Natural Resources Wales
'Nature and Us' Survey

Summary of views submitted by the Microbiology Society

We note that our response reflects the views expressed by fourteen individuals who responded to our call for input and shared their views on key issues that matter to them. Therefore, our response is by no means comprehensive, and it is not our intention to speak on behalf of the whole microbiology community. Rather, we highlight anecdotes and the perspectives of our respondents, and provide scientific context and recommendations where appropriate. We have not provided responses to all the questions posed in the survey. Instead, we have selected the questions[1] where we believe our input would be most valuable.

Introduction

1. The Microbiology Society is a membership charity for scientists interested in microbes, their effects and their practical uses. It is one of the largest microbiology societies in Europe with a worldwide membership based in universities, industry, hospitals, research institutes and schools. Our members have a unique depth and breadth of knowledge about the discipline. The Society's role is to help unlock and harness the potential of their knowledge to bring maximum benefit to society.
2. We welcome the opportunity to inform Natural Resources Wales by responding to this survey. We have over 140 members in Wales who possess expertise spanning many areas including agriculture, environmental science, industrial biotechnology, conservation, waste management and more. Microbiology can therefore contribute to efforts to adopt sustainable practices and reduce environmental damage.

Part 1

Question 1: Do you think climate change is a global emergency?

3. Our respondents unanimously responded 'Yes'

Question 2: Do you think the nature crisis is a global emergency?

4. Our respondents unanimously responded 'Yes'

[1] We have provided responses to questions 1, 2, 5, 6, 18, 19, 23 and 25.

Question 5: What do you think are the three most important actions to take over the next 10 years, and who should be taking them?

5. Respondents commonly cited **reducing energy consumption** and **transitioning to renewable energy sources** such as wind, solar and tidal as actions to prioritise, with accountability primarily going to the national government. More specifically, responses highlighted a need for better insulation of homes and more incentives (or better communication of incentives) to improve insulation in older homes, environmental impact assessments prior to installation of renewable power plants and better conservation of the Cardiff Bay barrage.

6. Improvements to **public transport infrastructure** and more incentives to use public transport were also important actions flagged by respondents. Incentive suggestions included increasing taxation of air and car travel, reducing the cost of public transport, increasing the number of cycle lanes, reducing the tax on electric vehicle (EV) sales and increasing the on-street availability of EV-charging points. These policies would work to reduce carbon footprints and air pollution, keep individuals healthy and improve transport links for commuters. Respondents mainly held both national and local governments responsible for implementing these changes, with one respondent holding individuals accountable for making the switch from a petroleum-powered vehicle to an EV.

7. **Conserving more of Wales' green spaces** came up repeatedly among our respondents. Respondents suggested local and national governments stop building on green field sites, and instead investigate re-developing existing properties and sites in towns, using vacant buildings and occupancies as housing. Other respondents called for Natural Resources Wales to increase the protection of peatlands and wetlands and to tighten regulation to stop sewage discharges, agricultural run-off and faeces slurry from intensive farming spilling into waterways.

8. **Support for local farmers**, assurances that they will be fairly compensated for their hard work and further support of sustainable soil use was mentioned by two respondents. They held 'all of the above' (i.e., individuals, community groups, businesses, local governments, national government, financial institutions and investors) responsible for this. Another suggested that local governments introduce more schemes to incentivise sustainable farming, forestry and fishing practices to protect the environment and support local businesses. To implement, promote and/or reward 'good' management of soils, such support could take the form of policy development. A new food-labelling scheme, such as a modified Red Tractor logo, is also recommended for certified sustainably managed soils in order to create societal consumer demand for sustainable produce. You can read more about this in our Soil Health Policy Report.

9. Other respondents suggested that **recycling** should be a priority area. While they recognised that Wales performs well at kerbside recycling in towns and cities, they expressed a need for it to be equally considered throughout the whole of Wales, including in rural areas, and held 'all of the above' (i.e., individuals, community groups, businesses, local governments, national government, financial institutions and investors) responsible for this. One specific suggestion mentioned not just measuring recycling based on how much is separated on the kerbside but on how much actually ends up being recycled. Another respondent cited a need

for businesses, with support from the national government, to make more of an effort to be sustainable and reduce the amount of waste they produce. Another respondent argued that the national government should implement a directive that reduces the use of materials, for instant for packaging, that cannot or can only partially be recycled to ultimately avoid the use of unrecyclable (mixed) materials.

10. One respondent noted a need for the national government to increase funding for research into **metal and finding alternative sources**. Metals catalyse almost half of all microbial reactions and yet can poison micro-organisms. Engineering the metal-supply in micro-organisms is therefore highly relevant to industrial biotechnological processes such as renewable bioenergy production, bioremediation[2] of waste products and recovery of valuable metals from low grade substances. You can read more about metal-microbe interactions and how these can be exploited in the Metals in Microbiology collection from our journal *Microbiology*.

