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Scepticism and perceived self-efficacy influence fishers' low risk perceptions of climate change

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ABSTRACT

Climate change is impacting fisheries globally, posing both risks and opportunities to those dependent on marine resources. Understanding how fishers perceive climate change, and what factors shape these perceptions, can provide insights into behavioural intentions and support required for climate change focused strategies and management. This study interviewed demersal fishers from a south-west UK fishing port to explore: 1) the future risks fishers identified that may affect their business and wider industry; 2) fishers' beliefs and risk perceptions relating to climate change; and 3) the factors influencing these perceptions. Fishers identified a number of environmental, socio-economic and fisheries governance risks but climate change was rarely mentioned. While fishers overall had low risk perceptions of climate change, these perceptions were heterogeneous across the sample. Climate change scepticism and a high perceived self-efficacy to adapt to climate change were associated with lower risk perceptions. These findings provide new insights into how fishers perceive climate change and, importantly, greater understanding of the possible drivers of such perceptions. Findings suggest that undertaking climate-awareness raising initiatives in isolation to support adaptation strategies could be limited in success. Instead, wider focus should be applied to removing barriers to adaptation, managing wider risks and incorporating fishers into decision making to effectively support and motivate fishers' adaptation.

1. Introduction

Fishers globally are increasingly exposed to the impacts of climate change, such as changing catchability and availability of stocks, and changing storminess damaging fishing gear and affecting access to fishing grounds (Barange et al., 2018; Sainsbury et al., 2018). Understanding and anticipating fishers' future responses to climate impacts, and developing strategies to support their adaptation, requires information on how they perceive climate change (Grothmann and Patt, 2005; Dannevig and Hovelsrud, 2016). Although risks and uncertainty linked to climate impacts can be technically assessed, lay-peoples' responses to risk are often informed and guided by their intuitive, subjective judgements (van der Linden, 2015). Examining knowledge levels, beliefs and risk perceptions can hold valuable insights into how people may respond to future climate impacts (Grothmann and Patt, 2005; Gifford et al., 2011).

Compared to other environmental risks and hazards, climate change presents unique dimensions and qualities that make it difficult

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for people to interpret (Weber, 2010; van der Linden, 2015). Climate change occurs over long time periods, is cumulative in its impacts, and people often think it will affect others, in different places, and sometime in the future (Spence et al., 2012; van der Linden, 2015). People can be sceptical of climate change, questioning climate trends, likely causes and potential impacts (Rahmstorf, 2004; van Rensburg, 2015). Wider sceptical beliefs may focus on biases in climate science, media exaggeration of the issue, and doubts over individual, political and societal willingness, capacity or effectiveness in responding to climate change (Capstick and Pidgeon, 2014; van Rensburg, 2015). Sceptical climate beliefs and lower risk perceptions can lead to lower willingness to support initiatives or policies aimed at addressing climate change as well as preparedness to act and respond to impacts (O'Connor et al., 1999; Leiserowitz, 2006; Hidalgo and Pisano, 2010). Examining how fishers perceive climate change is useful for anticipating future responses to climate impacts, and for fisheries management developing climate-smart measures and thus requiring fishers to support and engage with measures introduced.

What drives climate change risk perceptions and why they differ among people has been the research focus in multiple disciplines including psychology, sociology, geography, and anthropology (Weber, 2010; Hornsey et al., 2016). Influential factors can include psychological determinants such as knowledge levels and cognitive judgements (Whitmarsh, 2011; Shi et al., 2016); experiential processing including emotions and personal experiences (Leiserowitz, 2006; Akerlof et al., 2013); socio-cultural influences including values, beliefs, and wider social factors such as social networks and norms (Brody et al., 2008; Renn, 2011); and socio-demographics such as age, gender, political beliefs and education (Leiserowitz, 2006; Hornsey et al., 2016). Identifying influential factors is important for understanding how risks should be communicated and can help to capture individual heterogeneity in perceptions that in turn may lead to differences in adaptation responses (Grothmann and Patt, 2005).

Due to the intimate connection fishers have with the sea and their exposure to environmental change, it could be assumed that fishers are likely to perceive climate change as a risk. However, current evidence suggests fishers often consider climate change as a low secondary risk particularly when compared to other risks such as financial pressures or management measures (Tingley et al., 2010; West and Hovelsrud, 2010; Nursey-Bray et al., 2012). Fishers have also been shown to hold sceptical climate change beliefs regarding trends in warming, whether humans cause climate change and the extent of its impacts (Nursey-Bray et al., 2012; Zhang et al., 2012). While current research has provided useful insights into fishers' climate change perceptions, little work has explicitly examined what factors drive these perceptions or how perceptions vary among individuals. These insights are crucial to understand the consequences of fishers holding different risk perceptions and aid fisheries management decision-making to support fishers' climate adaptation.

This study examined the climate change risk perceptions and beliefs of fishers in Brixham, a major south-west UK fishing port. Three questions were investigated: 1) What risks do fishers identify to the future of fish stocks, their businesses, and fisheries more widely?; 2) What are fishers' beliefs and risk perceptions of climate change and how do these vary among individuals?; and 3) How do self-efficacy, informedness regarding climate change, personal experiences and scepticism shape these risk perceptions?

