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Our Ocean Climate Story: connecting communities with local data

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Abstract

The ocean has a vast capacity for absorbing heat and carbon dioxide, seriously threatening local habitats for marine life. Challenges in connecting wider society with this crisis may originate in its poor visibility for non-specialists: the data can be inaccessible and hard to relate to. In a series of immersive community workshops, participants created artworks combining recent physical ocean climate data recorded in Otago, New Zealand, with impacts on local species from published studies. We found that crafting visual stories was a powerful way to distill greater meaning from complex climate data, and engage participants with harmful changes underway locally.

Keywords

Environmental communication; Public engagement with science and technology; Visual communication

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Context

The ocean is at the heart of our changing climate and it is a powerful protector, tempering far greater changes on land. Over 90% of the excess heat trapped by human emissions of greenhouse gases over the past 50 years has been absorbed by the ocean [IPCC, 2021]. Just nine percent has been taken up elsewhere, by warming the air and land, and by melting ice. At the same time, the ocean has absorbed around a third of all carbon dioxide emissions from human activities [Bindoff et al., 2019]. The impact of this is enormous, and without immediate and far-reaching action to reduce emissions, the end of this century will see profound changes throughout the ocean that will take tens of thousands of years to reverse [IPCC, 2014].

Despite this blunt warning, many of these changes are not readily visible to us, and so our collective appetite for action is weak [Knutti, 2019]. There is a striking disconnect between public and expert knowledge of threats to the marine environment from climate change [Lotze, Guest, O'Leary, Tuda & Wallace, 2018; Eddy, 2014]. In New Zealand, ocean acidification and rising sea temperatures pose

by far the greatest risks of all human influences [MacDiarmid et al., 2012], whilst public perceptions of commercial fishing and pollution/sewage as the top two threats reflect the greater visibility of these issues [Eddy, 2014]. A review by Eberhard [2021] highlights the positive role that visualization of information plays in enhancing not only comprehension of an issue, but decision-making too. Visual imagery can be exceptionally powerful, providing new narratives that can help make sense of complex information and change perspectives [Metze, 2020]. However, there is a risk that even innovative and engaging visual media is simply an extension of the much-critiqued deficit model of communication, and fails to translate into action [Pearce, Brown, Nerlich & Koteyko, 2015; Simis, Madden, Cacciatore & Yeo, 2016].

The cavity between possession of environmental knowledge and adoption of pro-environmental behaviour is well-documented [Kollmuss & Agyeman, 2002; Naustdalslid, 2011]. In the context of climate change, Knutti [2019] refers to a 'clash of worldviews' as a significant barrier to action, and empahsises the need to embrace interdisciplinary and transdisciplinary approaches that involve and connect stakeholders and communities. The deeply human dimension of our climate challenge fundamentally requires that the physical sciences are integrated with social sciences and humanities to drive transformational behaviour change [Castree et al., 2014]. Diverse societies make sense of change in different ways, and the reasons for engaging or disengaging are equally important as the change itself [Hulme, 2011]. Evoking meaning, through emotional aswell as cognitive engagement, may be a prerequisite for action: unless we care personally about an issue, we're unlikely to be strongly motivated to act [Roeser, 2012; Brosch & Steg, 2021]. Recognising the richness of lay knowledge existing within communities through lived experiences is at the core of emerging participatory practice [Burke, Ockwell & Whitmarsh, 2018; Liguori, McEwen, Blake & Wilson, 2021; Savoie, 2022], and harnessing this strength will enable communities to be vital agents of change in tackling our ocean climate crisis [Fletcher & Potts, 2007].

The Otago region on the South Island of New Zealand is an ideal place to nurture this connection, since it is home to some of the longest physical ocean climate records in New Zealand. Sea surface temperatures have been measured in the Otago Harbour by the Portobello Marine Laboratory almost daily since 1953, with the latest decade starkly the warmest on record [Cook et al., n.d.]. Marine heatwaves are becoming more frequent, with the extreme temperatures during the summer of 2017/18 resulting in severe disruption to coastal habitats and local extinction of bull kelps in some regions of the South Island [Thomsen et al., 2019]. Measurements of ocean carbon and pH have been collected along the Munida Transect offshore the north Otago coast seasonally since 1998, making this timeseries the longest of its kind in the southern hemisphere [NZOA-ON, 2021]. Dissolution of carbon dioxide in the surface waters here has caused a seven percent rise in acidity over the past twenty years [Ministry for the Environment & Stats NZ, 2019], and further projected declines seriously threaten native ecosystems across New Zealand [Law et al., 2018].

