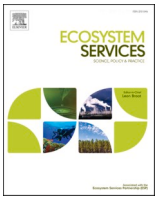
Ecosystem Services 76 (2025) 101783

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser



Full Length Article

Offshore cultural ecosystem services: evidence from open-sea research

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ARTICLE INFO

Keywords:
Marine ecosystems
Cultural ecosystem services
Environmental humanities
In situ research
Ethnography

ABSTRACT

Offshore marine environments tend to be characterised as uninhabited resource pools, and therefore, compared to terrestrial and coastal environments, have received little attention as sources of cultural ecosystem benefits. Ecosystem valuations of offshore marine areas have largely been based on the monetary values of provisioning and regulating services, and have not taken full account of intangible and non-monetary values. Effective management of marine areas depends upon a comprehensive assessment of the wide range of ecosystem benefits to society, including such cultural benefits as sense of place, cultural identity, aesthetic appreciation and inspiration, connection with nature, and education and research. This paper describes a novel approach to collecting data on cultural ecosystem benefits in offshore areas by stationing a cultural ecosystem services researcher on board a research vessel to carry out observational and ethnographic research, and to conduct semi-structured interviews with researchers and crew. The approach draws from humanities and social science methodologies for investigating embodied experiences, emotional responses, and psychological attachments. Results show a wide range of cultural ecosystem benefits associated with offshore, and a high degree of recognition of the sea as a powerful yet vulnerable environment demanding care and respect. Greater understanding of the cultural values of key users of offshore marine ecosystems will help to inform more effective marine management decisions and practices, and there is considerable scope for *in situ* participatory and observational research as described in this paper to help to achieve a more holistic assessment of marine cultural ecosystem benefits.

1. Introduction

Cultural ecosystem services (CES) refers to the emotional, experiential, and psychological processes that emerge from and influence individual and collective human interactions with environments and which have the capacity to affect human wellbeing (Fish et al., 2016a). CES has become an increasingly essential part of assessments of ecosystem health and valuations, although it remains challenging to capture and integrate the more complex CES relating to identity, sense of place, and heritage (McElwee et al., 2025; Gould et al., 2019). CES are understudied compared to other ecosystem services, and it is often only the most easily counted services such as recreation and tourism that are assessed (Martin et al., 2016; Hynes et al., 2018). The challenges of including CES are even more acute in offshore marine environments, in which ecosystem services in general are more difficult to capture due to lack of data, the fluid and highly mobile nature of the ocean environment, and the relative lack of accessibility (Townsend et al., 2018; Hattam et al., 2015). There is a significant risk that CES in offshore environments are critically undervalued because they are under-researched, and novel approaches are required to understand and find ways to capture more complex services producing cultural values (Garcia Rodrigues et al., 2017; Martin et al., 2016). The arts and humanities can facilitate such novel approaches, bringing a special attunement to emotion, embodiment, and socio-cultural dynamics when it comes to CES (Ryfield et al., 2019; Bieling, 2014; Fish et al., 2016b; Edwards et al., 2016). These sensory and embodied insights typically require researchers to engage in-depth fieldwork approaches (Howkins et al., 2019; Cohen et al., 2024; Breslow et al., 2024). This paper presents

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https://doi.org/10.1016/j.ecoser.2025.101783
Received 24 March 2025; Received in revised form 4 August 2025; Accepted 25 September 2025
Available online 15 October 2025
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an *in situ* humanities-led cultural valuation study carried out on a research vessel, demonstrating approaches that can directly capture the sensory, socio-cultural, and environmental aspects of the sea which affect its CES and associated human benefits.

Water has a "sensual charisma" that draws human interest (Chen et al., 2013). Understanding embodied aspects of human-sea interactions can illuminate cultural benefits in terms of people's physical and mental health—for example the benefits of sea air or feelings of escape (Dobrin, 2021; Britton and Foley, 2021). These aspects often cross over with creative, emotional, and socio-cultural dimensions to inform benefits such as sense of place, aesthetic appreciation, and cultural identity (Anderson, 2012; Urquhart and Acott, 2014; Ainsworth et al., 2019; Britton and Foley, 2021). Participatory methods have shown some good potential for capturing CES in studies of Marine Protected Areas (de Abreu et al., 2025), using interviews, surveys, and participatory mapping with stakeholders to highlight benefits that are not easily assessed through remote data. Moreover, sensory and socio-cultural insights capture and validate various ways of interacting with and understanding environments, creating space for the inclusion of diverse cultures, academic disciplines, and knowledge systems (Mentz, 2019; Dobrin, 2021). The sea can be a challenging and unpredictable environment which thwarts the types of security, certainty, and control that one may experience on land. It can have potent bodily effects such as seasickness or cold. The power and unpredictability of the sea—intensified by anthropogenic pressures like climate change—are very material elements which underpin its provision of CES, benefits, and disservices (i.e. potential harms to human wellbeing [Shackleton et al., 2016]). The sea may lead to experiences of stress, fear, or worry, but it may also lead to experiences of adventure, variety, and escape. Marine-oriented subfields of the arts and humanities–such as the Blue Humanities or Ocean Studies–embrace the specificities and agencies of marine environments and their ability to inculcate more relational, cyclical, and fluid notions of human-nature relations (Dobrin, 2021; DeLoughrey, 2019; Brannigan, 2022). *In situ* research through physical interaction, such as swimming, surfing, or sailing, has been a key constituent of the argument for embodied research in environmental humanities studies of the sea (Mentz, 2019). In this paper, we argue that such sea-centric perspectives may lead to more eco-centric and contingent notions of human-nature relations which enhance relational (i.e. relationship-based) attitudes and practices towards ecosystems and which in themselves are key CES and benefits (Bullock, 2020).

The sea provides unique perceptions of nature and animals which are key to its relational values. As Alaimo (2019) argues, many sea spaces and marine organisms exist beyond traditional human domains (whether far out from land or in the sea depths) and thus require scientific or technological mediation to be engaged by humans. The sea is also highly mediated by cultural stories and products (e.g. films, poems, documentaries), which in modern Western culture have often historically positioned it as either an empty backdrop for human dramas or a wild space against which humans must struggle (Dobrin, 2021; Cohen, 2010). Yet, cultural stories or products can indicate and generate public feelings of bequest and existence value toward a space that they enjoy without direct engagement (Garcia Rodrigues et al., 2017). Even where people have direct access to remote sea space (often on ships on the surface), water's agency is primarily experienced through the body as motion which can register it as an unfamiliar and new spatial experience of nature (Couper, 2018). Previous marine CES valuation studies have been largely limited to land or coastal regions, whether in their focus or execution, and the need for more direct engagement with communities and stakeholders has been recognised as a gap for some time (Martin et al., 2016; Rivero and Villasante, 2016; Barbier, 2017; Milon and Alvarez, 2019). This study carries out the research *in situ*, and engaging in participatory research with specific offshore marine ecosystem stakeholders it captures direct embodied, emotional, and psychological responses to offshore environments. By offshore, we refer to any marine environment physically beyond (though potentially still in direct vision) of terrestrial and coastal spaces.

