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Jefferson, RL

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Title: Public perceptions of the UK marine environment

R. L. Jefferson^{a*}, I. Bailey^{a,b}, D. d'A. Laffoley^c, J.P. Richards^{d, e}, M.J. Attrill^a,

Affiliations

^a Marine Institute, Plymouth University, Drake Circus, Plymouth, PL4 8AA, UK.
rebecca.jefferson@plymouth.ac.uk; m.attrill@plymouth.ac.uk

^b School of Geography, Earth and Environmental Sciences, Plymouth University, UK
ibailey@plymouth.ac.uk

^c IUCN (International Union for Conservation of Nature) 28 rue Mauverney, CH-1196
Gland, Switzerland. danlaffoley@btinternet.com

^d Greenmantle Partnership, RD1 Collingwood, NZ. jonathan@ecotrails.co.nz

^e Open Polytechnic, Lower Hutt, New Zealand

* Corresponding author. R. Jefferson, Postal address, Marine Institute, Reynolds Building, SMSE, Plymouth University, Drake Circus, Plymouth, PL4 8AA, UK. Email: rebecca.jefferson@plymouth.ac.uk, tel: +44 (0) 1752 586 167, fax: +44 (0) 1752 584950

Abstract

The damaging effects of human activities on marine ecosystems suggest that a major shift is required in the way marine resources and systems are viewed and used by individuals. Identifying how to engage society in this shift is an ongoing debate. This includes strengthening the positive connections between society and the sea. Currently, the major focus of research in this area is on coastal areas, whilst the limited work on public perceptions of the subtidal UK seas shows opinions characterized by pessimism, disgust, shame and sadness. This study uses an internet survey (n = 1047) to investigate UK public perceptions of subtidal species marine health and assess whether it is possible to build more positive connections between society and the sea. The analysis shows pessimistic perceptions of subtidal diversity, but highest interest in traditionally charismatic

species (puffins, seals and seahorses) which many respondents thought did not live in UK seas. Significant differences were found between males and females, with male respondents showing stronger utilitarian values (with higher interest in edible species such as cod) and females stronger aesthetic values (with higher interest in species such as seahorses). Experience of intertidal environments is suggested as being powerful for developing connections with subtidal environments. Public perceptions of marine health showed issues such as litter to be considered as the greatest indicator of poor health. Ecological concepts of habitat integrity and biodiversity were also rated as important to marine health. Social values were found to influence public perceptions of marine health. The results show that perceptions are far from uniform across the population, and such diversity of perceptions is likely impact upon methods to catalyse societal engagement with marine conservation. These findings reinforce previous research on public perceptions of UK seas, but also provide indications on how to build more positive connections between society and the sea.

Highlights

(3-5 bullet points, maximum 85 characters, including spaces, per bullet point)

- Society are an essential contributor to achieving marine conservation goals
- Pessimistic perceptions of UK seas are a barrier to engagement
- Survey identifies opportunities of positive connections between society and the sea
- Experience appears important in the connections between society and the sea
- Ecological concepts of marine health were widely selected by respondents

Keywords

Marine conservation, public perceptions, UK seas, marine citizenship, gender, experience

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1. Introduction

Marine systems provide many services essential to human life [1]. The everyday activities of individuals are reducing the health of marine systems and undermining their ability to provide vital services [2, 3]. There is increasing recognition of this need to engage society and deliver behaviour changes as part of the solution to marine conservation issues [4-7]. A number of concepts have been proposed to engage society with the sea in response to this challenge, e.g. Marine Citizenship [8] and the Shallow Seas approach [6] but questions of how to realise the outcomes of these concepts abound [9, 10]. Understanding how to connect society with the sea presents a significant challenge for achieving the behaviour changes necessary to deliver marine conservation goals. Overcoming this challenge is a national and global research priority and an area which requires urgent attention [9, 11, 12]. This paper contributes to this on-going debate through further investigation of public perceptions of the UK marine environment and identification of future research priorities.

The benefits of successful marine conservation may be measured through ecological health methods, but the tools required to deliver it will draw from the social sciences. Understanding the values, attitudes and knowledge of society is key to developing engagement which can achieve the desired outcomes [9]. Recognising the current gaps in our understanding of public perceptions of the marine environment, this study investigates public perceptions (knowledge, UK association and interest) of subtidal UK marine species and public understanding of marine health. Socio-demographic and social values variables are known to influence perceptions of issues, and their influence is assessed in this study.

1.1. Understanding societal engagement with the environment

Extensive research into behaviour changes for health, safety and non-marine environmental benefits has been conducted in recent decades and can inform this marine challenge and how to engage society with marine issues [13]. Understandings of how behaviour change occurs has improved considerably from early “knowledge deficit models”, which argued that environmentally detrimental behaviours occur because individuals are unaware of the effects of their behaviours, and, thus, that behaviours could be changed simply by ‘supplying knowledge’. This has repeatedly been shown to be a gross simplification of the processes influencing behaviour change [14] and it is now recognised that many variables, such as values, emotions and enabling infrastructure, can influence behaviour choices [15]. Values have a strong effect on behaviour with different values leading to different behavioural responses. Environmental values are of notable importance, as they underpin the way a person interprets situations and issues and therefore decides how to engage with the issue [16]. By understanding the values of a target audience, it is possible to identify the different motivations driving individuals to perform a particular behaviour. Social segmentation models are tools which enable a

person's values to be measured and identified, providing an opportunity to investigate how these factors influence behaviours or perceptions[17].

Factors which influence environmental values are also indirectly related to behaviour. Personal experience of an environment or environmental issue has been found to have a considerable effect on environmental values and behaviour. Experiences facilitate stronger emotional connections to natural environments, which in turn increase the willingness of the person to protect that environment [18, 19]. Maiteny [20] describes the positive effects of emotional involvement as essential to sustained pro-environmental values and behaviours. Indeed, the need to reconnect people and nature is considered as one of the current priorities for conservation biology, ensuring that behavioural change is rooted by a connection to the wider environment [21].

In addition to the values of the audience, the way messages are framed influence the chances of engagement. Issues framed with negative emotions, such as fear and loss, often translate into fatalism and powerlessness among audiences that lead to disengagement rather than connection [22, 23]. Research has repeatedly shown that building positive associations and personalising benefits is more potent in eliciting potential behaviour change than a focus on negative impacts [24]. This implies that developing more holistic and more positive connections between individuals and the sea may be necessary to successfully engage society marine conservation issues.