These robust datasets are immensely valuable for understanding ocean climate change at a local scale [Scannell & Gifford, 2013]. However, for non-specialists in climate science, datasets can be difficult to access and digest, and their meaning can become muddied or lost [Coen, 2021]. Engaging local people in the process of

visualizing this climate data in ways that are personally relevant allows for immediate investment and better understanding of the issue [Selvin & Buckingham Shum, 2014]. Plentiful material for emotive narratives can be found in scientific literature reporting impacts of ocean warming and acidification on important local species, from pāua [Espinel-Velasco, Lamare, Kluibenschedl, Moss & Cummings, 2021] to penguins [Mattern et al., 2017]. Embedding stories such as these into emerging climate data may be a compelling fusion [Joubert, Davis & Metcalfe, 2019], and a powerful tool for alerting our wider community to the risks from local ocean climate change.

We present here a case study of a project spanning 2021 titled, 'Our Ocean: bringing marine climate data to life'. Community participants took part in a series of immersive workshops to explore local ocean climate records and impacts, choosing narratives that resonated meaningfully for them, whilst cultivating skills in data-interpretation and distilling complex information into relatable and engaging visual media. These artworks were collated into a 2022 calendar, distributed locally to extend the reach beyond those immediately involved in the project. Our goal was to connect people with the ocean's central role in our changing climate, and the role that we play through our collective lifestyle choices. Empowering communities with both knowledge and ownership of local issues will be key to paving the way for a healthier future ocean. The study was approved by the University of Otago's Human Ethics Committee (21/027).

Our Ocean: bringing marine climate data to life

We designed a series of immersive participatory workshops to bring members of the local community together: to discuss their connection with the ocean; to explore ocean climate data from the local region; and ultimately to find ways of communicating ocean climate change in ways that would have greater impact and deeper meaning for other community members. Introductory workshops were held in central Dunedin during the New Zealand International Science Festival (NZISF) in July 2021, followed by full-day creative sessions at the University of Otago's New Zealand Marine Studies Centre (NZMSC) on the shores of Otago Harbour in October. Participants were recruited through a number of channels: the advertising campaign for the 2021 NZISF programme; Eventbrite; NZMSC newsletters and social media; and targeted social media posts by the Centre for Science Communication at the University of Otago. We invited anyone with an interest in the marine environment to take part, with the intention that participants would then feel natural in sharing experiences or knowledge of the ocean as a starting point for developing a sequence of visual stories. With this in mind, we also specifically recruited participants from Dive Otago's cohort of student dive instructors.

Introductory workshops

Reflecting the different catalysts that inspire change in each of us, a large part of the introductory workshops was dedicated to providing fertile space to talk and share ideas. One workshop was held at the Dunedin City Library, and a second at Dive Otago, attracting eleven and nine participants, respectively. We found that this small group size was ideal for encouraging an open and equal platform for discussion and personal reflection.

Each workshop ran for three hours, starting with group introductions followed by a quiz (Table 1, appendix A) that served three important purposes: firstly, as an ice-breaker (the opening question was about chocolate); secondly, to set the scene for the project with questions about the role the ocean plays in our climate system and changes underway locally; and finally, as a general barometer for the participants' knowledge. The quiz was highly successful as a spring-board for group discussion, particularly since the answers were often surprising to participants.

Notably, even within a group of individuals sharing a passion for the ocean and a deep concern about climate change, only a small number were aware of the enormity of the role that the ocean plays in our climate system and of local programmes to monitor ocean climate change. Out of twenty participants, just three were aware that the ocean has taken up over 90% of the excess heat from greenhouse gas emissions, whilst five correctly answered that the ocean has absorbed around 30% of anthropogenic carbon dioxide. We found that the concept of pH was challenging, with just seven participants indicating that the ocean was becoming 'warmer with lower pH', whilst six answered 'warmer with higher pH'. Subsequent discussions demonstrated that participants were largely familiar with the issue of ocean acidification, but had confused rising pH for rising acidity. Just under half of participants were aware that the Portobello Marine Lab had been collecting sea surface temperature since 1953.