For question three, we focused on these four factors in particular due to current fisheries literature indicating their potential influence on fishers' risk perceptions. Research suggests that fishers may downplay risks or be resistant to the idea that climate change poses significant and novel changes, due to their identities often linked to characteristics of fearlessness and ability to cope in a constantly changing environment (Edvardsson et al., 2011; Nursey-Bray et al., 2012; Dannevig and Hovelsrud, 2016). Perceived high self-efficacy and resilience of fishers to cope with change were therefore expected to lower fishers' risk perceptions of climate change, as suggested by others (West and Hovelsrud, 2010; Nursey-Bray et al., 2012). In certain studies outside of fisheries, higher levels of informedness regarding climate change heighten risk perceptions (Ranney and Clark, 2016; Shi et al., 2016). Fishers can sometimes detect climate-driven changes within fisheries, but they may not always attribute such changes to climate change or use this knowledge to prepare for impacts (Bennett et al., 2014; Geetha et al., 2015; Dannevig and Hovelsrud, 2016). Similarly, because fishers depend on observing and responding to change within their environment, personal experiences may also influence fishers' risk perceptions whereby experience of climate impacts should heighten risk perceptions (Zhang et al., 2012; Akerlof et al., 2013). However, how informedness of climate change and personal experiences influence fishers' risk perceptions is relatively unexplored. Finally, some fishers have been shown to hold sceptical views regarding climate change, but the extent to which this shapes their risk perceptions has not been fully examined (Nursey-Bray et al., 2012; Zhang et al., 2012).

2. Methods

2.1. Study site

Within the UK there are a total of 12,043 fishers working on a total of 5,911 UK registered fishing vessels (MMO, 2020). UK fisheries are regionally diverse, for example English ports capture high value shellfish and demersal species while Scottish ports often land larger volumes of pelagic species (MMO, 2020). Recent estimates suggest that the UK fishing and aquaculture sector (including marine and freshwater fishing) contributed £446 million to the UK economy in 2019 (Gross Value Added; Uberoi et al., 2020).

Brixham port is situated in Devon in the south-west UK (Fig. 1). In 2019 it was the largest port in England in terms of landings value (£36.6 million), and second largest in terms of landings weight (12,500 tonnes) (MMO, 2020). Fishing is an important industry for Brixham town and the wider south-west region. Many fisheries in the region are mixed demersal fisheries, catching a broad variety of species of which cuttlefish, lemon sole, monkfish, plaice and Dover sole have particular commercial importance. In 2019, 561 fishers and 283 vessels were registered at Brixham (for their administration port) (MMO, 2020).

Climate change is increasingly warming the English Channel and Celtic Sea in which Brixham's fishers operate and projections suggest further increases in sea surface temperatures of between 2.83–3.13 °C (English Channel) and 2.68–3.01 °C (Celtic Sea) by the

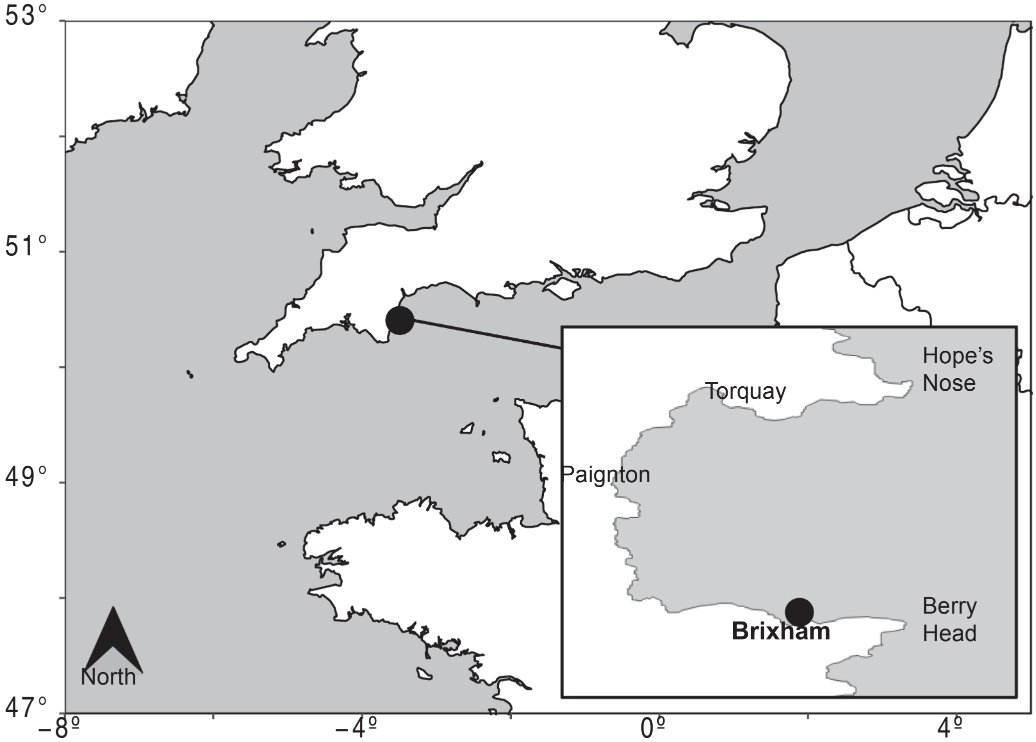

Fig. 1. Locality of Brixham port in the south-west UK. (50.39 N, 3.51 W; black dot). Inset: Brixham port is located in a sheltered harbour to the south of Tor Bay, which is defined by the outcrops of Hope's Nose to the north and Berry Head to the south.

end of the century (Tinker and Howes, 2020). Many demersal species targeted by fishers are already responding to climate change and it is expected that fishers will be increasingly exposed to future climate-driven changes in their target species, alongside other impacts such as sea-level rise and changing storminess (Maltby et al., 2020; Pinnegar et al., 2020).

2.2. *Interviews*

Fishers registered at Brixham for both their administrative and home port were identified from a Marine Management Organisation vessel list (MMO, 2017). Through personal observations and consultation with fishers and key informants, this list was validated to identify vessels considered to be routinely operating, full-time, from Brixham. This resulted in a list of 65 vessels, comprising 30 vessels of 10 m length and under and 35 vessels over 10 m. The majority of vessels over 10 m in length used beam trawl and/or scallop gear, went on fishing trips for up to seven days, and most were members of a Fish Producer Organisation (PO; through which their quota is allocated and managed). Vessels 10 m and under in length generally used bottom trawls although some had other gears such as pots or static nets, usually undertook day trips, and most were not members of a PO or fishing association.