1.2. Public engagement with the marine environment

The existing understanding of how society engages with environmental issues must be used to inform the debate of how to engage society with the marine environment. However, the specific nuances of marine engagement must also be better understood because marine environments are manifestly different in character, positioning, and in terms of cognition. A particular challenge in achieving increased and higher quality engagement with marine issues is the spatial and cognitive disconnect between society and 'the sea'. 'The sea' is seen as something 'far away' by many people, and its benefits and impacts can appear distant. Marine conservation issues are also very complex as they are driven by a range of human activities which cause a variety of impacts on complex systems, at a range of temporal and spatial scales [3]. There is limited knowledge of the behaviour changes that would deliver the most environmental benefit, and there is little direct feedback to the individual from the environmental benefits their behaviour change may create. Disconnectedness in environmental issues is not new, however other characteristics make them more accessible. For example, climate change is complex, but a focus on specific behaviours (e.g. recycling) and wider links to prominent concerns, such as energy security and resource depletion, help to overcome the disconnect [25]. Similarly, chlorofluorocarbons (CFCs) causing the hole in the ozone layer had a strong industry and policy supported solution and clear behavioural change implications and messages (ref). Campaigns to conserve priority species which may be unlikely to be seen by the campaign's target audience can successfully raise money for the cause, but this perhaps represents a relatively simple behavioural response[26]. The

characteristics of the marine environment, and the existing knowledge, attitudes and values they have act as a filter through which society interpret attempts to engage them in marine conservation issues. Therefore, these characteristics must be recognised in order to understand how they influence public perceptions and engagement with marine conservation issues.

1.3. Marine health: an overarching marine conservation goal

An overarching goal for marine conservation, and the driving force of any behaviour change priorities is to achieve healthy marine environments. From an ecological perspective, a healthy ecosystem can be defined, like a healthy human body, as a system which functions well and is able to resist or recover from disturbance [27]. Quantifiable components of this are vigour (the activity, metabolism or primary productivity of an ecosystem), organisation (biodiversity, food web and biophysical structure of an ecosystem), resistance to disturbance (its ability to maintain structure and functions under stress) and resilience (the ability of the system to recover from a disturbance). These ecosystem attributes are widely accepted as underpinning ecosystem health [28-31]. Globally, marine management is moving towards this aim, and various examples of policies which attempt to deliver the necessary holistic approaches to achieve healthy marine ecosystems are being developed or implemented, such as Europe's Marine Strategy Framework Directive [32].

1.4. Public perceptions of the marine environment

In order to catalyse engagement for marine conservation outcomes ecologically defined marine goals for a healthy marine environment need to resonate with public audiences. Existing research on public perceptions of the marine environment does not provide a societal definition of marine health, and currently does not identify how to connect ecological and societal perspectives of marine health. Relatively little research has been conducted to investigate public perceptions of the marine environment and those studies which do exist have been often focused on negative components of marine conservation such as threats to marine health, and on measuring public concern [33, 34]. Additionally, most research on connections between society and the sea is focused on the coastal or intertidal space, with little known about connections to subtidal environments. Evidence supports strong positive associations with the UK coast being a popular destination (over 18 million UK residents took seaside holidays in 2010 [35] and 63% of the public considered visiting the coast important to their quality of life (National Trust Coastal Values Survey, Pers. Comms). Such positive associations are often connected to personal experiences, but opportunities to make such connections with sub-tidal areas are much more limited.

Two studies of public perceptions of English subtidal seas have found overwhelmingly pessimistic perceptions. When asked about the "undersea" environment, people instinctively talked about the coast [36]. When pushed to consider subtidal areas,

respondents perceived the sea surface to be cold and grey, and the seabed to be the same as the surface, “just covered in water” [37]. Consideration of undersea landscapes elicited perceptions of disgust (towards a cold, dark, dangerous environment), shame (about pollution and litter) and sadness prompted by comparing English seas with how they used to be or in comparison to seas in other countries. In terms of biota, 44% of respondents considered the seabed to be generally, mostly or utterly barren [36]. This implies that a barren marine environment will have no perceived benefits; it provides no utilitarian value from the provision of seafood or intrinsic value in terms of sea life and is unlikely to drive societal support for conservation.

These studies existing research suggests that subtidal marine environments (which contain the majority of biota, suffer the greatest threats, and are the target of most management responses in the marine environment) are rarely or pessimistically contemplated [37]. In other words, ‘out of sight’ equated strongly to ‘out of mind’. The ‘in sight’ coastal and intertidal zones, in people’s minds, represented the marine environment, while subtidal seas remained ‘unseen’ and pessimistic perceptions, often based on the fear of the unknown, dominated. This research suggests there is a lack of positive connections between society and the sea in the UK.

The study described in this paper presents the results of a large scale survey of UK public perceptions of subtidal seas. It investigates whether there is the potential to develop more positive associations with UK seas, to allow a transition away from doom and gloom orientated methods. This study provides insight into public perceptions of the marine environment and forms a basis from which further questions can be identified to guide this new but essential area of marine conservation research.

2. Method

2.1. Survey development and analysis

Following pilot testing of the survey questions, an internet-based survey was conducted during February and March 2009. This was administered by a commercial market research company who drew from a bank of registered respondents to ensure a UK representative sample. Respondents credit as a form of payment for completing surveys, which helps to reduce the likelihood of bias from auto self-selection of respondents. Internet surveys have been shown to be a robust method for delivering surveys [38]. A total of 1047 respondents completed the survey. Analysis of socio-demographic variables showed respondents to be representative of the UK adult population. The gender split was 48% male and 52% female, whilst age and geography showed similar distributions to the most recent UK data published at the time [39].

2.2. Survey questions

The survey included three groups of questions: 1) species questions – assessing species knowledge, UK association and interest in a suite of 12 subtidal UK marine species; 2) health questions to assess public perceptions of healthy and unhealthy marine environments and 3) respondent profiling, including interactions with the marine environment, standard socio-demographic variables and social values

2.2.1. Species Questions

Three ‘species’ questions were selected to investigate public knowledge and interest in species. Twelve species were selected to reflect a cross-section of the ecological, economic and charismatic values of UK subtidal marine life. Selection criteria included taxonomic and functional representativeness, commercial, non-commercial, charismatic, or ecologically importance determined by previous analysis[13]. All the species selected are subtidal, although some are also intertidal, and most have a UK-wide distribution. Table 1 details and justifies the species included. Each question included photographs and the common names of the twelve species and the following questions were asked, focusing on species recognition, presence in UK seas, and interest:

Which (if any) of the following plants and animals have you heard of or recognise?

Which (if any) of the following plants and animals do you think can be found in the seas around the UK?