Question 6: Imagine life in 2050 – think about how different life may be for you and your family. Describe the future natural environment that you would choose.

11. One respondent imagined a future where we are less dependent on petroleum-fuelled cars and can rely on extensive, affordable public transport systems.

    "I would choose to be living much the same way I am now, but with less reliance on cars to visit family in England, with better public transport options. I would rather be spending more on good quality food and that be my 'luxury' than paying hundreds for return train tickets that take many hours when it is much quicker and cheaper to drive and see family/visit spaces around Wales. I believe we have great scenic destinations nearby, but these are not approachable via foot, as there is a lack of pavements on many routes." - Microbiology Society respondent.

12. Some spoke about a future with less waste, a ban on single use and virgin plastics and a societal effort to remove pollutants from the Welsh environment.

    "With bans on single use plastics already being forefront in 2022, additional measures to reduce and remove plastic and other environmental contaminants and pollutants from the mass-production chains would positively impact the natural environment." – Microbiology Society respondent.

13. A more sustainable and environmentally conscious lifestyle was cited by other respondents, who imagined a future where society is no longer reliant on fossil fuels and works together to protect the Welsh environment.

    "Using the knowledge and resources we have accumulated, we would ensure people are fed in a more sustainable way, such as insect protein being a base for protein powder. We would

[2] Bioremediation is the process whereby micro-organisms convert contaminants into less hazardous substances.

approach farming and food production with the aim to reduce and remove damaging practices that are currently destroying wild, endangered, or protected spaces or species. By assigning additional protected areas and ensuring the land allocated for food production is used in as minimally damaging a way as possible, we would protect and reverse the decline of the natural environment. Water ways should be protected in the same way." – Microbiology Society respondent.

"I'd like more incentives for young people to go into careers that would help secure the planet's future, e.g., heating engineers." – Microbiology Society respondent.

Part 2

Question 18: What environmental issues are you worried about impacting your life, your family, or your home?

14. Climate change was the most prevalent worry cited among respondents, with one expressing concern about the impact of climate change on the mental health of their children. Climate change has long-term consequences for children, yet as individuals they have little power to limit its harm, which makes them particularly vulnerable to climate anxiety.
15. Damage to property as a result of climate change was also cited as a concern. Wales is most densely populated at its coastline, which is particularly exposed to wind and flood damage following extreme weather events.
16. Two respondents cited air pollution and the consequent health issues as a source of concern. Areas of Wales that are reliant on industrial activities (for example, manufacturing and steel works) and congestion within cities are huge contributors to this.
17. Another commonly highlighted concern was plastic and microplastic pollution. One member specifically mentioned the amount of plastic generated by their research. While this is not necessarily an issue specifically for the Welsh government, it is something that needs to be considered and will require investment from universities, suppliers and funders. It also demonstrates the importance of each industry reflecting on their waste production and considering internal efforts to reduce plastic waste. For instance, microbiologists at the University of Edinburgh's Roslin Institute developed an approach to reduce plastic waste by replacing single-use plastics with re-usable equipment, and decontaminating plastic equipment which would have usually been thrown away after one use. This is an economical and sustainable way to reduce waste, and demonstrates the impact of small, simple changes to everyday practices.
18. While plastic waste continues to accumulate in all of Earth's systems, we would like to recognise that Wales has long been a UK frontrunner when it comes to recycling. Since devolution, Welsh recycling rates have increased from just 4.8% in 1998-99 to over 65% in 2020-21, demonstrating what Wales can achieve when government, businesses and the public work towards a common goal.

Question 19: If you had to choose one action Wales could take to protect its environment, what would this be?

19. Renewable energy and carbon emissions came up repeatedly among responses to this question. Wales has a sunny, windy and tidal coastline, so investing in efficient solar, wind and tidal energy generation strategies and power storage has huge potential to reduce Wales' reliance on fossil fuels and levels of air pollution. One respondent suggested modifying building standards to save energy by improving home insulation. Additionally, microbiologists investigating fossil fuel alternatives are exploring ways in which biofuels can be produced from waste plant feedstock. Microbes can produce bioethanol from biomass through enzymatic digestion. Using this renewable organic material as an alternative energy source can further contribute to the decarbonisation of energy systems. You can read more about how we can harness the power of microbes to generate renewable energy in our Climate Change Policy Briefing.

20. Respondents also called for improvements to environmental management practices, for instance by more tightly regulating sewage discharges into rivers, reducing rates of organic pollution due to agricultural run-off and adopting holistic management practices of both farmed and wild spaces. Soil microbes can be used to clean-up polluted wastewater and organic pollution via bioremediation. This can restore healthy soils and water systems and preserve biodiversity by cleaning up pollutants and reducing leaching. You can read more about using soil microbes for bioremediation and conserving soil microbial diversity in our Soil Health Policy Report.