The vessel list was split by vessel size and gear type to identify fishers to interview and ensure broad representation from across the fleet. Vessel skippers' contact details were obtained from key informants, other fishers or directly approaching individuals. Skippers were targeted as they are typically the main decision makers aboard vessels, planning their future trips and activities. Thirty-one fishers were interviewed, representing approximately 47% of the fleet. All fishers were male with an average age of 51.6 years. Most had left school with no qualifications. The most common gear types used were beam trawls, scallop dredges or bottom trawls, with fishers typically using one gear type, or beam and scallop gear on larger vessels. Given most fishers used demersal gears, they tended to catch a similar range of species, with reports of catching up to 40 different species in a single tow (Pers. Comm).

After three pilot interviews at another port, face-to-face interviews took place during January–April 2017, with ethical approval from the University of Exeter. Interviews lasted between 30 min to 2 h. Interviews were semi-structured and began with broad questions about perceived risks to explore fishers' perceived future risk landscape. Climate change was not mentioned initially to avoid influencing responses. The latter part of the interview used open-ended and statement-based questions to understand fishers' climate change beliefs, perceived risks of climate change to fisheries, and factors influencing these perceptions.

To robustly determine fishers' climate change risk perceptions and capture different aspects of their perceptions, five likert-style statements were used (Table 1). Statements were obtained from reviewing the literature and adapted into a fisheries context, measuring aspects of: concern (Leiserowitz, 2006); worry (adapted from Capstick et al., 2015); perceived negative impact (Brody et al., 2008); distribution of impacts among the fleet (developed from Spence et al., 2012); and uncertainty in planning for the future.

Table 1
Statements and summary statistics for factors influencing risk perceptions.

Response variable and factors explored	Statements	Median	% fishers agreeing to statement
Response variable: risk perceptions†	I am concerned about the impact of climate change on my fishing business	2	16
	Climate change makes me feel uncertain when I try to plan for the future	2	6.4
	I am worried about the impacts climate change could have upon fisheries in the south-west	2	19.3
	Climate change will have a negative impact on the future sustainability of fish stocks	2	16
	Climate change will affect other fishermen more than it will affect me‡	2	32
Scepticism†	Recent climate change is mostly caused by human activities‡,§	4	60
	Increased greenhouse gas concentrations have contributed to recent climate change‡,§	4	63.3
	I am uncertain that climate change is really happening	2	19.3
	The seriousness of climate change is exaggerated	3	46.6
	Climate change is too complex and uncertain for scientists to make useful forecasts¶	4	62.9
	The effects of climate change are uncertain	4	77.4
Self-efficacy to address climate impacts in general†	There are simple things I can do that would have a meaningful effect to alleviate the negative impacts of climate change	4	61.2
Self-efficacy to adapt to impacts†a	I have the ability to adapt to any potential impacts of climate change on my fishing business	4	70.9
	I have the necessary skills to adapt to any potential impacts of climate change on my fishing business	4	80.6
	Self-efficacy to cope/adapt scale	4	75.7
Informedness b	How informed do you feel about climate change… in general (*NB: non-fisheries specific*)	3	48.3
	… in terms of its potential impact on fisheries	2	19.3
	… in terms of its potential impact on your fishing business	2	19.3
	Impacts informedness scale	2.5	19.3
Personal experience	Would you say that you and your fishing business have personally been affected by climate change?	Yes: 3 No: 27 Don't know: 1	

†: Likert scale – 1: Strongly disagree, 5: Strongly agree.
‡: Statements reversed when included in PCA, but reported statistics here are not.
§: 1 missing value (mean calculated with N = 30).
¶: 4 missing values (mean calculated with N = 27).
a: These two statements are subtly different; the first captures feelings towards the wider system in which fishers operate and how this may affect their perceived ability to adapt (e.g. management or governance constraints) while the second statement offered a more direct measure of their own personal ability.
b: Likert scale – 1: Very uninformed, 5: Very informed.

Four factors influencing risk perceptions were examined: scepticism, self-efficacy, informedness and personal experience (Table 1). Six scepticism statements were derived from Whitmarsh (2011) and Poortinga et al. (2011), capturing sceptical views regarding climate change trends, attribution and impacts (Rahmstorf, 2004). Informedness of climate change was measured through three statements. Two aspects of self-efficacy were explored to reflect the differences in how people feel about their own ability to address climate change impacts in general and their ability to cope with its impacts on their fishing livelihood. Personal experience was captured by asking whether people felt they had been affected.

2.3. Analysis

A mixed methods approach was used to analyse responses using NVivo 11.0 for thematic analysis and R software for quantitative analysis (R Core Team, 2020).

2.3.1. Quantitative analysis

Climate change risk perceptions were explored through descriptive statistics. A Cronbach alpha score of 0.69 indicated adequate reliability of the five statements measuring risk perceptions (Cronbach, 1951). While this score falls slightly below the commonly reported, although subjective, 0.7 threshold for 'acceptable' reliability (Nunnally, 1978; Peterson, 1994; Taber, 2018), because we were additionally interested in examining possible underlying themes across the risk perception statements, we retained all five statements in the subsequent analysis. A Principal Component Analysis (PCA) was undertaken using the R packages *FactoMineR* and *factoextra* to identify underlying patterns in responses to these statements and examine where statements differed (Lê, Josse and Husson, 2008; Kassambara and Mundt, 2017). A scree test helped determine the number of axes to retain. Using the axes generated within the PCA, a Hierarchical Agglomerative Cluster analysis (HAC) using Euclidian distances and Ward's algorithm were used to determine whether individuals could be grouped according to their risk perceptions (Ward, 1963; Husson et al., 2017).

In some instances, when multiple statements had been used to measure the factors influencing risk perceptions, these were developed into one scale so their overall influence on risk perceptions could be examined (Table 1).