As a group, we then explored a number of datasets tracking physical ocean climate change in the Otago region. We limited this to temperature and carbon system parameters, noting that ocean warming and acidification pose the two greatest threats to marine habitats in New Zealand [MacDiarmid et al., 2012]. These included the Sea Surface Temperature (SST) timeseries from the Portobello Marine Lab [Cook et al., n.d.], and three timeseries from the Munida Transect: pCO_2; pH; and aragonite saturation state [NZOA-ON, 2021]. Further datasets were considered to add unnecessary complexity.

Finally, we discussed a number of local marine species where studies have been published in the academic literature documenting measured threats posed by ocean warming and acidification. These ranged from calcified organisms like cockles and pāua, to kelp forests and penguins. 'Stories' of impacts on locally important marine creatures have more power to bring this physical data to life — this is *why* it matters; this is how we can *relate* to these abstract physical concepts; and revealing the dangers faced by these species in our home waters in more *accessible* ways may capture wider interest and engage our community more sincerely as 'ocean citizens' [Fletcher & Potts, 2007].

Creative immersion

The core ambition of this project was to raise the visibility, locally, of our ocean climate crisis. Discussions throughout the introductory workshops revealed a perception amoung participants that there is a critical gap between the rigorous scientific reporting of ocean warming and acidification, and wider public understanding of the significance of these issues. For this data to have the impact that it needs to, and to ignite action, we suggest that it needs to first arouse interest

and curiosity. This requires a greater level of accessibility than is currently available. By way of comparison, the exceptional clarity of communication in New Zealand around the Covid-19 pandemic, and the reporting of data in an accessible way for the public to understand and relate to, is heralded as an essential factor in the success of their early elimination campaign [Beattie & Priestley, 2021].
In contrast, ocean climate data is not easy for non-specialists to find and view: it is either not publicly available or is locked behind a technical file format; graphical visualisations of data often use complex language and discipline-specific charts; and scientific presentation of data on its own often lacks a personally relevant 'so what?' that is essential for engaging wider audiences. This is all for good reason — primarily that scientists need to communicate with clarity and objectivity to expert audiences — but there remains a communication-void beyond these specialist communities.

Over two full-day workshops, a total of twenty participants explored a wide range of published scientific literature describing impacts of ocean climate change on local marine species, guided by experts at the NZMSC. Reflecting on their own passions and curiosities relating to the marine world, individuals chose scientific narratives to pursue that had a depth of personal meaning, and delved into artistic ways to present these (Figure 1). Distilling data into visual stories through printmaking, watercolour, acrylic, pencil, ink, weaving, and collage, a series of highly diverse creations emerged. Crucially, these present the latest available physical data of local ocean climate change, alongside clear messages of why this data highlights such concern for marine life.

Within these full-day creative workshops, participants were introduced to local marine species in the aquarium and were invited to help pull in the plankton net

Figure 1. Collective creative focus: participants explored a range of visual media to bring data to life through these immersive workshops.

