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Forgotten landscapes: Public attitudes and perceptions of coastal saltmarshes

Abstract

As the field of public perceptions research continues to grow alongside an increasing recognition of the importance of understanding the complex interactions between society and the natural environment, this needs to consider all types of ecosystem, habitat and species. Although interest in public perceptions towards the global seas and coasts is increasing, the field is dominated by research focused on charismatic environments and species (e.g. coral reefs or marine mammals), and specific activities or human interactions with the seas and/or coasts (e.g. beach use, marine renewable energy). Whilst there has been some research on beaches and sand dunes, this is the first discrete piece of research which evaluates public views on the less 'attractive' coastal fringe environments, such as saltmarshes or mudflats, particularly in temperate regions. This paper presents the findings of a national survey (n = 1136) that aimed to understand public awareness and attitudes towards Welsh saltmarshes, and the ecosystem services and benefits derived from such systems. Through the questionnaire, we found limited public awareness, and a high amount of uncertainty, associated with saltmarshes and their societal benefits, indicating a need to foster and enhance current levels of public knowledge and understanding of saltmarshes, and their role within the wider coastal landscape, as well as exploring the influence of a range of respondent characteristics on perceptions. Given the position of salt marshes at the land-sea interface, the myriad of socio-ecological interactions they experience, and ongoing efforts to develop effective complementary marine and land-based planning and management, it is increasingly apparent that understanding public perceptions towards saltmarshes is crucial. This study contributes to the evidence base of public attitudes for the more commonly under-valued coastal fringe environments, such as saltmarshes.

Keywords: marine social sciences, public attitudes, RESILCOAST, coastal fringe, ecosystem services.

1. Introduction

The marine social science landscape is undergoing unprecedented growth, with increasing recognition of the role the social sciences can play in developing effective marine and coastal management. There has been a long-standing research dialogue around the interaction between society and land-based environments, extending back to early theories of environmental determinism and the significant geographical discourse around this (Johnson and Sidaway, 2015 for a review of human geography dating to 1945). In recent decades, work on the New Environmental Paradigm, which originated in 1978 (Dunlap and Van Liere, 2008) and environmental citizenship/ stewardship (Hawthorne and Alabaster, 1999; Bennett et al., 2018) has been informed by this approach. Contemporary conservation and environmental management on land has seen a growing focus on the role of social science (see for example, Bennett et al., 2017). The interconnection between society and the sea and coasts, however, has generated a more recent wave of research interest (Bennett, 2019; McKinley and Fletcher, 2010; 2012; Fletcher and Potts, 2007), with greater emphasis on understanding the often complex socio-ecological systems of coastal and marine environments. Furthermore, the need to take account of the three pillars of sustainability (namely economic, social and environmental) is

increasingly seen as the foundation of effective sustainable coastal management (Cummins and McKenna, 2010). This shift to a wider focus has been mirrored in both recent UK national (e.g. the House of Commons Environmental Audit Committee Sustainable Seas Report (2019)) and international goals (e.g. UN Sustainable Development Goals (2015) and the Aichi Targets (2011)).

As one facet of this emergent multi-disciplinary research field, public perceptions research related to marine and coastal issues is garnering an increasing level of attention (Jefferson et al., in prep). Public perceptions research as an umbrella term takes into account the attitudes, values, knowledge, emotions, and concern, among other things, held by individuals and considers how this influences their interaction with marine and coastal environments (Jefferson et al., 2015). Furthermore, public perceptions research is a lens through which the societal relationships with the sea and coasts can be examined, with the additional benefit of improving our understanding of the factors that might influence these connections (for example: gender, age, social background, experience of the marine and coastal environment). Jefferson et al. (2015) sets out a framework for understanding public perceptions in the context of marine and coastal spaces, mirroring other longstanding arguments regarding the importance of including public perceptions within decision making. In particular, Fiorino (1990) sets out three key elements relating to this, including: substantive arguments which suggests that public perceptions and opinions are as valuable as those from 'expert' communities; the 'normative' argument which suggests that including public perceptions in decision making is an inherent component of democratic decision making; and finally, the instrumental argument, which suggests that inclusion of public views and perceptions legitimises governance processes and decision making.

Increasingly, we are recognising that our coasts are in reality 'peopled seascapes' (Bennett, 2019) and, in recent years, there has been an upward trend in the volume and scope of research being undertaken in this area, showcasing the importance of understanding societal interactions and public values (both monetary and non-monetary) of marine and coastal environments across the world. Gelcich et al. (2014), for example, report on the results of a large pan-European study (n=10,106) examining public understanding of anthropogenic pressures on marine environments, with pollution and overfishing prioritised by the respondents. In a UK context, numerous authors have examined public connection and awareness of the sea (see for example, Fletcher et al., 2009; Jefferson et al., 2014; Hawkins et al., 2016 and Potts et al., 2016). There were a number of commonalities across these studies – namely that while respondents indicated a high level of interest in marine issues, there remained a significant level of disconnect between the public and the marine environment. This was clearly evidenced by Jefferson et al. (2014) who found that although people showed interest in some species (e.g. puffins, marine mammals), they were not aware that these species could be found in the UK waters.

Despite the seemingly low levels of public connection with the seas and coasts, public interest, engagement and concern are increasingly recognised as being integral to the development and implementation of effective marine and coastal policy (Hamilton and Safford, 2014; McKinley and Fletcher, 2012; 2010; Fletcher et al., 2014). By understanding societal connections, perceptions and knowledge of the natural world, we can encourage greater levels of public buy in and support for environmental management, garner support for behaviour change efforts and raise political will to drive change from a national policy level (Bennett, 2019; McKinley and Fletcher, 2012). Indeed, recently, the public response to the 2017 BBC Blue Planet 2 documentary series has been credited with resulting in fundamental changes in single use plastic consumption and waste management in

the UK – with suggestions that these changes are only the start of wider publicly driven movements to tackle the challenges facing global seas and coasts (Gell, 2019). There is clearly a need to build global ocean literacy and over the last 15 years or so, this has been increasingly promoted by both academic community (e.g. Steel et al., 2005) as well as through other initiatives (for example, UN Environment -World Conservation Monitoring Centre's (UNEP-WCMC) programme on ocean literacy and behaviour change and the Gulbenkian Foundation's recent work on understanding ocean values and collaborations with Wild Lab). While recognising that knowledge and related literacy is only one facet of connection, there is a view that by working through the lens of ocean literacy, these initiatives will not only serve to improve public knowledge and connection but will also enhance public understanding of management and policy decisions, as well as engender a sense of marine citizenship (McKinley et al. 2010; 2012) within UK communities.