Following Whitmarsh (2011) as a guide, a single scepticism scale was derived using PCA to reduce dimensionality across the six statements.[1] Statements that loaded onto the first Principal Component (PC1) were used, representing 46% of variance (PC2 represented 18% of variance). A higher score indicated higher scepticism. Self-efficacy to respond to climate change impacts in general was measured using one statement (Table 1). Self-efficacy to cope/adapt to climate change impacts on fisheries was measured through two statements, which were combined into a single scale indicating respondents' mean score (Table 1). Informedness was measured through three statements (Table 1). One statement measured informedness about climate change in a general, non-fisheries specific context. Two statements regarding fisheries impacts were averaged into an overall 'impacts informedness scale' as similar distributions of responses were obtained (Table 1). Personal experience was measured through asking fishers if they had been affected by climate change, and analysed through the number of fishers answering 'yes', 'no', or 'don't know'. The four factors were analysed in relation to risk perceptions by examining differences across groups identified in the cluster analysis.

2.3.2. Qualitative analysis

To examine the future risk landscape, risks perceived by fishers were inductively coded and subsequently grouped into wider themes informed by literature (Tingley et al., 2010; Booth and Nelson, 2014). Thematic analysis of the entire interview was also undertaken to identify other factors that weren't necessarily captured in specific statements but may have influenced perceptions. Themes were derived semi-deductively using wider literature (Nursey-Bray et al., 2012; van Rensburg, 2015; van der Linden, 2015) but also allowing other themes that were more specific to fisheries and fishers to emerge.

3. Results

3.1. Future risk landscape

Fishers identified 19 future risks to fisheries in Brixham that were categorised into six themes (Fig. 2). Environmental risks were most frequently discussed (67% of 31 fishers interviewed) and perceived to present problems for the future sustainability of fish stocks. Overfishing was the predominant environmental risk identified, thought to cause declining catches and reduced fishing opportunities. Only four fishers discussed weather and climate change, including impacts of warming waters on fish stocks and storm events affecting shoals or fishers' safety at sea.

Socio-economic risks included increasing fuel prices on future operating costs and profitability, and declining recruitment of fishers into the industry. Fishers also discussed perceived increases in consolidation of vessel ownership (and hence quota) among fewer individuals, risking future quota access for non-company owned boats and leading to uncertainty regarding how this could affect markets and power dynamics within the fishing community. Environmental groups, the media and public opinion were seen as problematic, with fishers concerned about the negative images such groups had of the industry and the impacts this could have, alongside other concerns regarding their (perceived) negative influence and involvement with management or policy decisions.

Within the fisheries governance theme, risks from changing rules and regulations of domestic fisheries management and policy were commonly discussed. Fishers felt uncertain and unprepared about future management measures and whether they were complying with them. Other management measures were also discussed, including difficulties in adjusting to the EU Landings Obligation ('Discard Ban'); increasing restrictions from closed areas such as Marine Conservation Zones risking future access to fishing grounds or opportunities; and quota issues including the total availability and distribution of quota. Linked to fisheries governance risks but more political in nature was the UK withdrawal from the EU ('Brexit'), perceived as a risk by some due to the uncertainty about future domestic fisheries management and policy.

3.2. Climate change risk perceptions

Regarding the risk perception statements, most fishers disagreed/strongly disagreed that they were concerned and worried about climate change, or that it made them feel uncertain when planning future activities (Table 1). Approximately half disagreed that climate change would have negative impacts on fish stocks. While 32% of fishers agreed climate change would affect other fishers more than themselves (perceiving it a psychologically distant risk), 52% disagreed. Fishers disagreeing with this statement felt that if they were to be impacted, generally all fishers would feel the impacts of climate change to a similar extent.

There was a range in how soon fishers expected they would feel the consequences of climate change, with the most common answer being in 11–30 years (Fig. 3). Fifty-eight percent of fishers believed it was 'unlikely' or 'very unlikely' that they would have to respond to climate impacts (Fig. 3).

PCA revealed patterns in the extent to which fishers perceived climate risks. Two primary axes explained 60.3% (PC1) and 19.4% (PC2) of the variance amongst responses to the five risk perception statements. Four statements (worried, concerned, uncertain and negative) loaded strongly onto the first axis with a higher score representing a higher risk perception of climate change (Fig. 4, Table 2). The statement '*climate change will affect other fishers more than me*' strongly loaded onto the second axis. This statement was reversed, so a higher score represented a higher individual risk perception.

[1] Cronbach alpha score across the six scepticism statements was 0.76.

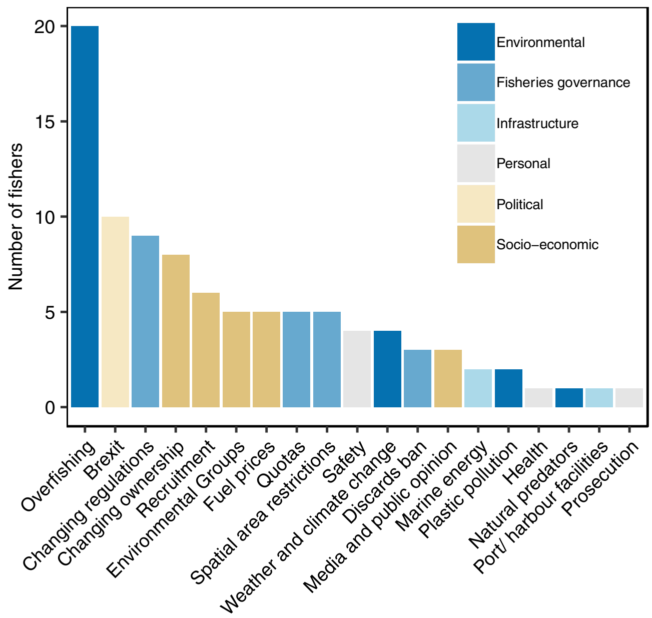

Fig. 2. Future risks identified by fishers (n = 31), categorised into six main themes.

