NatureScot
Scotland's Nature Agency

**NatureScot**

**SCIENTIFIC ADVISORY COMMITTEE**

**DISCUSSION PAPER**

# Horizon scanning, March 2024

## Purpose

1. This is the regular horizon scanning item.

## Action

1. The SAC is invited to:
   * discuss the paper, including any additional items to note, and to comment on whether a deeper dive is required into:
   * our work/advice around resilience and positive/negative climate feedbacks, as opposed to, e.g. ‘preferred’ states of nature (para 15/Environment).
   * comment on style and content, to refine future versions accordingly.

## Preparation

1. The paper was written by Clive Mitchell and Ben James with contributions from the Science and Evidence Leadership Programme. It is sponsored by Eileen Stuart.

## Background

1. In addition to references below, this paper draws on recent work by Natural England (applying the IPBES Nature Futures Framework to England) and JNCC (horizon scanning approach for the Chief Scientists Group).
2. Highlights are summarised below, grouped by STEEPLE (social, technology, environment, economy, political, legal and ethics), starting with the nearer-term (1-5 years) and then longer term (5-10 years).

## Near-term - 1-5 years

1. *Social*
   * many issues continue to be divided on Brexit fault-lines and associated ‘culture wars’ including climate-nature[[1]](#footnote-1), and these narratives are likely to intensify in an election year. The net effect of polarisation is nil action[[2]](#footnote-2), which is in nobodies’ interests if we only have one planet to play with. (**NatureScot - this and several other entries highlight the need to develop climate-nature truths that rise above this, including through our Evidence Briefs**).
   * the World Economic Forum annual Global Risks Report[[3]](#footnote-3) highlights environmental risks, driven by underlying geopolitical and economic trends (including the cost of living) and mal/dis-information. It also notes the **health impacts of climate change**, e.g. increasing resistance to antibiotics[[4]](#footnote-4), infectious diseases, chronic health conditions, fall in crop yields and nutritional value3.
   * **Severe mental health deterioration and impacts of climate change**, e.g. eco-anxiety, and the impact of **Gen Z** on values and attitudes towards climate change, demands/expectations.
2. *Technology*
   * The threats and opportunities of Artificial Intelligence depend largely on the mindsets behind it. Increasingly reliance on data-driven energy and transport systems, but also precious metals and mining, protected areas and communities in other countries creates security risks. There is the potential for novel solutions to problems as well as job losses in white- and blue-collar professions, social displacements. ChatGTP could be used in NatureScot’s work: AI underpins the ‘informed’ CivTech projects to increase our capacity to handle the volume and complexity of casework in planning and on protected sites in coming years. In procurement, we may want to place conditions on contractors about AI use.
   * **Macrogenomics** uses publicly accessible genetic datasets from thousands of species to explore large-scale patterns and predictors of intraspecific genetic variation[[5]](#footnote-5). This is being applied to invasive alien species, the representativeness and effectiveness of protected areas and the impacts of landscape scale features including wetlands and roads. This is part of a wider movement to incorporate molecular tools in biodiversity conservation[[6]](#footnote-6). While open access to sequence data is a cornerstone of biology and biodiversity research, it is a source of tension under the Convention on Biological Diversity (CBD). Policy decisions could compromise research and development, unless a practical multilateral solution is implemented[[7]](#footnote-7).
3. *Environment*
   * Continuing concerns about the **pace of climate change** from transgressing planetary boundaries[[8]](#footnote-8) to triggering global tipping points[[9]](#footnote-9). El Niño boosts ocean warming[[10]](#footnote-10) - El Niño events tend to warm the eastern Pacific Ocean and helped make 2023 the hottest year on record. This year, it will likely compound with climate change, potentially pushing global surface temperatures to 1.5°C above preindustrial levels for the first time, with disastrous effects on marine ecosystems - and beyond. (**NatureScot could strengthen our narrative on climate-nature and the futures we are trying to avoid**).
