The Phytoplankton Project: Blurring Boundaries Through Art and Science

This SDA is centred around phytoplankton, which are microscopic organisms that live in bodies of water and are photosynthetic. They provide valuable services to other living beings by forming the base of aquatic food webs, producing oxygen and supporting the ocean's absorption of carbon dioxide. Yet they are completely invisible to the naked eye.

I have chosen phytoplankton for my SDA primarily because they show that there are many unseen processes occurring in water at any given time. They demonstrate that water is more than meets the eye: it provides a home to millions of organisms who shape the water they live in and in turn are shaped by it. These interactions then have wider implications for life on land, which is deeply connected to what happens underwater.

This points to a broader question about the relationship between humans and the natural world. Western thought has long been shaped by a desire to separate humans and nature, which can be traced back to influential thinkers such as Rene Descartes, who argued that humans are distinguished from the natural world by their ability to reason.[1]

This thinking has persisted for centuries and runs through politics, law, economics, and even the UN's sustainable development goals (SDGs), which are often presented in ways that separate 'people' from 'planet'.[2] SDG 14, 'life below water' is particularly relevant, as it implies a division between the human world on land and the non-human underwater world.

This separation begins to dissolve when we consider the role of phytoplankton, which both support human life and are affected by human activity. By focusing on the relationship between phytoplankton and human beings, I aim to show that the boundaries we create between humans and nature are not as neat as they may first appear.

Core Questions

This SDA incorporates a creative element and a research element.

The research element focuses on answering the following questions:

- What is the role of phytoplankton and how do they support human life?
- How are phytoplankton being impacted by humans?

The creative element will then explore the following:

- How can I communicate these findings in a way that encourages people to care, and how can I make the invisible visible?

[1] Loreau, M. (2023) 'A brief history of the divorce between humans and nature', in *Nature That Makes Us Human: Why We Keep Destroying Nature and How We Can Stop Doing So*. Oxford: Oxford University Press, pp. 25–44.
[2] United Nations *The 17 goals*. Available at: https://sdgs.un.org/goals (Accessed: 2 May 2026).

The Medium

Although it was not immediately clear which medium would best suit the aims of this project, I decided that a visual format would be most appropriate. During the research stage I came across microscopic images of phytoplankton, which are highly intricate and eye-catching. I felt that I could communicate their importance by first drawing people's attention to their appearance and then encouraging people to think more deeply about their meaning.

An art piece seemed that it would be a suitable way of combining the aesthetic element of the project with the educational. Research shows that art can play an important role in engaging audiences with new perspectives on climate change and environmental issues, by helping inspire feelings of responsibility, care and connection.[3] A series of sea turtle murals in Baja California Sur, Mexico, for example, were found to shape pro-environmental attitudes in the local population, and increase knowledge about marine ecosystems, particularly amongst young people.[4]

This led me to choose murals as a medium for several reasons. Firstly, their placement in public spaces introduces an element of surprise, which can capture attention and encourage engagement with new ideas.[5] Their public placement would also allow them to be viewed by a wide audience, and their large scale would allow phytoplankton to be represented in a way that better reflects their importance.

Because of feasibility issues, the murals will take the form of design proposals, rather than art works physically painted onto buildings.

The Location, Audience and Purpose

I chose to create four murals which would each represent a different concept from the research findings. They would be designed for different locations around the university campus, which felt like a natural choice as it is an active learning environment. Each mural is placed on a different building to reach a wider audience and also to connect the physical location to the meaning of the mural where possible.