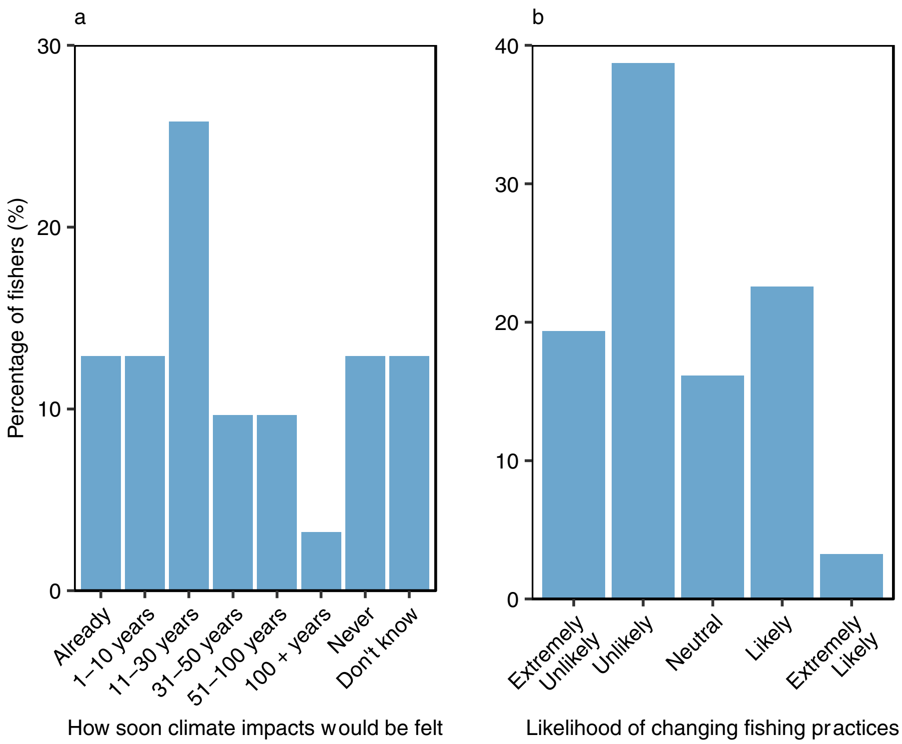

Fig. 3. Percentage of fishers responding to questions regarding a) how soon they think climate change will impact their fishing business; and b) how likely they think it is that they will have to change their fishing practices in response to climate change.

Fishers were unevenly distributed along these axes with cluster analysis identifying three main groups with distinct risk perceptions (Fig. 4, Table 3). For PC1, Group Three had the highest scores reflecting higher risk perceptions and Group One had the lowest (Table 3). Groups One and Three had similar PC2 scores but Group Two had the lowest, reflecting lower individual risk perceptions whereby fishers perceived climate change as being more psychologically distant (Table 3). Groups were similar in terms of socio-

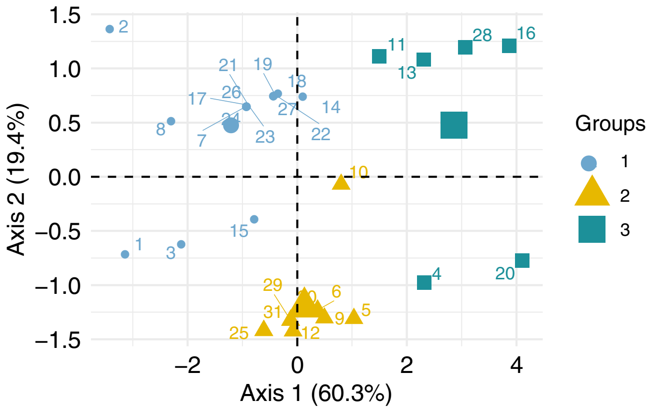

Fig. 4. Results of PCA and HAC. Individual fishers on the core PCA axes are coloured according to the groups identified from cluster analysis.

Table 2
Loadings of five climate change risk perception statements onto PCA axes.

Risk statement	PC1 Axis	PC2 Axis
I am concerned about the impact of climate change on my fishing business	0.50	−0.04
Climate change makes me feel uncertain when I try to plan for the future	0.52	0.07
I am worried about the impacts climate change could have upon fisheries in the south-west	0.53	0.11
Climate change will have a negative impact on the future sustainability of fish stocks	0.40	0.07
Climate change will affect other fishermen more than it will affect me	−0.13	0.98

Table 3
Key characteristics of the three groups identified through cluster analysis.

Characteristic	Group 1	Group 2	Group 3
Number of fishers	16	9	6
Average PC1 score	−1.14	0.12	2.85
Average PC2 score	0.49	−1.20	0.47
Average age	50.7	51.5	54.1
Number of fishers in 10 m and under sector/over 10 m sector	8/8	5/4	4/2
Number of fishers who owned their boat(Yes/No/Part owned)	12/4	4/5	2/3/1
Number of fishers who left school at 16/went onto higher education	12/4	8/1	5/1

demographics (Table 3). However, qualitative data suggested that age played a role in influencing risk perceptions as fishers approaching retirement age or planning to leave the industry did not see climate change as something to worry about. As one fisher described: "*I don't think it's going to happen in my lifetime, you know climate change is there but it's so gradual that this isn't an issue for my generation.*"

3.3. Factors affecting risk perceptions

3.3.1. Scepticism

Many fishers held sceptical views about climate change as a trend, its causes and impacts. Sceptic views varied among the three groups with Group One having the highest scores and Group Three the lowest. A significant difference in scores was found between Groups One and Three (Kruskall-Wallis test, $\chi^2 = 7.95$, df = 2, p = 0.01; Dunn multiple comparison test p = 0.01; Fig. 5).