Offshore marine environments tend to be characterised as uninhabited resource pools, and therefore, compared to terrestrial and coastal environments, have received little attention as sources of CES (Garcia Rodrigues et al., 2017; Liu et al., 2019; Fletcher et al., 2014; Kosanic and Petzold, 2020; Stamatiadou et al., 2023). Marine ecosystems are heavily exploited around the world, and with high levels of degradation, it is important that their cultural values are better understood (Barbier, 2017). Where studies of CES in offshore environments do exist, these have largely deployed monetary valuation methods, which excludes the types of shared, subjective, and non-use values (e.g. cultural identity) which are difficult to quantify in monetary terms (Van Schoubroeck et al., 2024; Ainsworth et al., 2019; Crowe and Frid, 2015; Urquhart and Acott, 2014). While there has been some work to take account of how valuation of marine recreation services may be affected by cultural identity (Hynes et al., 2018), our study redresses this knowledge gap by performing non-monetary valuation. We use a participatory approach with offshore stakeholders–thirteen marine scientists and ten research vessel crewmembers–in the Irish Sea. Participatory approaches are favoured in non-monetary CES valuation to attend to how these values are often shared and embedded in collective ways of life (Cheng et al., 2019; Ainsworth et al., 2019; Ryfield et al., 2019), to align valuation with immediate social needs and to address diverging or conflicting views of CES and benefits (Van Schoubroeck et al., 2024; Bullock, 2020). Yet, such participatory approaches have rarely, if at all, been carried out directly in offshore environments where researchers can observe empirical evidence of CES and where certain categories of offshore stakeholders may feel most comfortable and enthusiastic about articulating their value.

Our study investigates potential synergies and conflicts between offshore stakeholders by linking offshore CES to perceptions of the sea and attitudes towards environmental valuation and management. These links also highlight the potent character of offshore CES and how they arise from and contribute to two-way relations between culture and marine environments. We show how the gathering of qualitative evidence is key for providing preliminary information which can guide more extensive strategies for incorporating these social and cultural dimensions in decision-making about offshore environments where they are more difficult to comprehend or reach. The CES of offshore environments are important for consideration in various policy contexts, including Marine Spatial Planning, Marine Protected Areas, and Marine Cultural Heritage (Van Schoubroeck et al., 2024; Jobstvogt et al., 2014). While provisioning services of offshore environments are relatively well known, better knowledge and understanding of the diversity of beliefs, values, and cultures associated with the sea is needed to inform approaches to conservation and management, as well as sustainable practices (Gee, 2019; Agnew et al., 2022; Blanco and Otero, 2025).

This paper presents a novel method for collecting data on cultural ecosystem benefits in offshore areas. The aim of the paper is to show how there is considerable scope for *in situ* participatory and observational research to: (1) identify interplays between embodied, emotional, and cognitive dimensions of human-sea interactions which underpin the generation of CES and benefits; (2) identify the dual production of use and nonuse ecosystem values in the context of offshore environments;

and (3) explore relationships between offshore CES and perceptions of the sea which can influence attitudes towards environmental care and management.

2. Methods

2.1. Case study area

The method involves stationing a CES researcher on board a research vessel to carry out observational and ethnographic research, and to conduct semi-structured interviews with researchers and crew. The approach was applied in the North Atlantic Ocean and the Irish Sea and draws from humanities and social science methodologies for investigating embodied experiences, emotional responses, and psychological attachments.

In September 2023, the CES researcher joined a team of thirteen geologists on a seven-day research cruise as part of the Quest 1 survey to study and map carbon storage in Ireland's seabed habitats and to investigate their potential to reduce greenhouse gas emissions (https://www.ucd.ie/newsandopinion/news/2022/march/03/bluecarbonresearchreceives26mtoinvestigatinghowmarinehabitatsreducegreenhouseemissions/). The survey took place on the RV Celtic Explorer (Fig. 1), which is one of two state-owned research vessels operated by the Marine Institute in Ireland. It came into service in 2003, and is designed for various research purposes, such as fisheries acoustic research, and oceanographic, hydrographic, and geological investigations. The ship facilitates dynamic positioning and coring, which were essential for the Quest 1 survey. It is 65.5 m long, can host up to 35 people, and contains a wet and dry lab, a workroom, two lounges, and a gym and sauna. Research vessels such as the RV Celtic Explorer provide safe and comfortable ways for scientists, fishers, industry representatives, and other marine stakeholders to access marine locations for research and development. Crew members tend to be former fishers or merchant sailors, who typically find stable working hours and comfortable conditions in the Irish research sector. The Marine Institute encourages public education and interdisciplinary collaboration regarding the activities that occur on the RV Celtic Explorer and its partner, the RV Tom Crean, evidenced by the public blog *Scientists@Sea (https://scientistsatsea.blogspot.com/)* and programmes such as the Artist at Sea Residency (https://www.icrag-centre.org/news-and-media/artistatsearesidencycalllaunched.html) run by iCrag, the Science Foundation Ireland Research Centre in Applied Geosciences hosted by University of Dublin, in conjunction with University of Galway.

Fig. 1. The RV Celtic Explorer, one of two state-owned research vessels operated by the Marine Institute in Ireland. Photo credit: Ashley Cahillane.

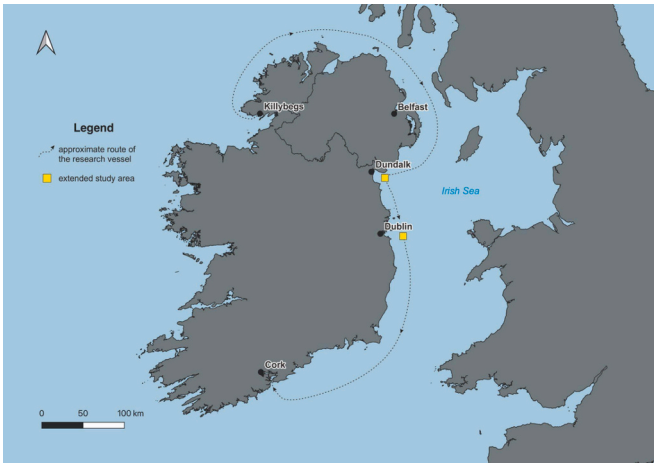

Fig. 2. The seven-day journey of Quest 1 from 26th September to 4th October 2023. Map created by Dorota Kołbuk.

On 26th September 2023, the expedition mobilised in Killybegs, a fishing village on the northwest coast of Ireland, and sailed around the north and east coast of Ireland (Fig. 2). It spent extended time offshore in the Irish Sea, before demobilising at Cork harbour in the south of Ireland on 4th October 2023. The sailing and sampling operated twenty-four hours a day with breaks. Despite starting during a storm, the survey enjoyed favourable weather and calm conditions.

2.2. Methods and data collection

This study took an inductive and deductive qualitative approach to explore the range of CES and benefits derived from and experienced in open-sea environments. Data collection included empirical and ethnographic (i.e. cultural) observations (n = 23), complemented by semi-structured interviews lasting twenty to thirty minutes with geologist team members (n = 9) and ship crew (n = 6). The observations facilitated a holistic capture of CES and benefits that might not emerge in print, media, or interviews. This method provided flexibility in a context where interviews were occasionally cut short due to the ship's geological and operational activities. The researcher observed the physical and social surroundings (the ship environment, the marine and coastal environment, and social activities on board) and took detailed notes to supplement and add context to the contributions of the participants.