Students, who are already engaged in learning, may be likely to stop and discuss the meaning of the murals, especially as they would pass by them every day. I have selected students as the audience as many will go on to work in a broad range of fields, and some will become future decision makers. Amongst these individuals, I hope to foster a greater sense

[3] Bentz, J. (2020) 'Learning about climate change in, with and through art', *Climatic Change*, 162(3), pp. 1595–1612. Available at: https://doi.org/10.1007/s10584-020-02804-4

[4] Schneller, A.J. and Irizarry, A. (2014) 'Imaging conservation: Sea turtle murals and their effect on community pro-environmental attitudes in Baja California Sur, Mexico', *Ocean & Coastal Management*, 89, pp. 100–111. Available at: https://doi.org/10.1016/j.ocecoaman.2013.12.009

[5] Thompson, B., Jürgens, A.-S., Bohie and Lamberts, R. (2023) 'Street art as a vehicle for environmental science communication', *Journal of Science Communication*, 22(04), A01. Available at: https://doi.org/10.22323/2.22040201

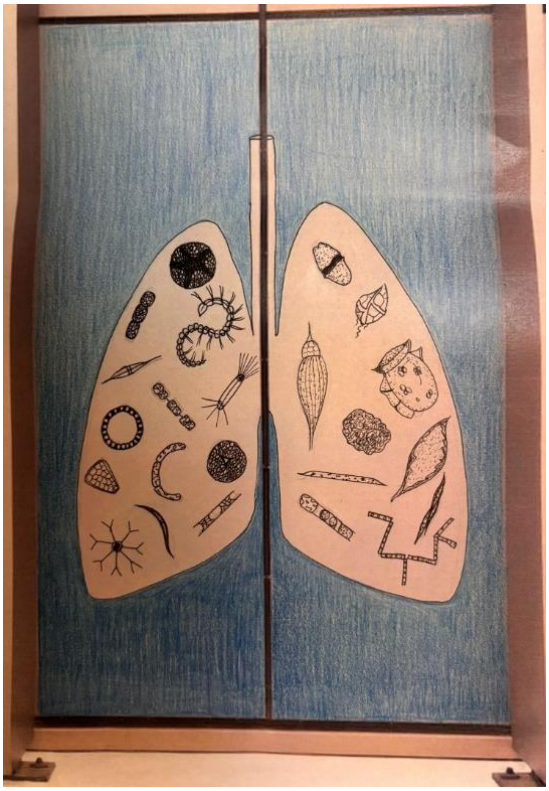
of responsibility and awareness of life below water, in order to influence how they think about environmental issues in the future.

Rather than aiming for direct knowledge transfer, the murals are intended to act as a conversation starter, and to introduce phytoplankton to individuals from many different disciplines and backgrounds. The intention is not necessarily to cause behaviour change, as the processes that are impacting phytoplankton are complex and cannot be directly linked to any one action. Instead, the project aims to bring the unseen natural world into public awareness, and to encourage viewers to reexamine their relationship it.

The Murals:

The murals are shown below, along with a short explanation of the underlying science. The phytoplankton depicted in the murals are artistic interpretations of microscopy images sourced from an online educational database.[6]

Mural 1: Ocean Lungs



The first mural is intended to highlight one of the most important connections between phytoplankton and other living beings. Whilst many people do not know that phytoplankton even exist, they continuously support life both above and below water. Through

[6] University of California, Santa Cruz *Phytoplankton Identification Gallery*. Available at: https://oceandatacenter.ucsc.edu/PhytoGallery/

photosynthesis, phytoplankton produce roughly half of global oxygen, some of which diffuses into the atmosphere and becomes part of the air we breathe. [7]

This is represented through an image of lungs submerged in water and filled with floating phytoplankton. Placing phytoplankton inside the lungs makes them appear part of the human body, rather than inhabitants of an invisible underwater world, and breaks down the imagined separation between humans and aquatic environments.

The Interdisciplinary Biomedical Research building, which is dedicated to the study of the human body, felt like a logical place to locate this mural. Situating the mural here emphasises that human life is intimately connected to the natural world and challenges the idea that the human body exists in isolation from nature.

