

Public Perceptions of Ocean Acidification

Summary findings of two nationally representative surveys of the British public, October 2014

Adam Corner, Stuart Capstick, and Nick Pidgeon

Cardiff University Understanding Risk Research Group and
Ipsos MORI

Understanding Risk Working Paper 14-01

This report may be cited as: Corner, A., Capstick, S., and Pidgeon, N. (2014). *Public perceptions of ocean acidification: Summary findings of two nationally representative surveys of the British public conducted during September 2013 and May 2014*. Understanding Risk Research Group Working Paper 14-01, Cardiff University.

The research is funded by the Natural Environment Research Council, the Department of Environment, Food and Rural Affairs, and the Department of Energy and Climate Change as part of the UK Ocean Acidification (UKOA) research programme, grant number NE/H17518/1. The research is also supported by the Tyndall Centre for Climate Change Research, the Climate Change Consortium of Wales (C3W), and the Cardiff Sustainable Places Research Institute.

The authors thank Paul Pearson and Ian Hall of the School of Earth and Ocean Sciences, Cardiff University, for their support in carrying out this research, as well as Phil Williamson and Carol Turley of UKOA/NERC. Elspeth Spence of the School of Psychology at Cardiff contributed to discussions of the research design.

Executive Summary

The oceans are absorbing large quantities of the carbon dioxide (CO₂) which has been emitted into the atmosphere from human activities. This absorption of CO₂ is leading to a reduction in the pH of seawater – termed ‘ocean acidification’ (OA) – with consequences for marine ecosystems and the societies which depend upon them. Ocean acidification and climate change are closely related phenomena, however to date OA has received far less attention as a subject of policy and public concern.

We currently know very little about how the British public perceives the problem of ocean acidification. We report the findings of two online representative surveys of the British public (aged 18-80 years) on this topic conducted pre- and then post- the recent round of Inter-Governmental Panel on Climate Change (IPCC) 5th assessment reporting.

The first fieldwork (Phase 1) took place during September 2013 (n= 1,001) and the second (Phase 2) during May 2014 (n= 1,500). This research was funded as part of the UK Ocean Acidification Research Programme (UKOA) of the Natural Environment Research Council.

Key findings of the research include:

- Only around 1 in 5 participants state that they have even heard of ocean acidification. Among those who do say they have heard of it, levels of self-reported knowledge about the subject are very low. Additionally, we found no significant increase in levels of awareness of OA post- the most recent round of IPCC reporting.
- Of those who reported being aware of OA, only around a half said they had encountered any information about it since the beginning of 2014. Of those who reported encountering information, this was primarily via TV News or science programmes; only a very small proportion stated they had seen or heard about OA via the IPCC reporting process.
- Linked with this low level of awareness, most people do not initially express concern about OA. Once provided with some basic additional information, however, a majority do then express some concern about the subject.
- Despite a lack of knowledge and awareness about OA, the term itself evokes associations with themes of pollution, and deleterious environmental consequences. A surprisingly large proportion of people also correctly attributed anthropogenic carbon emissions as the main cause of OA; though

as many again perceived that OA was caused by 'pollution' from shipping. Damage to coral reefs and consequences for marine organisms were recognised by many as consequences of OA. A sizeable minority of those we surveyed were also of the view that OA could lead to erosion of the physical environment such as coastlines and ice-shelves.

- There was perceived to be greater expert consensus about the harmful consequences of OA, than about the fact that carbon emissions caused OA. Independent scientists were trusted more than any other group to give correct information about OA.
- A majority of participants were of the view that OA was likely to constitute a serious problem for Britain, and to have consequences for themselves or their family. Most participants stated that OA should be a medium-high priority for the UK government.
- Whilst other threats to the marine environment – such as industrial pollution and overfishing – were felt to be more serious than OA, a majority of participants perceived that OA represented a significant risk. However, when compared to risks such as flooding, heat waves and droughts, fewer people were of the view that OA constituted a risk either to the UK or globally over the next 50 years.

The results point to a clear need to further engage members of the public in innovative ways about this important environmental risk issue.

Introduction

The oceans are absorbing large quantities of the carbon dioxide (CO₂) which has been emitted into the atmosphere from human activities. This absorption of CO₂ is leading to a reduction in the pH of seawater – termed ‘ocean acidification’ (OA) – with consequences for marine ecosystems and the societies which depend upon them.

There has been a recent surge of scientific interest in understanding ocean acidification. Little is known, however, about the extent to which ocean acidification is recognised and understood by members of the public.

We conducted two online surveys of public opinion. The first (Phase 1) took place during September 2013 and collected responses from 1,001 members of the British public. The second (Phase 2), conducted during May 2014, collected responses from 1,500 members of the British public. Both were conducted by Ipsos MORI on behalf of the Understanding Risk group at Cardiff University. The research was funded as part of the UK Ocean Acidification Programme (UKOA) of the UK’s Natural Environment Research Council (NERC).

The sample in both cases was representative of the British population aged 18-80 in terms of age, gender and geographical region. Reported results are accurate to within a margin of error of approximately +/- 3%.

Data were collected in two phases to facilitate comparisons between the two time-points. The first time point was chosen because it was directly before the release of the first part of the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report. The Assessment reports (which are released approximately every seven years) are a major scientific undertaking which aim to provide policy makers with comprehensive and policy-relevant summaries of climate change science, impacts, and possible methods of responding to climate change. The 5th Assessment Report also included a significant amount of information about OA. As the IPCC reports have previously attracted a significant amount of media interest, it was possible that the 5th Assessment Report would have a measureable effect on attitudes towards climate change and/or OA.

The second phase of data collection was conducted immediately after the release of the third part of the Assessment Report (which contained the most OA-relevant information). Although it is not possible to *causally* demonstrate a link between the release of the 5th Assessment Report and public perceptions using this method, a significant change in attitudes towards OA could reasonably be attributed to the impact of the report.

An additional difference between Phase 1 and Phase 2 of the research is that a ‘framing manipulation’ was included in the design of the second phase, whereby

some text giving information about OA to participants was slightly different for the 500 'additional' participants that were included in Phase 2. 1,000 participants in Phase 2 received exactly the same information about OA (indeed, exactly the same survey altogether) as in Phase 1, meaning that there was a directly comparable sample of 1,000 participants in each phase of the research. The additional 500 participants in Phase 2 received information about OA that was explicitly described as being linked to climate change. This 'climate change framing' of the OA information involved emphasising the fact that climate change and OA were both consequences of rising levels of human-caused CO₂. In the standard framing used in Phase 1, this link was more implicit. The findings of this framing manipulation are to be presented in a separate report. Further analyses concerning the role of participants' general and environmental attitudes as influences upon their perceptions of OA will also be reported separately.

What follows is a presentation of the key descriptive findings from both phases of the project. We report data for all 2,500 participants for questions 1-8 (which were asked prior to the provision of information about OA to participants). For subsequent questions (question 9 onwards) we report responses from the 2,000 participants' data who received the *same* framing of OA information as in Phase 1 in order to facilitate direct comparisons. For a small number of remaining questions only asked of phase 2 participants, we report data for either 1,000 or 1,500 individuals as appropriate.