Despite a growth in social science research, and more specifically public perceptions research focusing on the marine and coastal, a recent review (Jefferson et al., in prep) indicates that the focus of much of this effort remains on charismatic (e.g. coral reefs – Benham, 2017; Lucrezi et al., 2014; Elliott et al., 2010) or topical issues, such as climate change (Capstick et al., 2015; Lorenzoni and Whitmarsh, 2014). The emphasis on the charismatic, or the more aesthetically pleasing elements of the natural world, is not particularly surprising. Recent studies have shown that public concern and awareness tends to be higher for places or species considered to be more attractive or charismatic, rather than for their biodiversity value or the ecosystem function role they play within a system (Shah and Parsons, 2018; Colleony et al., 2017). While there is considerable work on beaches and dunes (see for example – Kindermann and Gormally, 2013; Everard et al., 2010; Vaz et al., 2009; Tudor and Williams, 2005), the less accessible or attractive coastal fringe systems, for example saltmarshes or mudflats, particularly those found in temperate regions are rarely considered through this lens, regardless of the importance of these systems to global society. The majority of marine social sciences work conducted in the context of saltmarshes tends to focus on sea level rise (e.g. Thomas et al., 2015), or managed realignment (e.g. Luisetti et al., 2011), rather than on public perceptions and attitudes towards the saltmarshes themselves.

Coastal fringe ecosystems, including saltmarshes, encompass some of the most dynamic, productive environments globally (McKinley et al., 2018). Given their position at the land-sea interface, saltmarshes are a unique ecosystem, often acting as a link between marine, brackish and freshwater systems (Mcowen et al., 2017). Saltmarshes support a diverse range of ecosystem services and related societal benefits from coastal protection, carbon storage, nutrient cycling, important habitats for biodiversity, to providing tourism and recreation value, food production and fisheries, inspiration for arts and culture, and benefits for physical and mental health and wellbeing (McKinley et al., 2018; Mcowen et al., 2017; JNCC, 2016; Adnitt, 2007). In spite of their recognised importance and a considerable level of global legal protection through a range of designations (e.g. RAMSAR sites), these highly valuable ecosystems are vulnerable to ever increasing anthropogenic threats. Saltmarshes around the world experience significant loss and deterioration of habitat quality, through conversion of land for agriculture, port development, coastal squeeze, and other damaging/ deleterious activities (Mcowen, et al., 2017; Bouma et al., 2014; Luisetti, et al., 2011). Recent predictions have shown that this loss is set to continue, with global projections indicating a loss of between 20 and 90%, depending on sea level rise, by the end of the 21st century (Schuerch et al., 2018). Loss of this magnitude will have immeasurable impacts - on biodiversity due to habitat loss, deterioration of natural coastal protection, and impacts on fisheries as a result of losing valuable nursery habitats. Despite their

importance and contribution to everyday lives globally, and recent emphasis on their restoration across the globe, saltmarshes have frequently been overlooked from a social science perspective (Mcowen, 2017).

Using Wales as a case study, this study examines public perceptions towards Welsh saltmarshes, their ecosystem services and the benefits people perceive them to provide through a (Welsh) national survey questionnaire. This is particularly timely given the implementation of a suite of recent forward-thinking environmental legislation and policy in Wales, including the Well-Being of Future Generations (Wales) Act 2015 (McKinley and Ballinger, 2018) which places local communities centre-stage in the quest for sustainable development. Coastal areas in Wales are of significant importance, supporting over 60% of the Welsh population, with saltmarshes making up 6950ha. of the Welsh coastline (Thomas, 2016). Despite a long tradition of coastal landscape protection in Wales, dating back to the National Trust's first acquisition of coastal cliffs tops (near Barmouth) in 1895 (Williams, 1987) and the seminal work of John Steers, which pioneered the current distribution of protected coastal landscapes across Wales (Steers, 1978), there has been limited academic research examining the Welsh public's relationship with their coastline, and none that looks specifically at coastal fringe environments, such as saltmarshes.

From a social perspective, little is known about how saltmarshes are understood, perceived and valued by coastal communities, never mind how this might feed into effective coastal management and decision making. We suggest that by developing a clearer understanding of public views towards these often poorly understood and under-valued systems, more effective decisions regarding coastal management, sustainable management of natural resources and potential trade-offs between a diverse set of uses, users and benefits can be understood and taken into consideration. The paper first presents the methodological approach applied to the study, followed by an examination of the results, discussion of key findings and concludes with the presentation of a series of recommendations, which, although focused on promoting public understanding and delivering effective management of saltmarshes in Wales, is equally applicable to other coastal fringe ecosystems worldwide.

2. Methods and Questionnaire design

The purpose of this study was to develop an understanding of public perceptions and attitudes towards saltmarshes in Wales. With the need for a large sample size, an online questionnaire was determined as being the most effective method of data collection. The questionnaire had three main sections: Section 1 – focused on awareness, understanding and perceptions of saltmarshes and their ecosystem services and/ or benefits; Section 2 – comprised of an Analytical Hierarchy Process exercise where participants were required to complete a number of pairwise comparisons to indicate their preference for saltmarsh ecosystem services. Due to the in-depth methodological discussion required to support the AHP analysis, this component of the questionnaire will not be discussed in this paper but will be available in a later publication. Finally, Section 3 – socio-demographic and background information about the respondents (including gender, age group, employment, postcode, and education).

A range of question types were used in the data collection instrument. A number of the questions presented to respondents required a degree of self-reporting on levels of awareness, concern, knowledge and behaviour, with respondents required to rate their responses to questions through a

Likert scale style answer. Although often used to measure pro-environmental behaviour and perceptions, the potential limitations of self-reported data should be recognised. These include a perceived tendency for self-report measures to exaggerate or respond to social norms or desirability; the effect of time and distance on recovery of accurate memories about a particular situation or behaviour; and the potential subjectivity that can be inherent within this type of question. Despite these potential limitations, self-reporting remains a common approach in questionnaires, and is beneficial due to its low cost, easy use and flexibility (see for example, Millfont 2008; and Kormos and Gifford, 2014 for a review on self-reporting). For the purposes of this questionnaire, this style of question was considered to be the most accessible way of collecting this information from a bilingual and diverse audience. Of further note is Question 5, which asked respondents to rate their level of agreement to a series of statements relating to saltmarshes and their ecosystem services. Drawing on existing literature and expert knowledge within the RESILCOAST research team, these statements were designed with a view to covering a diverse range of saltmarsh ecosystem services and benefits.

The questionnaire was piloted by 15 people to test for understanding and identify any need for clarification, with only minor amendments required following the pilot. The final questionnaire was distributed online and made available bilingually (i.e. in English and in Welsh) between June and August 2017. The data collection process was administered by CINT, a data collection company; while data collection companies have their limitations (for example, respondents taking part due to incentive, rather than interest in an issue which may lead to bias), overall, they have been found to be beneficial in identifying relevant samples, and efficient in terms of data collection (Schoenherr et al., 2015). In terms of sampling, the aim was to get a spread of views from across Wales to take account of views from non-coastal areas, a range of age groups, gender and across rural, urban and coastal communities. The research team set a target of 1000 respondents, with a final sample size of 1136 respondents achieved.

Data Analysis

Closed questions collected data focused on (i) public awareness of saltmarshes ('To your knowledge, have you ever visited a saltmarsh?'), (ii) public understanding of saltmarshes ('Please indicate how highly you would rate your knowledge of saltmarshes in Wales?'), (iii) perceptions of saltmarshes and their ecosystem services and/or benefits ('Please indicate how much you agree with the following statements about saltmarshes, the threats they face, their management and their contributions to society') and (iv) socio-demographics of the respondents (including gender, age group, employment, postcode, and education). A range of different data visualisation methods were used to explore the raw data (e.g. pie charts, bar plots, bubble plots for the spatial distribution of respondents using postcodes etc.) to identify overall trends in the data set.