Prior to boarding, the co-authors [AC, JF, DK, and JB] developed an interview guide (Appendix A) designed to explore the interactions between participants and the sea, as well as its wildlife, which may underpin their perceived CES benefits. The sea was conceived in a general sense, as the participants had experience working in different seas which would inform their answers. The guide aimed to uncover participants' own articulations of the meanings and benefits they attach to the sea and its wildlife, and to understand how they perceive these connections in relation to management and decision-making. A semi-structured format was employed to accommodate the emergence of unanticipated topics or

further elaboration on any relevant topic (Gould et al., 2015).

Participatory, *in situ* research enables deeper insights where being immersed in the environment and building rapport with participants facilitates quicker and easier capture and communication of CES and benefits (Smith, 2019; Britton and Foley, 2021; Mentz, 2019). It allows a nuanced understanding of the sensory, emotional, psychological, and socio-cultural dimensions through which offshore environments influence human health and wellbeing (Smith, 2019; Britton and Foley, 2021; Mentz, 2019). It aligns with approaches such as "observant participation" (Smith, 2019), which prioritise active researcher involvement and attentiveness to the sensory and environmental elements of socio-ecological activities. While it risks subjectivism, it offers the sensitivity necessary for rich insights into sensory, psycho-emotional, and social dynamics. Researcher bias was offset by reflective journaling and regular consultations with co-authors [JF, DK, and JB], including extensively during data analysis and interpretation.

Most participants requested anonymity, so their descriptive details have been generalised. Participants varied in age (from twenty-three to sixty), nationality (predominantly from Ireland and the United Kingdom, with some from other parts of Western Europe, Asia, and North America), and professional role (from master's students to senior lecturers and from deck crew to bridge crew) (see Table 1). The scientists comprised an even mixture of men and women, but all the ship crew members were men. Participants' sea experience varied widely, from as little as two days to as much as twenty years, calculated as cumulative days at sea over their lifetime or career (e.g., three years of direct sea experience within a ten-year career). Many scientists had prior direct involvement in offshore science projects, and all crew members were seasoned seafarers with backgrounds in fishing (60 %), recreational sailing (20 %), or merchant sailing (20 %).

The study received institutional ethical approval (reference: HS-24–26-Cahillane-B). The CES researcher contacted gatekeepers from University College Dublin and the Marine Institute to inform the scientists and crew about the study prior to boarding. All participants consented to the ethnographic observations and formal interviews. The individual interviews were audio-recorded and held in the conference room during the expedition.

Table 1
The 23 participants who took part in the study. Their anonymous ID, professional role (scientist = 13; crew = 10), gender, age range, nationality, direct time spent studying or working offshore over their lives.

ID	Category	Gender	Age range		Nationality		Time spent at sea
			23–38	39–60	IR/UK	Non-IR/UK	
1	Scientist	Female	✔		✔		0–7 days
2	Scientist	Male	✔			✔	2–4 months
3	Scientist	Female	✔		✔		2–4 months
4	Scientist	Male		✔	✔		1–2 years
5	Scientist	Male	✔			✔	2–4 months
6	Scientist	Female	✔		✔		2–4 months
9	Scientist	Female	✔		✔		2–4 months
13	Scientist	Male		✔	✔		3–4 years
15	Scientist	Male	✔		✔		0–7 days
16	Scientist	Female	✔			✔	0–7 days
17	Scientist	Male	✔			✔	2–4 months
18	Scientist	Female	✔		✔		0–7 days
19	Scientist	Female	✔		✔		2–4 months
7	Crew	Male	✔			✔	3–4 years
8	Crew	Male	✔		✔		3–4 years
10	Crew	Male	✔		✔		3–4 years
11	Crew	Male		✔	✔		15–16 years
12	Crew	Male		✔	✔		15–16 years
14	Crew	Male	✔		✔		4–5 years
20	Crew	Male	✔		✔		5–6 years
21	Crew	Male		✔	✔		15–16 years
22	Crew	Male		✔	✔		9–10 years
23	Crew	Male	✔		✔		5–6 years

2.3. Data analysis and interpretation

The anonymised handwritten observational notes and interview transcripts were uploaded to NVivo 12 for several rounds of coding by the lead researcher [AC]. The method of "reflexive thematic analysis" (Braun and Clarke, 2022) was chosen to include the researcher's embodied experience on the ship as part of the data analysis. Reflexive thematic analysis involves iterative, subjective coding that is nonetheless systematic and grounded in a study's research objectives and theoretical framework (Braun and Clarke, 2022). Throughout the coding process, the researcher used a diary to reflect on their own assumptions, experiences, and positionality (Haraway, 1988) to develop nuanced and contextualised insights. An inductive (i.e. bottom up) coding approach was first used to familiarise the researcher with the data and identify unanticipated insights relevant to the research questions. Words and phrases relating to (a) all types of ecosystem services, (b) socio-ecological spaces and processes, (c) embodied, emotional, or psychological experiences, (d) perceptions of the sea, (e) perceptions of the sea's value to human society, and (f) perceptions of how the sea should be managed for decision-making were coded initially by the lead researcher, and checked for consistency and interpretation by co-authors [JF and JB].

A deductive (i.e. top-down) approach was then taken. The researcher adapted an overarching codebook developed by Ainsworth et al. (2019) which integrates two Ecosystem Services conceptual frameworks (Fish et al., 2016a; Díaz et al., 2015) in the context of marine and coastal environments (Appendix B). The first is the framework developed by Fish et al. (2016a) for the UK National Ecosystem Assessment follow-on (UK NEA, 2014) and the second is the International Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Conceptual Framework (Díaz et al., 2015). These frameworks are useful for the present study because they (a) more explicitly foreground culture within human-nature relationships and they (b) depict two-way relationships whereby nature and culture shape and affect each other. The codebook allowed the identification of dynamic relationships between cultural practices, cultural ecosystem benefits, and human wellbeing. This codebook was used to integrate the observational and interview data and look for common themes or interesting (i.e. significant in relation to the research objectives) datapoints. First, words and phrases connected to CES and benefits were coded and checked for their frequency of appearance in both the interview data and field notes. Then, the same process was applied to words and phrases connected to cultural practices, environmental spaces, and human wellbeing. In some cases, datapoints emerged which were not represented by the pre-existing codebook, and the researcher created new codes for these points (in red text in Appendix B). An abridged codebook of CES and human wellbeing themes is presented in Table 2.

Based on these overarching codes, the researcher then conducted two more distinct sets of analyses to develop further sub-themes and to identify patterns between data points. The first focused on perceptions of the sea. The second focused on attitudes towards valuing and managing the sea for decision-making.

After the coding, the researcher discussed the findings with all co-authors and wrote them out in a narrative form (Urquhart and Acott, 2014) to fully integrate the observed and felt sensory, environmental, emotional, psychological, and socio-cultural dimensions with the coded data.

