Marine Policy 97 (2018) 232–238

Contents lists available at ScienceDirect

Marine Policy

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

Harmful algal blooms: the impacts on cultural ecosystem services and human well-being in a case study setting, Cornwall, UK

Cheryl Willis[a,*], Eleni Papathanasopoulou[b], Duncan Russel[a], Yuri Artioli[b]

[a] University of Exeter, College of Social Sciences and International Studies, Rennes Drive, Exeter EX4 4RJ, UK
[b] Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth PL1 3DH, UK

ARTICLE INFO

Keywords:
HABs
Cultural ecosystem services
Coastal
Marine
Well-being

ABSTRACT

Whilst harmful algal blooms (HABs) are a natural phenomenon, the impacts of these events can have devastating impacts on human societies. To date, these have largely been studied with reference to economic and health impacts, which can be significant and have impact at both individual and community levels. This paper builds on previous work and addresses recent calls to more fully understand the nuanced human impacts of HABs. Using a framework of cultural ecosystem services, the paper explores how HABs can impact human well-being through disruptions to therapeutic and inspirational opportunities in the natural environment, opportunities for re-creation, aesthetic enjoyment, and losses to traditional ways of life, sense of place and collective identity. A snapshot is gleaned into the lived realities of six local residents of St Austell bay, Cornwall, UK, an area frequently affected by HABs via interviews which illustrate how the impacts of HABs can be felt at a much deeper level than are revealed through economic and health analysis. Whilst it is acknowledged the sample size here is limited, the findings nonetheless point to some of the key impacts of HABs in this specific setting and indicate a need for continued research to incorporate local experiences into decisions about how to respond to environmental shocks and what safeguards could help to buffer against the worst of these. It is argued that locally-directed management policies can be developed at scales more appropriate to coastal communities to better respond to their specific needs when considering HAB impacts.

1. Introduction

The marine environment provides a range of ecosystem services, or benefits for people as defined by the Millennium Ecosystem Assessment (MEA [33]), which are important, if not essential, for human well-being. Benefits include the provision of protein food sources, biomedicines and economic benefits from tourism and fisheries (MEA [33], [17]). Other important, and less tangible benefits include a deep spiritual connection to the sea, a sense of inspiration, stress relief, feelings of being uplifted and invigorated and a sense of well-being that comes from simply knowing the sea exists and will continue to exist for future generations [19,47,48]. Whilst the literature around these marine ecosystem services has burgeoned in recent years (see [12] for a history), understandings of environmental dis-benefits (or dis-services) are equally important to gain a holistic picture of how nature impacts on human societies, and these are attracting increased academic attention [39,40,46]. Harmful algal blooms (HABs) provide an example and the context for exploring these dis-benefits in more depth. HABs occur when certain species of phytoplankton increase in abundance and cause negative impacts on human uses of marine ecosystem services [27]. Specifically, these HABs can have direct negative impacts on human well-being, mainly through their impact on fisheries, tourism and recreation, as well as on human health through exposure to biotoxins through inhalation, direct contact or through ingestion through the food chain [6]. Whist the ecological, economic and health impacts typically provide the focus for the HAB literature [14,23,35] it is argued here that disruptions to the wider range of benefits to human well-being can be significant for both individuals and for communities and thus deserve more focussed attention.

This may be especially important given recent arguments that HABs have been increasing in frequency, magnitude and location over the last two decades [1], potentially having wide ranging impacts on a variety of ecosystem services and human well-being. With expanding human populations, particularly in coastal areas, mitigating the impacts of HABs is becoming recognised as a more pressing economic and public health need. This paper aims to extend discussions to include considerations of the more nuanced and contextual human impacts of HABs. It sets discussions within the context of a cultural ecosystem

* Corresponding author. Present address: Natural England, Nobel House,17 Smith Square, London SW1P 3JR, UK.
E-mail addresses: Cheryl.willis@naturalengland.org.uk (C. Willis), elpa@pml.ac.uk (E. Papathanasopoulou), D.J.Russel@exeter.ac.uk (D. Russel), yuti@pml.ac.uk (Y. Artioli).

https://doi.org/10.1016/j.marpol.2018.06.002
Received 25 May 2018; Accepted 2 June 2018
Available online 15 June 2018

services framework which explicitly accounts for the intangible benefits of nature and the role they play in contributing to human well-being. Cultural ecosystem services have been described by the Millennium Ecosystem Assessment [33] as 'non-material' benefits and include the spiritual, recreational inspirational and aesthetic qualities of nature. Despite considerable advances in techniques to measure and account for these qualities [8,9,41,43], they remain notably elusive in the literature around impacts of environmental shocks such as HAB events [5].