Survey findings

Basic knowledge and awareness

There is very limited awareness among the British public of the term ‘Ocean Acidification’, and correspondingly low levels of self-reported knowledge about what it means. Only around 20% had heard of OA. Only a very small proportion reported that they knew a fair amount or a great deal about it.

Q1 Before today, had you heard of Ocean Acidification?

	Yes	No
Average (phase 1 and 2)	19.6%	80.4%
Phase 1	18.3%	81.7%
Phase 2	20.5%	79.5%

Q2 How much, if anything, would you say you know about ocean acidification?

	Average (phase 1 and 2)	Phase 1	Phase 2
I have not heard of ocean acidification before taking part in this survey	74.9%	76.4%	73.9%
I have heard of ocean acidification, but I know almost nothing about it	11.3%	10.7%	11.7%
I know just a little about ocean acidification	10.9%	10.2%	11.3%
I know a fair amount about ocean acidification	2.6%	2.4%	2.7%
I know a great deal about ocean acidification	0.3%	0.3%	0.3%

Linked to the low levels of knowledge and awareness, when asked whether they were concerned about OA, most people answered that they were unsure or did not have an opinion. However, ***among those who did volunteer an opinion, expressing concern was more common than expressing a lack of concern.***

Q3 How concerned, if at all, are you about ocean acidification?

	Average (phase 1 and 2)	Phase 1	Phase 2
Very concerned	8.9%	8.4%	9.2%
Fairly concerned	23.1%	23.2%	23.0%
Not very concerned	8.4%	8.6%	8.3%
Not concerned at all	3.1%	3%	3.2%
Don't know	43.0%	42.6%	43.3%
No opinion	13.5%	14.3%	12.9%

Changes in perceptions between September 2013 and May 2014

Comparison of data between phase 1 (September 2013) and phase 2 (May 2014) of data collection suggest that there is very little difference between these in terms of participant responses. A chi-square test comparing responses to Q1 on levels of basic awareness suggests that this is not statistically significant at the $p < .05$ level ($\chi^2 = 1.92$, $p = .16$). Further analyses of potential differences between years will be reported separately. However, because initial tests suggest these are minimal, for the following sections of this report we present combined data (mean scores from phases 1 and 2, based on combined $n = 2,501$).

Spontaneous image associations

Question 4 in the survey asked people to report spontaneous associations with the term 'ocean acidification'. This approach is useful to understand the sorts of ideas the notion of OA may bring to mind, even where a person may know little (or nothing) about the topic itself. Participants were asked: "When you hear the term 'ocean acidification' what are the first three thoughts, images or phrases which come to mind".

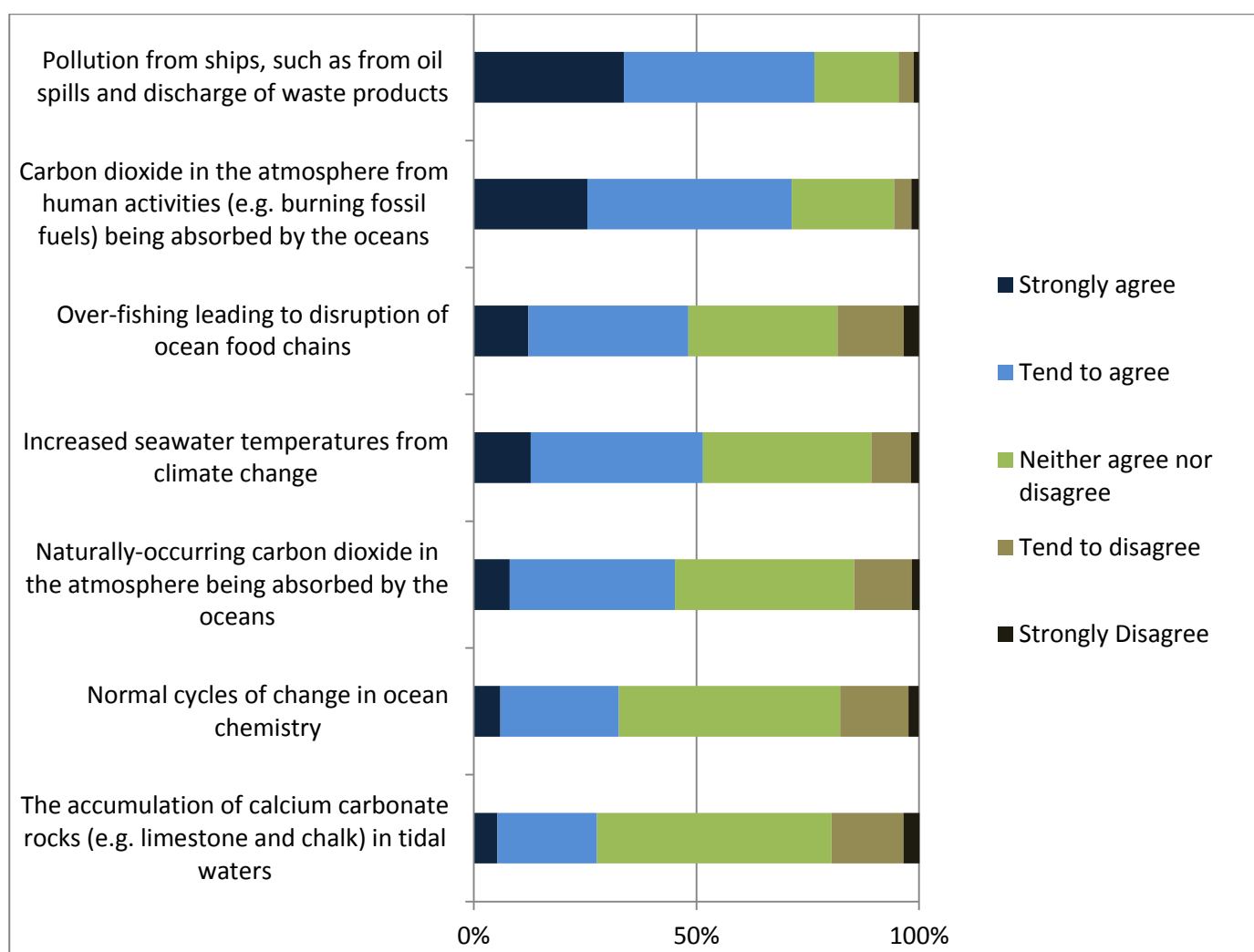
Illustrative responses with respect to the more commonplace themes obtained are given below.