3. Results

3.1. Cultural ecosystem services and benefits

Table 3 presents the CES results from the fifteen formal interviews. These were combined with the informal interviews and observations to identify three key CES of offshore environments within the data: sense of community (with people); adventure; and knowledge acquisition or

Table 2
Abridged codebook for the interview and observational data analysis, including the main CES and human wellbeing themes, subthemes, and further subthemes. Numbers denote the number of codes applied within each theme. Total codes in this abridged table = 658. The codebook is adapted from Ainsworth et al. (2019), which builds on the conceptual frameworks IPBES (Díaz et al., 2015) and cultural ecosystem benefits (Fish et al. 2016a). Additions from Ainsworth et al. (2019) to these two conceptual frameworks are in black bold text. Additions from the authors of this article are in red text.

Theme	Sub-themes and further sub-themes	Total codes applied

Identities	• cultural identity (18)
	• belonging
	  • sense of community (with people) (63)
	  • sense of community (with nature and people) (1)
	• sense of place (24)
		106

Experiences	• aesthetic pleasure (24)
	• awe (33)
	• challenge (69)
	• **curiosity (4)**
	• excitement **or fun (53)**
	• **fear (13)**
	• **isolation or seclusion (3)**
	• **loss or sadness (11)**
	• **love or affection (8)**
	• relaxation (18)
	• **self-discipline (2)**
	• uniqueness (21)
	• **variety (17)**
	• physical sensation
	  ○ wave motion (4)
	• connection
	  o connection to nature (7)
	  o connection to people (8)
	• adventure (24)
	• escape (12)
	• boredom (2)
	• conflicts (4)
		337

Capabilities	• knowledge acquisition **or transferral** (57) • personal advancement (3) • skill development (16) • bodily comfort (7)	83
Good quality of life	• human wellbeing (12) • access to food, water, shelter, health, education (24) • equity (2) • freedom of choice (4) • good social relationships (11) • material prosperity (14) • physical and mental wellbeing (47) • physical, energy and livelihood security (4) • living in harmony with nature (5) • interdependence among human beings, other living species and the elements of nature (4) • relationship with the wider human community (5)	132

transferral. The latter two were not the most frequently mentioned in the formal interviews, but gained added significance through the informal interviews and observations. Additional CES, often overlapping with the key ones, included (in no particular order): excitement or fun, challenge, physical exertion, awe, sense of place, fear, aesthetic pleasure, personal advancement, skill development, physical sensation, bodily comfort, loss or sadness, variety, love for nature, cultural identity, novelty, escape, perspective, connection to people, and connection to nature. Of these services, adventure, challenge, fear, physical sensation, and bodily adjustment (the latter two relating to the motion of a ship or a body in water) are highly pronounced in offshore environments. Fig. 3 (a) and (b) present visualisations representing (i) the frequency of concepts cited in the formal interviews to link CES to wellbeing benefits, and (ii) the frequency of concepts captured in the fieldnotes relating to psychological, embodied, and socio-cultural aspects of offshore CES.

3.1.1. *Sense of community (with People)*

All participants cited positive social interactions and good social

Table 3
Results from the formal participant interviews. Part One lists cultural ecosystem services and benefits associated with interactions with marine ecosystems. Part Two lists the contribution of marine ecosystems to human wellbeing. The table includes the total number of participants who mention each benefit, additionally disaggregated according to stakeholder category and gender (S = scientist, C = crew, F = female, and M = male). The table also includes selected example quotes (Participant references include an identifying number and designation of either scientist or crew member).

Cultural Ecosystem Service or Benefit Category	No. participants who mention				Selected example Quotes
	S		C	Total	
	F	M			
Sense of community (with people)	4	5	6	15	"I come from a small village and everyone in the village is like: sea, sea, sea! So that's an undercurrent of what brings us all together. We're all kind of interested in it." (ID#1, scientist) "If you have a good crew, your job is really easy. That's the main thing to working on ships: the crew." (ID#7, crew)
Excitement or fun	4	5	6	15	"The craic [i.e. banter] with the crew is really, really fun. I really enjoy that." (ID#8, crew) "I think it's a lot of fun. It's different from working on land because there's always something happening." (ID#2, scientist)
Knowledge acquisition or transferral	4	4	5	13	"Recently I have this academic way of looking at the seabed and how, especially in Ireland, our offshore resources are going to be used for energy production." (ID#15, scientist)
Awe	5	2	4	11	"You realise how small everyone really is. Not insignificant, but… how big the world really is when you're that far out…" (ID#14, crew)
Aesthetic pleasure	2	4	5	11	"The conditions can be amazing. I've just been standing outside having a coffee, because it's so beautiful, the sea." (ID#9, scientist)
Relaxation	4	3	3	10	"It definitely offers people that solace. That breathing space just to decompress." (ID#4, scientist)
Adventure	4	3	2	9	"The ocean's massive, and when you're on land, you're like, how do I actually get out there and explore. There's so much that I haven't explored." (ID#3, scientist)
Cultural identity	2	2	4	8	"Sure, it's core to so many communities around the coast. We're an island nation." (ID#10, crew)
Uniqueness	1	3	4	8	"You're seeing all these blue whales, and fin whales and other stuff. You're seeing colonies of seals. You wouldn't see it on the *Blue Planet*." (ID#8, crew)
Variety	2	3	2	7	"Whenever I go to sea, I always discover or find something new." (ID#4, scientist)
Sense of place	4	3	0	7	"I grew up next to the sea. So I'd nearly put that down to why I am where I am, what I'm doing now." (ID#1, scientist)
Fear	3	0	3	6	"The sea is something that needs to be respected and feared. Because people forget how powerful it is." (ID#6, scientist)
Escape	0	1	4	5	"It's nice to get away. A lot of the time, at home, you can feel weighed down by obligations." (ID#8, crew)
Loss or sadness	1	1	3	5	"I have a child at home. When I'm out here, I miss them so much." (ID#14, crew)
Connection to nature	1	2	0	3	"Just feels like you're out in nature, as opposed to being in an office." (ID#15, scientist)
Challenge	0	2	0	2	"It's like being a gambler. There's a lot that can go wrong, and it's extremely frustrating at times. Nothing ever goes entirely according to plan. But there's a real buzz when things do go well." (ID#13, scientist)
Human Wellbeing Benefit	**No. participants who mention**				**Selected Example Quotes**
	S		**C**	**Total**	
	F	**M**			
Physical and mental wellbeing	4	5	6	15	"I would have done a lot of fishing and sailing and scuba diving and surfing. I still do a lot of surfing." (ID#10, crew) "It's part of my mental health." (ID#6, scientist)
Access to food, water, shelter, health, education	4	5	6	15	"The sea provides food, through sustainable and unsustainable methods. We export a lot of our catches, very little of it stays in Ireland." (ID#10, crew)
Material Prosperity	2	3	3	8	"The sea benefits communities economically, through fishing or tourism." (ID#9, scientist)
Physical, energy and livelihood security	1	2	1	4	"In fishing villages, their livelihoods depend on the sea" (ID#1, scientist)

relationships as significant benefits of offshore experiences. All cited "fun" and "camaraderie" as highlights of Irish research vessels. For one scientist (ID#4), part of their reason for career choice came from a positive first experience on an offshore survey:

> *"Never been out before. And I just loved it. I loved the interaction between the crew and scientists. I loved the science. I loved the technology that went with it. I just loved being out at sea. I just loved being away from society."*

For this participant, the social dynamic intertwined with other benefits, including knowledge acquisition, connection to nature, and escape. In general, the ship's close quarters and shared spaces, such as lounges and the messroom, fostered interactions, while events like dolphin sightings sparked excitement, connection to nature, and collective joy. Camaraderie deepened through discussions of science, maritime culture (e.g. Irish Sea shipwreck history), and offshore renewable energy. Shared challenges, including fatigue and seasickness, further bonded participants. By the survey's end, strong friendships and professional collaborations had formed, leading to post-survey social gatherings and future joint projects.