Qualitative data indicated that sceptical views spanned a number of themes. Trend scepticism was apparent in a small number of fishers (mostly in Group One), who questioned whether climate change was a trend leading to warming or simply saying they didn't believe in it. As one fisher stated: *"I'm hanging in the wind as to whether it's real or [not]. I think we need more proof."* While most fishers tended to agree that climate change was occurring and caused by humans, there was some scepticism over the extent to which humans were causing recent warming and whether it was just natural changes: *"I'm just not seeing this climate change bit at the minute. I'm really not convinced that it's not just a natural cycle of the world."*

Scepticism and wider uncertainty regarding climate change impacts and the seriousness and extent to which it would affect fish stocks, fishers or the industry was the most common evidence-scepticism theme across fishers. As one fisher described: *"I haven't seen any difference whatsoever in 30 years. I know everyone's been going on about how much the ice caps are melting and so on, but it's made absolutely no difference as far as I can see."* This was strengthened by wider views from some, many within Group One, that climate change was not necessarily an important driver affecting fish stocks and that other factors had more of an impact, including fishing

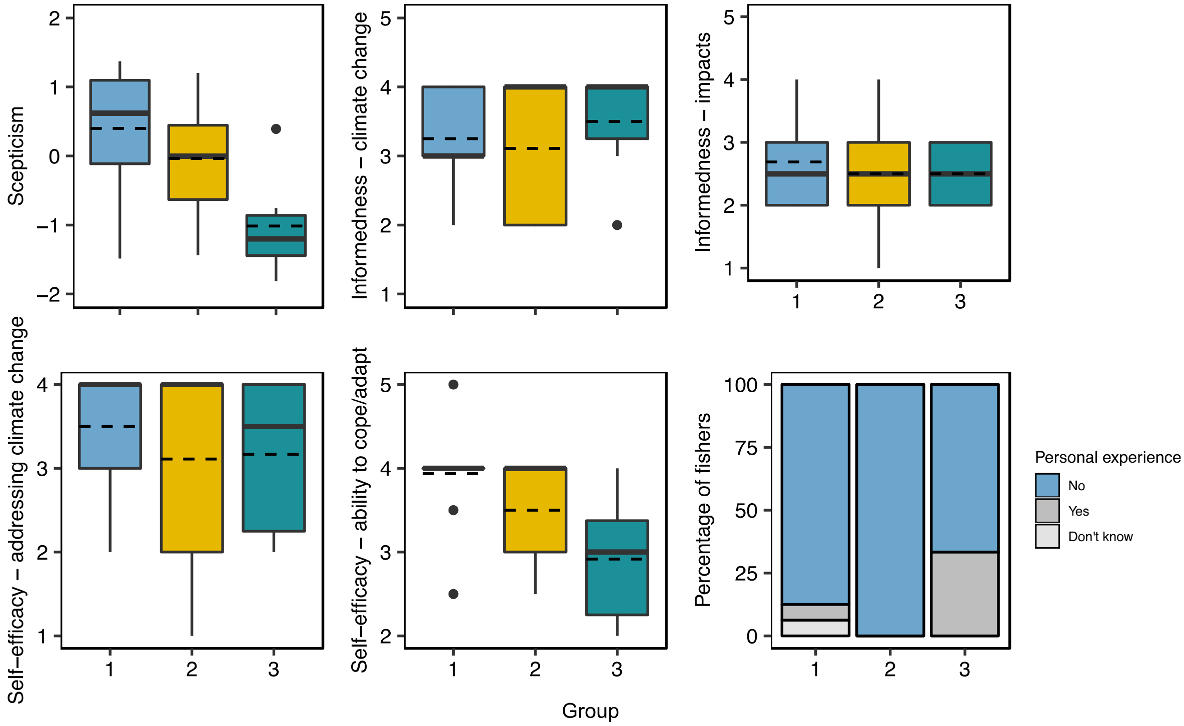

Fig. 5. Differences between each measured factor and Groups identified in PCA. From top left: scepticism, informedness about climate change in general, informedness about climate change impacts, self-efficacy (addressing climate change impacts), self-efficacy (ability to cope/adapt) and fishers' personal experience of climate change. Solid black line in box plots represent median; dashed black line represents mean. Colours denote cluster groups as shown in Fig. 4.

effort, pollution and plastic.

Process scepticism views were discussed by 48% of fishers. Many fishers felt that the media exaggerated and sensationalised climate change, often 'scaremongering' the public. For example: *"They tend to lie I think, well maybe not lie, but blow things out of proportion. Blow things out of proportion, anything to make a story."* Other fishers expressed scepticism regarding the way climate change research is conducted, the reliability of data and modelling methods generating information. As one fisher described: *"I don't think that the tests that they're doing or they've done go back far enough… There's so many differences in the way they measure temperature and salinity and what not, it fluctuates so much from one year to another, I don't think it's been measured long enough or accurately enough to make big decisions on it."*

Some fishers described how there was a lucrative 'industry' built upon climate change that led to biased information. Others felt that environmental or political groups pushed a 'climate change agenda', pursuing their interests and not providing other sides of the argument (why climate change may not be human caused). Some expressed strong views on this topic: *"It's a whole industry. However people are employed in the climate change industry, they're not going to turn around tomorrow and say that's just the way it is, cos they'd be all out of a job. They have to, it's almost like a religion, they have to keep the faith, keep moving forward in the understanding that climate change is caused by humans. But, I mean, it isn't."*

Fishers also spoke about scepticism regarding the role that individuals play in responding to climate change and how much their actions help in reducing its impacts. Others expressed scepticism regarding the extent to which countries or governments were acting to address climate change and whether such measures would help mitigate its impacts. As one fisher stated: *"One country can do one thing and another country can do another thing. They all say 'Oh we'll agree to do things for climate change' but they don't… They have all these meetings…, but they say one thing and don't do it."*

3.3.2. Self-efficacy – Individually addressing climate change impacts

Sixty-one percent of fishers agreed that they could do something to address the negative impacts of climate change and this scoring was similar across all groups (Fig. 5). Fishers often used other examples of things they had done to help the marine environment, such as participating in a local 'Fishing for Litter' scheme, as evidence that individuals can play their part in addressing environmental issues.