Despite a growing weight of evidence around the interconnections between the sea and human health and well-being, and the growing understanding of the role that cultural ecosystem services play in this, ([16,17]; MEA, 2003), there is less clear evidence around the impacts that disruptions to these services might have for the well-being of those who experience them. Moreover, despite a small amount of HAB literature calling for further exploration of these more nuanced human effects of HABs on people and their well-being, [31,5,6], there remains a paucity of studies in this area. It is important that this gap is filled as the link between the quality of the marine environment and the well-being of coastal communities is an emerging policy concern. The UK Marine Policy Statement [20], for example, frequently mentions this link and emphasises that marine plans should both take into consideration local perspectives and ensure they contribute to vibrant coastal communities by considering cultural heritage, local environmental quality and improving quality of life. This paper responds to these needs by providing a window into the experiences and lived realities of six local residents in Cornwall, UK, who have first-hand experiences of HABs and the ways in which these dis-benefits impact on both the quality of the environment and on their quality of life. Whilst it is recognised that this is a small sample, this paper nonetheless demonstrates the range of impacts and the depth of feeling around HABs in a specific area, which are rarely captured in the existing literature. It asks questions about how these understandings might be important in more locally responsive management decisions and points to the need for further research to more fully investigate the implications of changing environmental conditions on human well-being.

First, the important elements are highlighted from the academic discussions around the well-being benefits provided to people by the coastal and marine environment before the impacts of HABs at a local level are discussed, through a small case study investigation from Cornwall, UK. Importantly the interviews conducted show that disruptions are not only at the level of individual well-being, but they are also noted as impacting on wider community well-being through disruptions to traditional practices and industries and the potential erosion of place identity and regional distinctiveness. The paper argues for a broader picture of human well-being to be considered to understand HAB impacts more holistically and to be able to devise more locally responsive management activities.

2. Coastal/marine environments and cultural ecosystem services

At the heart of discussions about the human-nature relationship is a profound sense that nature deeply touches people and what it means to be human. Kellert and Wilson [28] for example, assert that 'human identity and personal fulfilment somehow depend on our relationship to nature' (p. 42). They discuss the satisfaction derived from nature in terms of benefits which include a sense of fascination, wonder and awe and mental and physical well-being associated with nature experiences. Given this powerful relationship, some authors suggest that people may form a protective impulse for natural resources which may translate into place-protective and pro-environmental behaviours [13,22]. Such connections to nature deserve greater recognition in decisions concerning the natural environment, given the profound, meaningful and, arguably, enduring nature of them. These need to be made explicit so they can be considered alongside other more tangible (often monetised) values in decision-making processes.

This call for greater recognition of the intangible values of nature has found popular expression and global recognition in recent years in the idea of cultural ecosystem services which are found in almost every assessment of ecosystem services. They have been defined in various ways but most notably by the Millennium Ecosystem Assessment [34] as 'the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences' (p. 8). The growing body of literature concerned with the links between cultural services and human well-being provides compelling evidence that coastal and marine environments are particularly conducive to well-being benefits. Kellert [29] for example, notes how coastal environments are areas rich in physical, intellectual, emotional, aesthetic and spiritual opportunities which aid human growth and development and that they can be so powerful that they lead to an 'attitude of reverence' for nature (p. 18). Similarly Kearns and Collins [26] consider the strong emotional connections that people develop with the coast and how these can be a resource and motivation for place-protective behaviours. This in part, may explain the profound connections that people appear to have with the coast and the sea [2,19,47,48] and the reason why so many find such settings to be therapeutic and seek out the coast for 'stillness, solace and rehabilitation' ([29]: 17). Cultural ecosystem services are thus important as they influence how people respond to the natural environment and they give indications of how they might behave in those environments and respond to changes in them. For coastal communities in particular evidence suggests that cultural ecosystem services can be understood as an expression of the profound connection and sense of place and identity that people feel that is intrinsically connected to the sea [18,19,45].

The consequences of HABs to human well-being is significant and largely researched in terms of the economic and health impacts on human populations. These are of course important because many human activities are located at coastal margins which means that closures of beaches and fisheries to protect public health can result in losses of recreational and commercial opportunities and losses in food supply. The economic impacts of these are evidenced to be considerable and come from public health impacts, losses to local service businesses such as restaurants and hotels, increased costs of beach clean-ups, lost recreational opportunities, reduced fishery yields and mortalities of passively valued species [24]. Through the lens of cultural ecosystem services, a new dimension is provided to understanding the impacts of HABs in a broader sense. Such events, for example, disrupt opportunities to interact with coastal and marine settings and connect with nature in ways which enhance well-being. Changing environmental conditions may therefore, erode the attachments and therapeutic opportunities that people have at the coast and significant efforts are required to fully understand these impacts and the implications of them. The following section presents some evidence of impacts and what they mean to a small group of people who have been affected by HABs in Cornwall, south-west England. These stories are important for conceptualising key issues of concern to local people, including disruptions to well-being for local people and communities which have not been captured fully in much of the existing HAB literature.

3. Case study selection

HAB events in the south west of England are a regular and natural occurrence. The Harmful Algae Event Database for example, records this area as having 'a relatively high number of results' (http://haedat.iode.org) and annual reports from the Centre for Environment, Fisheries and Aquaculture Science (Cefas) provide evidence of regular HAB activity. Cornwall, in addition, provides a good case for this study as its identity and history are strongly influenced by the sea and this connection also underpins a thriving tourist economy [11] which may be impacted by increased HAB events. The biggest impact of HABs is on the local aquaculture industry which is significant in this area [32] as shellfish such as mussels, scallops and oysters are filter feeders and thus

susceptible to accumulating HAB toxins in their tissue. For this reason, to safeguard public health, constant and statutory monitoring is in place to ensure safe levels of biotoxins are not exceeded. Where they are, strategies tend to be reactionary and shellfish farmers are forced to close until safe levels return [44]. For other users of this coastal and marine environment, HABs also present a problem when they interfere with recreational activities and disrupt certain benefits such as the aesthetics of the area which can be caused for example, by froth and scum on the ocean surface and beaches, which may also be harmful to humans and animals. Similarly, where oxygen supplies are depleted by collapsing algal blooms and marine life is no longer supported, dead fish wash up on beaches and this also interferes with the aesthetics of the area and the direct interactions that people can have with the coast [37].

