was advertising. Here, advertising was placed in *Inspirational* as we believe advertising draws on natural and cultural features as a source of inspiration. It could also however be used as evidence of tourism when promoting an activity. While the sub-class *Gastronomy* is hard to uniquely assign, we grouped these examples under *Cultural heritage* since recipes have a strong traditional and historical basis with regional ties, and which are passed on from one generation to the next. These examples illustrate that it can be difficult to isolate particular CES as many of the classes are inter-related, either by originating from a common theme, or building on one another (Gould et al., 2020). Another reason for this is that multiple types of meaning and value may be present in many of these instances. As long as allocation to classes was consistently applied across the study, and the assumptions were stated, this was not deemed to be a problem, and we recognise that other studies may take different allocation decisions.

Associations between ecosystem services are common and the idea of ecosystem service 'bundles' has currency in the literature (Ament et al., 2017; Bennett et al., 2009; Cumming & Peterson, 2005; Rodrigues et al., 2017). One ecosystem may provide several services (= co-provisioning) or some services may require another (= co-dependence) (Ament et al., 2017; Bennett et al., 2009). Such synergies are also common among CES bundles (Lee & Lautenbach, 2016). For instance, locations of recreational activities are often valuable due to a combination of their aesthetic nature, cultural heritage and identity (Chan et al., 2012; Daniel et al., 2012; Rodrigues et al., 2017). By engaging with food and food-related activities in festivals, tourists experience the culture and identity of the food-producing region with increased awareness of the associated community (Lee & Arcodia, 2011; Rusher, 2003). Similarly, a rich cultural heritage is likely to significantly affect local artistic creativity through its aesthetical and emotional value, and to have influenced inspiration through time (Cerisola, 2019), and our findings bear this out. In Spain for example, cockles appeared to be a substantial source of inspiration with a large selection of examples for ancient and modern art, advertising and literature. Within the same class of *Cultural heritage*, areas with a stronger heritage are likely to have more examples across more sub-classes where this is manifested, for example in slang, street names, folklore and symbols of cultural identity.

Lastly, we recognise that the focus of our study is on a single species. This has some implications for interpretation of the findings, and is an interesting comparator with ecosystem-based studies. Like oysters, which are well-documented providers of ecosystem benefits (Michaelis et al., 2020), cockles are often the dominant entity or 'keystone' of the coastal ecosystem in which they live. However, some of the cultural values associated with it are not limited to the organism but occur through wider associations. For example shellfish, including cockles, was the symbol of the movement 'Mariscos' in Spain, and some of the valued features such as cockle beaches are dependent on cockles within a wider landscape setting. Analysis for a single species also precludes consideration of many tradeoffs. However, by building up the information about multiple species or components of an ecosystem, this allows a stronger more informed quantification and discussion of the tradeoffs inherent in managing a particular ecosystem, compared with, for example, more simplistic assessments which involve converting one ecosystem type to another (Geange et al., 2019).

5 | CONCLUSION

With this study, we demonstrate that information on a diverse suite of CES can be collated and quantified, using a methodology that can be applied to other types of ecosystems and species. We

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comprehensively describe the CES provided by cockles and compare differences among countries from Europe's Atlantic coast. It was clear that cockles provide important CES across all countries given the rich and diverse examples across all CES classes. We identified associations among CES that differed among countries, such as strong evidence of *Cultural identity and practices*, *Folklore* and *Symbol* associated with cockles in Spain, which contrasted with the notable evidence of *Ornamental* value of cockles in Portugal. In assessing CES gained by cockles using an a priori framework during a series of workshop and virtual meetings, our study demonstrated the importance of CES in coastal areas and reflected the context dependent cultural values of cockles to humans. With ever increasing anthropogenic pressures, it is critical to find ways to integrate cultural practices into solutions for the management of ecosystems and thus improve ecosystem quality, coastal biodiversity and human well-being. CES can serve as a gateway for engaging the public with issues around cockle management and enhancing the ecosystems which support cockles (Cabana et al., 2020). As a result, understanding these relationships can help to design and implement sustainable management approaches for these ecosystems, supported by deeper local engagement (Bennett et al., 2009).

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COMPETING INTERESTS

The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

M.J.-B. led the analysis, interpretation and writing of the manuscript, both M.J.-B. and D.N.C. co-ordinated input from the separate country working groups, which were led by D.N.C., P.C., S.A.L., R.M.F.O. and X.d.M; All authors contributed to the development of the approach, ideas and examples of CES, and to editing of the manuscript; L.J. conceived the ideas and led the research.

DATA AVAILABILITY STATEMENT

The data that support the analysis of this study are available from the publicly accessible repository, NERC Environmental Information Data Centre: https://doi.org/10.5285/a924f41c-ae29-427c-8113-aebe6bc2d349 (Jackson-Bué et al., 2021). Detailed information of cultural ecosystem services examples are provided as an appendix.

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