All of the plants and animals can be found in the seas around the UK. Please select up to four pictures to show which plants and animals you would be most interested to learn more about.

2.2.2. Marine Health questions

Statements were defined to reflect the different values which can be used to assess the health, or lack of health, of a marine environment. These included ecological, policy and

known socially important statements. Table 2 details the statements and justification for inclusion, showing the nine statements for each of the two health questions:

Select up to three statements which you think best show a healthy marine environment.

Select up to three statements which you think best show an unhealthy marine environment.

2.2.3. Respondent profile

Standard socio-demographic questions were also asked, including age, gender and education level, along with questions about respondents' interaction with the coast: how often they visited the UK coast or sea, leisure activities undertaken there, and how far from the coast they lived, in order to assess their personal experience of the marine environment.

Social values were assessed using a social segmentation model developed from Maslow's Hierarchy of Needs. The layers of needs within the hierarchy reflect something about the values a person has, and their motivation for interest, or type of interest in a particular issue. Cultural Dynamics is an organisation which has developed this feature of the Maslow Hierarchy into a method for assessing social values. Through extensive research into social values across the UK they have developed an understanding of the typical characteristics which can be generalised across individuals within three broad Maslow groups based on the needs layers: Settlers, Prospectors and Pioneers [36, 40]. A key strength of the Maslow Group model is that it facilitates measurement of the social values of a population, providing a more detailed understanding of the motivations of behaviour and interest than solely socio-demographic data allow. The model has been developed for use in large scale surveys, and therefore is known to be well-suited to this type of study. Maslow Group is measured through the inclusion of 10 statement questions, determined by Cultural Dynamics to be the most concise but accurate application of the model. These questions are included in the survey, with the analysis being conducted by Cultural Dynamics.

2.3. Data analysis

SPSS 16.0 for Windows was used for the analysis. T-tests were applied to gender data. Variables with more than two categories were analysed using a Kruskal-Wallis test, with a Tukey Honestly Significant Difference (HSD) PostHoc test for significance of any differences found using a critical P value of <0.05. A Spearman Rank correlation was used to test for a relationship between distance lived from the coast and frequency of coastal visits.

3. Results

3.1. Respondent profile

The questions revealed a mix of interactions with the UK coast. 17% of respondents reported living on the coast, 58% visited more than once a year, and 25% rarely or never visited. Frequency of visits to the coast was negatively correlated with distance lived from the coast ($r = 0.362$, $P < 0.001$, $n = 867$ (excluding respondents who lived on the coast)). No relationship was found between frequency of visits or distance lived from the coast, and the types of coastal leisure activities. The most popular activities were walking (74%) and visiting the seaside (71%). A quarter of respondents reported looking for wildlife, while activities involving being on or in the sea (e.g. swimming or diving), rather than on the beach or coastline, were selected by 18%, while 13% reported doing no coastal leisure activities.

3.2. Public perceptions of marine species

As shown in figure 1, charismatic species were most familiar, particularly puffins (recognised by 95% of respondents), seahorses (93%) and seals (78%). Cod was also well recognised (89%). Two plant species were well recognised: kelp (74%) and seagrass (65%). Maerl, the third plant species surveyed, has a less typical seaweed appearance and was the least recognised of all the species (6%). Invertebrates were the least familiar group, with the native oyster (60%) and Norway lobster (49%) being most frequently recognised. Alongside maerl, brittlestar (10%) and sand mason worm (8%) were the least recognised species.

Respondent's association of species with UK seas varied with the familiarity of species. Species that were recognised by over 30% of the respondents all showed a lower percentage of respondents citing them as found in UK seas, whereas those recognised by less than 10% of respondents were thought to be in UK seas by a proportionately higher number of respondents. Over 90% of respondents recognised puffin and seahorse, but only 69% and 45% of respondents respectively thought they lived in UK waters. Norway lobster was recognised by 49% of respondents, but only 26% thought they lived in UK seas. In contrast, the sand mason worm was only recognised by 8% but over 20% thought it was likely to live in UK seas.

When asked what species were considered to be most interesting, three groups were evident (figure 2). The top-scoring charismatic species (seal, puffin and seahorse) were all selected by approximately 60% of respondents; a lower interest group consisting of Norway lobster, cod, dahlia anemone and native oyster was selected by 20-25% of respondents; and, an 'uninteresting' group of plants and invertebrates was selected by fewer than 13% of respondents. The "none" or "don't know" options were selected by 13% of respondents, inferring interest in none of the species.

A comparison of responses to the species questions by respondent gender revealed only slight differences in species knowledge, but considerable differences between male and female interest in species. Two main differences were found in knowledge of species

between males and females: more females recognised seagrass ($P = 0.001$) and more males thought harbour seals existed in the UK ($P = 0.016$). Gender differences also emerged in species interest (Fig. 2b). First, a larger proportion of females answered the interest question: 91% of females compared to 83% of males ($P < 0.001$). Seven significant differences between interest in species were recorded: males were more interested in Norway lobster ($P = < 0.001$), cod ($P = 0.003$) and native oyster ($P = 0.042$), whilst females were more interested in puffin ($P = 0.003$), seahorse ($P < 0.001$), dahlia anemone ($P < 0.001$) and maerl ($P = 0.018$). Interestingly, the species attracting greatest male interest were edible species, whereas those of greatest interest to females could be considered to have greater aesthetic appeal.

Further analysis revealed found that respondents who rarely or never visited the coast, or did no coastal activities were more likely to answer “none” or “don't know” to all three species questions. This group could be considered to be ‘unengaged’ with the marine environment and a considerably larger proportion of respondents from the unengaged group answered “none” or “don't know” to the species questions (Table 3).

3.3. Marine Health questions

The highest scoring statement for both healthy and unhealthy questions related to beach and sea cleanliness, 62% healthy and 61% unhealthy (Fig. 3). Contaminated seafood was selected by 60% of respondents in the unhealthy question. These answers form a set of responses which related to issues with a clear direct human impact. The second highest set of answers are those relating to ecological concepts and policy criteria; in healthy the healthy question food chain (55%) and diversity (50%) scored highly, whilst damaged habitat (48%) and low diversity (46%) scored highly in the unhealthy question. In both the healthy and unhealthy questions, megafauna was considered to be the least important indicator of marine health (<10%).

The analysis of socio-demographic variables showed social values to be the strongest influence on perceptions of marine health (Fig. 4; Table 4). Maslow group analysis found pioneers to be the most distinctive group showing greater recognition of ecological concepts. Pioneers were more likely than prospectors and settlers to select food chain as a sign of a healthy marine environment and habitat damage and low diversity as a sign of an unhealthy marine environment. The fourth ecological statement of diversity as a healthy descriptor found no differences in opinion between the three Maslow groups.