As a specific example of how HABs impact this area, results of the Food Standards Agency (FSA) official control monitoring programme for Marine biotoxins (conducted by Cefas) from January 1st to December 31st, 2014, showed that ASP toxins (responsible for amnesic shellfish poisoning) were recorded in 36 samples from 22 production areas throughout England and Wales. Of these samples, 26 were from the south west of England. The St Austell Bay classified production area recorded lipophilic toxins above the regulatory limit, in 11 consecutive results during this time, which instigated aquaculture closures and weekly sampling. Recorded toxins in St Austell Bay reached a peak on 04 August 2014 of 3700 µg/kg (over 20 times the regulatory limit). Toxins continued to be detected in this production area until the end of November 2014 ([10]: 9). Fig. 1 further illustrates the prevalence of HABs in the St Austell Bay and Fowey area. This figure shows the recorded HAB events, the causative species and the months in which the blooms occurred. This data covers events recorded in the last ten years and is obtained from the 'Harmful Algal Event Database' [21], a meta-database of harmful algal events which, when fully established will provide access to information on harmful algal events, harmful algae monitoring and management systems worldwide.

The prevalence of HAB events in this area is significant because Cornish fisheries and managed aquaculture practices contribute to livelihoods in Cornwall and importantly, they also play a 'key role in the social fabric and cultural identity of Cornwall's coastal villages, ports and harbour towns' (Cornwall Maritime Strategy, [11]: 26). The human impact of disruptions to these practices can therefore be significant, although not fully accounted for in any formal monitoring.

The impacts of blooms, which differ in terms of frequency and severity, are recorded via the database in terms of ecological metrics and levels of toxins, no detailed reference to impacts on people were revealed. This study therefore, sought to uncover impacts, from those who had experienced HAB events first hand and to reveal answers to the following questions which guided this exploratory study: what are the human impacts of HABs which are not captured by existing HAB data for Cornwall? In what ways do HABs impact on cultural ecosystem services and well-being?

3.1. Methodology

To answer these research questions and to understand some of the wider impacts of HABs, an inductive qualitative approach was taken during a small in-depth case study, as part of a short-term research placement. The intention was not to produce generalizable findings but to explore in some depth, the experiences of individuals in relation to the impact on cultural ecosystem services and well-being in the specific context of HAB events in the case study area. Semi-structured interviews were undertaken with a small sample of stakeholders from Cornwall who have been impacted by HABs on at least one previous occasion. A call for participants to discuss experiences of HABs was made via an on-line forum (http://www.coastproject.co.uk/). Others were contacted directly via email through contacts in the community, a process referred to by Babbie [3] as 'snowballing'. Six interviews were conducted in April 2016, either face-to-face or over the telephone which lasted 45–60 min each. Interviews were recorded using detailed note-taking. A profile of participants is given in Table 1. These interviews are not presented as representative of these different user groups, but are useful in providing an indication of the range of impacts caused by HAB events and how specifically they impact on well-being. Interview questions were semi-structured and allowed for some guided questioning, and importantly, also allowed respondents to articulate their experiences in their own words and in ways not beholden to a strict question guide. Questions were divided into two parts, the first focussing on personal experiences of HABs and how they impacted on what participants did and also, importantly, how they felt at the time of HAB events. The second section explored participants' feelings about the future and how HABS may impact on planned behaviours and any solutions which may be helpful to ensure the sustained well-being of this coastal community. The qualitative data generated by the interviews was coded against themes arising from the research questions, which included; 'well-being', 'physical impacts', 'experiences',

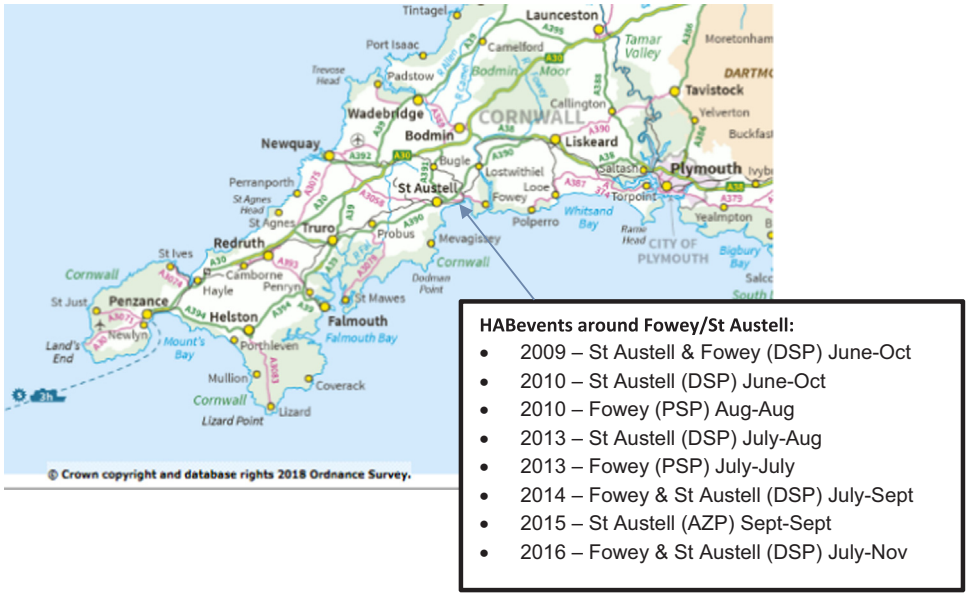

Fig. 1. HAB events around Fowey/St Austell in the last 10 years.