To statistically determine the influence of sociodemographic variables on public awareness of saltmarshes ('To your knowledge, have you ever visited a saltmarsh?'), a Generalised Linear Model (GLM) with binomial distribution (i.e. in essence this question identified the proportion of respondents that had visited a saltmarsh, and binomial GLMs are ideal for proportional data (Zuur et al. 2009)) was used. The full initial model included the following list of predictors, all included as fixed effects: Gender, age, employment, education, membership of an environmental NGO, and the rural-urban classification of the respondents' postcode (see Supplementary information for more details on how this variable was calculated). Akaike Information Criterion (AIC) and Log-likelihood ratio tests were

used to eliminate non-significant variables one by one until no more variables could be removed from the model (Zuur et al., 2009). Therefore, the final model only included those sociodemographic variables that significantly influenced the proportion of people that had visited a saltmarsh.

Ordinal regressions were used to analyse the influence of respondents' characteristics on the level of public understanding of saltmarshes ('Please indicate how highly you would rate your knowledge of saltmarshes in Wales?'). This is a type of regression analysis used for predicting an ordinal response variable, i.e. a variable whose values exist on an arbitrary scale where only the relative ordering between different values is important. For this question, the ordered levels were: No knowledge < Basic knowledge < Knowledgeable < Expert knowledge. Again, model selection was done on the full model including all sociodemographic predictors, and using AIC and Log-likelihood ratio tests, until no more predictors could be dropped from the model.

To statistically examine trends in respondents' perceptions of saltmarshes and their ecosystem services and/or benefits, one-sample Wilcoxon tests were used to determine if the responses overall differed from the mid-point (i.e. 'neither agree nor disagree'; 'somewhat beneficial' [both coded as 3 on 5-point scales]). In other words, Wilcoxon tests were used to understand if respondents had any inclination towards, or against the statements provided, or if they were indifferent. Given the non-normal distribution of responses Wilcoxon tests were used. To further understand the influence of respondents' characteristics on public perceptions, we again used ordinal regressions. In this case, the ordered variables – for example: No benefit < Slight benefit < Somewhat beneficial < Moderately beneficial < Very beneficial. Again, model selection was done on the full model including all sociodemographic predictors, and using AIC and Log-likelihood ratio tests, until no more predictors could be dropped from the model.

To summarise the results of ordinal regressions, we produced coloured tables. In these tables, all the sociodemographic predictors included in all initial models feature at the top row, with the different statements/questions that the respondents had to rate in a different row (a regression was run for each statement of the perceptions section of questionnaire, thus each row is the result of a different regression). Cells were coloured according to whether a predictor was dropped from the model (cells in grey), or if that predictor significantly influenced the answers to a given statement (cells in red or green). If the predictor was significant, we indicated the specific level of the predictor that was responsible for influencing the statement (e.g. being unemployed). If the level increased the odds of the respondent giving high ratings to the statement, the cell was filled in green. If the level of the predictor decreased the odds of the respondent giving high ratings to the statement, the cell was filled in red. Models were validated as recommended in Zuur et al. 2009 and Christensen 2015. Assumptions of normality and homogeneity of variance for the GLM were checked visually by inspecting model residuals and fitted values. Assumptions of proportional odds and scale effects were tested for all ordinal regressions. Additionally, care was taken to discard any ordinal regression with a Hessian number > 10000, which is a sign of non-identifiable models. All analyses were run in R (R Development Core 2018). The R scripts used to run all of the analyses reported here are available as a github repository (https://github.com/jordipages-repo/MarshPublicPerceptions_PUBLIC).

3. Results

3.1. Respondent Profile

Table1	N	%		N	%
Demographics					
Gender			Employability Status		
Male	494	44	Employed full time	522	46
Female	524	46	Employed part time	97	9
			Retired	143	13
Age Group			Volunteer	81	7
18-24	133	12	Student	104	9
25-34	210	19	Other	74	7
35-44	211	19	Education		
45-54	190	17	GCSE/ O Level or equivalent	250	22
55-64	166	15	A Levels or equivalent	189	17
65 or over	112	10	Undergraduate degree	159	14
Member of an environmental NGO			Postgraduate Masters Qualification	325	29
Yes	69	6	Postgraduate Doctoral Qualification	95	8
No	952	84	Professional Qualification	250	22

From the total sample of respondents, quantitative data analysis focused on those 882 that provided their abbreviated postcode (first 4 digits) – as postcode was needed to classify respondents as belonging to rural or urban areas. The distribution of these 882 respondents matched the main urban areas around Wales, with most of the population concentrated in the south (around Cardiff and Swansea), in Aberystwyth on the western coast, and along the Dee estuary and the northern coast (Figure. 1). Approximately 80% of the respondents came from urban areas, while the remaining 20% belonged to rural areas.

