Coining one currency for nature

Joseph Millard[1]

[1]Department of Life Sciences, Natural History Museum, Cromwell Road, London, SW7 5BD, UK

Keywords: spatial finance, global carbon reward, biodiversity modelling, central bank digital currencies (CBDC), monetary policy, carbon quantitative easing, planetary boundary

Abstract

Humanity is at a critical juncture. Despite our efforts to set targets and goals, biodiversity and climate are both changing rapidly, pushing us towards a biosphere our species has not known. To solve this problem one view is that we need transformational change of the economic paradigm, but that might be more an ideal than pragmatic. A new idea could be to take inspiration from recent developments in global carbon market theory and spatial finance, and devise a new central bank digital currency (CBDC) for nature. We could then track a conjunction of anthropogenic pressures from space or remotely, combine that with a model predicting biodiversity change, and then link that to our new global currency that would self-regulate those pressures towards bending the curve. In biodiversity modelling alone there is a lot we would need to learn to make this work, but I think one federated currency for nature might be the guiding principle we need to solve biodiversity change.

Main

Humanity is at a critical juncture. Biodiversity and climate are both changing rapidly, pushing us towards a biosphere our species has not known (Xu *et al.*, 2020). For climate and biodiversity change our efforts to halt both are insufficient (Mace *et al.*, 2018; Nordhaus, 2019). We have a 1.5°C target for climate change and some understanding of how to get there (IPCC, 2022), but such agreements and targets are not enforceable. For biodiversity the situation is worse. The Convention on Biological Diversity (CBD) regulates goals for biodiversity change, but our 23 Targets (Ainsworth, 2022) and associated indicators are not fully agreed by the broader scientific community (Geldmann *et al.*, 2023). Importantly, our Targets do not explicitly recognize that the mechanisms of the service of biodiversity are borne of biodiversity itself, and that the uncertainty of this relationship is unknown (Nicholson *et al.*, 2009). For both biodiversity and climate change our failures are the fault of no one individual. Our current economic paradigm has locked us into a trajectory that feels to have become unstoppable.

In parallel, private investment in biodiversity conservation is growing, with companies aiming to monitor biodiversity and the contribution it makes to people. These companies are wanting to make reasonable choices on the measurement and value of biodiversity, but a clear message and direction is not coming from us as biodiversity researchers. There is now I think a significant and real risk that private companies find ways of monitoring biodiversity at scale in real-time, but build systems that optimize parameters from the literature that we know are not correlated with metrics that are meaningful. This will be compounded when that same problem occurs independently across tech companies, such that collectively we will measure metrics that are not meaningful, and that don't map between one another.

There are ideas for how we might solve the biodiversity crisis. One view is that we need transformational change of the economic paradigm (IPBES, 2019). That might be an ideal, but it is not pragmatic. Our current economic paradigm I think is too embedded in the structure of states and the psyche of what's possible, such that a shift from without seems unlikely. Another view is that within the current paradigm organisations such as the TNFD (Taskforce on Nature-related Financial Disclosures (TNFD, 2023)) can incentivise a more equitable approach to biodiversity. There may be some ways in which we can say the TFND has worked, but it gives us no certainty or roadmap for approaching a stable state. Most importantly, at present the TNFD will not regulate or enforce metrics. Companies will be able to record one biodiversity metric and then make a decision to switch, meaning reported change in biodiversity will not be meaningful either within or between companies. There are also developments in biodiversity credits (Bruggeman *et al.*, 2005), biodiversity offsets (Maron *et al.*, 2016), and payments for ecosystem services (PES) (Farley and Costanza, 2010). Some of these may work at a given scale to shift metrics of biodiversity (although the evidence is scarce, e.g. see (Salzman *et al.*, 2018)), but given their decentralization and the lack of consensus on the appropriate valuing of biodiversity, it seems unlikely that these policies will pull biodiversity in any one consistent direction, and very unlikely with any associated degree of quantifiable uncertainty.