Theme	Illustrative responses
'Pollution'	"Acid pollution from chemicals from farms" "Wastes in the ocean turning the sea acidic" "Pollution of seas" "Contamination"
Effects on animals, plants	"Dead sea life" "Danger to marine animals" "Threat to species" "Loss of sea creatures"
Effects on ecosystems, physical environment	"Erosion of the oceans" "Eroding shorelines" "Destruction of marine habitat" "How will it affect limestone coastal features?"
'Negative' associations; concern	"I now feel worried" "Sounds quite concerning" "Disaster"
Climate change and related concepts	"CO ₂ " "Something potentially linked to climate change"
Effects on people, societies	"...fish stocks are likely to be badly affected" "The future of our children and grandchildren"

Perceptions of the causes and consequences of OA

Despite the low levels of awareness and self-reported knowledge about OA, **many participants perceived a link – when prompted – between levels of human-caused carbon dioxide and OA, and between pollution and OA.** Participants were asked to indicate how much they agreed or disagreed with a list of possible causes of OA, and then asked to select one from that list that they thought was the *main* cause of OA.

Q5a To what extent do you agree or disagree that each of these is a cause of ocean acidification? ¹



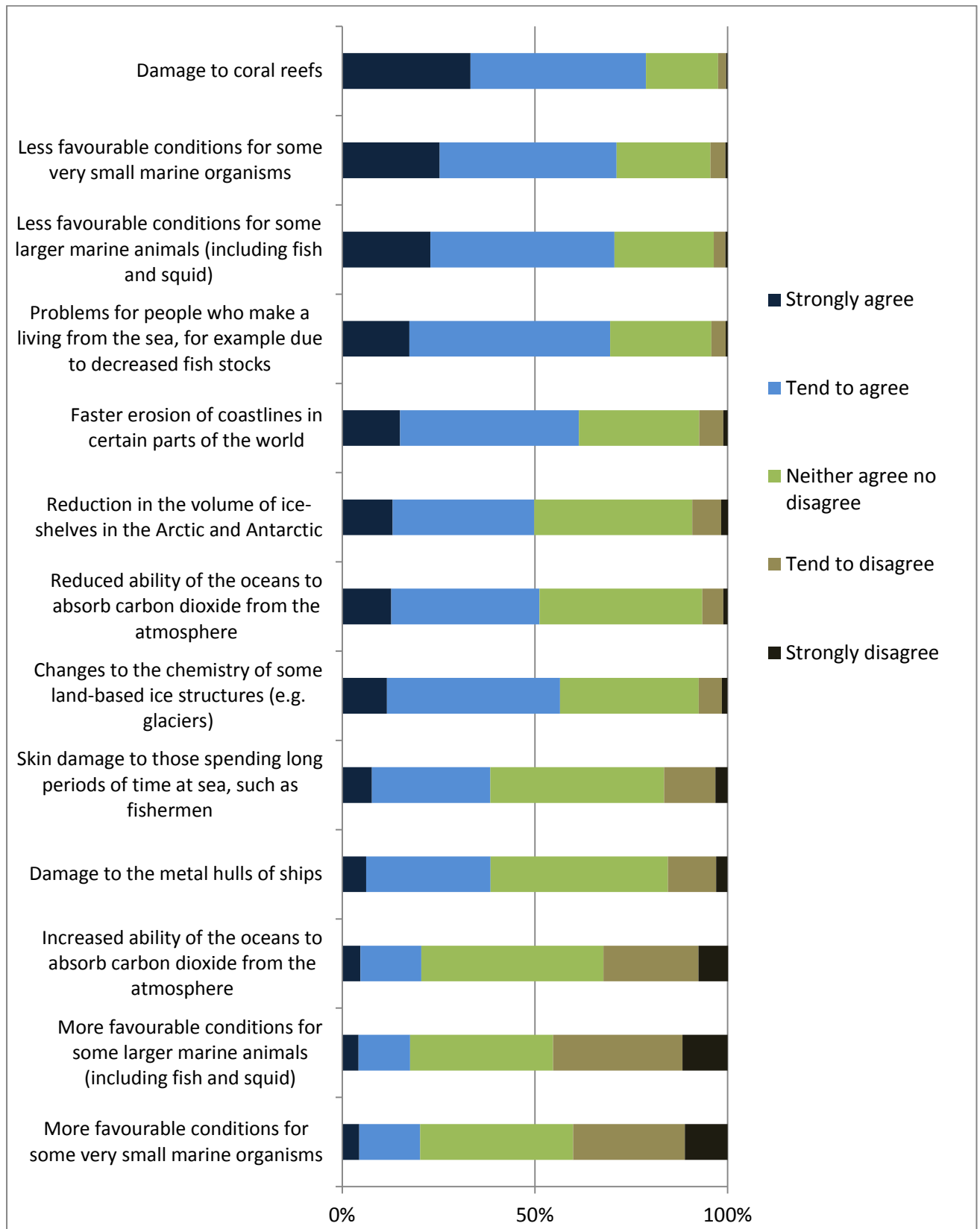
¹ Although multiple drivers may interact to contribute to the process of ocean acidification, only one of the options presented in Q5a refers to the principal cause of ocean acidification as understood in the scientific literature, this being carbon dioxide from human activities; the remaining options are distracter items that are not considered to be relevant.

Q5b Which, if any, do you think is the main cause of ocean acidification?

Possible cause	% responding
Carbon dioxide in the atmosphere from human activities (e.g. burning fossil fuels) being absorbed by the oceans	37.5%
Pollution from ships, such as from oil spills and discharge of waste products	34.1%
Normal cycles of change in ocean chemistry	5.6%
Increased seawater temperatures from climate change	6.3%
Naturally-occurring carbon dioxide in the atmosphere being absorbed by the oceans	4.0%
Over-fishing leading to disruption of ocean food chains	2.7%
The accumulation of calcium carbonate rocks (e.g. limestone and chalk) in tidal waters	1.8%
<i>None of these</i>	8.0%

Mirroring the questions about the perceived causes of OA, participants were also asked how much they agreed or disagreed with a list of possible *consequences* of OA, and then asked to select one from that list that they thought was the *main* consequence of OA. Compared to judgements about the causes of OA **there was less agreement about its consequences. There was most agreement that the consequences of OA would be damage to coral reefs, and less favourable conditions for marine organisms.**

Q6a To what extent do you agree or disagree that each of these is a consequence of ocean acidification? ²



² Although there is uncertainty about the precise consequences of OA, the options in Q5b are intended to represent effects which are considered likely and/or of active scientific investigation (such as damage to coral reefs) as well as distracter items that are not considered to be relevant (e.g. changes to the chemistry of land-based structures).

Q6b Which, if any, do you think is the main consequence of ocean acidification?