Sense of community offshore can be both a service and a disservice. Six participants emphasised the social environment's impact on happiness, noting its potential to cause distress. One crew member (ID#14) highlighted a contrast between Irish research vessels and merchant ships elsewhere:

Fig. 3. (a) & (b). Word cloud visualisations wherein the size of the word corresponds to the frequency of mention. Some words were changed slightly during data analysis to capture meaning clearly in one word while staying true to original sentiment. Fig. 3 (a) presents concepts used in the formal interviews to link CES to wellbeing benefits. Fig. 3 (b) presents concepts captured in the field notes relating to psychological, embodied, or socio-cultural aspects of offshore CES.

> *"Different on the bulkers and the merchant ships side of things, because you're only working with fifteen lads there. And you're stuck with those fifteen lads for four months. And no matter whether you like them or not, you have to get on with them. If you don't get on with somebody here, the ship becomes very, very small."*

3.1.2. Adventure

Nine (mainly scientist) participants cited adventure as a key benefit and motivation for going offshore. One scientist (ID#1) explained:

> *"There's a kind of a thrill to going out a ship and getting your samples. It's not like rocking up to a beach and looking at an outcrop of rocks. There's something different to it–it feels like you're exploring."*

This participant expressed that *"marine geology is that sense of adventure"* which underpins her interest in the subject. Another scientist (ID#3) conveyed something similar:

> *"The ocean's massive, and when you're on land, you're like, how do I actually get out there and explore. There's so much that I haven't explored. Being able to go offshore in a facility like this is unbelievable."*

Adventure related to both seafaring and coastal water sports. It arose from the unpredictable and challenging conditions of the sea, contributing to good quality of life in terms of physical and mental wellbeing and fostering relationships with nature. Good social relationships and anthropogenic assets such as ships, technology, and seafaring knowledge enhanced this sense of adventure.

The crew did not speak of sense of adventure in such excitable terms, but rather in deeper and more measured terms, citing variety and escape instead. They highlighted practical benefits such as work-life balance, afforded by extended periods off duty, alongside recurring experiences of fun, camaraderie, and variety in their routine environment. They also mentioned the role of offshore settings in facilitating feelings of "escape" from societal stresses, including traffic, monotony, and financial or social obligations. This framing of "escape" rather than "adventure" reflects the more regular, stabilising influence of offshore environments in fostering equilibrium over the long term.

Sense of adventure is typically seen as frivolous and even harmful for the environment (e.g. through the pollution effects of mass adventure tourism). Yet, adventure can be constructively embraced by policy—it can make environmental protection more playful and fun and thus more appealing and sustainable (Seymour, 2018). Adventure also connects to how recreation (e.g. water sports) is consistently targeted and revealed as key CES of marine and coastal ecosystems (Martin et al., 2016). Both adventure and recreation reflect how outdoor recreation carries social importance, relieves the stress of everyday life, and enhances psychological, emotional, and physical wellbeing (Martin et al., 2016).

3.1.3. Knowledge acquisition or transferral

The primary purpose of the expedition was to gather geological samples. Yet, intangible educational values were gained alongside physical samples for direct use. Offshore surveys allow scientists to directly see the environments they are studying, form relationships with these environments and other researchers, and acquire their own samples–all of which foster research independence and innovation. The field notes describe the direct engagement with sample material:

> *"I [the CES researcher] woke up at 5am and went to observe the sea at night, stopping at the wet lab first. The scientists were just about to do a box core. They were quiet and seemed tired from working throughout the night. I helped out with the sampling to learn about it. We bring up a box with core sediment, then check for shells for one of the scientists who is studying shells. Then we scoop out the sediment and put it in a bag and label it. We note time, date, depth, latitude, longitude, and other details, making notes on anything unusual. The scientists were happy to teach me the process and let me do some of it myself–they had pride in what we were gathering, especially those gathering their own samples. The sampling wasn't too difficult, but you must be precise. The tiniest details about the samples matter–as if you are trying to lock in the exact space and time you captured the sediment. I would find this work repetitive over the long-term, and I think some of the scientists were struggling to stay awake. But they seemed accepting and committed."*

This type of sampling juxtaposes the practical and mundane with the exciting and groundbreaking. Scientists have to perform the tedious work of sampling–adapting to weather, team dynamics, and equipment capabilities–before gaining their research insights. This fosters a strong material and emotional connection between the scientists, their

teammates, and their object of study, as noted by one scientist (ID#3) who encouraged junior marine scientists to *"go to the ocean, go explore. And you'll be some amazing person in the future."* The challenge of sampling—such as the fatigue observed in the field notes—enhances the learning value, as conveyed by another scientist (ID#4) who feels a sense of *"empowerment in the way that you can go out and gather your own data in challenging conditions."*.

The Quest expedition—like many offshore science expeditions—was explicitly geared towards networking and collaborative exchange. Masters students, PhD students, and researchers from other projects were invited to join for the purpose of knowledge exchange, skill building, and networking. The fun and social environment of the ship created a collaborative space, with scientists and crew discussing their research during their downtime.

3.2. Perceptions of the sea

For most participants, the sea was a familiar and well-understood environment. Two key perceptions of the sea emerged across the formal and informal interviews and observations: an environment demanding respect, and an environment to which participants feel a strong connection.

3.2.1. Respect

Nineteen participants emphasised that users of the sea need to respect the sea, speaking with conviction and empathy rooted in lived experience. They had witnessed the sea's full range—from quiet calm to wild unpredictability. One crew member (ID#10) summed it up poetically: *"The power is tranquil and treacherous"*. Like other crew members, he described the sea as great in good weather, horrible in bad. Another crew member (ID#7) discussed the need to respect the sea because of its cold waters and potential to be dangerous in bad weather. He described humans as *"visitors"* to the sea who need to be respectful of it for that reason: *"to be safe. To come back home"*.

Participants spoke about the sea's many forms—whether calm or stormy—and the mix of emotions it evokes in an offshore setting: awe, connection, relaxation, but also fear, frustration, and even boredom. Others discussed fears of swimming at the coast due to the sea's dangers and unpredictable conditions. One scientist (ID#3) from a coastal community described sea swimming as such:

> *"I grew up at the beginning a bit scared, and, yes the sea was there for sport, but….just because it was so wide and expansive…it was a bit nerve-wracking. But then once you understand how the sea works, your calmness comes a bit more. And once you respect it, it's a lot better."*

The lead researcher experienced the vulnerability of being at sea when an outbreak of Covid-19 occurred on the sixth day. While not caused by the sea, the outbreak was more dangerous offshore where it can easily spread on a ship and where there is no access to hospitals. Due to this, the survey ended early and abruptly, exemplifying the capriciousness of offshore work which had come to the fore in the research interviews.