Mural 2: Coccolithophore Flowers

The second mural focuses on phytoplankton and their ability to sequester carbon. The same photosynthetic process that allows phytoplankton to produce oxygen also helps them store carbon by converting it into biomass, some of which sinks to the deep ocean when they die and can be stored for hundreds or thousands of years. [8]

[7] NASA, *Oxygen factories in the Southern Ocean*. Available at: https://science.nasa.gov/earth/earth-observatory/oxygen-factories-in-the-southern-ocean-87465/

[8] Divya, M., et al, (2018) 'A study of carbon sequestration by phytoplankton', in *YOUMARES 8 – Oceans Across Boundaries: Learning from each other*. Singapore: Springer, pp. 277–284. Available at: https://link.springer.com/chapter/10.1007/978-981-10-7938-2_15

Calcifying organisms called coccolithophores are particularly central to this process, as they use carbon not only to build organic biomass but also to form calcium carbonate plates. This converts additional carbon into a solid form, and also adds weight which helps them sink more easily to the ocean floor.[9]

Unfortunately, this process is being disrupted by climate change. As carbon dioxide concentrations in the atmosphere increase, the ocean is becoming more acidic, which can weaken the shells of coccolithophores. This means less carbon reaches deeper waters, which therefore threatens one of the planet's natural defences against climate change.[10]

I have chosen to highlight this issue by creating a mural design of coccolithophore flowers. I have used flowers because it is well known that plants on land sequester significant amounts of carbon, particularly trees, but the role of phytoplankton in carbon storage often goes unnoticed. Phytoplankton are estimated to absorb between 20 to 35% of global CO2 emissions each year which is approximately equivalent to four amazon rainforests.[11] Many campaigns exist that aim to protect the amazon and other terrestrial ecosystems from deforestation, but the same level of attention is not given to phytoplankton.

By representing coccolithophores as flowers, the mural shows that they play a similarly important role in the carbon cycle to ecosystems on land. The particular wall that they are placed on has been chosen as the location because there is a plant bed at the base, which the coccolithophores blend into, emphasising their equal role alongside them. Although the coccolithophores in the mural largely appear healthy, one on the right-hand side is drooping and beginning to dissolve, which is to represent the impact of ocean acidification on coccolithophore shells.

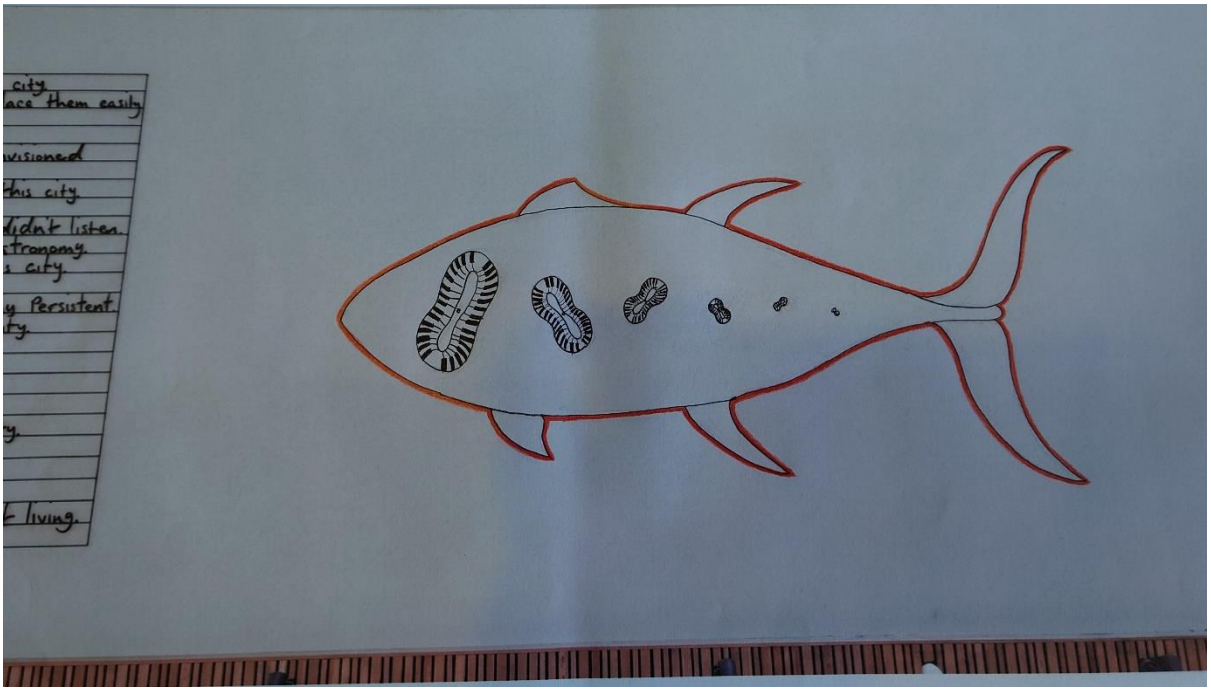
The Warwick arts building has been selected as the location for this mural as it reflects one of the main arguments of the project – that art and science can complement each other, and create new ways of understanding the world that each discipline cannot achieve alone.