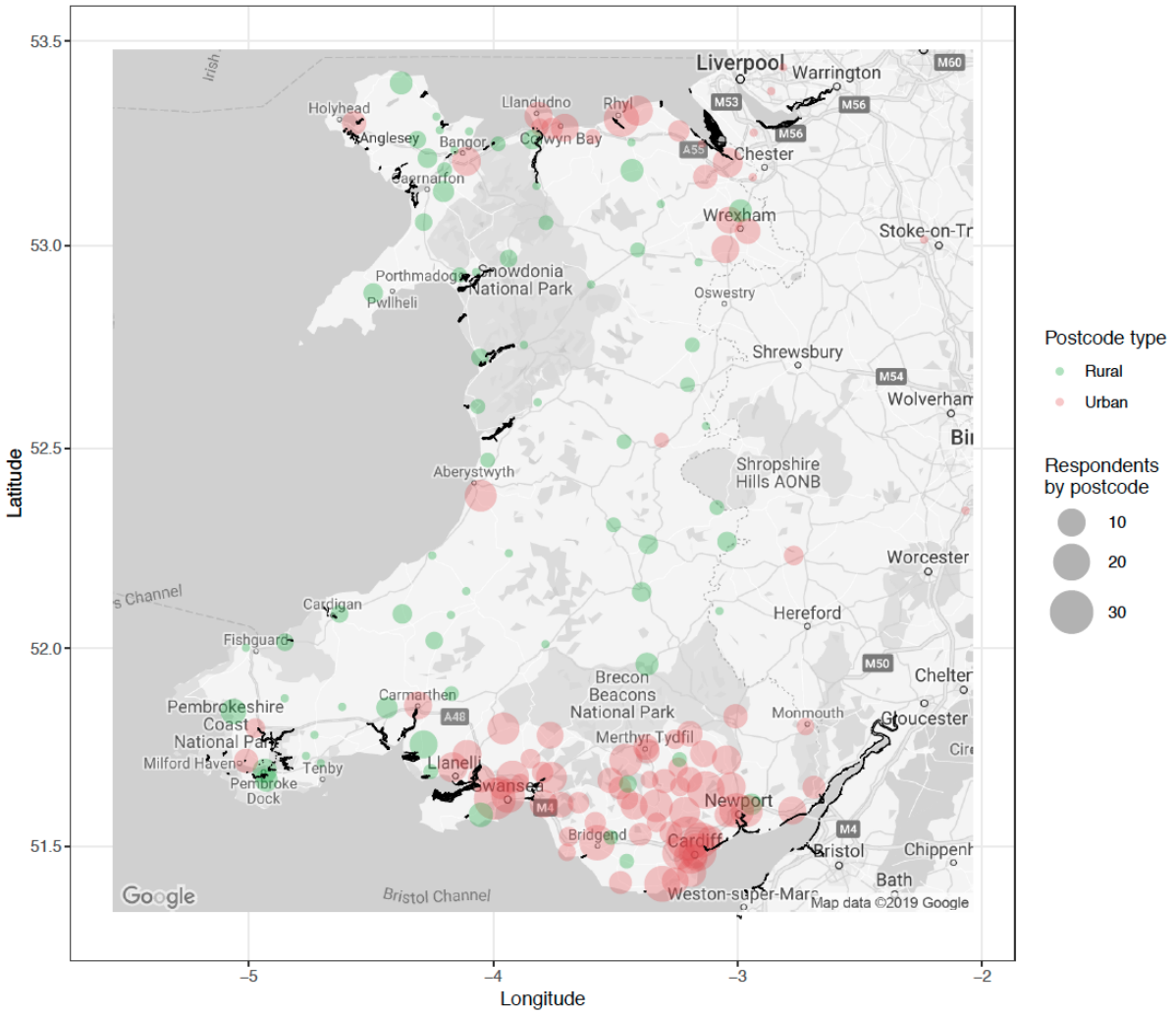

Figure. 1. Distribution of respondents that provided the first four digits of their postcode (n = 882). Each bubble is coloured according to whether the postcode was classified as rural or urban. Bubble size relates to the number of respondents for each abbreviated postcode. Note that the spatial distribution of our sample of respondents matched Welsh population distribution. Black polygons correspond to saltmarsh distribution around Wales.

3.2. Public awareness, knowledge and perceptions towards Welsh saltmarshes

As an initial question, respondents were asked whether they had knowingly visited a saltmarsh - with only 37 % of respondents responding positively. The proportion of respondents that had knowingly visited a marsh was significantly influenced by gender, employment, highest level of education and membership of an environmental organisation (Table S1, Fig. 2). Specifically, the proportion of respondents that had visited a saltmarsh was higher among males, self-employed or retired respondents, those having an A-level or higher levels of studies and members of environmental organisations (Fig. 2). In contrast, age or rural-urban classification did not influence the proportion of respondents that had visited a marsh.

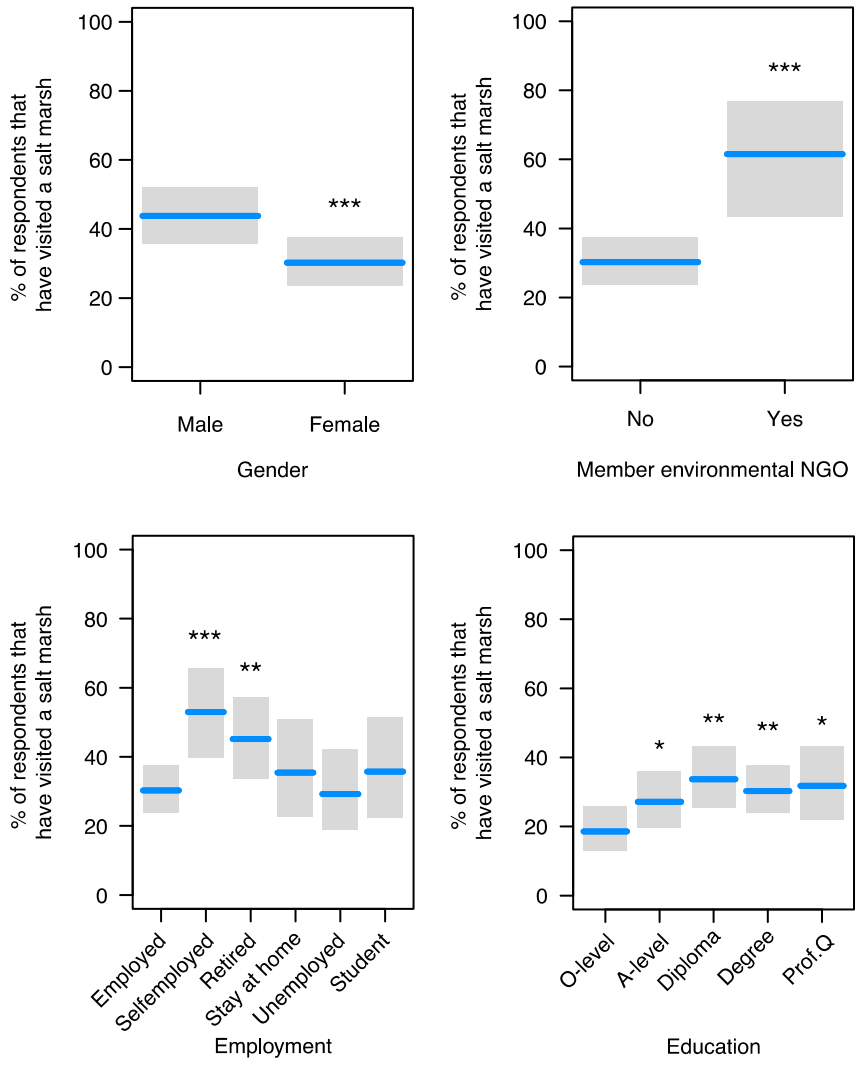

Figure. 2. Generalised Linear Model results for the response variable 'Proportion of respondents that have visited a marsh'. Blue lines represent model fitted values, shaded areas are the 95% confidence intervals around fitted values. Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

The following question asked respondents to rate their level of knowledge of saltmarshes, from no knowledge to expert – with only 1% of respondents rating themselves as having 'expert knowledge' and over 90% indicating that they had either basic or no knowledge of saltmarshes (Figure 3). Ordinal regressions showed that having visited a marsh and being a member of an environmental organisation significantly increased the odds of acknowledging a higher level of understanding of saltmarshes (Table S2). In contrast, the odds of acknowledging high levels of understanding were lower for respondents from urban areas (Table S2).