Possible cause	% responding
Less favourable conditions for some larger marine animals (including fish and squid)	17.7%
Damage to coral reefs	16.6%
Reduced ability of the oceans to absorb carbon dioxide from the atmosphere	13.4%
Less favourable conditions for some very small marine organisms	12.0%
Faster erosion of coastlines in certain parts of the world	9.9%
Reduction in the volume of ice-shelves in the Arctic and Antarctic	5.8%
Problems for people who make a living from the sea, for example due to decreased fish stocks	4.4%
Changes to the chemistry of some land-based ice structures (e.g. glaciers)	4.1%
Increased ability of the oceans to absorb carbon dioxide from the atmosphere	2.9%
Damage to the metal hulls of ships	1.0%
Skin damage to those spending long periods of time at sea, such as fishermen	0.8%
More favourable conditions for some very small marine organisms	0.7%
More favourable conditions for some larger marine animals (including fish and squid)	0.4%
<i>None of these</i>	10.4%

Perceptions of scientific agreement

Two questions asked about perceptions of scientific agreement on the causes and consequences of OA. ***A large majority felt that some or most experts agreed that OA is caused by human activities, and that it would have harmful consequences.***

Q7/Q8 Which of the following statements do you think most accurately reflects scientific opinion on ocean acidification?

Perceived position of experts	% responding
Most experts are of the view that ocean acidification is caused by carbon dioxide (CO ₂) emissions - from human activities - that end up in the ocean	35.3%
Some experts are of the view that ocean acidification is caused by carbon dioxide (CO ₂) emissions - from human activities - that end up in the ocean	52.7%
Only a small number of experts are of the view that ocean acidification is caused by carbon dioxide (CO ₂) emissions - from human activities - that end up in the ocean	12.0%

Perceived position of experts	% responding
Most experts are of the view that ocean acidification will have harmful consequences for certain types of marine life	47.4%
Some experts are of the view that ocean acidification will have harmful consequences for certain types of marine life	44.2%
Only a small number of experts are of the view that ocean acidification will have harmful consequences for certain types of marine life	8.4%

Information provision concerning ocean acidification

At this point in the survey, a paragraph of information was provided about OA to participants. For all of the 1,001 Phase 1 participants, and 1,000 of the Phase 2 participants, this paragraph read:

Ocean acidification

The oceans absorb carbon dioxide (CO₂) from the atmosphere. This is a natural process, but as well as absorbing naturally occurring carbon dioxide, they have taken up over a quarter of the carbon dioxide emitted as a result of human activities over the past 200 years. Carbon dioxide is a colourless gas which is released when we burn fossil fuels (e.g. coal, oil & gas) to produce electricity, heat our homes, and in transport and manufacturing.

The extra carbon dioxide that the oceans have absorbed has a number of consequences – and one of these is referred to as ‘ocean acidification’. Ocean acidification means that the oceans are gradually becoming more acidic as a result of the extra carbon dioxide they are absorbing. A person would find this change almost impossible to detect without the use of scientific instruments (e.g. if swimming in seawater now compared to 200 years ago). There may, however, be consequences from ocean acidification for some organisms which live in the oceans.

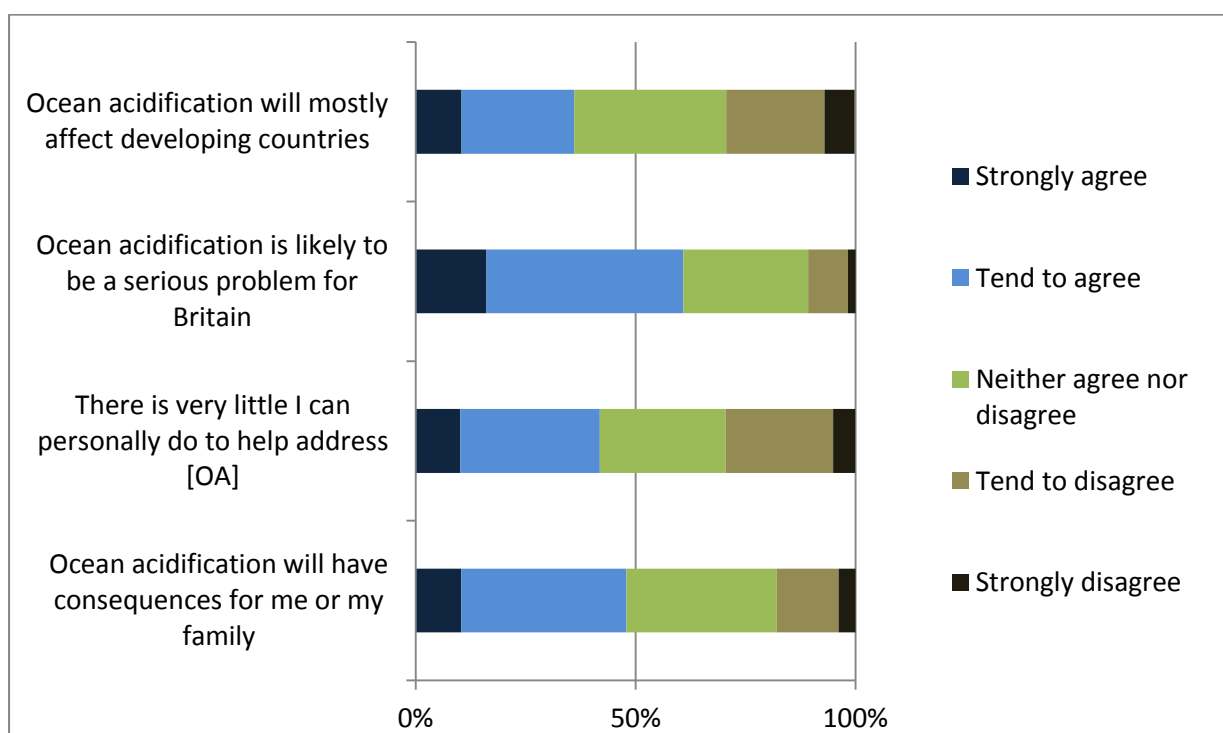
Scientific research has suggested that ocean acidification might affect coral reefs, animals which form shells (such as sea snails), and plankton (tiny, floating organisms). There may also be consequences for fish and other large animals, both directly (e.g. their ability to reproduce) and indirectly (e.g. the availability of their food supply). It is possible there will be further knock-on effects for human societies, especially for people who rely on the oceans to make a living. But there is at the moment a great deal of uncertainty about what the impacts of ocean acidification on ocean life and human societies will be. Whilst scientists are confident in their understanding of the basic chemical processes of ocean acidification, there is still a great deal that they do not understand about the wider consequences of ocean acidification.

The following sections of this report detail participant responses to a further series of questions concerning the perceived relevance and importance of OA, and concerning levels of trust in communicators. We report combined findings for participants from phase 1 and phase 2 who were provided with the text given above (n=2,001). Responses obtained from the remaining 500 participants in phase 2, who received a different information framing concerning OA, will be reported separately.

Perceived personal relevance and responsibility for tackling OA

There was **strong agreement that OA was likely to be a serious problem for Britain**. Participants were more evenly split on the question of whether OA would mostly affect developing countries. There was also a spread of responses regarding the capacity of individuals to do anything to personally address OA. Just under 50% of participants were of the view that OA would have consequences for themselves or their family. **Most people thought that OA should be a medium-high priority for the UK government.**

Q9 To what extent do you agree with each of the following statements about ocean acidification?