    Another serious concern is the transmission of disease via run-off from farmland. Livestock diseases in cows, pigs, sheep and poultry are likely to be the single largest cause of financial loss in British agriculture, and adversely affect animal welfare and trade. Infectious animal diseases can also spread to wildlife, threatening the well-being of entire ecosystems. In addition, the overuse of antimicrobials to treat infected animals is likely to affect future animal health and food production, as infectious organisms that cause livestock disease can adapt to escape control by existing drugs or vaccines. In addition, there is a concern over the potential for the transfer of antimicrobial resistance from farmland microbes to microbes found in soils that infect humans and vice versa. The presence of antimicrobial resistance in the environment is a potential reservoir for its spread and may also impact on human and animal health.

    There are considerable concerns about the number of viable growing cycles remaining in global soil stock, which will precipitate microbial habitat and diversity loss, leading to further decline in soil health. The soil microbiome – the interactive, living component of the soil including bacteria, fungi, protists and other single-celled organisms – is key for maintaining soil health and can help halt biodiversity loss of other organisms through increased nutrient availability and the breakdown of organic matter. Microbiology plays a key role in securing a future in which healthy and sustainable soils can effectively support agriculture and food security, while preserving our limited land resources. Whilst clear indicators of progress for air and water quality exist, there is a lack of a soil quality directive and accompanying soil health indicators that could be used to develop new policies or guidelines. Initiatives to

define clear indicators are currently being developed (see case study in point 24), however, further engagement with industry is needed to define meaningful indicators.

21. The need to increase recycling rates was also re-iterated (see points 9, 12 and 17). Microbiological methods of waste management using micro-organisms can be deployed in techniques such as composting, activated sludge, trickling filters and oxidation ponds, and play a key role in treating and converting waste streams into value-added products. You can read more about this in our Circular Economy Policy Report. The circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use and regenerating natural systems. Microbiology is essential for the development of the circular economy, including in the areas of plastic and food waste, and could be harnessed to move away from the throwaway society.

    Positive behavioural shifts, such as reduction of single-use plastic, have been reversed due to the COVID-19 pandemic and therefore public engagement across the UK should be prioritised to halt plastic pollution which damages the environment. Using the momentum of the 'build back better' campaigns, there is an opportunity for policymakers and microbiologists to engage with the public in this area and encourage behavioural change to adopt a more circular economy.

22. In order to reduce negligent environmental damage, environmental impact assessments were also recommended for all public and private developments and activities. These assessments should consider the impact of activities on factors such as microbial biodiversity, soil health, waste management and ecosystem services.

Question 23: Do you know of any ideas or policies used in other countries that support the environment and could be adopted in Wales? If so, what do these involve?

23. Case Study 1: Managing Plastic Waste

Respondents suggested establishing a legal requirement for all fast-food packaging to be completely recyclable, and the implementation of a sales levy to pay for this recycling. A scheme like this has been implemented successfully in Germany, which operates a producer responsibility model. This means that producers are responsible for the cost of recycling, and waste costs depend on the weight of a product that companies make. This policy was introduced to reduce the impact of packaging waste on the environment and incentivise retailers to promote the use of eco-friendly products.

Microbes can be used to produce eco-friendly products. For example, food waste is naturally converted into volatile fatty acids and by-products like nitrogen and phosphorus. Micro-organisms can use these to produce bio-alternatives to petroleum-based plastics. You can read more about this in our Climate Change Policy Briefing.

We can also employ microbes to bio-upcycle existing plastic waste. Micro-organisms have evolved to utilise a wide range of carbon energy substrates, including plastics or plastic-derived molecules. Use of plastic waste as a non-conventional feedstock with the capacity of

these micro-organisms to produce value-added molecules should be a perspective of the circular economy of plastics.

24. Case Study 2: Measuring Soil Health

To help policy makers and land managers, we need to define standards for soil health for our mix of soil types, land uses and climate zone combinations. We can recognise when a soil is becoming more unhealthy if regular data is available, but soil health is difficult to analyse.

Development work done in Japan at the National Agriculture and Food Research Organisation over a 20-year period resulted in the creation of a soil testing company called DGC Technology. DGC introduced BIOTREX as a numerical value of the diversity and activity of soil microbial communities[3]. Soils with a high BIOTREX value (and thus a high soil microbial diversity and activity) are less prone to crop disease, softer and therefore more able to accommodate root systems, and even produce vegetables with a better flavour. Measuring the BIOTREX value is a quick and economical way of assessing the microbiological properties of soils.