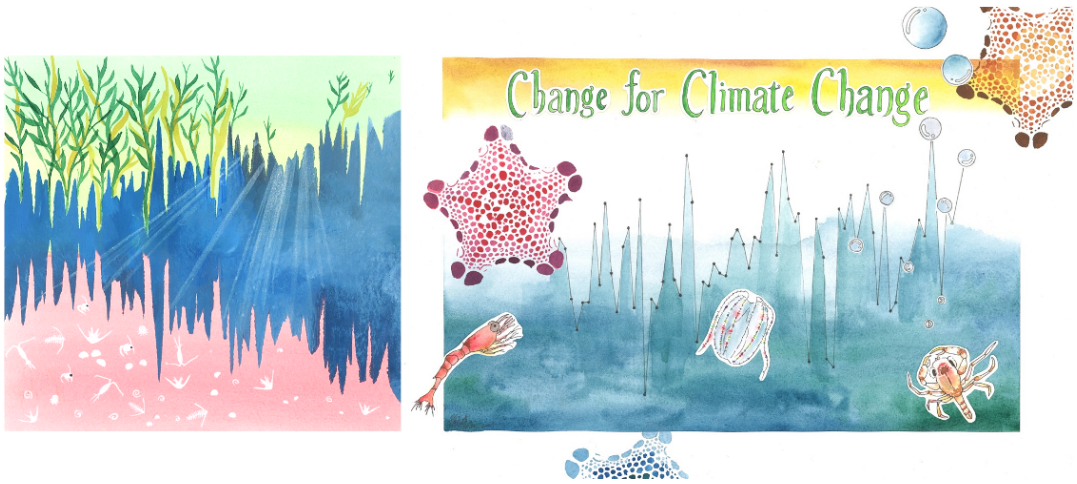

Figure 2. Artistic representations of local ocean acidification data (left: pCO_2 and pH from the Munida Transect) and winter temperature (right: Stats NZ), illustrating marine species threatened by these changes in climate.

from the wharf of the NZMSC. This was an opportunity to capture a seasonal snapshot of zooplankton in the Otago Harbour, since the majority of marine species start out with a planktonic larval stage [Armbrust & Palumbi, 2015]. Viewed at high magnification through a microscope lens, these ornate and glassy-looking specimens are visually spectacular, but their fragile structures are palpably vulnerable. Risks to marine life at these early stages of development are severe, and their chances of survival to healthy adult populations face increasing risks in a changing ocean [Espinel-Velasco et al., 2018]. This activity was popular among participants as it revealed a hidden treasure trove of marine life and inspired a number of artworks (Figure 2).

The examples in Figure 2 present different stories about local ocean climate change, with the data itself embedded in the artworks. On the left, data from the Munida Transect, offshore Otago, are printed in acrylic and watercolour showing rising carbon dioxide (top) and falling pH (bottom) in the surface waters from season to season over the past two decades and more. A disruption to Otago's rocky reef ecosystem is represented: coralline algae (in pink) has a rough surface that nurtures life from microscopic plankton to our great kelp forests, but it is immediately threatened by ocean acidification and as it declines an empty ocean looms, open to invasive species to take over.

On the right, winter temperature in Dunedin is depicted from 1947 to 2019 [Stats NZ, 2020]. Hand-printed biscuit stars and zooplankton impacted by rising temperature are illustrated alongside the data, and "bubbles" represent escaping oxygen from a warmer sea. The largest bubble sits on the peak of the year 2018 when there was a severe marine heatwave. The participant spoke of vivid memories from that year when breeding success for albatross and blue penguins was exceptionally low. In connecting their experience to this data, they commented that they 'immediately felt strongly how relevant and important this workshop is to the seabird conservation at [*place name removed for anonymity*].

Project outputs

Following the workshops, each of the artworks were scanned and compiled into a published calendar for 2022 (Figure 3). This compilation of visual stories presented the risks to our native marine ecosystems from ocean warming and acidification, and included stories of kelp forests; gulls; octopuses; penguins; shellfish; crustaceans; zooplankton; algae; and marine mammals.

A risk with any climate change communication practice, which we were eager to avoid, is conveying a strongly negative message that triggers unhelpful responses from anxiety through to dissonance and rejection [Stoknes, 2014]. Central to this project was the intention to empower communities to act by recognizing the local threats to our ocean environment and our potential role in reversing these. One participant had the idea (which we implemented) to include a positive message alongside each calendar month, sharing different ways that individuals can take action.

Calendars were distributed widely throughout the Otago region, with donations welcomed to support two non-profit organisations working in ocean conservation and education, Our Seas Our Future (http://www.osof.org) and Ocean Media Institute (http://www.oceanmediainstitute.org). The project coordinator also created a website to share further stories of the project, alongside digital versions of each artwork: http://www.moretosea.net.