Central banks are increasingly taking note of the systemic risks associated with a rapidly changing environment (Campiglio *et al.*, 2018). Central banks function to implement monetary policy for the stability of fiat currencies, taking actions such as changing interest rates or buying up government bonds to control inflation. These actions are distinct from fiscal policies such as taxes and subsidies which are set by the government. Importantly, central banks at least in principle act independently of government, meaning they can take more long term decisions on financial stability that don't necessarily concern immediate consumptive gain. Central bank digital currencies (CBDC) are an emerging technology that enable the creation of digital money by central banks (Bordo and Levin, 2017), as opposed to via commercial banks in the form of debt. Although there are many concerns regarding privacy and greater government control (Baronchelli, Halaburda and Teytelboym, 2022) CBDCs potentially enable a more efficient means of money transfer and better control of the money supply (Meaning *et al.*, 2018). Notably, money could be created by central banks without the indirect means of quantitative easing (i.e. ordinarily quantitative easing involves the lending of money to governments by central banks via the purchase of government bonds), and then distributed directly to a population in the form of "helicopter money" (Reis and Tenreyro, 2022). CBDCs are currently being actively researched by ~86% of central banks (Deloitte, 2022), with the first launch in a major economy in China in 2021 (Popper and Li, 2021). Central banks are historically highly resistant to mandate change and intervention that might itself cause financial or political instability (Campiglio *et al.*, 2018), but as the risks of inaction become more apparent, significant intervention does not seem unreasonable given the precedent set by the financial crisis of 2007-2009 and the COVID-19 pandemic (Haas, Neely and Emmons, 2020).

For biodiversity change, a new idea could be to take inspiration from recent developments in global carbon market theory, spatial finance (Patterson *et al.*, 2020), and central bank digital currencies (CBDC), and develop a CBDC for nature, modelled on the global carbon reward (Chen, Beek and Cloud, 2017). The philosophy of the global carbon reward is that central banks should back a new form of carbon currency, that can be issued to entities upon some action to mitigate emissions or capture carbon. Whereas cryptocurrencies are mined by using energy to validate transactions, a carbon currency would be mined by reducing emissions or storing carbon. Carbon currency would be created through a process called carbon quantitative easing, in which currency is issued by central banks debt free as a CBDC. To keep inflation in check, an international carbon exchange authority would ensure international currency devaluation is at least consistent. Two crucial outcomes of the global carbon reward are that it would be a single global carbon standard, and that it could ultimately help to self-regulate towards net zero. One of its core insights is that the floor price of carbon should be allowed to emerge as a function of systemic risk, rather than from consumption alone. For biodiversity, what that would mean is that with an aggregated metric of biodiversity, and an associated target and timeframe, our biodiversity pricing emerges without needing to value contribution in the form of an ecosystem service. As far as I know, biodiversity researchers have not been talking about a new standardized nature currency that would be backed and issued by central banks, such that biodiversity stability is reached through a coordinated international monetary intervention. If we can find a way to put the brakes on environmental change with a new currency for nature, and allow the Court Jester to catch up (Barnosky, 2001), it might be that biodiversity stability emerges organically.

Equally, stability might not emerge. We would need to guide the way in which our nature currency reduces anthropogenic pressure. If we do not, we risk mitigating inconsequential anthropogenic pressures, either because their effect size is smaller than we anticipated, or because their effect is actually inherited from elsewhere. To do that we would need a set of reasonable models that guide our decisions (Bateman and Balmford, 2023). The emerging field of spatial finance might hold a solution (Patterson *et al.*, 2020). Spatial finance refers to the integration of geospatial data and financial policy (Patterson *et al.*, 2020), giving a means through which assets and risk can be quantified in space unambiguously and remotely in real-time. Leaning on these developments, we could track a conjunction of anthropogenic pressures from space or remotely, combine that with our model predicting biodiversity change, and then link that to our new federated CBDC that would self-regulate those pressures towards bending the curve. Given the unambiguity of spatial finance, entities would be awarded a nature coin only when pressure change has been confirmed remotely for some specific period of time, thereby reducing the likelihood of false reporting. Such an algorithm could be made open, helping to increase buy in from low income counties that lack influential central banks, and to guide decision makers themselves on anthropogenic pressure reduction to maximise return on downregulation. We would still then need to monitor future biodiversity, but that comes secondarily to confirm that the currency is functioning. And then if it’s not, we use that future record to refine our model of biodiversity change and shift the reward weighting of the currency.

Recent developments in global carbon market theory rest on two principles: a target for climate change (1.5°), and a unit of measure responsible (carbon). For biodiversity we have no such simplicity. There is mixed consensus as to the value and importance of biodiversity at the global level (Seddon *et al.*, 2016); we don’t know with a quantified degree of uncertainty the extent to which these metrics can change before the biosphere reaches a tipping point or is overcommitted (Brook *et al.*, 2013); and among taxonomic groups we don’t know the extent to which multiple anthropogenic drivers are causally responsible for biodiversity change (Gonzalez, Chase and O’Connor, 2023). To settle some of these debates, we perhaps need to see that each individual means through which we measure biodiversity is to some extent capturing the variation of others. Perhaps we don’t need to measure everything; perhaps we just measure the minimum number of metrics such that we capture enough of the uncorrelated ways in which all metrics are collectively important, both to stability and services. That could then be manageable, and perhaps more crucially and hopefully, enough.