In both statements relating to water clarity, pioneers were significantly less likely than the prospectors or settlers to think these showed a healthy or unhealthy marine environment (Fig. 4; Table 4). There was also a recorded difference in the contaminated seafood score, with pioneers being more likely to select this than prospectors. The highest scoring statements of clean beaches and litter had no significant differences in opinions between the three Maslow groups. Although a low score response for all three groups, pioneers were twice as likely ($P < 0.001$) as prospectors or settlers to judge health on scientific opinion.

4. Discussion

The results from this study contribute to our understandings of the relationships between society and the sea in order to inform the debate on how to better engage the public to achieve marine conservation goals. The responses highlight some interesting patterns and identify useful outcomes for this debate.

4.1. Public knowledge of species

Previous studies have found that UK seas are not considered to be as 'rich' as seas in other countries [37]. This perception is also illustrated here with respondents tending to underestimate the presence of exotic and charismatic species with UK seas, whilst less colourful or less impressive-looking species, were perceived as more likely to exist in UK seas despite being unfamiliar. This reflects a knowledge gap in the diversity of UK marine species, and reveals a particular pessimism relating to the UK seas. Reversing the low association of familiar charismatic species with UK seas is an opportunity to promote marine life to a wider audience, in particular those who currently have more pessimistic perceptions.

4.2. Interest in marine species

The pattern of species interest was dominated by the three charismatic species: harbour seal, puffin and seahorse (Figure 2a). This result fits with the factors described by Kellert [16] as being important for positive species attitudes and the success of mega-vertebrates used as flagship species [26]. The interest in the three charismatic species suggests a considerable curiosity value: a zoo-like appeal. Larger animals attract greater attention from zoo visitors [41] reflecting the greater interest in vertebrates over other species. This survey suggests that this focus of curiosity value translates to wild animals.

The most ecologically valuable species were considered least interesting. These included all three plant species (kelp, seagrass and maerl), reflecting the low appeal of plants compared to animals [42]. The native oyster is ecologically important due to its biogenic reef-forming role and was considered to be of greater interest than the plant species (20%); however, this may be due to its status as a luxury food rather than any ecological functions. These associations merit further exploration to better understand the interpretations target audiences attach to particular species and, therefore, to ensure that intended messages are connected to suitable species.

Norway lobster was considered to be relatively interesting (25%). Crustaceans represent a divergence of characteristics; invertebrates tend to invoke dislike [43]. However, crabs were among the species most frequently associated with English seas [37], and are relatively easy to spot on UK coastlines due to many species inhabiting intertidal zones (e.g. common shore crab *Carcinus maenas*). Flagship species are not always large vertebrates; any species which resonates with the values and interest of the audience can connect the public with a subject [44]. It is possible that the familiarity of crustaceans and

the relatively high interest in the Norway lobster implies that crustaceans could be used to link intertidal experiences with subtidal seas.

4.3. Gender differences

The results by gender showed a pattern consistent with those found in previous studies. The higher male interest in cod, oyster and Norway lobster reflects stronger utilitarian views more frequently held by males [45, 46]. These species are popularised through their use as food items (although only 4% of respondents cited recreational fishing among their coastal leisure activities). Males were also significantly less interested than females in puffin, seahorse, dahlia anemone and maerl: species with no obvious utilitarian value. These species could be considered to have greater aesthetic value, having more intricate detail and potentially more attractive colouration. In general females show more humanistic and moralistic values [16, 46]; the higher female interest in these species could reflect interests driven by more intrinsic values.

These findings indicate that interest in, and values towards, the marine environment are not homogenous across the population. The gender results show a clear pattern which translates into potentially different motivations for engaging with the marine environment, and there are likely to be several other variables which also influence interest and, thus, need to be better understood when developing messages and communication mechanisms. Further investigation of these motivations, and of the values of different population sub-groups, is therefore needed to develop broader-based strategies to engage audiences with marine environments and conservation.

4.4. Public perceptions of marine health

As is implied by previous research [33, 34], it was predictable that the litter and sewage issues were likely to score highly in the health perception questions. These are issues where a non-expert can easily make a clear interpretation of a scenario to impacts detrimental to marine health. This may be because of the ease of understanding such issues, or due to an anthropocentric perspective which prioritises issues which cause potential harm to humans [47]. Issues which present the most severe threat to the health of marine ecosystems, such as habitat degradation and loss, loss of biodiversity or the effects of climate change, often do not have clear, direct, connections to human health. They do not fit within the existing social perceptions of environmental concerns, making them invisible to the public [48], and creating a barrier to engaging society with suitable responses.

However, in contrast to the interest in species, the ecological statements were recognised by a high proportion of respondents: species diversity, habitat degradation and intact food chain were thought to be some of the best indicators of the health of a marine environment. Previous studies have shown public audiences to place considerable importance on the ecological functions of species [49, 50]. The ecological principles in this survey were described, in lay-terms (Table 2); the statements were not specifically stated as being ecologically important, as in other studies. Therefore, the high selection of the

ecological statements in this survey illustrates a deeper level of understanding and value than has previously been recorded.

A surprising result in the health questions is the lack of importance given to the presence of megafauna as indicators of marine health. This is in contrast to the earlier results from the species questions which showed charismatic species to be the most interesting. This adds to the evidence that public recognition of the factors which underpin healthy marine ecosystems is higher than may previously have been thought. It also suggests that the interest in species is driven by curiosity value, and not through a link to concern for marine health. This suggests that less charismatic species may be more suitable to communicating ecological messages of marine health.

4.5. Experience of the marine environment

Respondents reporting limited interaction with the coast showed lower knowledge, greater pessimism and disinterest in sea areas (Table 3). Personal experience of an issue, place or environment has consistently been shown to be a powerful provider of informal education and a positive influence on pro-environmental behaviour choices [18, 51].

Only 18% of the adult respondents undertook activities which took them beyond low tide (and only 1% reported diving or snorkelling experiences of subtidal environments). Although it is unlikely that respondents who visited UK shores had encountered most or all of the species in the survey, they are likely to have encountered some form of marine life. The most frequently encountered charismatic species for most adults, therefore, are likely to be birds and seals, while those species which are easiest to observe are more likely to be considered less charismatic species, such as invertebrates and plants, particularly in rockpools. It is possible that these less charismatic, but easy to see species, are also providing important wildlife viewing opportunities, which, in turn, may encourage more positive associations with UK seas. This suggests that encounters with species not traditionally considered to be charismatic could play a role in nurturing environmental awareness [52]. The results also imply that intertidal and coastal experiences may have the capacity to develop connections to the subtidal environment.