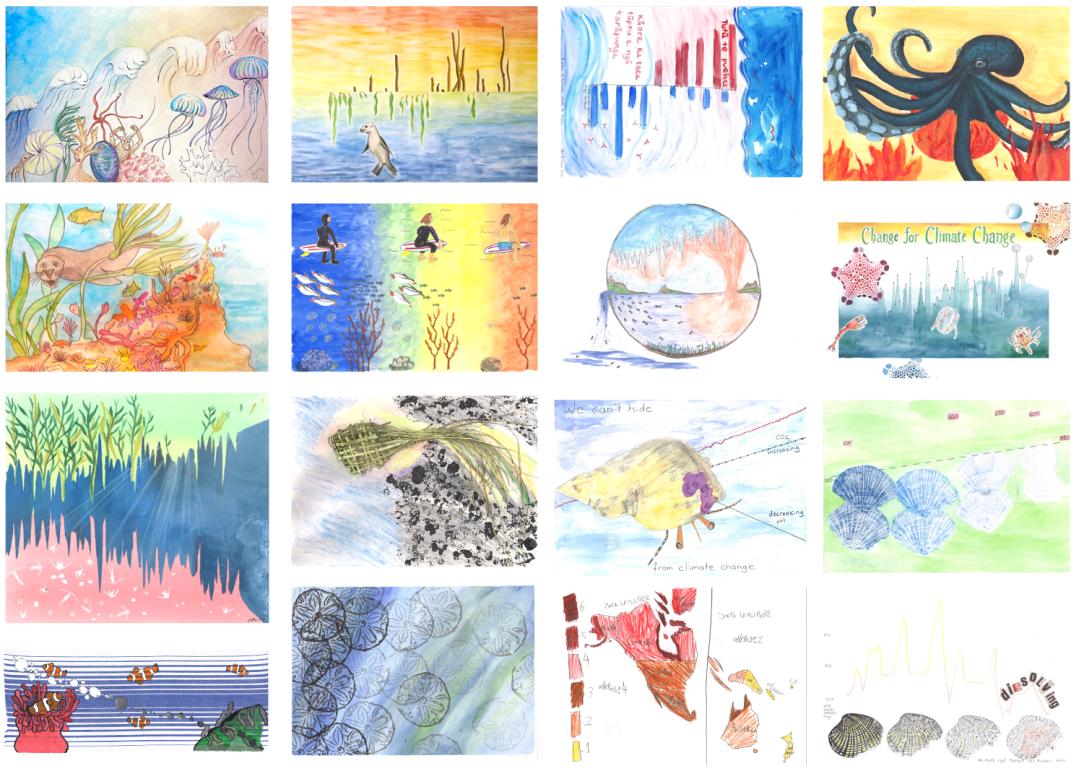

Figure 3. Community-created art works as displayed on the back cover of the 2022 Our Ocean calendar.

Participant survey

At the end of each creative workshop, participants were invited to complete a short anonymous survey to determine: how much of the information presented had been new to them; how concerned they had felt about ocean climate change prior to the workshop; and how the immersive experience of creating artworks from data had influenced their understanding of it. The questions are listed in appendix B, and Figure 4 presents a summary infographic of participant responses.

The survey was not compulsory, and fourteen participants chose to complete it. As expected, the pool of participants were united in a shared concern for climate change, with ten indicating that they had been concerned about global ocean climate change prior to the workshop, three answering 'somewhat' and just one answering 'no'. Interestingly, participant awareness about the role of the oceans in our changing climate; the extent of the threat to marine life from climate change; and local programmes to monitor ocean climate change, was low. Just two participants indicated that they had been aware of the enormity of ocean heat uptake prior to the workshop, whilst ten had been aware that the oceans have absorbed a large amount of carbon dioxide from human activities. Only one participant had been aware of local programmes collecting ocean climate data. These findings highlight the lack of public visibility of ocean climate change, and emphasise the need for fresh approaches to communicating this issue.

Following the workshop, ten participants said that they understood the data better having created an artwork about it, with the remaining four answering 'somewhat'. All participants said that linking physical data to impacts on marine life gave the data greater meaning for them. Reflecting on their connection with ocean climate change and impacts on local marine life in Otago, thirteen