Table 1
Sample profile.

Participant	Coastal/marine user type	Gender	**Age** (brackets given)	
			18–24	46–54
			25–35	55–64
			36–45	65 +
1	Recreationist	M	65 +	
2	Recreationist	F	36–45	
3	Diving instructor	F	46–54	
4	Mussel farmer	M	46–54	
5	Fisherman	M	55–64	
6	Seafood restaurant proprietor	M	46–54	

'emotional impacts', 'future', 'individual' and 'collective'. This allowed for the identification of common themes in the research findings.

4. Findings

Rather than drawing overarching conclusions based on this limited number of interviews, the aim here is to understand some of the key impacts on people in a discrete area who had experienced HABs and to uncover some of the more nuanced impacts including psychological and emotional impacts which have implications for human well-being. Findings are analysed through the lens of cultural ecosystem services and how impacts ranged from physical impediments to undertaking specific coastal/marine activities to more psychological and emotional impacts which affected individuals' well-being. What is also interesting, is that impacts were considered not only at the level of the individual, but also at wider, community scales.

The interviews highlighted that impacts were profound for those who had experienced them, both for economic and for deeper emotional ans. Interruptions to coastal and marine activities due to HAB events of course impacts greatly on those who rely on the marine environment for their living. A local diving instructor and owner of a dive company for example, commented that HABs had had considerable impact on her business because planned activities had to be cancelled at short notice during these events; *'you basically can't work when this happens as the visibility is so poor and we don't know if it's safe' (interviewee no.3)*. For those engaged in fishing or aquaculture, these disruptions can lead to particularly severe economic impacts *'it affects fishermen because there isn't anything there for them to catch when this happens'* (interviewee no.5). Moreover, industries can be disrupted not only for the duration of the bloom but also for a protracted period as the HAB toxins may take some time to disperse and so periods of economic uncertainty are not uncommon in these coastal areas. A local mussel farmer, for example, also noted how his business had been severely impacted by HABs in the previous few years and how, during the previous bloom, his business had to be suspended for five months until the HAB toxins had dispersed. During this time, despite not being able to harvest, he nonetheless kept his workforce employed as it was difficult to predict how long the bloom would last for and when they might be required again. He noted that if HABs continued to disrupt the business, it would become unsustainable and the economic loss would be not only for himself but also for his workforce and arguably, a loss to the regional mussel industry.

For individuals, the inability to interact at the sea and coast can result in reductions in experiences which may be important for well-being such as relaxation, stress reduction and opportunities for inspiration. A local walker/beachcomber for example, noted the impacts of witnessing dead fish on the beaches at times of blooms and the discoloured froth on the sea which both impacted on his interactions at the beach and also caused emotional distress at such favoured places being blighted in this way. Similarly, a local diving instructor noted that due to a lack of information and understanding around the safety and health implications of algal blooms, that she has been forced to cancel dives, sometimes at short notice. This was discussed during the interview with a sense of sadness, not only for lost business opportunities but also because of the loss of opportunities for inspirational and therapeutic experiences associated with diving experiences which for many people '*does contribute to a sense of well-being*' (interviewee no.3), emphasising the close interconnectedness between direct economic benefits and cultural well-being.

The loss of opportunities for even passively observing and enjoying the coastal and marine landscape were identified as significant for three participants in particular (interviewees 1, 2, and 3). This was also acknowledged as an issue not only for themselves, but also for the wider community, who, by virtue of living in this area, were engaged both with coastal and marine activities and even just enjoying the scenery was seen to be part of people's daily lives in this area. Significantly, disruptions to both economic and recreational activities and also to the aesthetic appreciation of the coast/marine environment by HABs were discussed with a sense of deep emotional upset by all participants, which again highlights the close relationship between direct economic and cultural well-being. Accounts of dead fish being washed up on seashores loomed large in recollections of HAB events which elicited deep sadness from some at a sense of loss of something important both locally and in a wider, global sense. A local fisherman for example noted that he was 'devastated at seeing all the fish swimming up to the beach and gasping for air' (interviewee no.5).

Notable through these interviews were the references to how HABs impacted individual well-being but also how they were significant in a wider community sense. With regards to the loss of diving opportunities for example, it was noted that most dives were simply cancelled during HAB events resulting in losses both to individuals and to the local community in terms of economic losses, and, also, in terms of destination image and confidence of visitors, as many travel some distances to participate in diving off the coast of Cornwall. The disruptions to the production of Cornish mussels similarly were felt at individual levels of psychological stress and economic hardship but also in terms of losses to the wider community identity as Cornish mussels were discussed as being '*local*' and '*iconic to this area*' (interviewees 4 and 6). The value of mussels and of traditional industries in Cornwall appear from these discussions and from the literature (e.g. [45]) to be much more than economically based as they are rooted in a cultural value which underpins a local sense of place and identity. Such industries appear to be clear distinguishing features of the coastal communities of Cornwall and they provide a tangible connection to the sea and impacts to them from environmental stressors can therefore, have wide-ranging consequences.