Mural 3) Food Webs Under Strain

[9] Chauhan, N. and Rickaby, R.E.M. (2024) 'Differential impacts of pH on growth, physiology, and elemental stoichiometry across three coccolithophore species', *Limnology and Oceanography*. Available at: https://doi.org/10.1002/lno.12738

[10] Ibid.

[11] Naselli-Flores, L. and Padisák, J. (2023) 'Ecosystem services provided by marine and freshwater phytoplankton', *Hydrobiologia*, 850, pp. 2691–2706. Available at: https://doi.org/10.1007/s10750-022-04795-y



The third mural demonstrates how phytoplankton support food webs and fisheries. They form the base of marine food webs as primary producers, and are eaten by larger aquatic animals which pass energy up the food chain.[12] They also play a key role in nutrient cycling, which moves essential elements through ecosystems so life can continue.[13] Through both of these processes, phytoplankton sustain fisheries, and this in turn supports food security and livelihoods across the globe.

However, climate change is disrupting phytoplankton's ability to provide these functions. Climate change alters light, temperature, and nutrient availability, all of which are needed for phytoplankton to survive.[14] This is resulting in a trend towards two negative impacts: reduced biomass [15] and regional changes in species compositions, with warm-water species expanding poleward, and cold-water species declining.[16] Smaller species are also expected to predominate in mid-low latitudes, while larger species move towards high latitudes.[17] These changes will have complex repercussions but broadly speaking are expected to affect