   * **Biodiversity monitoring for a just planetary future** - working towards governance systems and monitoring frameworks that engage with biodiversity data as social infrastructure[[11]](#footnote-11). Ecologists and conservation scientists have long acknowledged that biodiversity data reflect legacies of social inequity. Although the impact of data disparities on decisions is central to discussions on data governance throughout society - from policing to finance to health care - the environmental domain has skirted many of these critiques under the guise that its data reflect and affect the natural world, not people, politics, and histories. More data or better models will never fully solve systemic bias: solutions lie in contextualising data (**NatureScot - this is relevant across our work and the way in which targets and indicators are presented in the Natural Environment Bill**).
4. *Economy*
   * **Shoring up resilience in one area can have a multiplier effect on overall preparedness for other related risks** - investment in resilience must focus on solutions that address multiple risks, such as funding of adaptation measures that come with climate mitigation co-benefits, or investment in areas that strengthen human capital and development[[12]](#footnote-12).
   * **Defra announced revised payments for Environmental Land Management** in January to both incentivise maintaining habitats and creating more, with increases, for example, in payments for species-rich grassland from £182 to £646 per hectare[[13]](#footnote-13). Scottish Government contracted the same organisation that advised DEFRA to also advise SG on payment calculations based on NatureScot’s measures list. The payment rates better reflect costs to farmers, but the overall impact will be determined by the total budget available for the new payments scheme and how it is structured across the 4 tiers.
5. *Politics*
   * **COP28** marked at least two ‘firsts’ in the Global Stocktake (the “temperature check” of the Paris Agreement): the agreement to “transition away from fossil fuels” and the first mention for food in a major UN climate change negotiated text[[14]](#footnote-14). Various commentators noted the trebling of the industrial food lobby at COP28, signalling industry positioning in response to growing pressure for a need to transform land use and food production practices both for net zero and more resilient practices.
   * **Pushback on EU green ambitions**[[15]](#footnote-15) - high polling for far-right, nationalist parties in EU elections in June could fuel opposition to the green agenda. Even without this, the majority group - the conservative European People’s Party - has already cast itself as friendly to farmers and industry by pushing back against policies aimed at reducing pesticide use, for example. Legislators could also seek to limit the funding for the implementation of green legislation that has to date largely withstood conservative pushback - such as the Nature Restoration Law, which sets targets to restore degraded ecosystems. This is a reflection of Global Risks[[16]](#footnote-16), and we are seeing similar trends in **the UK, and, as an election year** (probably)[[17]](#footnote-17) climate-nature is likely to be caught up in populist identity politics.
6. *Legal*
   * New legislative proposals and policies are anticipated over the course of 2024 to underpin delivery of 30x30 aspirations and build on provisions introduced in the UK Energy Act 2023 to help accelerate offshore wind consenting. Public consultation exercises on the scope of any new powers are expected to start in March (for elements linked to the NE Bill).
   * Recent interpretation of the Marine (Scotland) Act 2010, raises questions about the power of marine plans (national and regional tiers). There are concerns that where policies can only guide decisions by public authorities (e.g. policy language of ‘should’ rather than ‘must’) this will mean the improvements to strategic-decision that RMPs had the potential to deliver will not be realised, perpetuating the deferral of difficult decisions to more resource-intensive, project-level processes.
7. *Ethics*
   * **What’s natural?** There’s a long-running debate about the terminology surrounding ‘invasive non-native species’, because both native and alien species can be invasive or otherwise problematic[[18]](#footnote-18). These issues are likely to intensify as climate envelopes shift. (**NatureScot - update the terminology to ‘Invasive Species’ or similar?**).