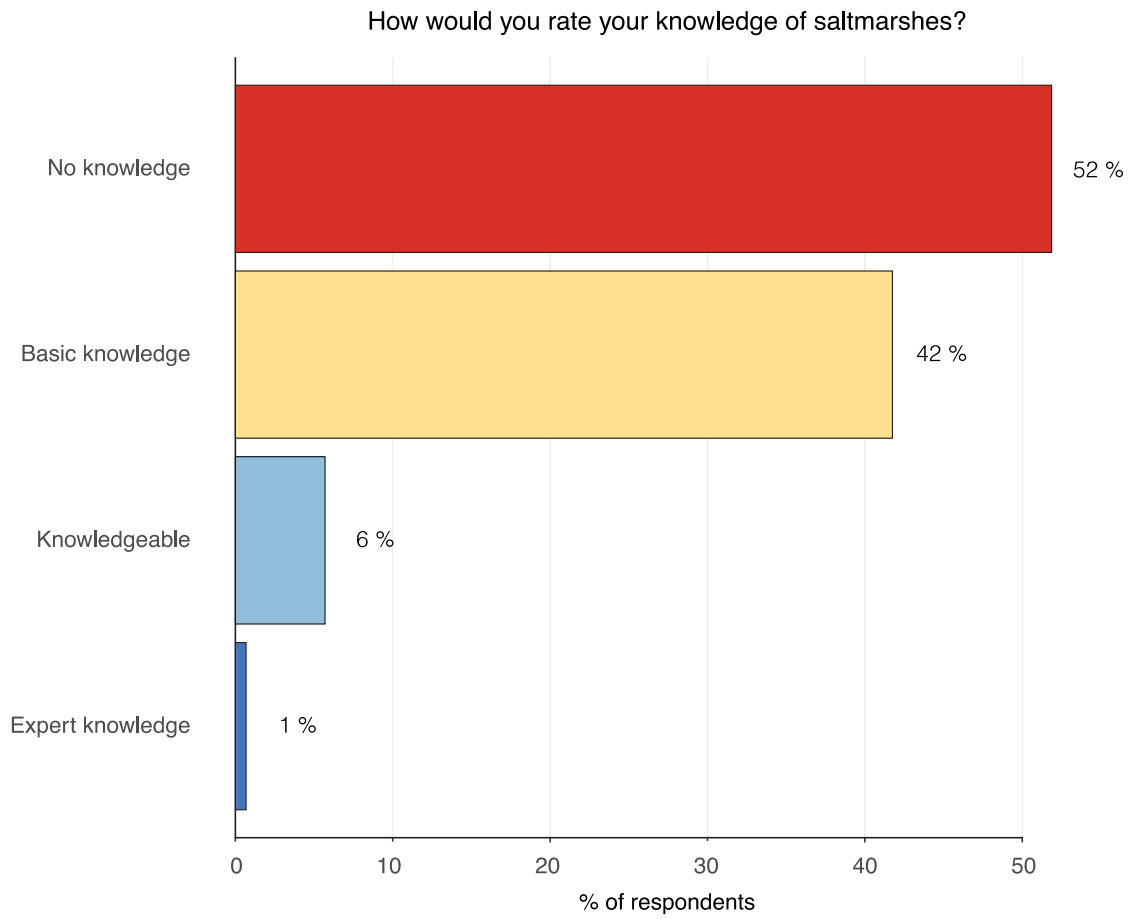

Figure 3: Respondents' self-reported level of knowledge of saltmarshes

Regarding public perceptions of the threats facing saltmarshes, their management and their contribution to society, between 16-38 % of the responses were marked as 'unsure' depending on the question (Figure 4, right panel), further highlighting the low levels of public understanding of these ecosystems. After filtering out all 'unsure' responses, it was found that respondents indicated high levels of agreement with most of the statements presented (Figure 4, left panel). The statement with the lowest level of agreement was 'Changing climates can be positive for coastal areas', while the statement with the highest level of agreement was 'Saltmarshes are important habitats for wildlife' (see also the Fig. S1, which shows the results of the Wilcoxon tests for all of the statements featured in Figure 4). According to ordinal regressions, respondents' views were mainly influenced by environmental NGO membership, employment, education and in some cases respondents' gender and age (Table 2 and Table S3). The odds of assigning high levels of agreement was consistently increased if the respondent was a member of an environmental NGO, and their highest education level was above A-levels. Being unemployed generally decreased the odds of agreeing with the statements, while identifying as female increased the odds of agreeing to 'saltmarshes are protected by existing legislation' and 'Managed realignment has a positive effect on saltmarshes'. In contrast, being from urban areas decreased the odds of agreeing to 'saltmarshes provide communities with protection from flooding' and 'Salt marshes can help to prevent coastal erosion'. See Table 2 and Table S3 for the complete list of significant effects and coefficients.

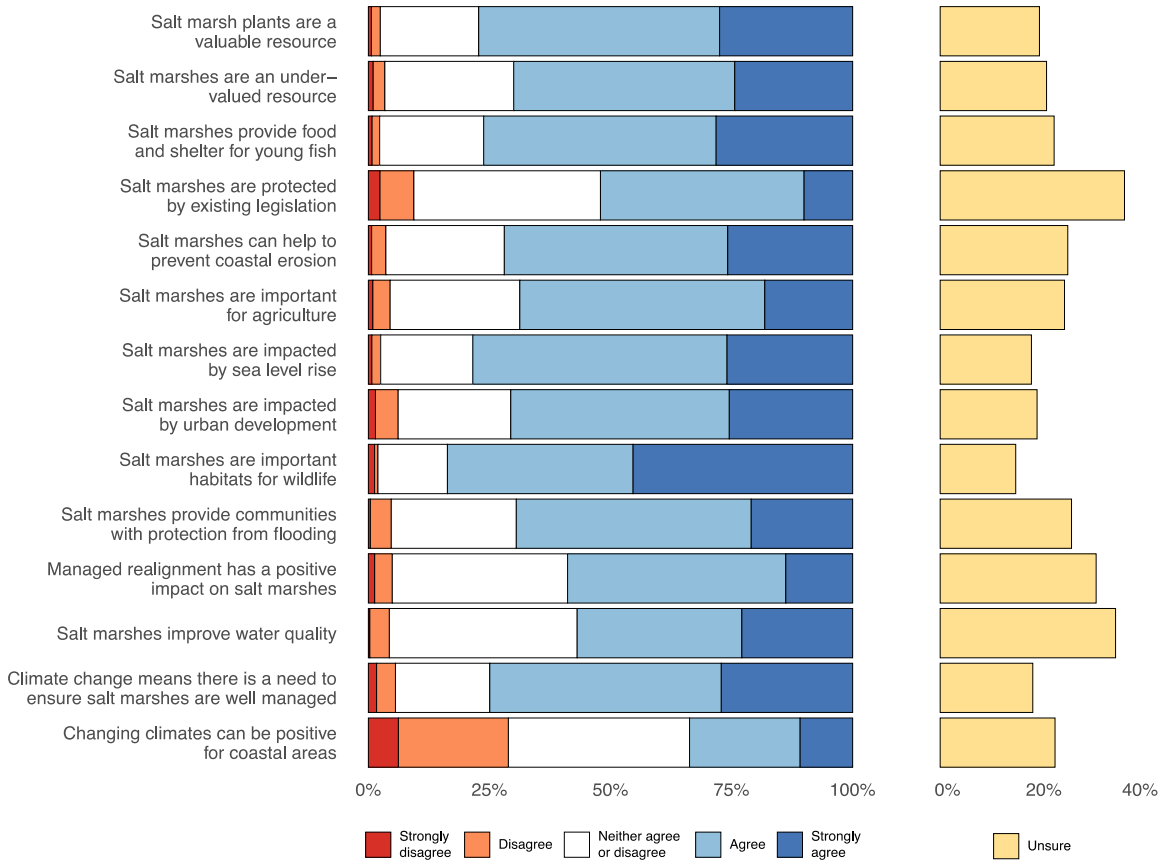

Figure. 4. Public perceptions towards the threats saltmarshes face, their management and their contribution to society, as indicated by respondents' percentage of agreement to different statements (left panel). Each statement was analysed with a Wilcoxon test, and in all cases, we found a significant departure from the mid-point (i.e. neither agree nor disagree), which indicates high levels of agreement to most statements (Fig. S1). There was a high % of respondents that answered 'unsure' for all statements (right panel).