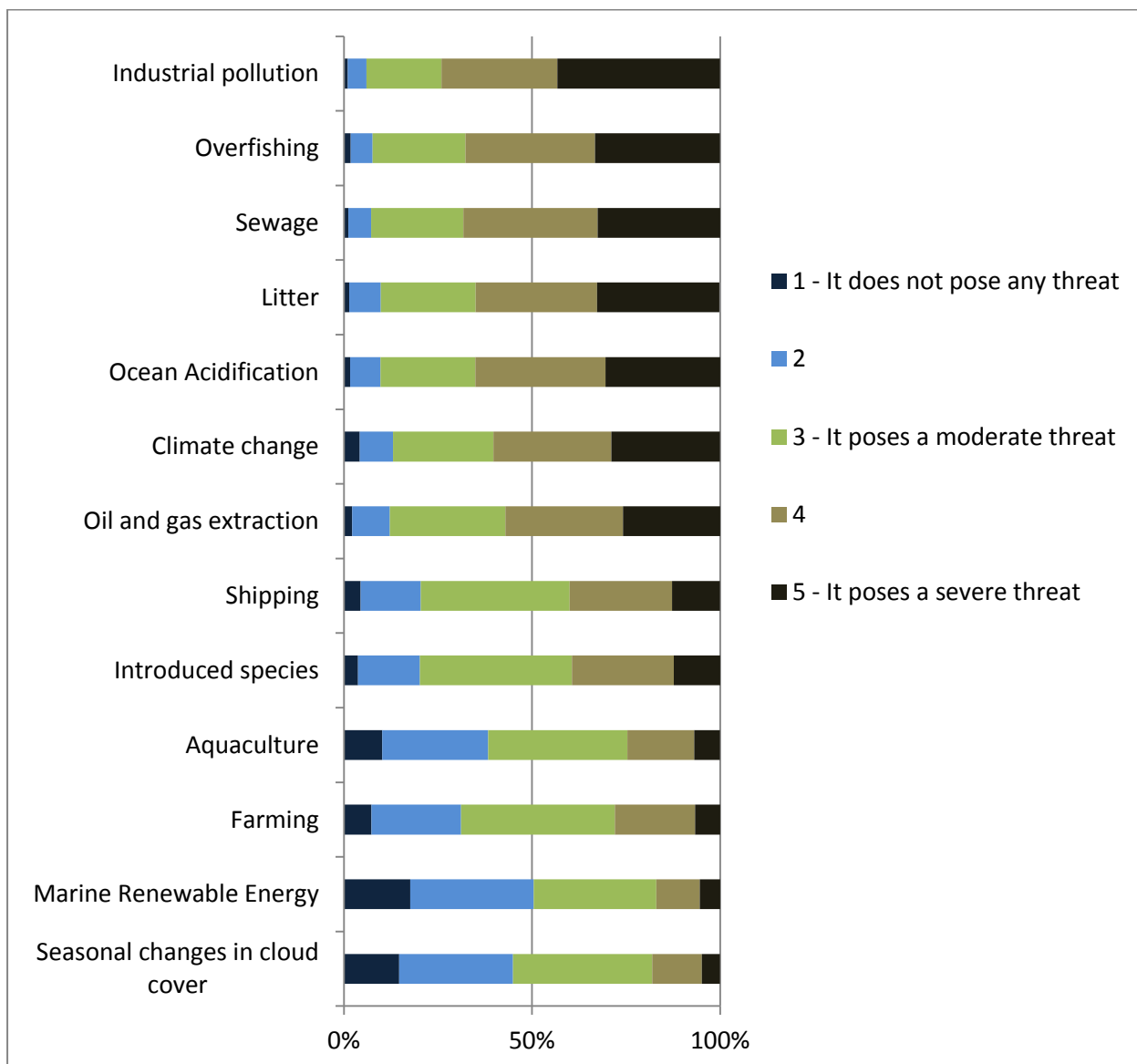
Q10 How high or low a priority should it be for the UK government to take action on ocean acidification?

Perceived priority	% responding
Very low priority	4.8%
Fairly low priority	12.8%
Medium priority	34.9%
Fairly high priority	33.5%
Very high priority	14.0%

OA compared to other environmental risks

Participants were asked to indicate the extent to which they thought a range of environmental factors – including OA – posed a risk to the marine environment. **The results showed that OA was perceived as a significant threat to the marine environment, at a similar level to overfishing, litter, climate change and oil/gas extraction.**

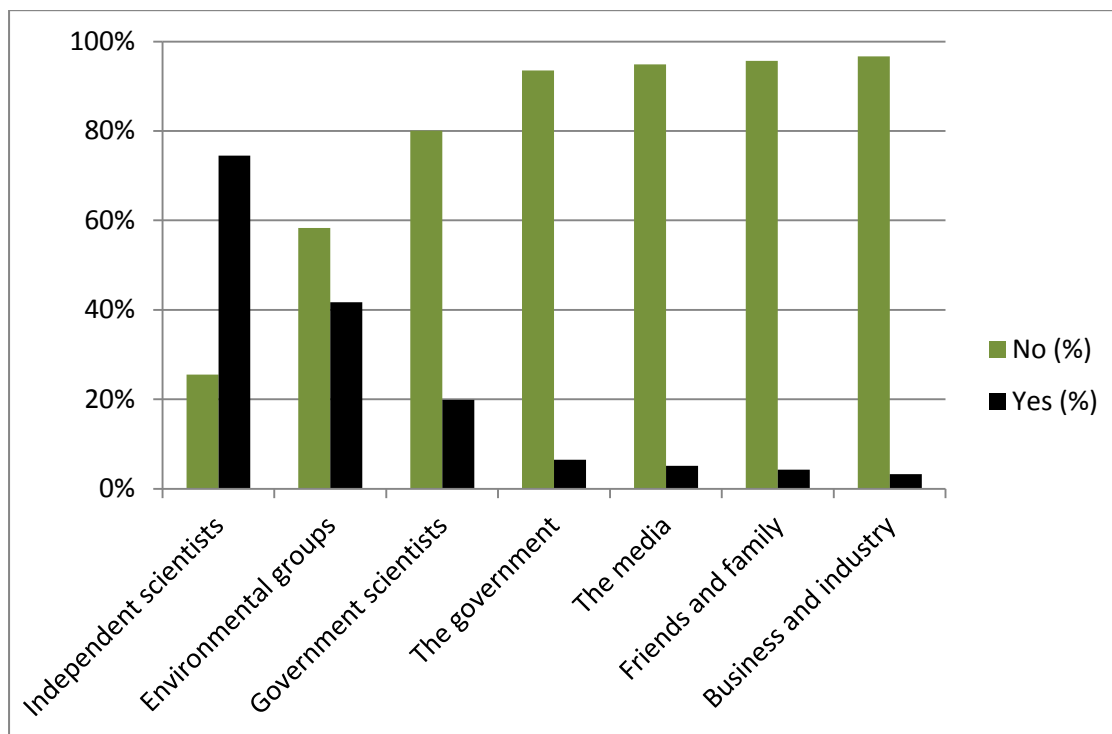
Q11 In your opinion, how much of a threat, if any, does each of the following pose to the marine environment?