## Longer term (5-10 years)

1. Fifteen items highlighted in Sutherland and co-workers annual global review[[19]](#footnote-19) are listed below. These are primarily technology- and environment-led and look mainly 5-10 years ahead. A few notes are added for items that may be of particular relevance to Scotland:
2. *Technology*
   * *New sources of hydrogen for energy production* - including subsurface with associated transport infrastructure and potential ecosystem disturbance; use of seawater (with residual high-oxygen hypersaline brines); at high rates of usage leakage of hydrogen could contribute to methane and water production (both greenhouse gases), offsetting some of the potential abatement potential.
   * *Decarbonised ammonia production* (but further disruption to the already highly disrupted global nitrogen cycle and associated declines in species, eutrophication and air quality).
   * *Food and animal feed from autotrophic hydrogen-oxidising bacteria*.
   * *Acceleration of light-free artificial photosynthesis with indoor agriculture*.
   * ***Use of ecoacoustics to monitor soil ecology*** *-* potential to monitor the presence, composition, or number of soil invertebrates in an effective and nonintrusive manner. The sounds in soils range from water moving through soil pores to the distinct vibrations of different animals moving and communicating, which can be analysed with acoustic indices. Potential for indicators of soil quality. Methods need to be improved and standardised for wide adoption (e.g. citizen science) and they could be coupled with e.g. eDNA metabarcoding for insights on soil community structure and function. (**NatureScot - exploring adoption via JHI, Rob Brooker, Mike Rivington and Roy Neilson**).
   * *Benchtop DNA printers*
   * *NEOM (The Line) linear skyscraper city* - Sutherland et al discuss potential impacts of a 75-mile mirrored structure on migrating bird populations, but not the wider implications of such vanity projects. For example, while the proposal incorporates naturalistic features it fundamentally fuels the underlying drivers of climate-nature degradation in separating people from nature and natural processes.
3. *Environment*
   * Four of the items expanded below relate to major climate feedbacks, including the potential to ‘accelerate’ negative feedbacks. **If it were possible to frame uses of the land and sea in terms of the potential to affect positive and negative climate feedbacks (with the latter significantly dependent on life and biological processes) while simultaneously building build resilience against climate risks, that might be a more secure basis on which to argue for better informed choices in uses of the land and sea (rather than ‘preferred’ states of nature) (potential follow-up for the SAC?)**.
   * ***Extensive adoption of carbon mineralisation techniques*** - accelerating a natural negative climate feedback (weathering of silicate rocks over 10s-100s of thousands of years - in healthy soils) to decadal removals by spreading rock dust on agricultural soils. Modelled results are impressive (0.5-2GtCO2/y removals) and field trials (including in the UK) suggest fertilisation effects and effective treatment of acidified soils, as well as reducing ocean acidification and eutrophication. Risks include heavy metal contamination depending on the source of the dust, siltation and freshwater/coastal turbidity and negatively affect species adapted to naturally acidic soils. **In Scotland, it may have a use in treating acid croplands arising from historic land use change from wetlands (field studies would be needed)**.
   * ***Evidence of earthworm population declines over large regions*** - based on a UK study (but not systematic monitoring) of earthworm trends over 100 years showing a 33-41% decline in earthworm populations over the last 25 years particularly in farmland (and more so in pasture than arable) and broadleaved woodland (especially in SE England). On farmland, pesticides, ploughing, fertiliser use and diffuse pollution are likely to be key factors, while in woodlands, sensitivity to soil moisture (e.g. drought, drainage) and grazing pressure (deer) are likely candidates. If the results apply to the whole of the UK and other countries with similar land uses, the effects on soil health, ecosystem structure and function would be significant. (**NatureScot - The Land Use for Net Zero (UKRI project) is seeking to harmonise soil monitoring requirements across the UK - we are involved**).