4.6. Influence of social values on public perceptions of the marine environment

Social values were found to be an important variable influencing public perceptions of marine health (Figure 4). Pioneers were more likely to select the ecological statements. This group represent individuals with a greater understanding of the holistic nature of the world. The results support previous findings that Pioneers are less likely to depend on direct connections to an issue in order to understand it as having detrimental implications. Prospectors and Settlers put greater importance on the state of the water as a measure of health than the Pioneers, interpreting murky water as poor health. This illustrates an important misconception, as water clarity is not an accurate measure of marine ecosystem health; estuaries are usually murky due to their slow flow rate and heavy load of fine suspended sediment, not due to poor ecosystem health. These findings suggest the importance of clear and direct connections between an environmental issue and human

health as a measure of environmental health [47] may be more applicable to the perceptions of Settlers and Prospectors than to Pioneers, who are more able to make connections between themselves and the wider ecosystem.

A number of health statements were similarly rated by all three Maslow Groups, illustrating those issues which have wide relevance. An example is the litter statements in both health questions, which were scored equally across the three groups of respondents (figure 4). This could be interpreted as uniformity in the perceptions of these three groups. However, given the known importance of social values as an influence on perceptions of an issue, it is also possible that there are different motivations behind these three groups selecting the same statement, and this potential should not be overlooked.

5. Conclusion

The overall picture emerging from previous studies is that the connection between society and the marine environment is limited to the coastal zone, and that strengthening connections with the subtidal seas faces multiple challenges. In order to achieve 'marine' rather than 'coastal' engagement, these challenges must be more fully understood and addressed in order to achieve marine conservation goals.

This study contributes to a debate about how to engage society with the sea and achieve marine conservation goals[9]. A key result from this study is the need to acknowledge the multiple audiences within the public. This is consistent with research from studies into marine and non-marine environments [36, 37]. A shift in thinking is essential, from considering the public as a homogenous group, requiring a single approach to engagement, to recognising this challenge to involve multiple audiences, each considering different elements of the marine environment to be most interesting, valuable or relevant. It is important to recognise that these multiple audiences are not necessarily differentiated by their demographic characteristics, but by the values held to the marine environment or their experiences of the sea. Marine conservationists must use all available tools, including social science methods, in order to 'see' the marine world through these multiple lenses. This is essential if marine conservation hopes to connect with the audiences whose engagement is essential to achieving healthy marine environments.

A number of opportunities for establishing positive connections between UK society and the sea (beyond the coast) are identified by this study. Charismatic species attracted considerable interest from respondents in this survey. UK seas are home to many species which could be considered as traditionally charismatic species; despite the low association with UK seas, this may be a starting point for building these links, and could be done in ways which avoid the 'doom and gloom' framing often associated with such approaches. There appears to be capacity, particularly with some audiences, to engage on more complex issues. There may be scope to engage beyond the obvious issues and aesthetically valuable species to open debates on those issues which threaten the ecological functioning of marine ecosystems. This requires further investigation, but could

lead to deeper engagement than offered by charismatic species and high profile issues by connecting on messages of how the seas function and the particular roles behaviour change could play in delivering healthy marine environments.

This study indicates that there is a need to better understand the role marine experience plays in contributing to the links between society and the sea. As described in the introduction, there are many strong and positive associations between the public and the coast. The UK has an extensive coastline, and as the Marine and Coastal Access Act drives even greater opportunities for people to visit this space, there is an opportunity to better understand how this may be a resource for catalysing wider changes in marine engagement.

Building on these conclusions, a number of key research areas should be prioritised to continue addressing the challenge of engaging society with the sea:

- Further research into establishing **positive connections** with UK seas beyond the coast. The current relationships suggest that a 'doom and gloom' perception of UK seas prevails, which is creating a pessimistic lens through which any engagement efforts are filtered.
- The study shows the appeal of **charismatic species**, of which many exist in UK seas. Further investigations would identify how to use this to make positive connections and avoid reinforcing pessimistic preconceptions through the threats to these species.
- The results highlight a capacity to engage audiences with **ecological concepts**. Further research is needed here to investigate why this result was recorded and what consequences this could have for connecting society with some of the complex issues which exist in marine conservation.
- The role of **experience** to influence marine values is an area of particular interest. The difficulty of engaging with subtidal seas will always present a barrier, but the extent to which visits to the intertidal zone, or aquariums as gateways to the marine environment should be assessed as a potentially important tool to engage society.
- The study clearly illustrates the **heterogeneous nature of the public audience** with gender and social values as particularly notable variables. Social science expertise should be used to explore these, and other variables influencing the connections between society and the sea.

These research priorities, and those highlighted by other authors in this field, require contributions from multiple disciplines, some traditionally marine, some not, in order to connect the expertise which is required to address the challenges facing the marine environment.

Table 1. Justifications of species included in survey. Species represent a particular taxonomic group and a range of values are reflected by the species selection as a whole, including: ecological, commercial importance, charismatic and unfamiliar species.

Species	Latin name	Justification
Brittlestar	<i>Ophiothrix fragilis</i>	Echinoderm, similar to familiar intertidal starfish
Cod	<i>Gadus morhua</i>	Fish, commercially important
Dahlia anemone	<i>Urticina felina</i>	Cnidarian, anemones familiar from intertidal
Harbour seal	<i>Phoca vitulina</i>	Mammal, charismatic
Kelp	<i>Laminaria hyperborea</i>	Plant, typical seaweed appearance, high ecological importance
Maerl	<i>Lithothamnion corallioides</i>	Plant, biogenic reef species, high ecological importance, unusual appearance
Native oyster	<i>Ostrea edulis</i>	Bivalve, commercially important, familiar food item, biogenic reef species
Norway lobster	<i>Nephrops norvegicus</i>	Crustacean, commercially important
Puffin	<i>Fratercula arctica</i>	Bird, charismatic
Sand mason worm	<i>Lanice conchilega</i>	Annelid, unusual appearance
Seagrass	<i>Zostera marina</i>	Plant, linked to seahorse, high ecological importance
Seahorse	<i>Hippocampus hippocampus</i>	Fish, non-commercial, charismatic

Table 2 Justification of health statements included in marine health questions. Statements in italics show issues represented in both the healthy and unhealthy questions. Policy values are represented through inclusion of statements from the EU Marine Strategy Framework Directive’s Good Environmental Status (GEnS) descriptors which will be used to assess the health of marine systems.