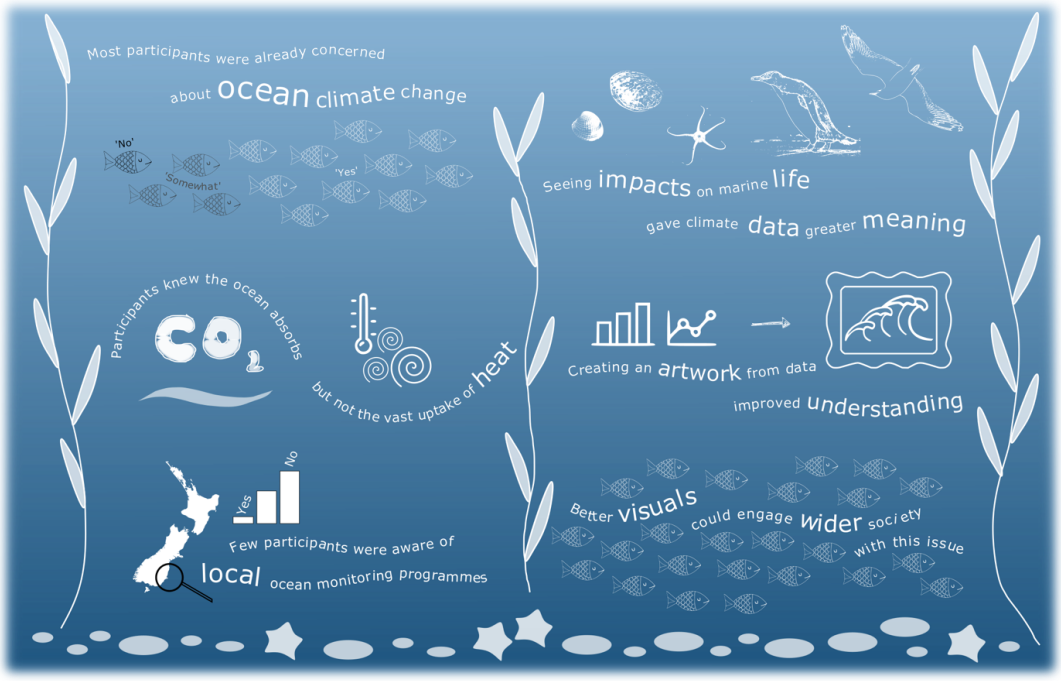

Figure 4. Summary of survey responses ($n = 14$) following the creative workshops.

participants indicated that the workshop had made them more concerned (one answered 'somewhat') and that the process of creating visual artworks from data could be an effective way of engaging wider communities with this issue. Two examples where participants elaborated on their experience are presented below:

> "*There are many ways to understand climate change. It's not exclusively for people who love science. When you add colours, drawings and fun in Science, it becomes not just a knowledge or fact, but an experience to remember and share with others! This art work is also a reminder to myself, to be more aware of the health of our environment, learn to be more environmentally responsible and celebrate the many possible ways of building this kind of connection with people, and with our Mother Nature.*"

> "*It's been awesome to combine art, science and communication, and an eye opener to delve deeper into the impact of our land based activities on the oceans. My everyday thoughts on climate change don't connect me with ocean issues so this workshop challenged me personally.*"

These insights highlight how the immersive experience of creating art from data, and diving deep into the meaning behind that data, forged a personal link for participants, and gave the issue of ocean climate change greater poignancy. The process of active participation was important, and the artworks represented more than illustrations of scientific data — they were a response to it. Such depth of engagement through participatory art is well-recognised in the literature [Lesen, Rogan & Blum, 2016; McKinlay & Rock, 2020], but remains underutilized. People possess far stronger motivation to take action against climate change if they come to it through *self*-persuasion [De Meyer, Coren, McCaffrey & Slean, 2021]. Art expands imagination, creates space for new perspectives, and bestows empowerment to those involved [Bentz, 2020]. In connecting the physical changes underway in the oceans with impacts on local marine species, participants in our study selected narratives rooted firmly in scientific understanding but brought to life through their perspective of why this matters. Viewed through a local lens, the significance and relevance of ocean climate change is strengthened [Scannell & Gifford, 2013; Moser, 2014; Savoie, 2022]. Additionally, participants were emotionally connected to the stories they were working to reveal. Emotions have profound impact [Roeser, 2012; Brosch & Steg, 2021], evident in this case through the commitment of participants to extend the project into future years. At the time of writing, plans are well-underway for 2022–2023 visual workshops, co-led by the authors and participants from this study. In sharing ideas and inspiring others within their spheres of work and play, participants may be powerful influencers beyond this early programme of work.