We need a policy 'pull' at government level to ensure soil health and monitoring is prioritised equally against other natural resources. Wales has already responded and now has soil carbon as one of its 46 National Indicators to track progress to achieving the United Nations Sustainable Development Goals. It is also recommended that legislation views soil as a public resource. To do this, we should look to the new European Union (EU) soil strategy that sets out a framework and concrete measures to protect soils and ensure that they are used sustainably. We need to start monitoring and taking action now as we are already behind the curve with 60-70% soil across the EU estimated as unhealthy using the incomplete data available. The BIOTREX value could be particularly useful for measuring soil health and informing environmental management in Wales.

25. Case Study 3: Measuring Water Toxicity

Microbes influence the physical structure of soil, affecting water resource quality and availability. Wastewater sludge is often applied to soils, both to increase soil fertility and as a method of disposal. However, soils can be polluted with pathogens and hazardous compounds present in insufficiently treated wastewater sludge, which can leach into soils, rivers and water supplies causing toxicity and negatively affecting resource quality.

The Continuous Toxicity Monitoring (CTM) system is the result of 40 years of fundamental research done in Cardiff, and won a Cardiff University Innovation prize. It is marketed by 'Modern Water' and uses a bioluminescent bacterium as a biosensor. A toxic water event is detected by a decrease in bioluminescence in response to toxic chemicals. The equipment is currently being used to monitor the Yangtze River (China), where it can continuously record

[3] International patent application number PCT / JP2010 / 051329. BIOTREX registered trademark application number (business application 2021-110626)

data which is then transmitted in real time. The CTM system could be employed in Wales to collect valuable data on water toxicity.

26. There is a need for better policy coherence and integration between food and agriculture, energy, waste and trade sectors in order to enable the transition to a circular economy. The Wellbeing of Future Generations Bill[4] , which has garnered cross party support in its call for public bodies to act in pursuit of the environment, social, economic and cultural well-being of the UK, is recognised as a positive step towards beginning to address the greatest threats facing future generations.

Question 25: Important additional comments

27. Respondents raised concerns that this survey does not acknowledge the extinction risk faced by organisms that are not animals or plants and the growing concerns on conservation of microbiomes. The British Isles form a biodiversity hotspot for many fungi (possibly other microbes too), and Wales is home to globally vulnerable (VU) populations of grassland fungi, as assessed by the International Union for Conservation of Nature. Natural Resources Wales has previously funded research to develop methods to detect rare Welsh grassland fungi, which are now widely deployed by Natural England (e.g., in 2019 a site near Birmingham was the first globally to acquire legal protection following deployment of eDNA approaches). Respondents worried that the Welsh government's current drive for afforestation has been prioritised without due consideration of biodiversity conservation (especially in grasslands whose true biodiversity importance is not fully appreciated). Tree planting does not necessarily lead to sequestration of carbon in soil where the soil already has a high carbon content. For instance, in many undisturbed grasslands tree planting can lead to net carbon emissions from such soils e.g., due to priming effects of disturbing mature environments. They raised concerns that tree planting is occurring in Wales without suitably rigorous regulation to ensure that the potential benefits of afforestation are balanced against biodiversity loss and the potential of damage to existing stores of soil carbon.

28. Another respondent raised a similar concern that afforestation is being prioritised over the protection of ancient trees that provide a unique habitat crucial for the survival of many fungi and invertebrate species (e.g. *Piptoporus quercinus*; assessed as globally VU by IUCN). Due to historic use of ancient trees, there is a large age gap in tree populations, so when ancient trees die, there are not enough younger trees aging to replace them. The respondent calls for the protection of ancient trees and woods so they can survive longer and provide continuity of habitat for the surrounding ecosystem.

29. One respondent noted the current lack of recognition of the importance of microbial communities in wider conservation and biodiversity efforts. Loss and re-introduction of key

[4] Wellbeing of Future Generations Bill [HL] 2019-21: https://services.parliament.uk/bills/2019-21/wellbeingoffuturegenerationsbill.html

microbial species in environments under stress underpinning critical biogeochemical cycles is also poorly understood. Further research into these processes will deepen our understanding of the role of microbes in biodiversity and conservation.

30. Microbiologists possess a deep, broad understanding on the topic of environmental management and protection, and a willingness to contribute to the Welsh environmental strategy by comprehensively responding to this survey. We welcome this call for input from Welsh citizens, and recommend that Natural Resources Wales also consult the scientific community specifically to gather detailed information on evidence-based solutions for conserving the natural environment, including micro and macro-biota, and moving towards a sustainable future.

We want to help

Professional societies and scientific organisations represent the research and innovation community at large and can supply evidence-based advice and in-depth analysis of the sector to governments and other agencies. They are also uniquely placed to foster a coordinated and constructive approach between the different parts of the scientific community in the public and private sectors. The Microbiology Society wishes to send a message of support to Natural Resources Wales and would welcome the opportunity to work together and inform future projects.

To get in touch, please email policy@microbiologysociety.org