3.3.3. Self-efficacy – Ability to cope/adapt to impacts

Perceived self-efficacy to adapt to future climate impacts differed among groups (Kruskal-Wallis, $\chi^2 = 10.10$, df = 2, p = 0.006;

Dunn multiple comparison tests p = 0.005 for groups 1–3, p > 0.05 groups 1–2 and 2– 3; Fig. 5), with Group Three having the lowest perceived ability to cope or adapt and Group One the highest.

Thematic analysis also found that for some fishers, climate change and the impacts it could have were not seen as being any different from the changes in fish stocks that they had experienced and adapted to already. Linked to this was a sense that fishers were good at adapting to changing resources, with 35% of fishers describing adaptability as being a strength of fishers and something that was a requirement of the occupation. As one fisher described: *"I believe one door closes and another one opens. It's the way fishing is, we always seem to be able to find something."* Another stated that *"They won't [feel the consequences of climate change] because fishermen will diversify if fish stocks go up or down. Fishermen are always diverse."*

3.3.4. Informedness

Levels of self-reported informedness were similar across the three groups (Fig. 5). All groups reported being more informed about climate change in general than about climate change impacts on fisheries and their fishing business. For some fishers, climate change was something that they simply didn't tend to think about and was 'out of mind', stating that *"I don't pay attention to it"* and *"It's not something I've really thought about."*

3.3.5. Personal experience

Eighty-seven percent of fishers felt that they had not been personally affected by climate change, and this did not differ by group (Fig. 5). The majority of fishers across all groups described personal observations of physical and ecological changes, such as changing patterns in extreme weather events, sea temperatures warming, and changing abundances, distributions and seasonality of targeted species. As one fisher described: *"The sea is full of dolphins and fish don't normally catch here, Tuna and that in the English Channel…It's all down to the warm water."*

However, the extent to which climate change was thought to be causing these changes varied, with not all fishers attributing these observations to climate change and instead attributing changes to other drivers such as fishing and pollution or simply expressing that they had seen no change: *"I haven't seen no change since I've been fishing."* Others talked about how despite observing changes, they hadn't been affected: *"I don't see it, I haven't really experienced climate change, in all the years I've been fishing, I haven't experienced climate change."*

4. Discussion

Anticipating fishers' future responses to climate impacts and developing strategies to assist adaptation requires understanding fishers' climate change perceptions. This research found that whilst fishers perceived a range of future risks for fisheries in the south-west UK, climate change was often perceived as low risk. However, perceptions differed among fishers and were influenced by wider climate change scepticism and perceived self-efficacy to adapt to future impacts. These findings have important implications for climate-risk communication and wider fisheries management.

Most fishers perceived climate change as a low risk to the future of fish stocks, fishing businesses and the wider industry. This was associated with high climate scepticism, matching findings from previous research showing fishers have sceptical climate change beliefs (Nursey-Bray et al., 2012; Zhang et al., 2012). Importantly, fishers' scepticism was more than simple denier/non-denier beliefs, instead including scepticism regarding the types and severity of impacts, how information is generated and communicated, and societal responses to the problem. This fits with wider scepticism research arguing people's climate scepticism beliefs are complex, including scepticism of 'evidence' (trends, causes), of 'processes' (including scientific and political processes behind climate research), and of 'responses' (societal and political responses to address climate change) (van Rensburg, 2015). This scepticism may also explain why levels of informedness and personal experiences appeared to have little influence on fishers' risk perceptions. Sceptical beliefs may lead individuals to be less willing to take on new information about climate change or attribute observed changes to climate change if they are uncertain of its trends and impacts, how such information is generated and communicated, or if this information challenges existing mental-models and values (Lorenzoni et al., 2007; Capstick and Pidgeon, 2014; van Putten et al., 2016). These insights are important for climate risk communication as the methods and messages used to raise awareness or implement climate-orientated management objectives may need to be adapted to help generate more effective engagement with fishers. This could include using trusted figures to communicate issues, and framing and contextualising impacts to local situations and experiences (Lorenzoni et al., 2007; Nursey-Bray et al., 2012; Hine et al., 2016).

Sceptical views and low risk perceptions together have fisheries management consequences. Wider research suggests that people with lower risk perceptions may be less willing to engage and support climate change policies and initiatives (O'Connor et al., 1999; Leiserowitz, 2006; Hidalgo and Pisano, 2010; van der Linden, 2015). Similar issues may occur in response to fisheries management decisions based upon climate change objectives, such as enforcing reductions in fishing mortality rates and catch limits to protect vulnerable or declining stocks (Gaines et al., 2018). Fishers may question the legitimacy of such measures if they hold sceptical views and low risk perceptions of climate change, particularly if actions have negative implications for them. Broader work has considered issues of legitimacy in marine management contexts, showing that perceived legitimacy can influence conflict between stakeholders and potential acceptance and compliance issues (Hard et al., 2012; Dehens and Fanning, 2018). As increasing emphasis is placed upon developing climate-orientated fisheries management measures, examining how these measures may be perceived, supported and responded to by fishers will be necessary to help reduce negative unintended consequences. Including stakeholders throughout the decision-making process or adopting effective co-management approaches could improve transparency and trust in how decisions are made and the types of information used to inform decisions (Stöhr et al., 2014; Dehens and Fanning, 2018).