These sentiments were echoed by a local seafood restaurant owner who remarked that mussels had to be removed from his menu completely in 2014 due to a bloom which lasted for the duration of the summer. He noted both the economic damage of this and, also, the psychological distress caused since the restaurant has important connections with the sea and the produce from it; 'our restaurant looks out over St Austell Bay and we can see the mussel farm from here, this is pointedly shown to our customers who appreciate the local, freshness and quality of the product' (interviewee no.6). The sense that seafood is inextricably linked to both the location itself and to the collective identity of the local community is strongly perceived through these discussions and this place-based identity appears particularly significant in Cornwall where many communities are linked with and influenced by the sea.

What is revealed through these interviews is that impacts of HABs are felt at a very profound level for individuals but also, and significantly, that they can also have wide ranging impacts for wider communities. Losses of traditional ways of life for example, such as fishing and shellfish farming, and the resultant loss of a local sense of distinctiveness and identity due to HAB events, could have significant impacts on coastal communities due to a risk of losing what is considered to be distinct to the area, in this case, Cornish mussels.

Moreover, this could have knock-on effects for regional economies more generally as they rely on that sense of place identity and distinctiveness for branding and visitor attraction. Local distinctiveness is for example, evidenced to be increasingly important for people seeking a 'sense of place' and meaningful tourism experiences and as such, promoting products with local provenance helps to enhance the visitor experience as well as generating more income for local businesses and ultimately repeat visits [7]. Increases in HAB events could, therefore, impact more widely on tourism businesses and regional economies in general.

The human impacts of HAB events are wide ranging and include health and economic effects but also, and importantly, they can also disrupt traditional ways of life and erode both individual and community sense of place, identity and well-being. Impacts on cultural ecosystem services and benefits from the coastal/marine environment appear then to be important, and yet largely overlooked effects of HABs. Urquart and Acott [45] note that 'sense of place' can be conceptualised as the meanings that people, both individually and collectively attribute to places. These meanings are attributed through the experiences and memories that people build up about places which can be severely disrupted by HAB events. The ways in which certain cultural practices and activities contribute to cultural ecosystem benefits, for example, how local seafood provides a tangible connection to the sea and contributes to a shared narrative about 'place' are important questions for future research which may shed new light into how HABs can disrupt these benefits and result in losses to both individual and community well-being.

5. Discussion

Findings from this research suggest that changing environmental conditions may erode the opportunities (i.e. provide dis-benefits) that people have for recreational and therapeutic experiences at the coast and significant efforts are required to fully understand these impacts and the implications of them. It is also evident that coastal communities may be impacted more widely, through losses to traditional ways of life for example, such as fishing and shellfish farming, and the resultant loss of a local sense of distinctiveness, place attachment and identity. This is important, since previous studies have shown that place attachment increases awareness of the environment, which in turn supports pro-environmental behaviour and, it also improves self-esteem and feelings of belonging to society or a cultural groups [25] and that such attachments to a community are positively correlated with individual well-being [42,49]. Findings from this case study show an interesting interaction between direct economic benefits, often in the form of provisioning services, and the less tangible cultural aspects of well-being attached to ecosystems such as identity, emotion etc. In so doing, they show how different ecosystem services can be interdependent. This is an important area for future research as a greater understanding of such interactions may be important for ongoing management of ecosystem services.

A small amount of HAB literature has explicitly called for increased recognition of the human impacts of HABs (e.g. [5,15]) and their dis-benefits to well-being. Whilst Berdalet et al. [6] note that studies concerned with understanding losses from HAB events, in a broad sense, are 'almost non-existent' (p. 13), some previous studies have provided examples of disruptions to behaviours and traditional ways of life. Rongo and Woesik [38], for example, demonstrate how a high incidence of ciguatera poisoning (the most common form of food-poisoning worldwide, caused by the ingestion of fish meat contaminated by HAB toxins) in Roratonga, Cook Islands, has led to a variety of socio-cultural impacts. Beyond direct health impacts, shifts away from traditional subsistence fishing have resulted because of the increased risk of fish contamination from HAB toxins. This has also lead to changes in diets and disruptions to the transmission of traditional knowledge from elders to children around fishing practices.

Interestingly, behaviour changes during HAB events can be unpredictable and demonstrate both a lack of understanding and often a general fear of HABs. Morgan et al. [37], for example, noted that visitors will alter their behaviour on days when 'red tide' is mentioned, regardless of whether an active bloom exists in the area. Similarly, Larkin and Adams [30] examined knowledge about Florida red tides among residents of Southwest Florida and found that despite relatively high levels of knowledge amongst Florida residents about red tides, consumers were unlikely to inquire about the sources of seafood served in local restaurants and may choose to avoid eating any shellfish, including that harvested from uncontaminated waters, during a red tide. Moreover, people might cancel fishing trips or beach visits that would not have presented any health risks due to uncertainty about the effects of algal blooms which would result in economic losses. Marine HABs may therefore, lead to complex societal responses in affected coastal communities, such as the more general avoidance of coastal and ocean resources due to misconceptions and inadequate communication of health risks [4,6,37].