Trust in communicators about ocean acidification

We asked participants which groups they would trust to give them correct information on ocean acidification. As for many other issues, **the government, the media and business/industry were generally not trusted to provide correct information about OA. However, independent scientists (e.g. from universities) were well trusted, with environmental groups somewhat less so. In addition, 68% of participants agreed or strongly agreed that they trusted ocean scientists in particular to tell the truth about OA.**

Q12 Which of the following groups, if any, do you trust to give you correct information on ocean acidification?



Q13 To what extent do you agree or disagree with the following statement? We can trust ocean scientists to tell us the truth about ocean acidification.

Level of agreement	% responding
Strongly agree	15.7%
Tend to agree	50.5%
Neither agree nor disagree	21.9%
Tend to disagree	8.2%
Strongly disagree	3.7%

Change in concern about OA during the survey

As well as asking participants about their level of concern about ocean acidification near the start of the survey (Q3), we repeated the question towards the end of the survey, to assess whether this had changed in light of the additional information provided. ***A large shift in levels of concern about ocean acidification was observed overall in comparison to the earlier question.*** This effect was obtained in both phases of the survey, and mostly entailed a large decline in the number of ‘don’t know’ responses, with subsequent increases in ‘concerned’ responses. It seems likely that many participants understandably did not express concern initially, having not heard about the phenomenon, but did so having learned more about it.

Q3 How concerned, if at all, are you about ocean acidification (start of survey)

Q14 How concerned, if at all, are you about ocean acidification (post information provision)

	Very concerned	Fairly concerned	Not very concerned	Not concerned at all	Don't know	No opinion
Concern about OA (Q3)	8.9%	23.1%	8.4%	3.1%	43.0%	13.5%
Concern about OA (Q14)	14.1%	49.5%	23.4%	4.6%	5.2%	3.1%

Concern about OA versus climate change

As well as gauging concern about OA, a series of questions asking about climate change more generally was included. **Levels of concern about climate change and OA were not dissimilar, but with more concern about climate change overall.**

Q15 How concerned, if at all, are you about climate change (sometimes referred to as global warming)?

Degree of concern	% responding
Very concerned	27.1%
Fairly concerned	45.6%
Not very concerned	18.7%
Not concerned at all	6.1%
Don't know	1.5%
No opinion	0.9%

Participants were asked whether they believed that the climate was changing, and if so what they perceived the main cause of this to be. **Around 80% agreed that the climate was changing, with approximately 82% agreeing that human activity was at least partly to blame.**

Q16 As far as you know, do you personally think the world's climate is changing or not?

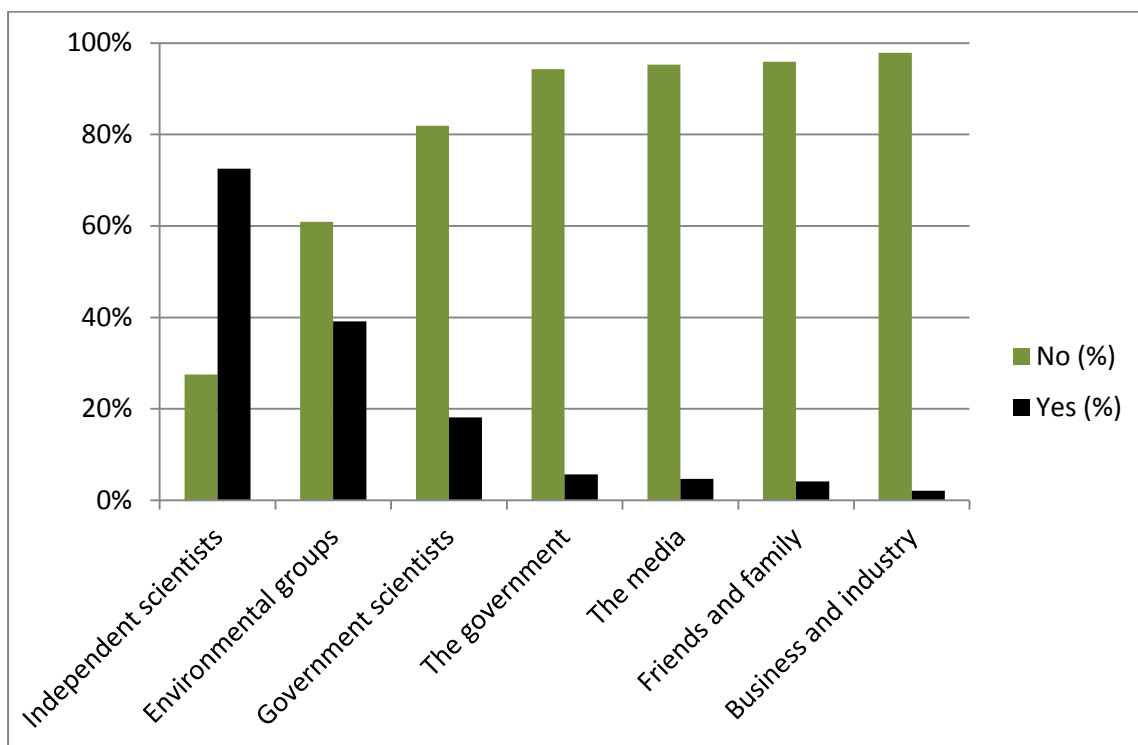
Response	% responding
Yes	80.2%
No	9.8%
Don't know	9.9%

Q17 Thinking about the causes of climate change, which, if any, of the following best describes your opinion?

Response category	% responding
Climate change is entirely caused by natural processes	4.4%
Climate change is mainly caused by natural processes	9.0%
Climate change is partly caused by natural processes and partly caused by human activity	45.5%
Climate change is mainly caused by human activity	31.2%
Climate change is entirely caused by human activity	4.6%
I think there is no such thing as climate change	2.5%
Don't know	2.6%

Levels of trust in various groups to provide correct information about climate change displayed a similar pattern to those for OA in Q12, with **independent scientists the most trusted source, while government, media and industry were trusted very little**. Friends and family were not trusted to provide correct information on either OA or climate change, but this presumably reflects an inferred lack of knowledge among these groups rather than a lack of trust per se. Furthermore, **around 60% agreed that climate scientists specifically were trusted to tell the truth about climate change**.

Q18 Which of the following groups, if any, do you trust to give you correct information on climate change?