Yet, amongst these nineteen participants, the dangers of the sea were not seen as detracting from its cultural benefits but rather contributing to an ongoing relationship of knowledge and interaction which ultimately strengthen that relationship. As the fieldnotes record:

> *"One crew member says all he knows is working at sea. He's an ex-fisherman. His father was a fisherman, and his father before him was a fisherman. He's been working at sea for fifty years. He reckons you have to respect the sea. It can be calm, serene, and beautiful. But it can change in a second, and it can be very dangerous. Then he immediately lightened and said he likes the social aspect of being at sea. The crew's lives are in his hands, and his life is in theirs. So, they depend on each other."*

Reflections such as this suggest that cultural benefits derived from the sea—in terms of aesthetic pleasure, sense of community, or connection to nature—can come from a relationship of respect formed through interaction over a long period of time.

3.2.2. Sense of connection

Eighteen participants described a deep connection to the sea as an integral part of their lives, a view common amongst regular sea or coast users (Whyte, 2019). One scientist (ID#1) remarked: *"the beach and sea were always a very integral part of my life"*, while another (ID#15) noted: *"It's definitely really important to me. I think about it all the time"*.

This connection was formed from growing up by the coast or spending extensive time at sea for work or recreation. For example, a scientist (ID#4) reflected:

> *"I come from a coastal community…I grew up beside the sea. I would have spent a lot of summers at the beach, swimming, fishing, doing all those kind of coastal activities. The sea was always a constant in my life."*

For many, this connection motivated career choices in marine science, watersports, or seafaring, underscoring how their sense of purpose, identity, and physical and mental wellbeing is dependent on continual access to the sea—something which is not always economically guaranteed (Britton and Coulthard, 2013). A scientist (ID#13) with over twenty years of marine research experience highlighted how this bond bridges potentially conflicting interests:

> *"I work a lot with the fishing industry and aquaculture. I would see perspectives around their connection to the sea, more than as a younger man when I would have been quite anti-fishing. There's a strong connection between the fishing industry and the communities that live by the sea. It's more than just a source of income for them—it's their identity. Just as I identify as a marine scientist, being a fisherman is important to being a fisherman."*

4. Attitudes towards valuation and management of the sea

4.1. Protection or stewardship

Eighteen participants (across the formal and informal interviews) emphasised the need for active protection and stewardship of the sea in response to anthropogenic drivers such as pollution, species depletion, and climate change. For some, this perspective developed through a changing relationship with the sea, influenced by age, increased knowledge, or exposure to different perspectives (e.g. from fishing, science, conservation, industry, or recreation). One scientist (ID#2) described how studying and working on the sea made them acutely aware of pollution, saying it revealed *"how much junk actually goes into the ocean"*.

For one crew member (ID#12), this sense of stewardship came from a recognition of the sea's economic benefits for fishing:

> *"Well it's a very important resource for us. Because we are isolated, on the western part of Europe. And it's a thing that we have to try and look after as best we can. From all angles."*

This participant also noted observed changes, including rising sea

temperatures in Irish waters and harmful practices like kelp harvesting which can damage environments for smaller fish. Another crew member (ID#7) highlighted efforts to minimise pollution from ships. Marine research vessels have a long history of accommodating alliances, collaboration, and knowledge exchange between researchers and crew (Mentz, 2019; K. Hardy, 2021). Our analysis suggests that, in the Anthropocene age of increased awareness of human-caused planetary damage, these researcher-crew exchanges are producing complex and shared forms of environmental concern. Marine scientists and sailors are at the forefront of witnessing changes and threats to marine environments, and are at risk of ecological grief or anxiety (Cunsolo and Ellis, 2018). One crew member (ID#10) exemplified a complex dual perspective:

> *"It's pretty horrible what's happening to them [marine wildlife] at the moment. Through climate change, through mining, and through fishing and all the rest of it. The diversity and the biodiversity in the ocean is just incredible…it's amazing working in this job, because you get access to be able to see, both in fishing, which obviously you're killing them. But you still get to study and see them and learn from them. Which is great. And then the observations with the mammals and the birds. It's incredible."*

Discussing the health of the sea, he added:

> *"It's hard to find a lot of positives at the moment, with the impacts so clearly visible in the research and the science. But obviously it's still a beautiful place and it's incredible to be on it. But it is worrying for sure."*

These reflections highlight the doubleness of CES, which can both conflict with and contribute to environmental care and stewardship.

5. Discussion

5.1. Place-based valuation

Our study introduces a novel, place-based approach to capturing non-use and non-monetary values of marine and coastal ecosystems, with a particular focus on offshore environments. We identify how these environments foster values such as sense of community, adventure, and knowledge acquisition or transferral, arising from their distinctiveness and the challenges they present. Offshore users directly experience the ecological agency of the sea, reflecting how the sea as a "powerful force of nature" is often cited as a value from the perspective of the coast (Gee and Burkhard, 2010). Offshore environments necessitate social cooperation and physical adjustment, while also offering excitement and variety. Our findings contribute a sea-centric perspective to the existing, often land or coastal-focused, literature on CES.

Many participants expressed enjoyment during and after the formal interviews, which highlights how ecosystem valuation can enhance as well as articulate human-nature relationships (Zunino et al., 2020; Ainsworth et al., 2019). This suggests that CES are latent in contexts where marine use-values are being sought (e.g. scientific sampling or fishing). Despite being latent, our study uncovered how these CES can be transformational to the beneficiary. In our case, these CES influenced long-term marine careers and recreational hobbies as well as a sense of environmental care and stewardship.

Marine stakeholders have deep socio-ecological bonds with the sea which can deepen over time (Ainsworth et al., 2019). This study highlights the sea itself as a cultural space—a material nexus of ideas, social connections, relations, and emotions (Urquhart and Acott, 2014). In other cultural contexts, such as in Polynesian and Micronesian cultures, the sea has long been figured as a cultural space which shapes human identities, traditions, and art (Santos Perez, 2020; Te Punga Somerville, 2017). Yet, the field of Ecosystem Services remains dominated by Western land-based paradigms that confine culture to the shore (Dobrin, 2021; Hofmeyr, 2021). As Dobrin (2021) warns, such paradigms perpetuate anthropocentric conceptions of the ocean within logics of possession and ownership, blocking our ability to "think of ocean outside of anthropomorphic land-based logics". To address this, future CES studies must rigorously consider the entire marine geography, extending beyond coastal areas to include the open sea.

Historical examples highlight the importance of experiential and cross-disciplinary knowledge in marine science. For example, Lajus (2021) documents how pioneering women marine scientists in early twentieth century Russia challenged gender norms by working alongside men on research vessels. Similarly, Mentz (2019) describes how mariners and scientists in 15th- and 16th-century Europe collaborated aboard ships, amalgamating academic knowledge with maritime expertise. Building on these insights, our study argues that practical, team-based offshore experiences shape marine science practices brought back to land. This reinforces the significance of various types of ocean literacy for enhancing marine protection (Zunino et al., 2020).