Healthy marine environment – full statement	Abridged statement	Justification
Clean beaches – no litter or sewage	<i>Clean beaches</i>	Marine litter GEnS descriptor (10), visual issue
Clear or blue water	<i>Clear water</i>	Visual issue
Many different plants and animals live there	<i>Diversity</i>	GEnS descriptor (1) and ecosystem health
Thriving local fishing industry	<i>Fishing</i>	Socio-economic, ecosystem approach, GEnS descriptor (3)
Big animals like whales and dolphins can be seen	<i>Megafauna</i>	Charismatic species
Parts of the sea are nature reserves–like the National Parks we have on land	<i>MPAs</i>	Policy and conservation
Enough plants and animals for the food chain to work properly	<i>Food chain</i>	GEnS descriptor (4) and ecosystem health
Areas which scientists say is healthy or important	Scientists	Public trust of scientist opinion over personal judgment
Having plants or animals which are regionally, nationally or globally important	Endemic species	Ecological importance, regional identity
Unhealthy marine environment – full statement	Abridged statement	Justification
Lots of litter on the beach or out at sea	<i>Litter</i>	Marine litter GEnS criteria (10), visual issue
Murky or brown water	<i>Murky water</i>	Public perception issue from NE survey
Not many types of plants and animals live there	<i>Low diversity</i>	GEnS descriptor (1) and ecosystem health
High unemployment in local fishing industry	<i>Fishing unemployment</i>	Socio-economic, ecosystem approach, GEnS descriptor (3)
No big animals like seals or whales	<i>No megafauna</i>	Charismatic species
No areas of the sea protected from human activities	<i>No MPAs</i>	Policy and conservation
Fish/shellfish not fit for humans to eat due to contamination	<i>Contaminated seafood</i>	GEnS descriptor (9)
The habitats where the plants and animals live have been damaged	Habitat damage	GEnS descriptor (6)
Close to a large city	City	Urban areas possibly linked with poor environmental health

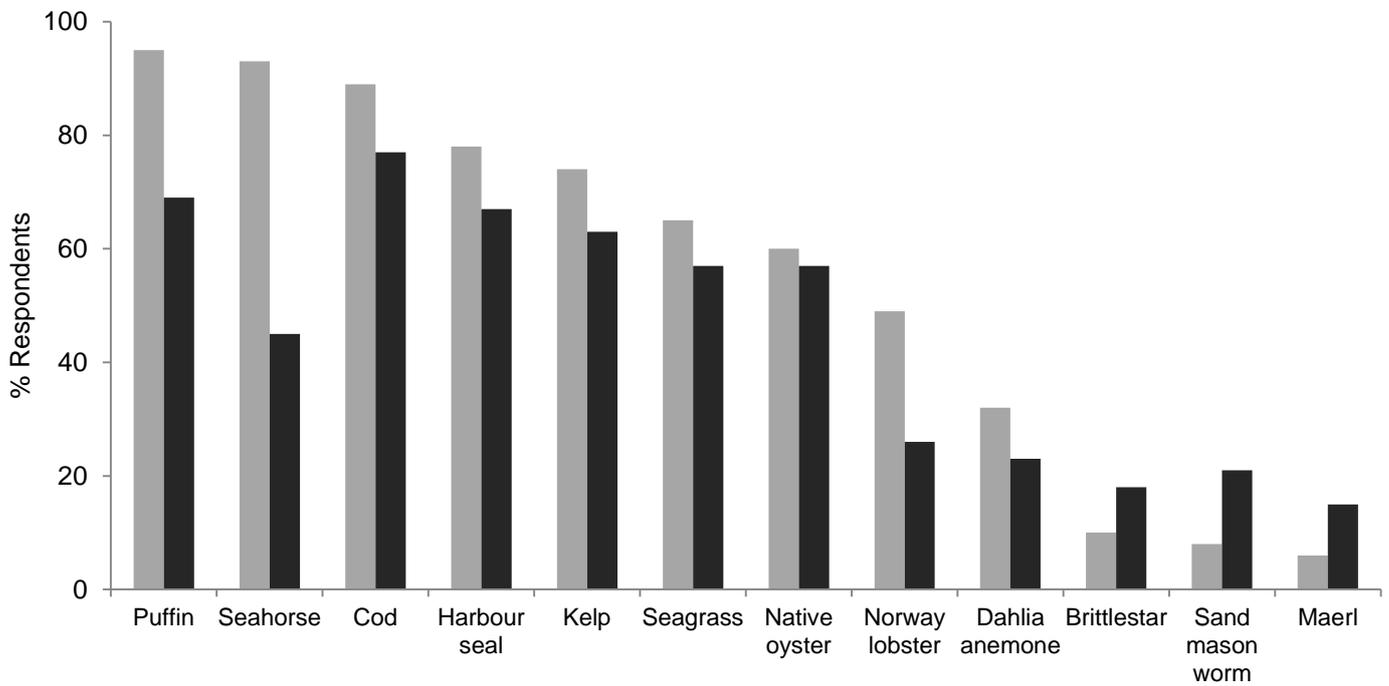
Table 3 Percentage of respondents answering “none” or “don't know” to species questions categorized by interaction with the coast. ▲ shows the range of responses from all other categories, i.e. respondents visiting the UK coast once or more during the year. For example, 8% of respondents who rarely/never visit the coast had not heard of any of the species, compared with a range of 0-2% for respondents who do visit the coast.

	Visit coast rarely/never	Visit at least once a year ▲	No activities	One or more activities ▲
Heard of species	8	0-2	13	0-4
Species found in UK seas	17	5-9	27	2-10
Interesting species	23	9-11	36	4-10

Table 4 Significant differences in results to health questions of respondents categorised by Maslow Group. Pioneer (Pio) n = 449, Prospector (Pro) n = 189, Settler (Set) n = 395. df = 1032. No P value indicates no significant result.