Table 2. Influence of respondents' characteristics in moderating the responses to statements about salt marshes, the threats they face and their management. Grey empty cells indicate respondents' characteristics that did not influence a given statement, the levels of respondents' characteristics in green cells increased the odds of giving high ratings to the statement, and the levels of respondents' characteristics in red cells decreased the odds of giving high ratings to the statement. NGO: membership of an environmental NGO, Prof. Q.: professional qualification. For the complete list of levels for each predictor variable, see methods section.

	Respondents' characteristics that moderated the responses (predictor variables)					
Question/statements to rate (response variables)	**Gender**	**Age**	**Employment**	**Education**	**NGO**	**Rural-Urban classification**
Salt marshes are protected by existing legislation	Female			A-level Prof. Q	Yes	
Managed realignment has a positive impact on salt marshes	Female		Unemployed			
Salt marshes are impacted by sea level rise			Retired	A-level Degree	Yes	
Salt marshes are an under-valued resource			Unemployed	A-level	Yes	
Climate change means there is a need to ensure salt marshes are well managed					Yes	
Changing climates can be positive for coastal areas			Unemployed			
Salt marshes are impacted by urban development			Selfemployed	A-level Degree	Yes	
Salt marshes are important for agriculture			Homecarer Unemployed			
Salt marshes provide communities with protection from flooding				Prof. Q	Yes	Urban
Salt marsh plants are a valuable resource		35-44 55-64 +65		A-level Degree Prof Q.	Yes	
Salt marshes provide food and shelter for young fish					Yes	
Salt marshes can help to prevent coastal erosion			Unemployed		Yes	Urban
Salt marshes are important habitats for wildlife		45-54 55-64 +65		A-level Degree Prof Q.	Yes	
Salt marshes improve water quality				Prof Q.	Yes	

Between 15-40 % of the responses linked to the benefits and services provided by saltmarshes to society were marked as 'unsure' (depending on the question) (Fig. 5 right panel). After filtering out all 'unsure' responses, it was found that respondents generally perceived all of the ecosystem services presented as beneficial (Fig. 5, left panel; and Fig. S2). Overall, respondents found tourism and agricultural land as the least beneficial ES provided by saltmarshes with providing habitats for wildlife as the most beneficial ES (see Fig. 5 and Fig. S2). According to ordinal regressions, respondents' values towards saltmarsh ES were mainly influenced by their being members of environmental organisations, age, gender, employment status and rural-urban classification (Table 3 and Table S3). The odds of valuing the different ES as highly beneficial were consistently increased if the respondent was a member of an environmental organisation, above a certain age (different for each ES) and identifying as female. Being unemployed and from urban areas generally decreased the odds of assigning high values to the ES. See Table 3 and Table S3 for the complete list of significant effects and coefficients.

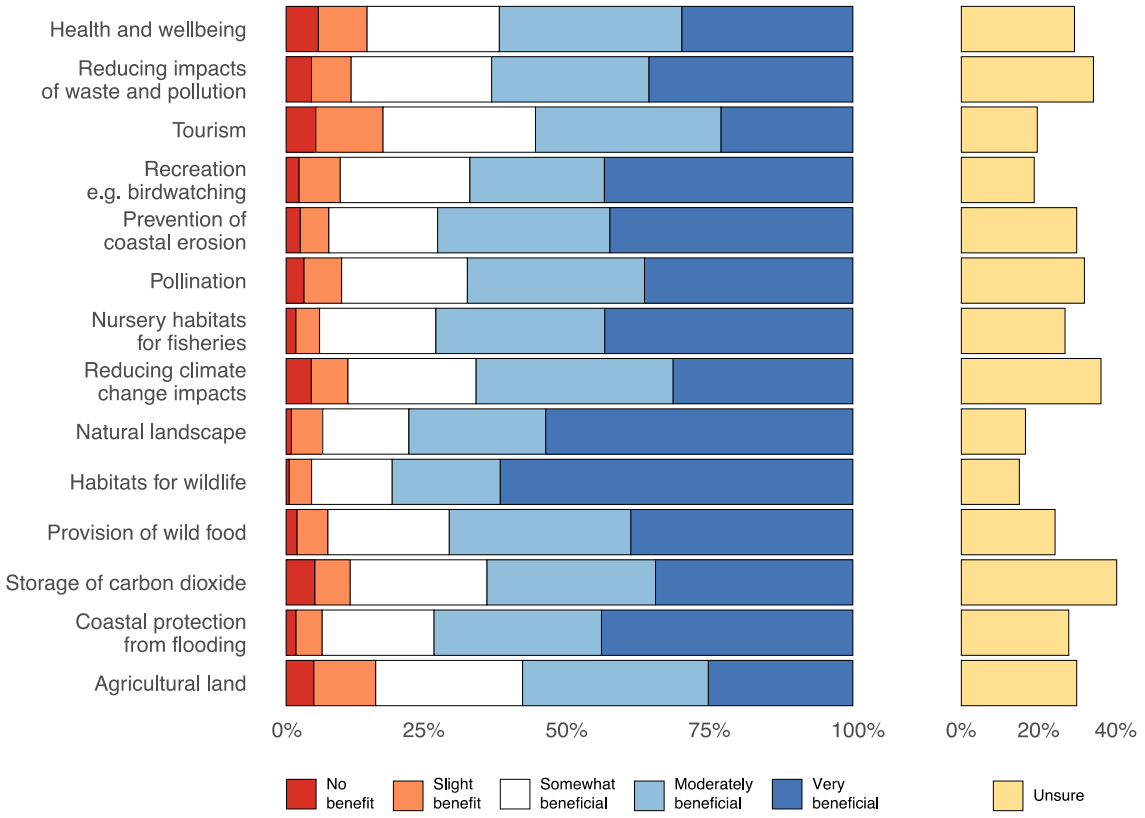

Figure. 5. Public perceptions towards the different services that saltmarshes provide, as indicated by how beneficial respondents rated the statements (left panel). Each service was analysed with a Wilcoxon test, and in all cases, we found a significant departure from the mid-point (mid-point = somewhat beneficial) towards 'Very beneficial' (Fig. S2). See also that % of unsure respondents was high for most questions (right panel). Respondents rated 'tourism' and '[being] agricultural land' as the least beneficial services, despite these were still considered significantly different from the mid-point and 'Moderately beneficial' (Fig. S2).

Table 3. Influence of respondents' characteristics in moderating the responses to statements about the benefits and services provided by salt marshes. Grey empty cells indicate respondents' characteristics that did not influence a given statement, the levels of respondents' characteristics in green cells increased the odds of giving high ratings to the statement, and the levels of respondents' characteristics in red cells decreased the odds of giving high ratings to the statement. * indicates a marginally significant effect (p-value = 0.05-0.07). NGO: membership of an environmental NGO. For the complete list of levels for each predictor variable, see methods section.