Irrespective of all of the above, for a single currency for nature to be workable, there are at least eight areas I think in which we would need to make significant advances in biodiversity modelling alone: 1) We need to be confident that the anthropogenic variables we measure do explain change in biodiversity. To do that we need more models built on the basis of causal inference (Arif and MacNeil, 2022); 2) we need to be confident that through valuing only some set of biodiversity metrics, we are not going to overlook something important, and we need to settle on what those metrics are; 3) we need to get better at building models that consider multiple anthropogenic variables together, such that we will not overlook surprising high magnitude interactions; 4) we need to be better at accounting for uncertainty by incorporating variation predicted by temporal or spatial autocorrelation (Johnson *et al.*, 2022); 5) we need to sample biodiversity in space across more locations and across a greater breadth of anthropogenic intensities (Daskalova *et al.*, 2021); 6) we need to know that space-for-time models can be used to back-project time series, in a manner that is not consistently wrong; 7) we need to build a consistent global monitoring system such that we can track biodiversity at future intervals (Gonzalez, Chase and O'Connor, 2023), to check the currency is working; and 8) we need infrastructure in place for tracking change in anthropogenic variables from space or remotely at high resolution (Antonelli, Dhanjal-Adams and Silvestro, 2023).

References

Ainsworth, D. (2022) 'Nations Adopt Four Goals, 23 Targets for 2030 In Landmark UN Biodiversity Agreement'.

Antonelli, A., Dhanjal-Adams, K.L. and Silvestro, D. (2023) 'Integrating machine learning, remote sensing and citizen science to create an early warning system for biodiversity', *Plants, people, planet*, 5(3), pp. 307–316. Available at: https://doi.org/10.1002/ppp3.10337.

Arif, S. and MacNeil, M.A. (2022) 'Predictive models aren't for causal inference', *Ecology Letters*, 25(8), pp. 1741–1745. Available at: https://doi.org/10.1111/ele.14033.

Barnosky, A.D. (2001) 'Distinguishing the effects of the Red queen and Court Jester on Miocene mammal evolution in the northern Rocky Mountains', *Journal of Vertebrate Paleontology*, 21(1), pp. 172–185. Available at: https://doi.org/10.1671/0272-4634(2001)021[0172:DTEOTR]2.0.CO;2.

Baronchelli, A., Halaburda, H. and Teytelboym, A. (2022) 'Central bank digital currencies risk becoming a digital Leviathan', *Nature Human Behaviour*, 6(7), pp. 907–909. Available at: https://doi.org/10.1038/s41562-022-01404-9.

Bateman, I. and Balmford, A. (2023) 'Current conservation policies risk accelerating biodiversity loss', *Nature*, 618(7966), pp. 671–674. Available at: https://doi.org/10.1038/d41586-023-01979-x.

Bordo, M. and Levin, A. (2017) *Central Bank Digital Currency and the Future of Monetary Policy*. w23711. Cambridge, MA: National Bureau of Economic Research, p. w23711. Available at: https://doi.org/10.3386/w23711.

Brook, B.W. *et al.* (2013) 'Does the terrestrial biosphere have planetary tipping points?', *Trends in Ecology & Evolution*, 28(7), pp. 396–401. Available at: https://doi.org/10.1016/j.tree.2013.01.016.

Bruggeman, D.J. *et al.* (2005) 'Landscape Equivalency Analysis: Methodology for Estimating Spatially Explicit Biodiversity Credits', *Environmental Management*, 36(4), pp. 518–534. Available at: https://doi.org/10.1007/s00267-004-0239-y.

Campiglio, E. *et al.* (2018) ‘Climate change challenges for central banks and financial regulators’, *Nature Climate Change*, 8(6), pp. 462–468. Available at: https://doi.org/10.1038/s41558-018-0175-0.

Chen, D., Beek, J. and Cloud, J. (2017) ‘Climate mitigation policy as a system solution: addressing the risk cost of carbon’, *Journal of Sustainable Finance & Investment*, 7, pp. 1–42. Available at: https://doi.org/10.1080/20430795.2017.1314814.

Daskalova, G.N. *et al.* (2021) ‘Representation of global change drivers across biodiversity datasets’, *EcoEvoRxiv* [Preprint]. Available at: https://ecoevorxiv.org/repository/view/4013/ (Accessed: 29 June 2023).