Whilst HAB research has made considerable strides in understanding the causes and some of the consequences of HABs, mitigation strategies are largely focussed on developing measures to predict future events. Whilst this is undoubtedly important, this small research study has illustrated that personal accounts of HAB impacts can provide important insight into the losses incurred by individuals and communities which may not be captured by technical recordings of HAB events. Moreover, by using methods to reveal these individual and community narratives around HABs, more locally responsive management strategies can be devised. These may include safety nets for example for those who are struggling in the face of lengthy closures to aquaculture activity and better assurances that Cornish mussels will continue to appear on future menus. Providing assistance to local aquaculture operators who are unable to harvest during HAB events may help to safeguard traditional industries from decline and by extension, protect the local identity formed around these industries and around local food. Better information and education programmes to assist the planning of recreational activities may also help to direct activities to appropriate locations. Whilst this may not fully address the emotional distress caused by witnessing dead marine life at bloom events, it may help to be able to plan activities around these and to understand better the causes of them. Similarly, locally-tailored warning and prediction systems could help small businesses to plan diving activities which would help both business management generally and ensure a better informed and prepared tourist base who otherwise, may travel long distances to undertake unique diving experiences in Cornish waters, only to be disappointed; it may not take too many such disappointments to persuade tourists to try alternative locations.

This small study has provided a window into the lived experiences of a number of coastal residents who have been impacted by HABs. It provides additional empirical detail around disruptions to cultural services in the face of environmental shocks to add to the weight of existing evidence around the impacts of HABs which largely deals with economic and health implications. This research points to the need to better explore and understand these impacts so that they can be factored into management strategies to help buffer individuals and communities from the worst impacts of HABs.

6. Conclusions

Qualitative data can provide rich insight into local knowledge and perspectives which can help form an additional layer of insight into the real and often emotional experiences of individuals who have experienced HABs. By taking the time to understand the nuance of socio-cultural impacts of HABs, more suitable responses and management practices can be devised. This may be even more pressing in future as along with rising population numbers, it is expected that public demand for attractive, healthy coastal access areas will continue to increase. The

increasing movement of the population to coastal areas has increased 'coastal consumer and business exposure, which in turn, has increased the economic impacts of these naturally-occurring environmental stressors' ([36]: 854). The pathways from stressor to impacts needs to be much better contextualised in order that cultural insights are paired with ecological and economic changes to arrive at a broad picture of HAB impacts which can be better addressed through more locally appropriate solutions.

Thinking about the impacts of HABs on cultural ecosystem services can help resource managers develop a framework for investigating the human dimensions of environmental stressors which take into account particular local lenses and interpretations of what is important in an area. Future research is thus challenged to fully understand cultural ecosystem services and the ways in which certain cultural practices and activities contribute to cultural ecosystem benefits and how these interact with other ecosystem services. One example, as highlighted here is how local seafood provides a tangible connection to the sea and contributes to a shared narrative about 'place'. These are important areas for investigation which may shed new light into how HABs can disrupt these benefits and result in losses to economic, individual and community well-being.

This paper has discussed how the human impacts of HABs are most widely discussed in health and economic terms and how an increased focus and recognition of the benefits of coastal and marine environments for human well-being should lead to a greater integration of cultural ecosystem services into HAB management. Health and economic impacts are of course important and continued research is needed in these areas, although for some, switching to alternative economically viable activities could mitigate some of the worst economic losses [6]. With regards to cultural ecosystem services and dis-benefits however, this paper shows that losses incurred as a result of HABs may also be significant, especially in terms of diminished well-being benefits from reduced opportunity for interactions in the environment and these may not be compensated for in any other way. Furthermore, such losses may become unsustainable and impact more widely on communities as well as individual well-being; conditions which may become more apparent in light of changing environmental conditions and possible increased instances of HAB events. Whilst much of the literature and policy responses (e.g. [8,20]; MEA [33]) tend to focus on enhancing the benefits of the natural environment to human well-being, our research shows that in managing marine environmental impacts, it is also important to consider environmental dis-benefits resulting from events including HABs in order to help coastal communities reduce the impact of these events on well-being. This paper therefore, calls for greater integration of nuanced information pertaining to wider well-being impacts of individuals and communities in the face of such environmental shocks as HAB events. This, it is argued will enable more locally responsive management strategies to be devised and a resultant increase in individual and community resilience in the face of future HAB events.

Acknowledgements

The research described in this paper was funded by the Natural Environment Research Council (Grant Number NE/M005410/1) as part of the Valuing Nature Programme. This programme aims to improve understanding of the values of nature and improve the use of these valuations in decision making. See www.valuing-nature.net. The funders had no role in the data collection, analysis or writing of this article. Thanks are due to Plymouth Marine Laboratory for acting as 'hosts' to this placement and for their generosity in providing access to their considerable expertise. Thanks also to the anonymous reviewers and the special issue editors for their helpful comments and detailed guidance for improving this paper.