   * *Wildfires affect climate oscillations*.
   * *Extrapolating chemical toxicity assessments*.
   * ***Sea urchin die-offs affect marine ecosystems*** - native and non-native sea-urchin die-off in the Caribbean (1983-4 and 2022), Mediterranean (2022) and Red Sea (2023) are raising concerns about threats of pathogens, which also affect corals, crabs and fishes, and hence tropical ecosystems resulting from environmental stressors, especially heat.
   * ***Removal of carbon dioxide from the ocean*** - attention is turning to the oceans as part of the trend to carbon dioxide removals (as part of the global ‘anything-that-allows-business-as-usual-use-of-fossil-fuels-and-land-use’ ‘response’ to the climate-nature crisis[[20]](#footnote-20)). NGO, research, government and private interest and capital are flowing towards ocean-based climate interventions including ocean fertilisation, macroalgal culture and sinking, enhancement of ocean alkalinity, and injection of carbon dioxide into marine rock formations, despite what little we know about the oceans and likely harmful environmental consequences, including reduced oxygen concentrations, macronutrient depletion, entanglement of marine life, and increased trace metal toxicity in seawater. (**NatureScot response - framing climate-nature as an Earth system problem, avoids false trade-offs**).
   * ***Rising temperatures in the twilight zone affect the biological carbon pump*** - about a quarter of ocean volume lies in the depth range 200-1000m. This zone is particularly rich in life, and fish biomass in these depths has been significantly underestimated. This zone is also critical to global carbon fluxes through the biological carbon pump - the downward transport of organic matter and subsequent sequestration of carbon (moving 10 GtCy-1 from the surface ocean and sequestering 1300 GtC[[21]](#footnote-21) for about 1000 years). The efficiency of the biological carbon pump is predicted to decline with rising temperatures, leading to increased rates of remineralisation of organic matter and reduction in the availability and quality of food for deep-sea organisms. The duration of carbon sequestration may also be affected with slower-sinking, smaller particles sequestered for only 140 years. Warmer temperatures and rapid decomposition of faster-sinking matter could reduce this oceanic sequestration potential (**NatureScot - see below**).
   * **Melting Antarctic ice affects deep sea ocean currents**. Although the impacts of climate change on the Atlantic meridional overturning circulation are receiving increasing attention (see March 2023 and Sept 2023 SAC papers), the importance of Antarctic abyssal overturning has been largely overlooked. Recent studies suggest that reductions in water density caused by increased melting and reduction in the concentration of salts may reduce abyssal overturning by 40% by 2050. These changes may affect nutrient flows, ocean oxygen levels, and global climate, with consequences for terrestrial and marine environments. The impacts of many of the potential changes, such as reduced oxygen concentration and biogeochemistry in the deep ocean, are poorly understood. These changes reduce the ability of the ocean to absorb carbon dioxide. However, changes in winds, especially easterly winds, may alter this process and potentially enhance overturning circulation. Antarctic bottom water influences circulation patterns. Decreases in the density of salts and changes in wind patterns may have nonlinear and long-lasting effects on oceanic circulation and climate patterns. (**NatureScot - here and above - the potential weakening of these key global negative feedbacks highlights the need for emission reductions and transforming land use as the primary and only real response to a climate-nature emergency**).