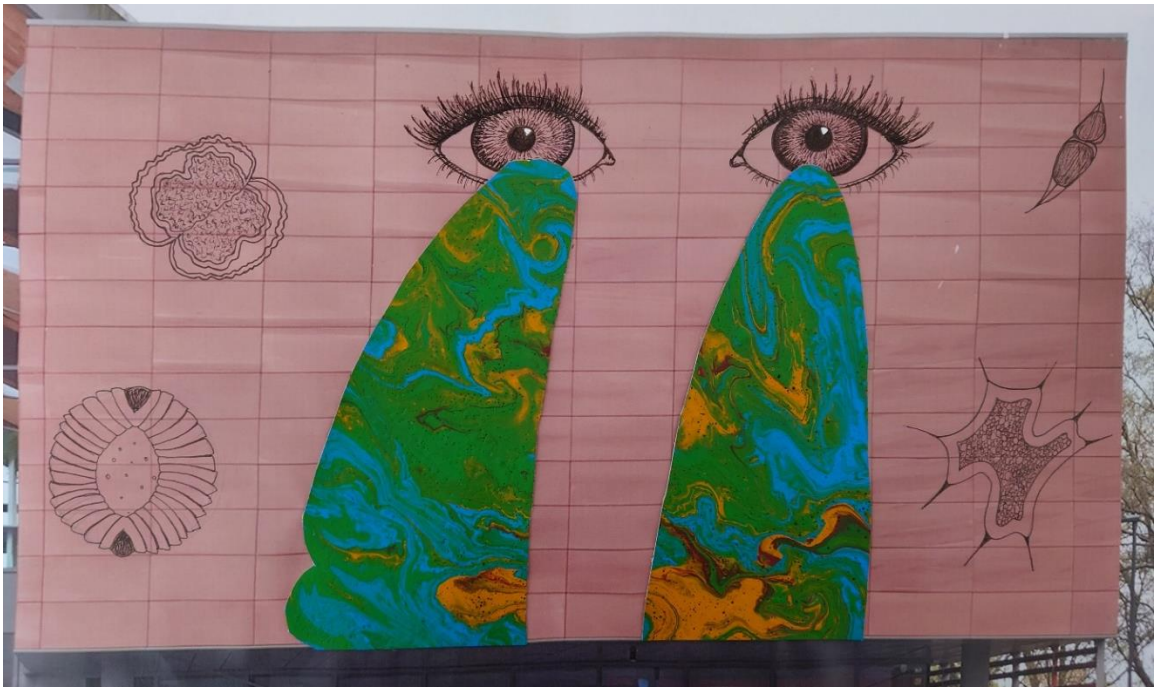
[12] Ibid.
[13] Ibid.
[14] Li, Z. *et al.* (2024) 'Ocean-scale patterns of environment and climate changes driving global marine phytoplankton biomass dynamics', *Science Advances*, 10. Available at: https://www.science.org/doi/10.1126/sciadv.adm7556
[15] Silsbe, G.M., *et al.* (2025) 'Global declines in net primary production in the ocean color era'. *Nature Communications*, 16, Article 5821. Available at: https://www.nature.com/articles/s41467-025-60906-y
[16] Hutchins, D.A. and Tagliabue, A. (2024) 'Feedbacks between phytoplankton and nutrient cycles in a warming ocean', *Nature Geoscience*, 17(6), pp. 495–502. Available at: https://doi.org/10.1038/s41561-024-01454-w
[17] Zhan, W. et al. (2026) 'Global responses of phytoplankton size structure to marine heatwaves', *Global Biogeochemical Cycles*, 40 (1). Available at: https://doi.org/10.1029/2025GB008854

fisheries productivity, especially in tropical regions, who depend heavily on fisheries for food and income.[18]

For this mural I have used an outline of a tuna fish filled with shrinking phytoplankton. Tuna was chosen because it is one of the most widely eaten and economically important fish species globally, and is a critical food source in many tropical regions. [19] The shrinking phytoplankton represent declining biomass and species shifts, and their placement within the fish shows the dependence of higher levels of the food chain on phytoplankton. The tuna is outlined in red to show rising temperatures, which is one of the primary drivers of the changes discussed.

The location for this mural is the interior of the faculty of arts building, due to the fact that this building was specifically designed to foster collaboration between different disciplines.[20] This location therefore has the potential to promote a key aim of the project, which is to encourage discussion and engagement over the meaning of the murals amongst a wide variety of individuals.

Mural 4) Toxic Bloom Tears



[18] Atkinson, A., *et al.* (2024) 'Steeper size spectra with decreasing phytoplankton biomass indicate strong trophic amplification and future fish declines', *Nature Communications*, 15, Article 381. Available at: https://www.nature.com/articles/s41467-023-44406-5

[19] BBC News (2024) 'How climate change threatens the economic lifeline of Pacific tuna'. Available at: https://www.bbc.co.uk/news/articles/cq57vxjvdy4o

[20] University of Warwick (2025) *Arts Faculty Facilities*. Available at: https://warwick.ac.uk/fac/arts/aboutus/artsfacultyfacilities/

The last mural shows one of the only visible indicators of human activity on phytoplankton – harmful algal blooms (HABs).[21]