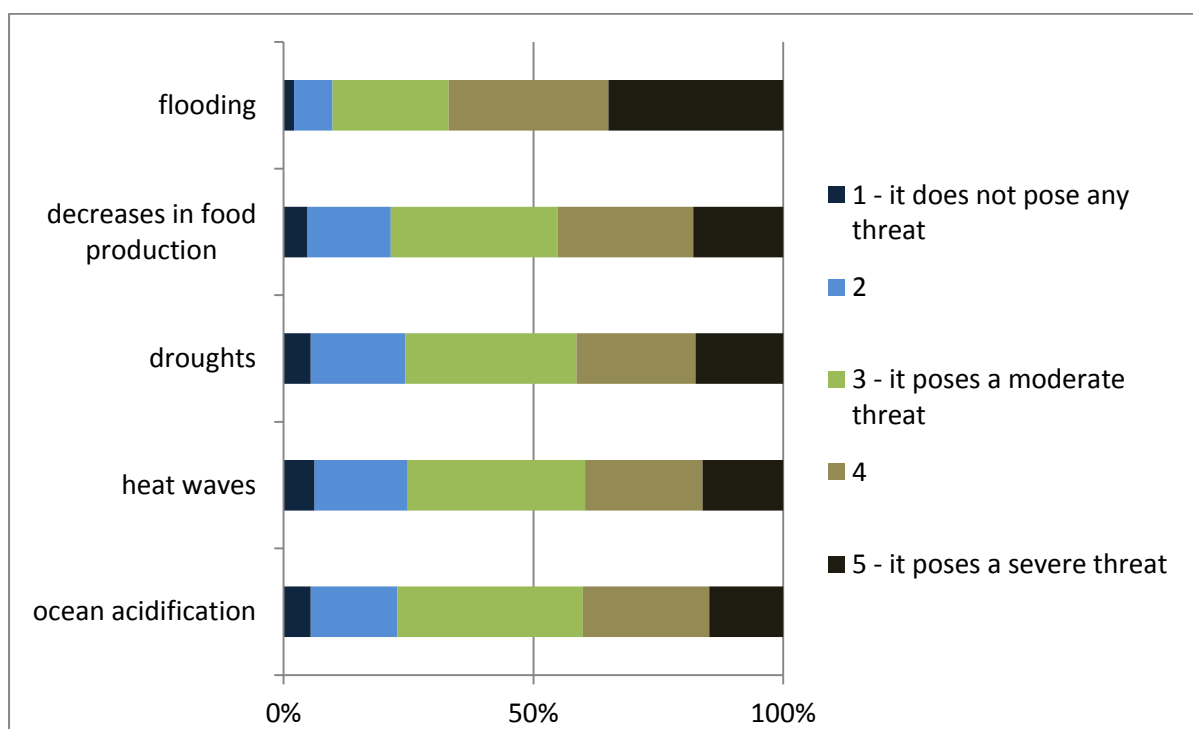


Q19 To what extent do you agree or disagree with the following statement? We can trust climate scientists to tell us the truth about climate change?

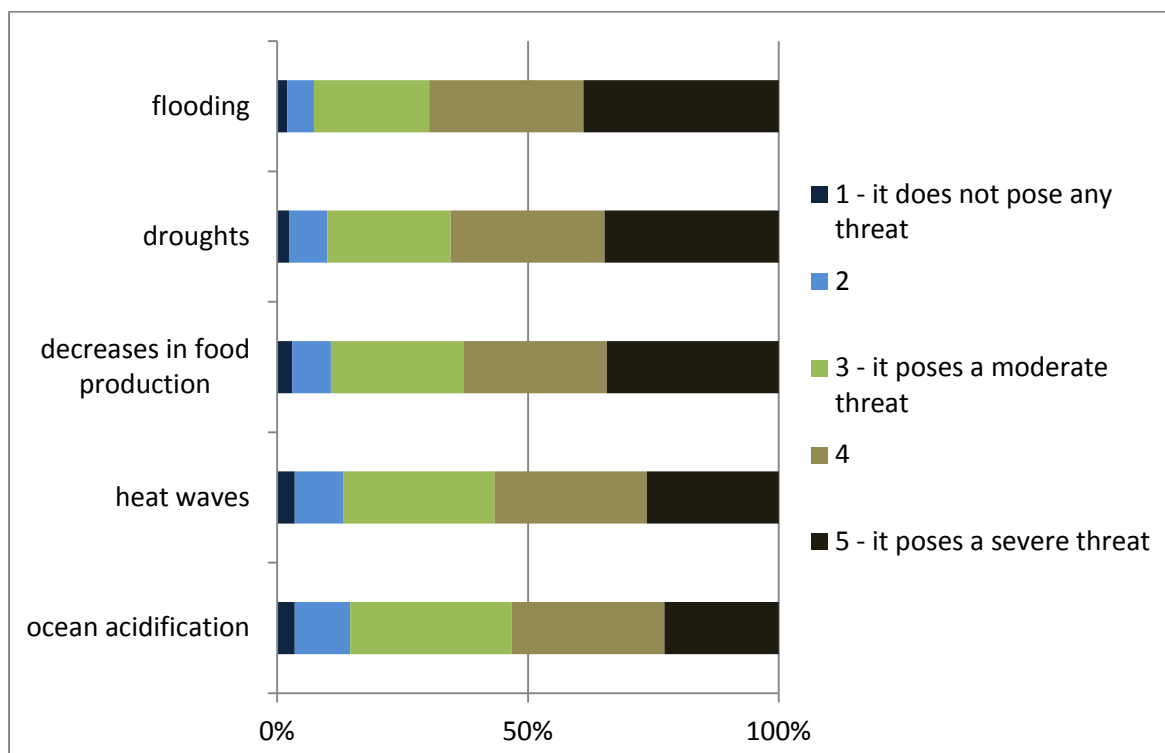
Level of agreement	% responding
Strongly agree	12.0%
Tend to agree	48.9%
Neither agree nor disagree	24.6%
Tend to disagree	9.6%
Strongly disagree	4.8%

Towards the end of the survey, participants were asked to indicate the extent to which each of a range of climatic impacts and environmental risks – including OA – posed a threat to the UK over the next 50 years. Participants were also asked an equivalent question concerning the threat of each of these at a global level. These questions were asked to gauge the perceived threat of OA relative to other risks. They were only asked of participants in the second survey phase, and are reported here for the sample which received the information framing about OA as described above (n=1,000). The highest perceived risk at a UK level was flooding. OA was perceived as representing a similar level of risk at a UK level to droughts, decreases in food production, and heat waves. ***At the global level, OA was perceived as a lower risk relative to other climatic and environmental risks.***

Q21a How much of a threat do you think each of the following poses to the UK over the next 50 years?



Q21b How much of a threat do you think each of the following poses on a global level over the next 50 years?