Participants were asked an open-ended question about barriers preventing people caring about ocean climate change and data. Responses showed that lack of visibility was perceived to be a problem:

> "*It's unrelatable — can't 'see' it*"

> "*Not being able to see beneath the ocean surface and engage with ocean species on a regular basis; not understanding the links between climate change and the ocean*"

Others highlighted a disconnect between people and the natural world, and an absence of space in busy daily life to seek out this information:

"*Managing day to day life and stress… climate change can seem too far distant*"

"*Because they don't interact or carry much care for the ocean, so aren't aware of what's happening*"

"*Because of media and because a lot of people are disconnected with the environment*"

Several respondents also indicated that there is a feeling that climate change is still too distant a problem, or that impacts for this community may even be positive:

"*It doesn't feel real or immediate; there's a perception that warmer is better especially in cold areas like Otago*"

"*Not close enough to home, i.e. don't know about local data collection/results*"

"*We are only small fish in this world*"

Participants also recognized that interpreting data required particular skills, and knowledge linking data with the real-world:

"*Lack of skills for interpreting data, lack of visualization*"

"*Lack of understanding about socio-economic impact*"

"*People mostly don't really understand what's happening*"

These responses suggest that climate change continues to be perceived as an intangible threat, which is either distant or difficult. General concern is reportedly high amougst New Zealanders, but a recent survey by IPSOS [2021] found they had a lower perception of the urgency to 'act now' compared to the global average. Stoknes [2014] refers to the growing 'psychological climate paradox', in which public prioritization of climate change is falling despite increasingly serious scientific assessment. One explanation for this may be that commonly-used narratives of fear are difficult to sustain in the long-term and can be counterproductive to deep and resilient action [O'Neill & Nicholson-Cole, 2009; Kundzewicz, Matczak, Otto & Otto, 2020]. Social identity strongly determines engagement with climate threats, and even inventive efforts to draw attention to the urgency of the crisis can be wasted if the audience is not primed to be engaged [Kahan, 2015]. As many previous authors have shown, there is a temptation to perpetuate the deficit model of communication in the well-meaning production of new materials and media, but this is largely ineffective in garnering enthusiasm for climate action [Pearce et al., 2015; Simis et al., 2016]. Finding the meaning for people remains the holy grail of climate communication, and this Practice Insight provides further evidence that participatory approaches offer deeper engagement [Burke et al., 2018; Bentz, 2020]. In essence, participants connect with climate change as something far more real when they are able to embed their own personal experience into the wider scientific evidence.

Reflections and future work

Across society, there is now wide acceptance that our climate is changing with serious consequences [Flynn et al., 2021], yet radical transformation escapes us. Whilst social movements demanding action gather pace, and international commitments respond with ambitious targets, atmospheric levels of greenhouse

gases continue to grow at alarming rates. Only when these trends slow and reverse will we be on track to a safer climate future. We as a society need to be engaged with this data as it emerges, and to ratchet our efforts accordingly. The issue of climate change is still too abstract for many people: it is not considered to be an immediate threat and other life challenges take centre stage [Stoknes, 2014]. The ocean is a particularly distant concern since its surface is an opaque shield to the majority of us, hiding away the living marvels of its depths. We are losing the richness of our ocean ecosystems with every delay, but largely without knowing what has been lost.

This project explored how we might leverage a deeper response to our changing climate by connecting communities with local data. As a participatory experience, following the changes in ocean temperature and acidity underway locally and the risks to local ocean life, participants felt a greater personal connection to these threats. Their active involvement in creating visual imagery was crucial here, as opposed to receiving it as spectators. Since these datasets are continuously updated, all participants were keen to be involved again in future workshops to develop artworks that keep pace with the emerging data and to share the latest understanding of the tangible risks from ocean climate change more widely. A core component of future work will be to track newly recorded data in this way, and to follow the natural rhythm of the seasons in the context of longer term change. Understanding the concept of natural variability in the climate system, in contrast to longer-term trends resulting from human activities, would enable communities to identify problematic change. Additionally, investigating how enthusiasm for continued workshops translates into changes in decision-making and behaviour will be important in assessing the scope of this project for turning awareness into action. A limitation of the current project was participants' high level of interest in the topic of climate change prior to the workshops, and further work is needed to determine how a climate-neutral or climate-denial audience might respond.

We plan to grow our website (http://www.moretosea.net) as a hub for ocean climate visualisations each year, and to involve our diverse community in creating these visual stories. This crucially must be kept up to date, and serve to make ocean climate data relevant, accessible, and engaging. Just as national attention to Covid-19 numbers in New Zealand has been captured from the clarity and regularity of communication, ongoing effort to harness a similarly widespread interest in climate data is important if we are to bring this issue out of academic classrooms and into our daily lives.