References

[1] D.M. Anderson, The expanding global problem of harmful algal blooms, in: R. Ragaini (Ed.), International Seminar on Nuclear War and Planetary Emergencies, 27th Session, Erice, Italy, 18-26 August 2002, World Scientific Publishing Co. Ltd, Singapore, 2003.
[2] K.J. Ashbullby, S. Pahl, P. Webley, M.P. White, The beach as a setting for families' health promotion: a qualitative study with parents and children living in coastal regions in Southwest England, Health Place 23 (2013) p138–p147.
[3] E. Babbie, The basics of social research, Belmont, Wadsworth Cengage Learning, California, 2010.
[4] L.C. Backer, Impacts of Florida red tides on coastal communities, Harmful Algae 8 (2009) p618–p622.
[5] M. Bauer, P. Hoagland, T.M. Leschine, B.G. Blount, C.M. Pomeroy, L.L. Lampl, C.W. Scherer, D.L. Ayres, P.A. Tester, M.R. Sengco, K.G. Sellner, J. Schumacker, The importance of human dimensions research in managing harmful algal blooms, Front. Ecol. Environ. 8 (2009) p75–p83.
[6] E. Berdalet, L.E. Fleming, R. Gowen, K. Davidson, P. Hess, L.C. Backer, S.K. Moore, P. Hoagland, H. Enevoldsen, Marine harmful algal blooms, human health and wellbeing: challenges and opportunities in the 21st century, J. Mar. Biol. Assoc. U. Kingd. (2015) p1–p31.
[7] I. Bromham, Coastal & Marine Tourism Development Project Report. North Devon +, 2015.
[8] A. Church, J. Burgess, N. Ravenscroft, W. Bird, E. Brady, M. Crang, R. Fish, P. Gruffudd, S. Mourato, J. Pretty, D. Tolia-Kelly, K. Turner, M. Winter, Cultural Services. UK National Ecosystem Assessment Technical Report - Chapter 16. The UK National Ecosystem Assessment Technical Report. UNEP-WCMC, Cambridge, 2011.
[9] A. Church, R. Fish, R. Haines-Young, S. Mourato, J. Tratalos, L. Stapleton, C. Willis, P. Coates, S. Gibbons, C. Leyshon, M. Potschin, N. Ravenscroft, R. Sanchis-Guarner, M. Winter, J. Kenter, UK National Ecosystem Assessment Follow-on. Work Package Report 5: Cultural ecosystem services and indicators. UNEP-WCMC, LWEC, UK, 2014.
[10] L. Coates, B. Stubbs, A. Turner, O. Williams, S. Milligan, M. Algoet, Annual report on the results of the Biotoxin and Phytoplankton Official Control Monitoring Programmes for England & Wales – 2014. Cefas contract report C5666 – C5667, 2015.
[11] Cornwall Council, A future for maritime Cornwall: Annex: background information, Corn. Marit. Strategy (2012) 2012–2030.
[12] R. Costanza, R. de Groot, L. Braat, I. Kubiszewski, L. Fioramonti, P. Sutton, S. Farber, M. Grasso, Twenty years of ecosystem services: how far have we come and how far do we still need to go? Ecosyst. Serv. 28 (2017) 1–16.
[13] P. Devine-Wright, Y. Howes, Disruption to place attachment and the protection of restorative environments: a wind energy case study, J. Environ. Psychol. (2010) p1–p10. Article in press.
[14] K. Dyson, D.D. Huppert, Regional economic impacts of razor clam beach closures due to harmful algal blooms (HABs) on the Pacific coast of Washington, Harmful Algae 9 (2010) 264–271.
[15] J. Endter-Wada, D. Blahna, R. Krannich, M. Brunson, A framework for understanding social science contributions to ecosystem management, Ecol. Appl. 8 (3) (1998) p891–p904.
[16] L.E. Fleming, E. Laws, The overview of oceans and human health, Oceanography 19 (2) (2006) p18–p23.
[17] L.E. Fleming, N. McDonough, M. Austen, L. Mee, M. Moore, P. Hess, M. Depledge, M. White, K. Philippart, P. Bradbrook, A. Smalley, Oceans and human health: a rising tide of challenges and opportunities forEurope, Mar. Environ. Res. 99 (2014) P16–P19.
[18] R. Fletcher, C. Baulcomb, C. Hall, S. Hussain, Revealing marine cultural ecosystem services in the Black Sea, Mar. Policy 50 (2014) p151–p161.
[19] K. Gee, B. Burkhard, Cultural ecosystem services in the context of offshore wind farming: a case study from the west coast of Schleswig-Holstein, Ecol. Complex. 7 (2010) p349–p358.
[20] UK Marine Policy Statement, HM Government, Northern Ireland Executive, Scottish Government, Welsh Assembly Government, London. UK, 2011.
[21] Harmful Algal Event Database - 〈http://haedat.iode.org/〉 (last (accessed 9 April 2018).
[22] D. Harmon, The source and significance of values in protected areas, in: D. Harmon, A.D. Putney (Eds.), The Full Value of Parks. From Economics to the Intangible, Rowman & Littlefield Publishers Inc, 2003.
[23] P. Hoagland, D.M. Anderson, Y. Kaoru, A.W. White, The economic effects of harmful algal blooms in the United States: estimates, assessment issues, and information needs, Estuaries 25 (2002) p677–p695.
[24] P. Hoagland, D. Jina, A. Beet, B. Kirkpatrick, A. Reich, S. Ullmann, L.E. Fleming, G. Kirkpatrick, The human health effects of Florida Red Tide (FRT) blooms: an expanded analysis, Environ. Int. 68 (2014) p144–p153.
[25] V. Kati, N. Jari, Bottom-up thinking – Identifying socio-cultural values of ecosystem services in local blue-green infrastructure planning in Helsinki, Finland, Land Use Policy 50 (2016) p537–p547.
[26] R. Kearns, D. Collins, Feeling for the coast: the place of emotion in resistance to residential development, Social. Cult. Geogr. 13 (2012) p937–p955.
[27] B.L. Keeler, S. Polasky, K.A. Brauman, K.A. Johnson, J.C. Finlay, A. O'Neill, K. Kovacs, B. Dalzell, Linking water quality and well-being for improved assessment and valuation of ecosystem services, Proc. Natl. Acad. Sci. 109 (2012) 18619–18624.
[28] S.R. Kellert, E.O. Wilson (Eds.), The Biophilia Hypothesis. Island Press, Washington D.C, 1993.