	Respondents' characteristics that moderated the responses (predictor variables)					
Question/statements to rate (response variables)	**Gender**	**Age**	**Employment**	**Education**	**NGO**	**Rural-Urban classification**
Recreation e.g. birdwatching		35-44 45-54 55-64 +65			Yes	
Tourism			Unemployed			Urban*
Coastal protection from flooding		45-54 55-64			Yes	
Habitats for wildlife		35-44 45-54 55-64	Unemployed		Yes*	Urban
Reducing impacts of waste and pollution					Yes	
Health and Wellbeing						Urban
Agricultural land	Female	55-64 +65			Yes*	
Natural landscape		35-44 45-54 55-64 +65				
Nursery habitats for fisheries	Female		Unemployed			
Pollination	Female		Unemployed Student		Yes	
Storage of Carbon dioxide					Yes*	
Provision of wild food	Female	45-54 55-64 +65				
Prevention of coastal erosion		45-54 55-64		Diploma Degree	Yes	
Reducing climate change impacts	Female				Yes	

4. Discussion

As the field of marine social sciences continues to grow, there is increasing recognition given to understanding the relationship between society and our coastal environments (Bennett et al., 2019; McKinley and Fletcher, 2012). This paper provides valuable insights into current levels of public awareness, knowledge, understanding and perceptions towards coastal fringe environments, using Welsh saltmarshes as a case study environment. To our knowledge, and, as noted above, this is the first discrete piece of research with specific focus on the publics' relationship with a specific coastal fringe system, such as saltmarshes, contributing to the emerging field of marine public perceptions research (see Carpenter et al., 2018; Jefferson et al., 2015 and Jefferson et al, in prep for more information on marine public perceptions research). While there has been work on managed realignment (see Esteves and Thomas, 2014 for definition) related to saltmarshes (e.g. Luisetti et al., 2014, Myatt et al., 2003), which have indirectly examined values, there has been no examination of public attitudes specifically relating to saltmarshes and their ecosystem services and benefits more generally.

A key finding of the research is the significantly low levels of public awareness and uncertainty associated with saltmarshes and their societal benefits, indicating a very real need to foster and enhance current levels of public knowledge and understanding of saltmarshes, and their role within the wider coastal landscape. For example, despite the presence of saltmarsh environments across much of Welsh estuaries (see black polygons in Fig. 1), there was an overwhelming lack of public engagement with saltmarshes. This provides some insight into levels of awareness and knowledge, with over 60% of respondents stating that they had never knowingly visited a saltmarsh. Given the often isolated and remote locations and lack of easy access often associated with saltmarsh environments, the low numbers of visitors may not be unexpected. It should, however, be noted that a number of Welsh saltmarshes are located alongside primary tourist sites – for example, alongside Laugharne Castle, in south Wales, where visitors using the carpark would see saltmarsh from their parking space (Image 1). Others run alongside major road and rail routes, including along the Severn Estuary and seaward of National Rail infrastructure notably along the North Wales and Carmarthenshire coasts and in the estuaries of Cardigan Bay.

Image 1: Saltmarsh at Laugharne, south Wales, UK.

It is feasible that respondents may have visited, seen or experienced saltmarshes without their knowledge – i.e. as a result of the low levels of knowledge and awareness of saltmarshes, respondents may have been unable to identify the site as such; perhaps providing additional evidence regarding the limited awareness and knowledge held by the public about these environments. Equally, however, it is possible that someone could have knowledge about an ecosystem without having visited one (one is unlikely to have visited deep sea hydrothermal vents, for example, but could still have a detailed

knowledge and understanding of them). The relationship between knowledge and behaviour and how this can be used to understand perceptions and attitudes is complex – further work could be done to understand the intricacies of this relationship and what it might mean for public perceptions and, therefore, for natural resource management. In the case of saltmarsh systems, although analysis found all services and benefits to be considered beneficial by respondents, there was some variation in respondent perceptions in this study. For example, a higher proportion of respondents indicated saltmarshes to be highly beneficial as spaces for wildlife than for their role in carbon storage or coastal defence. This variation in perceptions could be as a result of the visibility of these benefits. As indicated in the introduction to this paper, saltmarshes in Wales are often designated sites due to their biodiversity or their support of vulnerable species – additionally, saltmarshes are commonly visited by birdwatchers or sites owned by conservation organisations (e.g. Cwm Ivy in South Wales, owned by the National Trust, perhaps making their value as a site for wildlife more understandable and visible to the wider public. The variation in perception of benefits seen in this study has potential implications for future communication and engagement efforts around saltmarshes, highlighting a need for the less visible, but equally, if not sometimes more important, ecosystem services and benefits to be emphasised and communicated.

Socio-demographic characteristics and backgrounds are increasingly cited as having an impact on perception (see for example Jefferson et al., 2014). However, despite collecting socio-demographic data, few studies examining public perceptions of coastal fringe environments report the interaction they have with respondent perceptions and attitudes (for example – Luisetti et al., 2011; Thomas et al., 2015; Tudor and Williams, 2006). In this study, gender, age, education level, employment status, membership of an environmental NGO group and where respondents lived (i.e. whether within rural or urban areas) were all found to have an influence not only on respondents' probability of having visited a saltmarsh, but also on their likelihood to agree with statements about their societal benefit and their management. It should be noted that the influence of these factors varied in significance, with age and employment found to be less significant than other drivers. Location was seen to have an effect with those living in an urban area seen to have lower levels of awareness and understanding. The differences in the perceptions of those living in urban and rural communities towards nature and environmental management have been noted in numerous studies (Berenquer et al., 2005; Lutz et al., 1999; Bogner and Wiseman, 1997; Gomez-Pompa and Kaus, 1992). For example, Lutz et al. (1999) highlight a difference in the perception of wilderness in urban and rural participants, finding that although both groups had positive attitudes towards wilderness and nature, perceptions of what constitutes wilderness varied. This variation in perception of nature, and of ecosystems that are less well known or understood in particular, such as saltmarshes as seen in this study, is perhaps not unsurprising; contact and/or experience with nature is thought to influence perceptions and attitudes, although this relationship is not always linear and can be influenced by a range of factors (see Jefferson et al., 2015 for a discussion on public perceptions research in a marine context). Furthermore, proximity to the coast has been found to influence individual's perceptions, knowledge, awareness or concern about a range of issues (see for example, Milfont et al., 2014 where proximity to the coast was linked to belief in climate change or Myatt et al. 2003 where proximity to the coast was positively correlated within residents' awareness of managed realignment). This relationship is not always a given, however - see for example Perry et al. (2014); nor is it always linear i.e. the greater the distance from the coast, the lower the levels of awareness or attribution of value (see for example, Luisetti et al., 2011). Furthermore, when asked to indicate their agreement to a series of statements about

saltmarshes, the benefits derived from them and potential threats to their stability, a significant proportion of respondents (between 15 and 40% depending on the question) indicated that they were 'unsure' – and only 33 % respondents provided a certain response to all of the statements presented. This high level of uncertainty about saltmarsh environments and the services and benefits they provide illustrates, in the first instance, a lack of connection and knowledge of saltmarshes, and perhaps more broadly of similar, hard-to-access and less visually distinctive coastal environments. This finding mirrors the limited engagement of artists, policy makers and even high school curricula with these environments, compared with the more charismatic and well-studied rocky coastlines (see, for example: McInnes and Benstead, 2013). Interestingly, however, despite this self-reported uncertainty, respondents who felt they could provide an answer indicated an overwhelming level of agreement with most of the statements elucidating views on the benefits of saltmarshes. On reflection, it is of note that the statements used for the questions relevant to this data were largely positive, which may have led to some degree of agreement bias from respondents i.e. respondents agreeing with all statements. It is possible that this may suggest an overarching awareness of the value of the coast more broadly, rather than saltmarshes in particular and could be indicative of public perceptions towards other, historically under-valued and misunderstood, temperate coastal fringe systems. Furthermore, it should be noted that female respondents are often more likely to agree with statements presented to them (Rapoport, 1985), which may explain some of the variation in the results seen in this study. However, more in-depth work is required to understand both positive and negative attitudes and perceptions towards saltmarshes and other coastal fringe environments.