5.2. Policy and management contexts

Stakeholder engagement is now considered key for ensuring the success and legitimacy of marine spatial planning initiatives (Banela et al., 2024). We propose that stakeholders with lived experience at sea must be involved in the work to identify offshore CES, and that this can increase participation, perspectives, and vocabularies for transformative marine management (Martínez-Harms et al., 2025). Additionally, our study highlights new avenues through which policymakers can engage categories of stakeholders who spend extensive time in offshore areas, like fishers, offshore industry workers, recreational sailors or divers, Indigenous peoples with cultural marine ties, or cultural heritage officers. Their respect for and connection with the sea could be nurtured through policies which emphasise offshore CES as well as the sea's power, alterity, and complexity as reasons for protecting it. This would foster mutual respect among diverse sea users. As Gee and Burkhard (2010) highlight, the sea as an untameable and unknowable entity is often what is valued by stakeholders, for it provides feelings of "freedom", "inspiration", and "mystery". We add that this warrants more eco-centric decision-making frameworks and language. Similarly, sense of place could serve as a shared motivation for marine biodiversity protection, cultivated through workshops, the interior design of ships, or funding for cultural heritage initiatives. The Lamlash Bay No Take Zone on the West Coast of Scotland is an example of how local sense of place attached to the health of offshore environments can drive community activism for marine protected areas (Stewart et al., 2020).

A key challenge for policymakers will be discerning links between policy, particular places, and CES and benefits (Urquhart and Acott, 2014), especially in the context of fluid open-sea environments. The growing emphasis on spatial mapping within CES assessment (Van Schoubroeck et al., 2024; Banela et al., 2024) may be difficult to apply in remote deep-sea or undersea areas. Thus, it may be necessary to combine localised spatial mapping with conceptions of broader aquatic regions. Alternatively, policymakers could identify bundles of CES which intertwine with and influence each other (Ingram et al., 2024), or determine links between CES and forms of infrastructure, governance, human engagement (e.g. sailing routes, resource extraction, diving spots), and ecological conditions (Fish et al., 2016a).

Policy strategies should consider potential conflicts and trade-offs,

but also co-operations and collaborations between the needs of different offshore stakeholders. For example, studies of recreational divers suggest that recreation benefits are often combined with educational benefits attached to marine biodiversity and can enhance motivations for environmental stewardship and protection (Zunino et al., 2020; Stamatiadou et al., 2023; Jobstvogt et al., 2014). We highlight common ground between recreational and professional sea users–both experience stress relief at sea–which can inform co-operative and transformative approaches to marine spatial planning. Multi-stakeholder policy consultations could foreground such CES common ground in specific contexts to ensure that offshore wellbeing benefits are maintained for various types of users and to stimulative collaborative policy buy-in. Adventure and escape benefits, often dismissed as secondary, can be powerful grounds for environmental activism (Whyte, 2019). Another powerful premise for collaboration is that, ultimately, the ability of marine ecosystems to provide CES depends on their ecological health.

Many participants expressed a strong desire to go out to sea, not just enjoy it from the coast. Losing access would not only sever their connection to the sea but also impact cultural heritage, community bonds, identity, and livelihood. This is critical for policies such as fishing quotas or marine spatial planning, which may limit how certain communities engage with the sea (Britton and Coulthard, 2013). If offshore work becomes legally, physically, or financially unviable, it risks reshaping individuals' and communities' entire relationship with the natural world, with significant impacts on job satisfaction, cultural heritage, and wellbeing (Britton and Coulthard, 2013; Santos Perez, 2020). Policymakers should avoid such losses, or provide compensation or alternatives when such losses occur. This is also critical for broader policies on environmental protection and climate change, as seas are becoming more dangerous for navigation due to ecological despoliation or the weather vagaries of climate change (Izaguirre et al., 2021; Brooke, 2015). This is exacerbated in contexts of the Global South where economically precarious maritime users or workers experience disproportionate levels of risk and danger (Izaguirre et al., 2021; McCabe, 2023).

5.3. Validity and limitations

Being at sea while discussing its value yielded intimate and powerful reflections. By interviewing participants in a familiar environment, the method helps to build relationships and trust between researchers and participants (Ainsworth et al., 2019). This can further the aim of IPBES to integrate multiple knowledge systems into environmental management. The *in situ* dimension of our study transformed the CES researcher and their knowledge of and sensitivity to offshore environments. The motion, unpredictability, and unique social environment of a long-term offshore expedition takes a degree of adjustment, which can only be gained through lived experience. It equips the researcher with place-based knowledge which can inform a sense of mutual respect and recognition between disciplines and cultures.

There were challenges in implementing the method. The sea itself is a risk: bad weather, technological issues, sickness, fatigue, unsuccessful sampling, or sailing issues can all compromise the ability to make observations, take notes, or carry out interviews. The researcher had to take a flexible approach to respond to these conditions. Yet, this enhanced the understanding of offshore CES, highlighting the very unpredictability of the sea as a key material element which can underpin services or disservices such as adventure or fear.

Our approach is subjective and personal, relying on the observations of an individual researcher, but in collaboration with co-authors to reduce bias. No two offshore expeditions are the same, and they contain variables such as research team or crew dynamics. It would be difficult to replicate the findings; but the methodological approach is entirely replicable for others to adapt. Living and working amongst participants means that personal relationships are formed which can influence biases. It can also risk social discomfort for the researcher or participants if a participant is unhappy or chooses to withdraw from the study. This can be mitigated through providing information on data rights and ensuring the confidentiality of collected data. Researchers should also practice reflexivity through journaling. Researcher fatigue is a risk, as this is a concentrated form of ethnography which blurs the boundaries between personal and work time.

This was also a relatively short-term participatory and ethnographic study. It yields preliminary results which would be productively built on with other studies. A follow-up expedition with geologists occurred in December 2024 to extend this research over a longer period. Research vessel crew members tend to be male, therefore it may be difficult to recruit female crew participants in future studies.

6. Conclusion

The place-based method articulated here highlights the long-term, socio-cultural, and material interconnections between offshore users and the sea, which underpin its CES and benefits. Benefits such as sense of community, adventure, and knowledge acquisition arise from context-specific human-sea interactions facilitated by cultural practices and environmental spaces. Such benefits underpin and advance perceptions of respect and connection toward the sea which reinforce attitudes of environmental care. These attitudes constitute a relational value between offshore stakeholders and the sea–one that policies can nurture by recognising the sea's agency. The power, unknowability, and unpredictability of the sea not only shape offshore CES but also illustrate how human-nature relationships thrive on challenge and dynamic interaction. Policies can support these relationships by protecting and enhancing access to offshore areas for key stakeholders while ensuring ecological sustainability. Offshore users navigate the sea through infrastructure and knowledge, yet they remain aware that the sea is never fully within human control.