Healthy marine environment		F value	P value
Food chain	Pio > Pro	26.685	<0.001
	Pio > Set		<0.001
Clear water	Pro > Pio	8.74	<0.001
	Pio > Set		0.02
MPAs	Set > Pio	3.109	0.047
Scientists	Pio > Pro	9.145	0.012
	Pio > Set		<0.001
Unhealthy marine environment		F value	P value
Habitat damage	Pio > Pro	7.384	0.025
	Pio > Set		0.001
Fish contamination	Pio > Pro	4.948	0.009
Murky water	Pro > Pio	18.511	<0.001
	Set > Pio		<0.001
Low diversity	Pio > Pro	6.032	0.002

Figure 1 Responses to “Which of the following plants and animals have you heard of or recognise?” (grey bars) and “Which of the following plants and animals do you think can be found in the seas around the UK?” (black bars). n = 1047



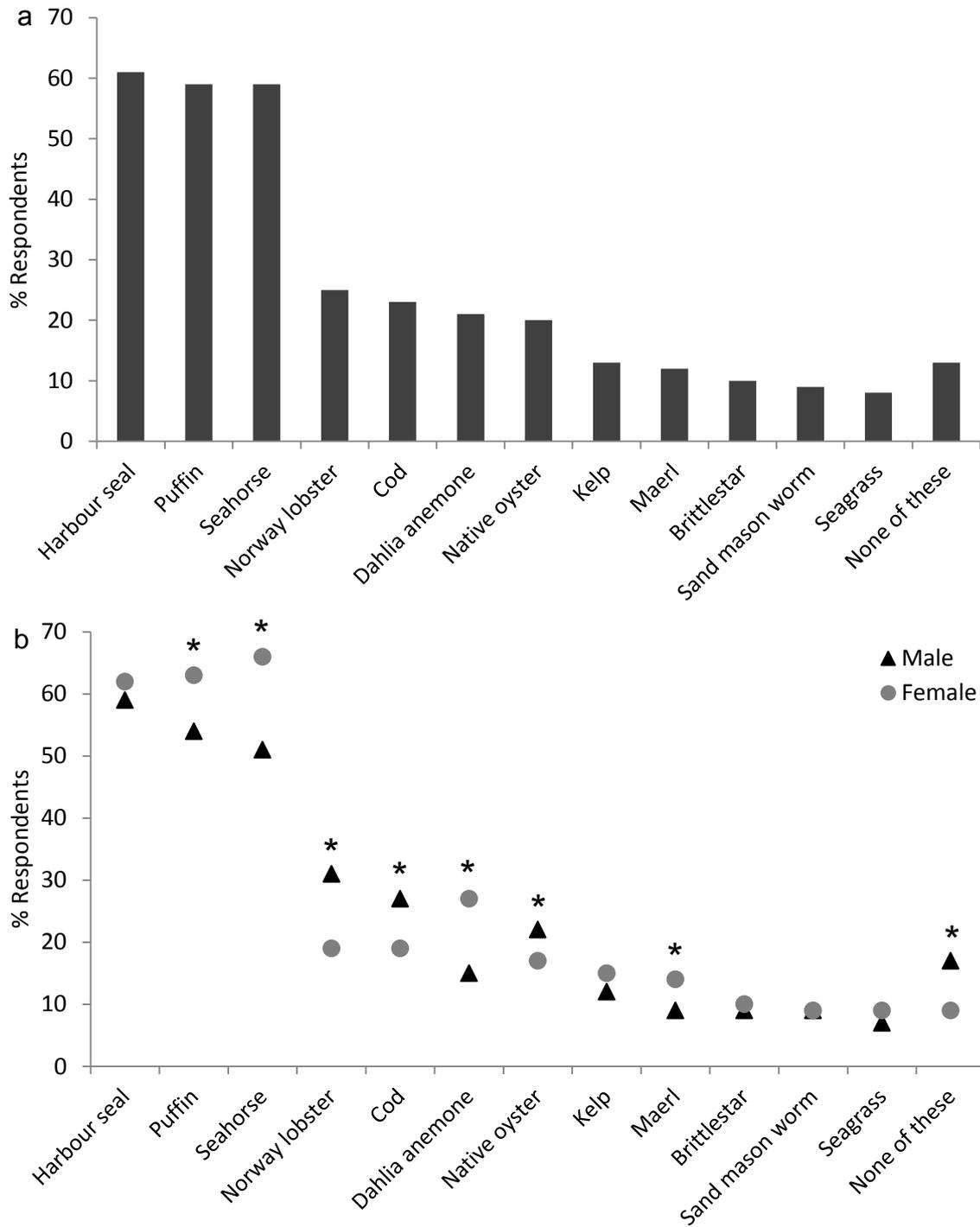


Figure 2 a) Results of question “Please select up to four pictures to show which plants and animals you would be most interested to learn more about.” n = 1047. **b)** Results of “Please select up to four species which you would be most interested to learn more about” by gender. Male n = 499, female n = 548. * Indicates significant result; see text for P values.

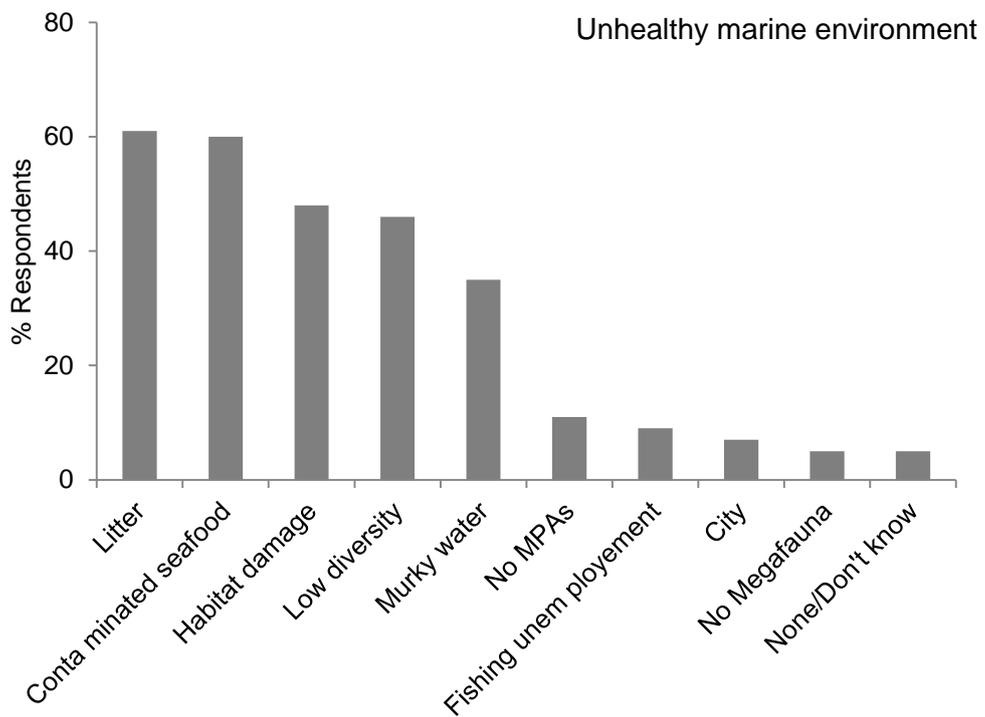
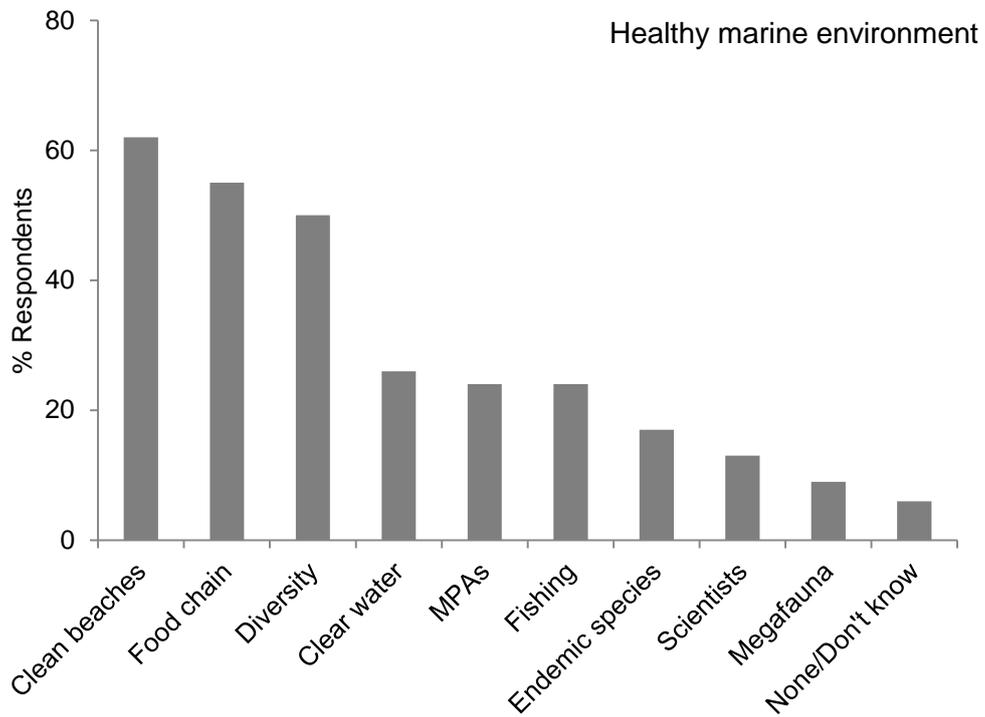