Information encountered about OA

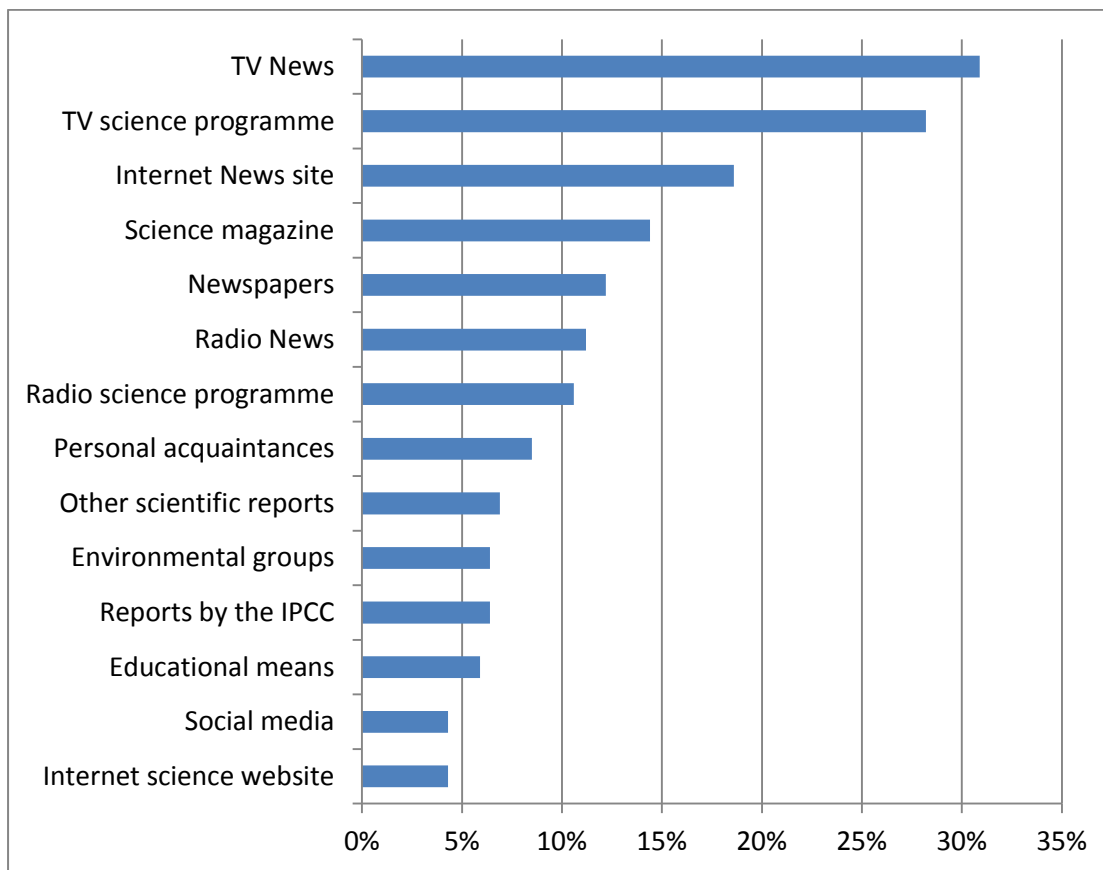
In Phase 2 only, we asked participants whether they had heard any information about OA since the beginning of 2014. This was a direct attempt to capture any impact of the IPCC 5th Assessment Report on public attitudes towards OA. Here we report data for all 1,500 participants in Phase 2. Only those participants who had reported having at least heard of OA before taking part in the survey (a sub-sample of 392 out of 1,500 participants, based on responses from Q2) were asked for further questions about whether they had heard more since the beginning of 2014.

Results indicated that around half of this sub-sample had not seen, read or heard *anything* about OA during this time. **The most frequently reported means by which participants had heard about OA was via TV News or science programmes. Only around 6% said they heard about it through the IPCC 5th Assessment Report** although the TV coverage people saw may have been based on this. As a proportion of the full phase 2 survey sample (n=1,500), this equates to less than 2% of participants who reported having heard about OA via the IPCC reports (assuming that those reporting no awareness of OA had not done so).

Q14b: Earlier you said that you are aware of ocean acidification. Have you seen, read or heard anything about ocean acidification at any point since the beginning of the year, that is since 1 January 2014? (based on sub-sample, n=392)

Encountered information about OA?	% responding
Yes, definitely	17.1%
Yes, I think so	30.9%
No	52%

Q14c: In which, if any, of the following ways have you found out about ocean acidification since the beginning of the year? (based on sub-sample, n=392)



Conclusions and implications for communication

Only around 1 in 5 participants state that they have even heard of ocean acidification. Among those who do say they have heard of it, levels of self-reported knowledge about the subject are very low. We found no significant increase in levels of awareness post- the most recent round of IPCC 5th Assessment reporting.

The low levels of awareness about OA obtained from this research point to a need to develop effective techniques to engage the public with this important topic. The science communication literature has shown that simply providing factual information about environmental risks cannot be relied upon solely to generate awareness and concern. However, there are two areas where our research suggests misconceptions may arise unless communication is carefully structured.

First, a large proportion of participants perceived that OA was caused by ‘pollution’ of one form or another. It is arguable as to whether carbon emissions can – or should – be considered a form of pollution; but leaving this aside, it is likely that for the most part participants conceptualised pollution here in terms of direct and localised contamination of the marine environment (such as from oil spills or industrial processes). Those interested in generating accurate awareness of OA might therefore seek to counter this plausible but misleading interpretation. This said, it is worth noting that a comparable proportion of participants did correctly link OA to carbon emissions. Given that many more participants made this connection than had even heard of OA, it seems reasonable to conclude that people’s recognition of a link between carbon emissions and climate change was incorporated into people’s understanding of another global environmental risk. However, there is a need for more qualitative research to explore the precise meanings people bring to their understandings and responses to the issue.

Second, participants perceived greater consensus among scientists about the consequences of OA than regarding its causes. Whilst a detailed commentary on current expert consensus is beyond the scope of this report,³ this perspective is not in line with the current state of knowledge: it is not controversial among experts that carbon emissions are the principal cause of contemporary ocean acidification.⁴ An additional area for attention for those seeking to communicate about OA may therefore be to stress this expert consensus. We also note that of the potential communicators we asked participants about, independent scientists were trusted

³ Gattuso et al. (2013) present findings of expert positions on OA: see Gattuso, J. P., Mach, K. J., & Morgan, G. (2013). Ocean acidification and its impacts: an expert survey. *Climatic change*, 117(4), 725-738.

⁴ The IPCC WGI technical summary notes that “[o]ceanic uptake of anthropogenic CO₂ results in gradual acidification of the ocean” and states with a high level of confidence that “[t]he pH of ocean surface water has decreased by 0.1 since the beginning of the industrial era”.

above all others to provide correct information about OA; with a majority also agreeing that ocean scientists could be trusted on this topic.

Our findings suggest that where people are provided with further information about OA, this raises levels of concern about the subject: the majority of participants who had not expressed concern about OA at the start of the survey then did so having been provided with some basic explanatory text. Following this information provision, many participants also perceived that there were consequences to themselves and their family from OA, and to Britain as a country. However, participants were evenly split on whether there was anything they could do personally to help address OA. As with other distributed risks in the environmental domain, there may be a need for communication which advocates personal action on OA to be carefully structured in order to promote a sense of individual and collective efficacy on this subject.