Encouragingly, despite low levels of public awareness, there is a growing recognition of the ecological, social, economic and cultural values of systems such as saltmarshes and mudflats across local, regional and, indeed national scales of policy development and governance (MEA, 2005; McKinley et al., 2018). Natural resource management continues to strive for sustainability, driven on an international scale by the UN Sustainable Development Goals, but also through national policy – e.g. the recent Environment (Wales) Act (2016). However, the low levels of public awareness and understanding of saltmarshes seen in Wales indicates a very real need for targeted, and, importantly, locally appropriate awareness raising campaigns to highlight the importance of saltmarshes, and perhaps where relevant, other coastal fringe environments, their societal value (both monetary and non-monetary) and their contribution to everyday life. This is particularly important in the context of sea level rise, as communities need to understand the role which natural systems, including saltmarshes, play in attenuating wave action and reducing flooding (Moller et al., 2014; Moller et al., 1999). Across Wales, where there is a clear need for nature-based solutions in many rural areas, the funding of and support for such schemes requires a broad understanding from both rural and urban populations as national policy and practice develops (see for example, the Wellbeing of Future Generations (Wales) Act (2015)).

Assigning value and importance to natural resources is the lynchpin of both the ecosystem service and natural capital frameworks of thought. However, the diversity and indeed the very nature of the wider environment means that attributing value can be challenging – not least due to the propensity for this particular discussion to centre on economic values (Munday et al., 2017; Raymond et al., 2013; Granek et al., 2009). This study has provided a snapshot of a particular socio-ecological system, examining the current public perceptions towards saltmarshes, taking account of how these might change with different socio-demographic characteristics and likelihood of experience/exposure to saltmarsh, and indeed, wider coastal environments. Crucially, this is a fluid relationship; as indicated by the results of

this study, public attitudes, values and perceptions may vary in response to a range of drivers and changing social norms. This dynamism and potential for change needs to be taken account of through a) greater inclusion of social sciences within research programmes to support the development of longitudinal socio-economic and socio-cultural studies alongside ecological data collection, b) an understanding of value, and how these may change both spatially and temporally, and c) providing a mechanism for including this information within decision making.

At a time when our coasts are under ever increasing anthropogenic pressures, including the impacts of climate change, a key message from these findings is that saltmarshes, and most probably others that fall within the category of less charismatic coastal environment (mudflats, for example), require concerted efforts to raise public awareness levels to safeguard, maintain and protect these vulnerable, yet highly valuable systems in the future. This will be especially necessary to increase public's trust, if governments are to "sell" these systems as nature-based solutions, such as in managed realignment schemes (Roca and Villares, 2012). Indeed, taking a socio-ecological system perspective, it is vital that further research is undertaken to better establish the human-environment linkages, including perceptions of these systems, so that they can be managed in a more holistic and sustainable manner (Stojanovic et al., 2016). To date, societal relationships with and perceptions of coastal fringe systems (i.e. saltmarshes, mudflats, wetlands) have received significantly less research attention when compared to other more charismatic components of the marine and coastal environments (e.g. coral reefs, marine mammals) (Jefferson et al., in prep). There is a clear gap in our understanding regarding how these environments are perceived and valued by the communities who live, work and recreate in and around them. At a time when marine planning is *the* primary tool for marine and coastal management, not only in the UK, but elsewhere, understanding the ecosystem service values of the individual components of the whole system, including coastal ecosystems that have been traditionally under-valued is crucial (Borger et al., 2014).

5. Concluding comments and recommendations

As the governance landscape continues to focus on ecosystem services and the natural capital approach, it is vital the whole value of an entire system is taken account of. Despite challenges relating to access and the perception that they are, perhaps, less aesthetically pleasing than other coastal environments, saltmarshes continue to deliver vital ecosystem services and benefits to society, from across the four MEA ecosystem service categories. For the natural capital approach to be effective, and indeed sustainable, it is crucial that the whole spectrum of values associated with saltmarshes is taken into consideration. It is acknowledged that challenges remain as to how to value the non-market services and benefits we obtain from nature (Small et al., 2017). However, the growth of marine social sciences (Bennett, 2019), the emergent wellbeing agenda (see for example the Wellbeing of Future Generations (Wales) Act (2015) and the contribution of coastal blue space to societal health and wellbeing (White et al., 2013; Wheeler et al., 2012) and indeed the concept of natural capital itself indicates a shift in this thinking. New methods are being developed to support understanding of the complexity of society's relationship with the natural world (see for example, Burdon et al., 2019). By using the findings from this study and drawing on the wider existing evidence base, the following recommendations have been developed:

- There is a need for the development of effective and appropriate awareness raising schemes that support a higher level of public understanding of the role of saltmarshes, and the wider coastal ecosystem in everyday life.
- Local and national perceptions and values of coastal environments may vary, and this relationship is not always linear or expected. From a coastal management perspective, it would be prudent to develop a programme of research to elucidate *local* values to ensure local specificity to management plans and decision-making.
- Valuation approaches should take account of the dynamism that is inherent within all socio-ecological systems allowing for spatial and temporal shifts in perceptions, attitudes and value.
- More public perceptions research, and indeed more marine social sciences more broadly, focusing on the human dimensions of the 'forgotten' coastal fringe is suggested. Historical emphasis on mangroves and coral reefs can only give so much insight into public attitudes and values about the coast, and cannot be applied to those harder to reach, more 'out of sight, out of mind' areas such as saltmarshes. There is a very real need to take account of 'social values' associated with the coast, and to move the natural capital dialogue away from a purely economic debate (McKinley et al. 2019; Nahuelhual et al., 2016; Chan et al., 2012a, b). The emerging field of marine social sciences provides a new lens, and indeed new methodologies and approaches, through which these relationships can be disentangled (Bennett, 2019).

Finally, the importance of coastal systems and their position within the land-sea interface means that this kind of work to examine societal' views, attitudes and, indeed, their values across a range of scales provides valuable insight for those developing management and policy. While this study has focused specifically on saltmarsh environments, it is our view that this work and the recommendations presented have potential applications for other, similar coastal fringe environments across the UK and in other temperate coastal regions.

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