Figure 3 Responses to marine health questions, “Select up to three statements which you think best show a healthy marine environment” and “Select up to three statements which you think best show an unhealthy marine environment.” n = 1047.)

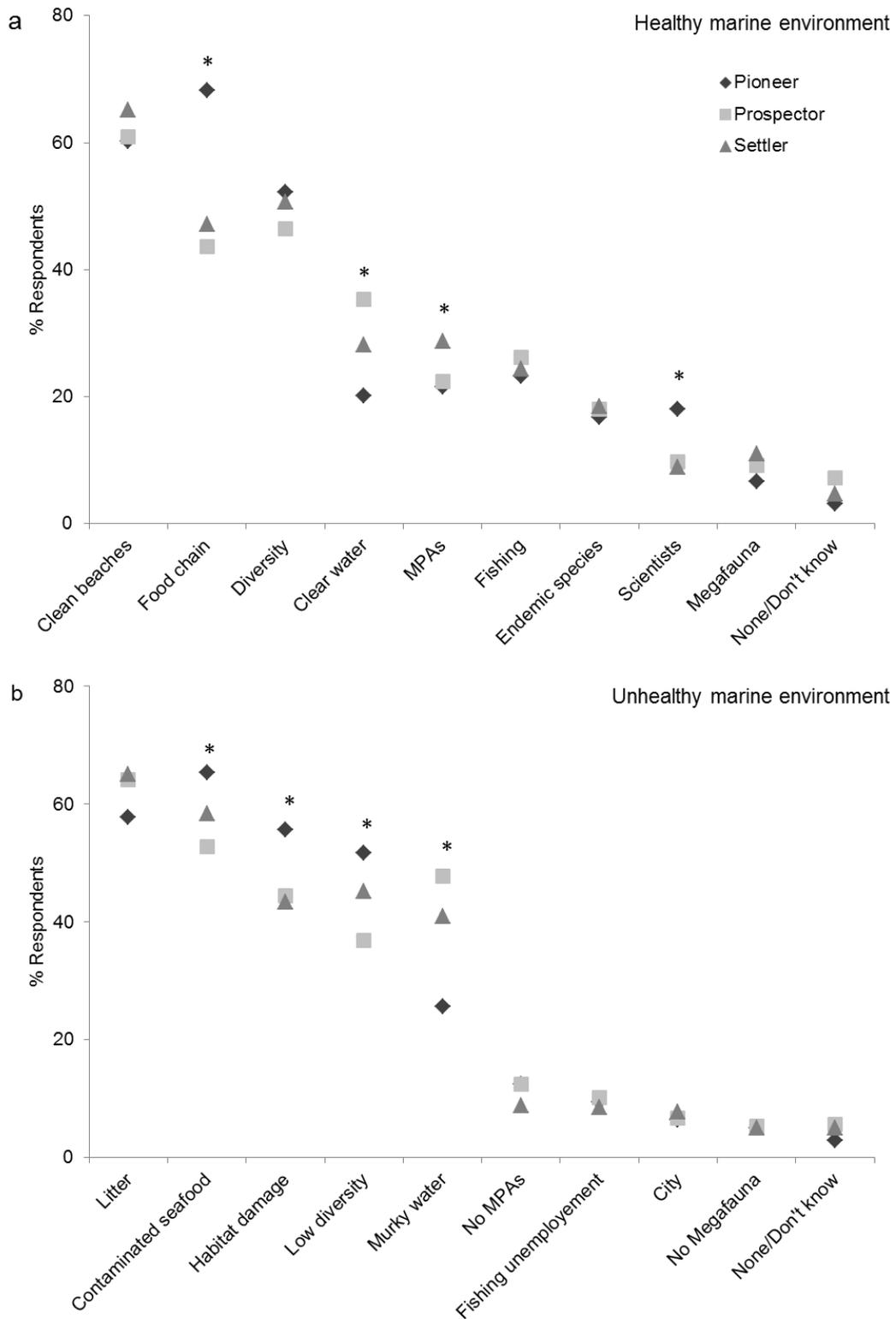


Figure 4 Responses to health questions by Maslow Group. “Select up to three statements which you think best show a healthy marine environment” and “Select up to three statements which you think best show an unhealthy marine environment.” Pioneer n = 449, Prospector n = 189, Settler n = 395. * Indicates significant result; see Table 4 for P values.

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