HABs are primarily caused when certain species of phytoplankton grow rapidly in a specific area. In healthy aquatic ecosystems, phytoplankton blooms can be positive, serving as feeding spots for marine life and supporting the functions of the ecosystem they are found in.[22] However, due to human activity, harmful blooms have started to become a major problem globally. These blooms can produce toxins that poison fish, wildlife and humans, or create low oxygen conditions that kill marine life. As a result they can have negative impacts on ecosystems, human health, and economic activities such as tourism.[23] The 2016 toxic bloom in Chile, for example, caused the death of tens of millions of farmed salmon and approximately $800 million worth of economic losses, resulting in public protests among coastal communities who depended on these fisheries.[24]

HABs are often caused by pollution, primarily from agricultural runoff or sewage, which increases the amounts of nutrients in the water.[25] Climate change is another key cause, as it favours the growth of some harmful species, and changes environmental conditions such as sea-level rise and rainfall patterns, further increasing the risk of blooms in many areas.[26] Broadly, research shows that climate change is increasing the frequency and intensity of HABs, although some regions are worse affected than others.[27]

These findings are represented through a mural that shows a HAB flowing from a pair of eyes. I chose to depict the bloom this way to highlight how HABs can be severely detrimental to human health and livelihoods, yet their occurrence is often connected to situations of our own making. The flowing tears are representative of the grief and frustration associated with this dynamic, where marine and freshwater environments are increasingly being degraded at our own expense. Phytoplankton are drawn floating in the background, to ensure that the connection to them remains clear.

The outside of the Oculus building was chosen for this mural as it has high foot traffic and high visibility, making it the perfect setting for arguably the most visually impactful mural. The

[21] For visual examples of HABs see: Sky News (2023) 'Striking satellite images reveal beauty and danger of algal blooms'. Available at: https://news.sky.com/story/striking-satellite-images-reveal-beauty-and-danger-of-algal-blooms-12823550

[22] Atkinson, A., *et al.* (2024) 'Steeper size spectra with decreasing phytoplankton biomass indicate strong trophic amplification and future fish declines', *Nature Communications*, 15, Article 381. Available at: https://www.nature.com/articles/s41467-023-44406-5

[23] Wang, P. (2022). Harmful Algal Blooms. In: Cui, W., Fu, S., Hu, Z. (eds) Encyclopedia of Ocean Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-10-6946-8_345

[24] Díaz, P.A., *et al.* (2021) 'Disentangling the environmental processes responsible for the world's largest farmed fish-killing harmful algal bloom: Chile, 2016', *Science of the Total Environment*, 763, 144183. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0048969720379146

[25] Wang (2022) 'Harmful Algal Blooms'

[26] Brenckman, C.M. (2025) 'A review of harmful algal blooms: Causes, effects and mitigation strategies', *Water*, 17(13). Available at: https://www.mdpi.com/2073-4441/17/13/1980

[27] Dai, Y., *et al.* (2023) 'Coastal phytoplankton blooms expand and intensify in the 21st century', *Nature*, 615(7951), pp. 280–284. Available at: https://www.nature.com/articles/s41586-023-05760-y

Oculus was also the building where the 'thinking water' sessions took place, which brings the project full circle.

Limitations

This project has several limitations. Firstly, the research findings show elements of uncertainty and complexity regarding human impacts on phytoplankton, which it was not possible to fully convey through the murals. In the original proposal I planned to use QR codes alongside the murals to give additional scientific context, however as the aim of the murals shifted away from direct information transfer it felt unnecessary to keep them. The project takes a broad approach instead, prioritising accessibility and engagement over providing a full analysis.

Another limitation is that the murals exist as design proposals rather than physical works of art. Creating actual murals would require funding, planning permission, and collaboration with a professional muralist, which was not possible within the scope of this project. Nonetheless, the design proposals still allow the main concepts and themes of the project to be explored.

Perhaps the greatest limitation is the use of the language of 'ecosystem services', which refers to the framing of natural systems in terms of what they can do for humans, as opposed to their inherent value.[28] By using this language, there is a risk that the human-nature divide is inadvertently reinforced. I have attempted to address this by ensuring the visual symbolism within the murals avoids any sense of hierarchy, and the emphasis is on relationality instead. However, the reliance on the language of ecosystem services shows the difficulty of trying to critique an intellectual tradition from within it.