[29] S. Kellert, Coastal values and a sense of place, in: D. Whitelaw, G. Visgilio (Eds.), America's Changing Coasts: Privare Rights and Public Trust. Edward Elgar, Cheltenham, 2005.
[30] S.L. Larkin, C.M. Adams, Harmful algal blooms and coastal business: economic consequences in Florida, Soc. Nat. Resour. 20 (2007) p849–p859.
[31] D. Loomis, S. Paterson, The human dimensions of coastal ecosystem services: managing for social values, Ecol. Indic. 44 (2014) p6–p10.
[32] M. Lobley, D. Barr, L. Bowles, R. Huxley, E. Kehyaian, N. de Rozarieux, A. Shepherd, 'A Review of Cornwall's Agri-food Industry'. CRPR Research report 32, University of Exeter, 2011.
[33] Millennium Ecosystem Assessment, Ecosystems and Human Well-being: Synthesis, Island Press, Washington, DC, 2005.
[34] Millenium Ecosystem Assessment, Ecosystems and Human Well-being: A Framework for Assessment, Island Press, Washington D.C., 2003.
[35] S.K. Moore, V.L. Trainer, N.J. Mantua, M.S. Parker, E.A. Laws, L.C. Backer, L.E. Fleming, Impacts of climate variability and future climate change on harmful algal blooms and human health, Environ. Health 7 (Suppl 2) (2008) S4.
[36] K.L. Morgan, S.L. Larkin, C.M. Adams, Empirical analysis of media versus environmental impacts on park attendance, Tour. Manag. 32 (2011) p852–p859.
[37] K.L. Morgan, S.L. Larkin, C.M. Adams, Red tides and participation in marine-based activities: estimating the response of Southwest Florida residents, Harmful Algae 9 (2010) p241–p333.
[38] T. Rongo, R. v. Woesik, Socioeconomic consequences of ciguatera poisoning in Rarotonga, southern Cook Islands, Harmful Algae 20 (2012) p92–p100.
[39] C.G. Sandbrook, N.D. Burgess, Biodiversity and ecosystem services: not all positive, Ecosyst. Serv. 12 (2015) 29.
[40] T. Schaubroek, A need for equal consideration of ecosystem disservices and services when valuing nature; countering arguments against disservices, Ecosyst. Serv. 26 (2017) 95–97.
[41] S.S.K. Scholte, A.J.A. Van Teeffelen, P.H. Verburg, Integrating socio-cultural perspectives into ecosystem service valuation: a review of concepts and methods, Ecol. Econ. 114 (2015) p67–p78.
[42] G.L. Theodori, Examining the effects of community satisfaction and attachment on individual well-being, Rural Sociol. 66 (4) (2001) p618–p628.
[43] J.A. Tratalos, R. Haines-Young, M. Potschin, R. Fish, A. Church, Cultural ecosystem services in the UK: lessons on designing indicators to inform management and policy, Ecol. Indic. 61 (2016) p63–p73.
[44] A.N. Tyler, et al., Strategies for monitoring and managing mass populations of toxic cyanobacteria in recreational waters: a multi-interdisciplinary approach, Environ. Health (Suppl 1) (2009) p1–p8.
[45] J. Urquhart, T. Acott, A sense of place in cultural ecosystem services: the case of cornish fishing communties, Soc. Nat. Resour. 27 (2013) p3–p19.
[46] A.S. Vaz, C. Kueffer, C.A. Kull, D.M. Richardson, J.R. Vicente, I. Kuhn, M. Schroter, J. Hauck, A. Bonn, J.P. Honrado, Integrating ecosystem services and disservices: insights from plant invasions, Ecosyst. Serv. 23 (2017) 94–107.
[47] M.P. White, I. Alcock, B. Wheeler, M. Depledge, Coastal proximity, health and well-being: results from a longitudinal panel survey, Health Place 23 (2013) p97–p103.
[48] C. Willis, A human needs approach to RevealingNature's benefits at the coast, *Area* 47 (2015) p422–p428.
[49] N. Yetim, U. Yetim, Sense of community and individual well-being: a research on fulfillment of needs and social capital in the Turkish community, Social. Indic. Res. 115 (1) (2014) p93–p115.