Contact: Clive Mitchell, [clive.mitchell@nature.scot](mailto:clive.mitchell@nature.scot)

1. E.g. Euronews (2023) [Weaponising the climate crisis: How extremists and politicians are polarising the debate](https://www.euronews.com/green/2023/08/20/weaponising-the-climate-crisis-how-extremists-and-politicians-are-polarising-the-debate); Kings College London (2023) [Public increasingly see politicians as stoking culture wars](https://www.kcl.ac.uk/news/public-increasingly-see-politicians-as-stoking-culture-wars-study-finds), also, responses to highly protected marine areas and SFA’s [Fishy Falsehoods](https://www.shetlandfishermen.com/papers/fishy-falsehoods). [↑](#footnote-ref-1)
2. The Climate Majority Project. (2023). [Theory of Change](https://usercontent.one/wp/climatemajorityproject.com/wp-content/uploads/2023/05/ToC-Pre-Launch-Disseminate.pdf?media=1698701187). (page 9). [↑](#footnote-ref-2)
3. [WEF Global Risks Report 2023](https://www.weforum.org/publications/global-risks-report-2023/). [↑](#footnote-ref-3)
4. [Global antimicrobial resistance and use surveillance system (‎GLASS)‎ report: 2022](https://www.who.int/news/item/09-12-2022-report-signals-increasing-resistance-to-antibiotics-in-bacterial-infections-in-humans-and-need-for-better-data). [↑](#footnote-ref-4)
5. Leigh DM et al.(2021). [Opportunities and challenges of macrogenetic studies](https://doi.org/10.1038/s41576-021-00394-0). *Nat Rev Genet* **22**, 791-807. [↑](#footnote-ref-5)
6. Bertola, L.D. (2024). [A pragmatic approach for integrating molecular tools into biodiversity conservation](https://doi.org/10.1111/csp2.13053), *Conservation Science and Practice*, 6(1), e13053. [↑](#footnote-ref-6)
7. Scholz, A.H., et al. (2022). [Multilateral benefit-sharing from digital sequence information will support both science and biodiversity conservation](https://doi.org/10.1038/s41467-022-28594-0). *Nat Commun* **13**, 1086. [↑](#footnote-ref-7)
8. Katherine Richardson et al*.* (2023). [Earth beyond six of nine planetary boundaries](https://www.science.org/doi/10.1126/sciadv.adh2458). *Sci. Adv.* **9**, eadh2458. [↑](#footnote-ref-8)
9. Lenton T.M. et al. (2023). *The* [*Global Tipping Points*](https://global-tipping-points.org) *Report 2023*. University of Exeter, Exeter, UK. [↑](#footnote-ref-9)
10. Science (2024). [Ten science stories poised to make headlines in 2024](https://www.science.org/content/article/ten-science-stories-poised-to-make-headlines-2024?utm_source=sfmc&utm_medium=email&utm_campaign=ScienceAdviser&utm_content=lifeacademic&et_rid=697952388&et_cid=5050684). [↑](#footnote-ref-10)
11. Chapman et al. (2024). [Biodiversity monitoring for a just planetary future](https://www.science.org/doi/10.1126/science.adh8874?utm_source=sfmc&utm_medium=email&utm_content=alert&utm_campaign=SCIeToc&et_rid=697952388&et_cid=5050979), Science. [↑](#footnote-ref-11)
12. [WEF Global Risks Report 2023](https://www.weforum.org/publications/global-risks-report-2023/). [↑](#footnote-ref-12)
13. Defra. (2024). [Environmental land management in 2024: details of actions and payments](https://defrafarming.blog.gov.uk/2024/01/04/environmental-land-management-in-2024-details-of-actions-and-payments/). [↑](#footnote-ref-13)
14. See Carbon Brief (2023) COP28: [*Key outcomes for food, forests, land and nature at the UN climate talks in Dubai*](https://www.carbonbrief.org/cop28-key-outcomes-for-food-forests-land-and-nature-at-the-un-climate-talks-in-dubai/) - see ‘greenwashing and lobbying by ‘big ag’’. [↑](#footnote-ref-14)
15. Science (2024). [Ten science stories poised to make headlines in 2024](https://www.science.org/content/article/ten-science-stories-poised-to-make-headlines-2024?utm_source=sfmc&utm_medium=email&utm_campaign=ScienceAdviser&utm_content=lifeacademic&et_rid=697952388&et_cid=5050684). [↑](#footnote-ref-15)
16. [WEF Global Risks Report 2023](https://www.weforum.org/publications/global-risks-report-2023/). [↑](#footnote-ref-16)
17. BBC News (2024). [Rishi Sunak suggests general election in second half of year](https://www.bbc.co.uk/news/uk-politics-67883242). [↑](#footnote-ref-17)
18. E.g. Smout. (2014). [What’s natural: a species history of Scotland in the last 10,000 years](https://www.biodiversitylibrary.org/partpdf/240629). *Glasgow Naturalist*, **26**(1), 11-16. [↑](#footnote-ref-18)
19. Sutherland W.J. et al. (2023). A horizon scan of global biological conservation issues for 2024. *Trends in Ecology and Evolution* (<https://doi.org/10.1016/j.tree.2023.11.001>). [↑](#footnote-ref-19)
20. See Carbon Brief (2023) COP28: [Key outcomes for food, forests, land and nature at the UN climate talks in Dubai](https://www.carbonbrief.org/cop28-key-outcomes-for-food-forests-land-and-nature-at-the-un-climate-talks-in-dubai/) - see ‘greenwashing and lobbying by ‘big ag’’. [↑](#footnote-ref-20)
21. Siegel et al. (2023). Quantifying the Ocean's Biological Pump and Its Carbon Cycle Impacts on Global Scales. *Annual Review of Marine Science 2023* **15**:1, 329-356, <https://doi.org/10.1146/annurev-marine-040722-115226>. [↑](#footnote-ref-21)