Alternative critiques of the human-nature divide can be found in indigenous work. The book 'Braiding Sweetgrass' by Robin Wall Kimmerer, for example, argues that plants and the natural world are not resources, they are living beings with agency. [29] The book promotes reciprocity between humans and nature and draws on the author's lived experience as a member of the Citizen Potawatomi Nation. Whereas my project starts from a point of separation, Kimmerer's world view assumes that humans and nature are inseparable.

Summary

Together, the four murals tell a story about how phytoplankton underpin many of the processes that support human life, including oxygen production, carbon storage, and marine food webs. Despite the fact that phytoplankton are invisible to us, they play a huge role in our lives, and we also impact theirs. Through climate change, pollution, and other activities, we

[28] Tallis, H., et al. (2013) 'Ecosystem services', in Simon A. Levin (ed.) *Encyclopedia of Biodiversity*. 2nd edn. Academic Press, pp. 96–104. Available at: https://doi.org/10.1016/B978-0-12-384719-5.00284-7

[29] Robin Wall Kimmerer (2013) *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants*. Minneapolis: Milkweed Editions.

are damaging the marine and freshwater environments that phytoplankton call home, ultimately creating problems that will come back to affect us.

This challenges the Cartesian divide between humans and nature, which is reflected in SDG 14, 'life below water'. While it is easy for many current decision makers to assume that life below water is far removed from human life, and therefore less important, this is not the case. Phytoplankton show that humans are inseparable from marine and freshwater environments, and actions to protect them are ultimately actions to protect ourselves. Moving towards a more relational way of thinking may help overcome the disconnect between human societies and the natural world.

Although the project has limitations, by merging art and science, it has aimed to engage the audience through curiosity as opposed to fear. Rather than presenting information through facts alone, it uses art to communicate a complex topic in a way that goes beyond the rational mind. Placing phytoplankton into the heart of campus makes the unseen underwater world visible, and provides a brief insight into its true importance to humanity.

Overall, the murals encourage people to see water in a different light; not as something external but as an integral part of ourselves that requires greater care and attention. And to understand that although the processes below water may be physically remote and out of sight, without them, the world as we know it would not be the same.

References

Atkinson, A., Rossberg, A.G., Gaedke, U. *et al*. (2024) 'Steeper size spectra with decreasing phytoplankton biomass indicate strong trophic amplification and future fish declines', *Nature Communications*, 15, Article 381. Available at: https://www.nature.com/articles/s41467-023-44406-5

BBC News (2024) 'How climate change threatens the economic lifeline of Pacific tuna'. Available at: https://www.bbc.co.uk/news/articles/cq57vxjvdy4o

Bentz, J. (2020) 'Learning about climate change in, with and through art', *Climatic Change*, 162(3), pp. 1595–1612. Available at: https://doi.org/10.1007/s10584-020-02804-4

Brenckman, C.M. (2025) 'A review of harmful algal blooms: Causes, effects and mitigation strategies', *Water*, 17(13). Available at: https://www.mdpi.com/2073-4441/17/13/1980

Chauhan, N. and Rickaby, R.E.M. (2024) 'Differential impacts of pH on growth, physiology, and elemental stoichiometry across three coccolithophore species', *Limnology and Oceanography*. Available at: https://doi.org/10.1002/lno.12738

Dai, Y., Yang, S., Zhao, D. *et al*. (2023) 'Coastal phytoplankton blooms expand and intensify in the 21st century', *Nature*, 615(7951), pp. 280–284. Available at: https://www.nature.com/articles/s41586-023-05760-y

Díaz, P.A., Álvarez, G., Varela, D. *et al*. (2021) 'Disentangling the environmental processes responsible for the world's largest farmed fish-killing harmful algal bloom: Chile, 2016.', *Science of the Total Environment*, 763, 144183. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0048969720379146