Fishers with low risk perceptions also showed higher perceived self-efficacy regarding their ability to cope with and adapt to climate impacts. This supports research arguing that the variable nature of fisheries systems requires fishers to observe and adapt to changeable conditions, leading to a heightened sense of adaptability to climate impacts (West and Hovelsrud, 2010; Nursey-Bray et al., 2012; Zhang et al., 2012). In itself, a heightened sense of self-efficacy can motivate individuals to respond to climate change and mobilise other domains of their adaptive capacity because people feel able to address impacts and believe their actions will fulfil desired outcomes (Grothmann and Patt, 2005; Cinner et al., 2018). However, climate change may present new or unfamiliar risks and impacts which fishers have less knowledge and experience adapting to, as reflected in these results showing fishers had low levels of informedness regarding climate impacts on fisheries. In these cases, observations or knowledge traditionally used in fishers' decision-making may be insufficient (West and Hovelsrud, 2010; Nursey-Bray et al., 2012). For example, fishers in south-east India have struggled to predict fish availability due to large, unexpected seasonal variations, leading them to be unable to rely on climatic parameters they traditionally used to inform their decisions (Geetha et al., 2015). Instead, new information such as model projections and forecasts may be needed to inform adaptive responses. However, fishers may be sceptical or less trusting of these information sources, or dismissive of information that doesn't fit pre-existing beliefs, thus limiting their levels of planning and preparedness (Bennett et al., 2014; Dannevig and Hovelsrud, 2016; Bercht, 2017).

Importantly, the combination of high perceived self-efficacy, high scepticism and low climate change risk perceptions found among many fishers here has the potential to remove incentives for fishers to adapt. Consequently, fishers may ultimately not perceive the need to adapt, being more inclined to 'react to' rather than 'prepare for' climate impacts (West and Hovelsrud, 2010; Nursey-Bray et al., 2012; Dannevig and Hovelsrud, 2016). Improved climate change communication could partly overcome these issues by increasing awareness to future risks (Nursey-Bray et al., 2012). Yet, these initiatives depend upon assumptions that increased knowledge and awareness leads to heightened risk perception and therefore consequent pro-adaptive responses, but which don't always hold true (Brody et al., 2008; Hornsey et al., 2016). As these and other findings indicate, wider psycho-social factors, aside from knowledge, influence risk perceptions and adaptive behavioural intentions (Grothmann and Patt, 2005; West and Hovelsrud, 2010; Gifford et al., 2011; Nursey-Bray et al., 2012). Therefore, additional approaches alongside improved communication may be needed to assist fishers' adaptation. One potential strategy could address other existing barriers to fishers' adaptation, creating an environment in which fishers can respond to climate risks and opportunities autonomously (Moser and Ekstrom, 2010; Islam et al., 2014) but without the need to change beliefs and perceptions first. This could include removing tight regulations restricting catch diversification or improving access to financial grants (Cinner et al., 2018). Such an approach may be more effective and time-efficient compared to investing often-limited resources to raising awareness to incentivise subsequent action. Fishers should be consulted in identifying these barriers, which could also act as an indirect way of engaging fishers in climate issues without directly challenging sometimes deeply-held beliefs.

A smaller proportion of fishers showed heightened risk perceptions of climate change which were typically associated with lower levels of climate scepticism and self-efficacy to adapt. These fishers could benefit from greater assistance in their adaptation compared to those more confident in their abilities, as they may be more inclined to 'prepare for' climate change. Targeted strategies that seek to increase fishers' adaptive capacity and highlight adaptation options may be particularly valuable. These fishers may be more receptive to new information and greater planning to help them prepare due to lower levels of scepticism and viewing it as a more salient issue. Identifying patterns in fishers' risk perceptions reflects the importance of examining heterogeneity across individuals with similar occupational and socio-demographic backgrounds. Although most fishers interviewed here used similar gears, caught similar species and had similar socio-demographics, individuals exhibited differences in their beliefs and perceptions of climate change which may ultimately lead to differences in how they adapt and respond (Adger et al., 2009; Seara et al., 2016). These insights are critical when considering how best to support adaptation, and further work examining differences in perceptions and beliefs both within and across different fishing groups would be valuable to inform future adaptation planning.

Importantly, development of future fisheries management measures aiming to assist fishers adapt to climate change should also account for the wider risk landscape in which fishers operate and respond to. Climate change was less commonly perceived by fishers as a risk compared to a range of wider environmental, socio-economic and governance risks. Many of these risks may be considered more immediate in their effect on fisheries, and represent more familiar risks that have been identified by fishers in other countries (Tingley et al., 2010; Booth and Nelson, 2014). Recognising these risks and considering how they may influence fishers' responses to climate change is crucial given that some of these risks will affect the wider adaptive capacity and resilience of fishers to climate impacts (West and Hovelsrud, 2010). For example, overfishing was a risk identified by many fishers and reducing this risk can help increase climate-resilience of stocks, benefiting long-term sustainability (Gaines et al., 2018). Other examples include examining how rising fuel prices may affect fishers' behaviour and their ability to catch stocks with climate-driven shifting distributions (Abernethy et al., 2010). Identifying this wider risk landscape is important for any fisheries management system hoping to achieve goals of sustainable management and climate-smart fisheries by enabling a more holistic approach addressing wider social, economic and environmental issues.

In summary, this research indicates examining heterogeneity of individuals' perceptions of climate change and factors affecting these perceptions holds critical insights for informing fisheries management and adaptation strategies. While risk communication and awareness building have value by enabling fishers to evaluate climate change risks (and opportunities) and make informed choices, such strategies alone are unlikely to be enough. Increasing inclusion of fishers in management decisions could help overcome potential legitimacy issues of climate-orientated decisions and identify barriers and wider risks that may affect fishers' adaptation. A combined approach that uses multiple tools to engage, motivate and enable fishers to prepare for climate change will be most effective in supporting fishers in adapting to future change.

Declaration of Competing Interest

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

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Data availability statement

Anonymised quantitative data that support these findings are available from the author upon reasonable request, but are not held on an openly public database due to the confidentiality of the data.

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