Acknowledgments

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Appendix A. Introductory workshop quiz questions

Table 1. Number of correct responses to introductory quiz questions.

Question (answers in bold)	*City Library* ($n = 11$)	*Dive Otago* ($n = 9$)	*Total* ($n = 20$)
	Number of participants who answered correctly		
Which Whittakers flavour is the best?			
Portobello Marine Lab has the longest sea surface temperature record in New Zealand. ***True*** *or False?*	10	7	17
When did PML begin collecting sea surface temperature data? A) 1904 ***B) 1953*** C) 1965 D) 1992	5	4	9
What is the average sea surface temperature in the Otago Harbour in July? ***A) 7 °C*** B) 8 °C C) 9 °C D) 10 °C	3	0	3
What is the average sea surface temperature in the Otago Harbour in January? A) 11 °C B) 13 °C ***C) 16 °C*** D) 18 °C	2	3	5
How much of the excess heat energy (trapped by greenhouse gases from human activities) have the oceans absorbed? A) 20% B) 30% C) 60% ***D) 90%***	2	1	3
How much anthropogenic carbon dioxide have the oceans absorbed? A) 10% ***B) 30%*** C) 50% D) 75%	1	4	5
How is ocean climate changing globally? ***A) Warmer with lower pH*** B) Warmer with higher pH C) No clear trend in temperature or pH D) Warmer, but no change in pH	6	1	7
Which year has been the warmest on record for sea surface temperature in the Otago Harbour? A) 2013 ***B) 2019*** C) 2018 D) 2017	7	7	14

Continued on the next page.

Table 1. *Continued from the previous page.*

Question (answers in bold)	*City Library* ($n = 11$)	*Dive Otago* ($n = 9$)	*Total* ($n = 20$)
	Number of participants who answered correctly		
Ocean pH has decreased in Otago since measurements began in 1998. What % increase in acidity does this equate to? A) 2% ***B) 7%*** C) 15% D) 30%	7	5	12
New Zealand's ocean takes up more carbon than its forests. ***True*** or false?	7	8	15
What % of New Zealand's seabirds are threatened with extinction due to human activities on land and at sea? A) 30% B) 50% C) 75% ***D) 90%***	3	2	5
How much of New Zealand's marine environment is protected by no-take marine reserves? ***A) 0.3%*** B) 11% C) 17% D) 36%	9	5	14

Appendix B. Final survey questions for participants

1. Prior to this workshop, were you concerned about ocean climate change as an issue globally? *Yes / Somewhat / No*
2. Prior to this workshop, were you aware that the oceans have absorbed over 90% of the heat trapped on Earth by human greenhouse gas emissions, with the remainder taken up by warming air and land, and by melting ice? *Yes / Somewhat / No*
3. Prior to this workshop, were you aware that the oceans also absorb a large amount of carbon dioxide from human activities? *Yes / Somewhat / No*
4. Prior to this workshop, were you concerned about ocean climate change in New Zealand? *Yes / Somewhat / No*
5. Prior to this workshop, did you know that rising ocean temperatures and ocean acidification are the two greatest threats to marine life in New Zealand, greater than fishing and pollution? *Yes / Somewhat / No*
6. Prior to this workshop, were you aware of local programmes to collect ocean climate data, such as the Portobello Marine Lab sea surface temperature record and the Munida Transect? *Yes / Somewhat / No*
7. Having created an artwork about some data today, do you feel that you understand that data better compared to seeing it as the original chart? *Yes / Somewhat / No*
8. Did you find that linking physical data (such as temperature) to impacts on marine life gave this data greater meaning for you? *Yes / Somewhat / No*

9. Following this workshop, are you more concerned about ocean climate change and impacts on local marine life here in Otago, compared to before? *Yes / Somewhat / No*
10. Do you think that creating visuals from data can be an effective way of engaging wider communities with a serious issue like this? *Yes / Somewhat / No*
11. What do you think are some barriers to people caring about ocean climate change/data?
12. Was any information new to you today? If yes, can you say what this was?
13. What information from today's workshop are you most likely to talk about with friends/family?

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