Divya, M., Dinesh Kumar, S., Krishnaveni, N. and Santhanam, P. (2018) 'A study of carbon sequestration by phytoplankton', in *YOUMARES 8 – Oceans Across Boundaries: Learning from each other*. Singapore: Springer, pp. 277–284. Available at: https://link.springer.com/chapter/10.1007/978-981-10-7938-2_15

Hutchins, D.A. and Tagliabue, A. (2024) 'Feedbacks between phytoplankton and nutrient cycles in a warming ocean', *Nature Geoscience*, 17(6), pp. 495–502. Available at: https://www.nature.com/articles/s41561-024-01454-w

Li, Z. *et al.* (2024) 'Ocean-scale patterns of environment and climate changes driving global marine phytoplankton biomass dynamics', *Science Advances*, 10. Available at: https://www.science.org/doi/10.1126/sciadv.adm7556

Loreau, M. (2023) *Nature That Makes Us Human: Why We Keep Destroying Nature and How We Can Stop Doing So*. Oxford: Oxford University Press.

Marshmallow Laser Feast, *Information*. Available at: https://marshmallowlaserfeast.com/ (Accessed: 2 May 2026).

NASA, *Oxygen factories in the Southern Ocean*. Available at: https://science.nasa.gov/earth/earth-observatory/oxygen-factories-in-the-southern-ocean-87465/ (Accessed: 2 May 2026).

Naselli-Flores, L. and Padisák, J. (2023) 'Ecosystem services provided by marine and freshwater phytoplankton', *Hydrobiologia*, 850, pp. 2691–2706. Available at: https://doi.org/10.1007/s10750-022-04795-y

Robin Wall Kimmerer (2013) *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants*. Minneapolis: Milkweed Editions.

Schneller, A.J. and Irizarry, A. (2014) 'Imaging conservation: Sea turtle murals and their effect on community pro-environmental attitudes in Baja California Sur, Mexico', *Ocean & Coastal Management*, 89, pp. 100–111. Available at: https://doi.org/10.1016/j.ocecoaman.2013.12.009

Silsbe, G.M., Fox, J., Westberry, T.K. and Halsey, K.H. (2025) 'Global declines in net primary production in the ocean color era'. *Nature Communications*, 16, Article 5821. Available at: https://www.nature.com/articles/s41467-025-60906-y

Sky News (2023) 'Striking satellite images reveal beauty and danger of algal blooms'. Available at: https://news.sky.com/story/striking-satellite-images-reveal-beauty-and-danger-of-algal-blooms-12823550 (Accessed: 2 May 2026).

Tallis, H., Guerry, A. and Daily, G.C. (2013) 'Ecosystem services', in Simon A. Levin (ed.) *Encyclopedia of Biodiversity*. 2nd edn. Academic Press, pp. 96–104. Available at: https://doi.org/10.1016/B978-0-12-384719-5.00284-7

Thompson, B., Jürgens, A.-S., Bohie and Lamberts, R. (2023) 'Street art as a vehicle for environmental science communication', *Journal of Science Communication*, 22(04), A01. Available at: https://doi.org/10.22323/2.22040201

United Nations, *The 17 goals*. Available at: https://sdgs.un.org/goals . (Accessed: 2 May 2026).

University of California, Santa Cruz *Phytoplankton Identification Gallery*. Available at: http://oceandatacenter.ucsc.edu/PhytoGallery/ (Accessed: 2 May 2026).

University of Warwick (2025) *Arts Faculty Facilities*. Available at: https://warwick.ac.uk/fac/arts/aboutus/artsfacultyfacilities/ (Accessed: 2 May 2026).

Wang, P. (2022). Harmful Algal Blooms. In: Cui, W., Fu, S., Hu, Z. (eds) Encyclopedia of Ocean Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-10-6946-8_345

Zhan, W. et al. (2026) 'Global responses of phytoplankton size structure to marine heatwaves', *Global Biogeochemical Cycles*, 40 (1). Available at: https://doi.org/10.1029/2025GB008854