The interactive, subjective, and personal nature of offshore CES necessitates a humanities and social science approach, offering narrative and non-monetary insights that complement scientific and economic frameworks (Van Schoubroeck et al., 2024; Ainsworth et al. 2019; Urquhart and Acott, 2014). Expanding humanities and social science research aboard vessels can foster transdisciplinary perspectives, capturing the variety of types of experiences and meanings generated at sea. Future studies could combine the qualitative with a quantitative or monetary approach to generate more extensive and comparable insights. For example, participatory mapping surveys can identify key offshore locations valued by stakeholders, linking ecosystem values to ecosystem health. Large-scale structured surveys could generate representative, quantifiable results to complement existing economic frameworks. Numerical valuation methods can enhance monetary studies, whereas spatial mapping can directly enhance marine spatial planning. However, regardless of approach, CES assessments must incorporate non-monetary, place-based methods to ensure inclusive, context-sensitive, and effective marine ecosystem governance.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the lead author [AC] used ChatGPT in order to lightly edit small sections of the manuscript. After using this tool, the author [AC] reviewed and edited the content as needed and takes full responsibility for the content of the publication.

CRediT authorship contribution statement

Ashley Cahillane: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Johanna Forster:** Writing – review & editing, Supervision, Methodology, Funding acquisition. **Dorota Kołbuk:** Writing – review & editing, Visualization, Methodology. **John Brannigan:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank the participants of this study and the Chief Scientist of the Quest project and the Operations Manager of the RV Celtic Explorer for their support. The Quest project is carried out with the support of the Marine Institute and the Environmental Protection Agency, funded by the Irish Government (Grant: PBA/CC/21/01), with shiptime funded through the Marine Institute Ship-time Programme. This study was funded by the Horizon Europe project Marine Biodiversity and Ecosystem Functioning Leading to Ecosystem Services (MARBEFES) (Grant Agreement no. 101060937). We would like to thank the two anonymous peer reviewers of this article.

Appendix A

Semi-structured Interview Template

Part 1. Interactions with the sea and its wildlife

Can you tell me a bit about the work you are doing on this expedition?
How have you come to do this type of work?
Have you done similar work before? If so, where?
What is it like working at sea, either on this expedition or in general?
How often do you work at sea?
Do you use the sea much in your spare time, when you are not out at sea for work?
Do you ever interact with the animals in or around the sea, for work or in your spare time?
What do you think of the animals at sea (within it or around it)?

Part 2. Ecosystem services and cultural benefits of the sea

What does the sea mean to you?
What about the wildlife in the sea and around it, what do they mean to you?
Do you think the sea benefits human societies? If so, how?
Do you think marine wildlife benefits human societies? If so, how?
How important are those benefits?
How well managed or protected are these benefits?

Part 3. The sea and management and decision-making

Has your view of the sea changed in any way over time? If so, why?
Has your connection to the sea changed in any way over time? If so, why?
How do you think the sea should be treated?
How do you think marine wildlife should be treated?
How do you think the sea should be valued?
How do you think marine wildlife should be valued?
Is there a marine or coastal location that you feel particularly connected to?

Part 4. Stakeholder engagement

Is there anyone you would recommend me to talk to regarding this topic of the human benefits of marine ecosystems? Especially anyone connected to the Irish Sea.

Appendix B. . Full codebook for qualitative data analysis

Codebook for the interview and observational data analysis, including themes, subthemes, and further subthemes. Numbers denote the number of codes applied within each theme. Total codes in this table = 1,003. The codebook is adapted from Ainsworth et al. (2019), which builds on the conceptual frameworks IPBES (Díaz et al., 2015) and cultural ecosystem benefits (Fish et al. 2016). Additions from Ainsworth et al. (2019) to these two conceptual frameworks are in black bold text. Additions from the authors of this article are in red text.

Theme	Sub-themes and further sub-themes	Total no. of codes applied

Practices	• creating and expressing
	  • creative observational writing (3)
	  • participant reflections during research interviews (2)
	  • knowledge sharing and collaboration (5)
	  • CES researcher reflections after survey (4)
	  • creative hobbies, e.g. photography (1)
	• gathering and consuming
	  • scientific sampling (4)
	  • ethnographic research and semi-structured interviews (4)
	  • eating (2)
	  • acquistion of sampling equipment (2)
	  • acquisition of required seafarer's training and documentation (2)
	  • receiving social support (8)
	  • receiving knowledge or training (16)
	  • fishing (23)
	  • holidaymaking (4)
	  • attending coastal or maritime festivals (2)
	• playing and exercising
	  • casual talking (12)
	  • joking (10)
	  • relaxing (8)
	  • wildlife watching (19)
	  • enjoying the sea views (7)
	  • getting fresh air (e.g. on the ship deck) (3)
	  • playing board games (1)
	  • visiting the gym (2)
	  • connecting virtually with family and friends (3)
	  • sports (2)
	• producing and caring
	  • giving social support (4)
	  • preparing scientific samples for analysis (2)
	  • performing scientific analysis (2)
	  • sharing knowledge (8)
	  • connecting virtually with family and friends (3)
	  • preparing fish for the market (1)
	  • volunteering with sea search and rescue services (1)
	  • engaging in environmental activism (2)
		172

Identities	• cultural identity (18)
	• belonging
	  • sense of community (with people) (63)
	  • sense of community (with nature and people) (1)
	• sense of place (24)
		106

Experiences	• aesthetic pleasure (24)
	• awe (33)
	• challenge (69)
	• **curiosity (4)**
	• excitement **or fun (53)**
	• **fear (13)**
	• **isolation or seclusion (3)**
	• **loss or sadness (11)**
	• **love or affection (8)**
	• relaxation (18)
	• **Self-discipline (2)**
	• uniqueness (21)
	• **variety (17)**
	• physical sensation
	  ○ wave motion (4)
	• connection
	  o connection to nature (7)
	  o connection to people (8)
	• adventure (24)
	• escape (12)
	• boredom (2)
	• conflicts (4)
		337

Capabilities	• knowledge acquisition **or transferral** (57) • personal advancement (3) • skill development (16) • bodily comfort (7)	83
Nature	• biodiversity (17) • ecosystems (2) • intrinsic value (2) • living natural resources (4) • shared evolutionary heritage (2) • the biosphere (4) • climate (20) • the evolutionary process (3)	54
Anthropogenic assets	• built infrastructure (9) • health facilities (1) • knowledge (3) • technology (3) • communities (16)	32
Direct drivers	• natural drivers (4) • extreme events (2) • natural climate and weather patterns (8) • anthropogenic drivers (12) • climate change produced by anthropogenic carbon emissions (5) • degradation of habitats or species (5) • exclusion and restoration of habitats or species (4) • harvesting of wild populations (28) • intensification or abandonment (5)	87
	• pollution of soil, water or air (14)	
Good quality of life	• human wellbeing (12) • access to food, water, shelter, health, education (24) • equity (2) • freedom of choice (4) • good social relationships (11) • material prosperity (14) • physical and mental wellbeing (47) • physical, energy and livelihood security (4) • living in harmony with nature (5) • interdependence among human beings, other living species and the elements of nature (4) • relationship with the wider human community (5)	132

Data availability

Data will be made available on request.

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