Deloitte (2022) *Central Bank Digital Currencies | Future of Value Transfer Deloitte*. Available at: https://www2.deloitte.com/in/en/pages/financial-services/articles/central-bank-digital-currencies.html (Accessed: 5 October 2023).

Farley, J. and Costanza, R. (2010) ‘Payments for ecosystem services: From local to global’, *Ecological Economics*, 69(11), pp. 2060–2068. Available at: https://doi.org/10.1016/j.ecolecon.2010.06.010.

Geldmann, J. *et al.* (2023) ‘Prioritize wild species abundance indicators’, *Science*, 380(6645), pp. 591–592. Available at: https://doi.org/10.1126/science.adh4409.

Gonzalez, A., Chase, J.M. and O’Connor, M.I. (2023) ‘A framework for the detection and attribution of biodiversity change’, *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378(1881), p. 20220182. Available at: https://doi.org/10.1098/rstb.2022.0182.

Haas, J., Neely, C.J. and Emmons, W.R. (2020) ‘Responses of International Central Banks to the Covid-19 Crisis’. Rochester, NY. Available at: https://doi.org/10.20955/r.102.339-84.

IPBES (2019) *Summary for policymakers of the global assessment report on biodiversity and ecosystem services*. Zenodo. Available at: https://doi.org/10.5281/zenodo.3553579.

IPCC (2022) *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. 1st edn. Cambridge University Press. Available at: https://doi.org/10.1017/9781009157940.

Johnson, T.F. *et al.* (2022) ‘Overconfidence undermines global wildlife abundance trends’. bioRxiv, p. 2022.11.02.514877. Available at: https://doi.org/10.1101/2022.11.02.514877.

Mace, G.M. *et al.* (2018) ‘Aiming higher to bend the curve of biodiversity loss’, *Nature Sustainability*, 1(9), pp. 448–451. Available at: https://doi.org/10.1038/s41893-018-0130-0.

Maron, M. *et al.* (2016) ‘Taming a Wicked Problem: Resolving Controversies in Biodiversity Offsetting’, *BioScience*, 66(6), pp. 489–498. Available at: https://doi.org/10.1093/biosci/biw038.

Meaning, J. *et al.* (2018) ‘Broadening Narrow Money: Monetary Policy with a Central Bank Digital Currency’. Rochester, NY. Available at: https://doi.org/10.2139/ssrn.3180720.

Nicholson, E. *et al.* (2009) ‘Priority research areas for ecosystem services in a changing world’, *Journal of Applied Ecology*, 46(6), pp. 1139–1144. Available at: https://doi.org/10.1111/j.1365-2664.2009.01716.x.

Nordhaus, W. (2019) 'Climate Change: The Ultimate Challenge for Economics', *American Economic Review*, 109(6), pp. 1991–2014. Available at: https://doi.org/10.1257/aer.109.6.1991.

Patterson, D.J. *et al.* (2020) *Spatial finance: Challenges and opportunities in a changing world*. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/34894 (Accessed: 5 October 2023).

Popper, N. and Li, C. (2021) 'China Charges Ahead With a National Digital Currency', *The New York Times*, 1 March. Available at: https://www.nytimes.com/2021/03/01/technology/china-national-digital-currency.html (Accessed: 5 October 2023).

Reis, R. and Tenreyro, S. (2022) 'Helicopter Money: What Is It and What Does It Do?', *Annual Review of Economics*, 14(1), pp. 313–335. Available at: https://doi.org/10.1146/annurev-economics-051420-020618.

Salzman, J. *et al.* (2018) 'The global status and trends of Payments for Ecosystem Services', *Nature Sustainability*, 1(3), pp. 136–144. Available at: https://doi.org/10.1038/s41893-018-0033-0.

Seddon, N. *et al.* (2016) 'Biodiversity in the Anthropocene: prospects and policy', *Proceedings of the Royal Society B: Biological Sciences*, 283(1844), p. 20162094. Available at: https://doi.org/10.1098/rspb.2016.2094.

TNFD (2023) *TNFD – Taskforce on Nature-related Financial Disclosures*, *TNFD*. Available at: https://tnfd.global/ (Accessed: 29 June 2023).

Xu, C. *et al.* (2020) 'Future of the human climate niche', *Proceedings of the National Academy of Sciences*, 117(21), pp. 11350–11355. Available at: https://doi.org/10.1073/pnas.1910114117.

Acknowledgements

JM is funded by the NERC GLiTRS project (grant number NE/V006800/1). Thanks also to Bruna Millard, Nick Isaac, Tim Newbold, Andy Purvis, Thomas Frederick Johnson, Richard Cornford, Graeme Cumming, and Delton Chen for comments and edits on initial drafts.