Institution: University College London

Unit of Assessment: 5 - Biological Sciences

Title of case study: Biodiversity Indicators to inform international policy

Period when the underpinning research was undertaken: 2000 - 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Georgina Mace	Professor	2012 - 2020
Richard Pearson	Professor	2013 - 2020
Robin Freeman	Senior Research Fellow	2013 - 2020
Tim Newbold	Senior Research Fellow	2015 - 2020
Ben Collen	Reader	2013 - 2018

Period when the claimed impact occurred: 1 August 2013 - 31 December 2020

Is this case study continued from a case study submitted in 2014? Y

1. Summary of Impact

In response to the global biodiversity crisis, the Institute of Zoology (IOZ) and University College London (UCL) developed a suite of science-based metrics that have become globally influential tools for biodiversity assessment and leading indicators of the conservation status of the world's species. These indicators are now used by several United Nations (UN) bodies to measure conservation status around the world. Specifically, they are used to report global biodiversity change and to track progress toward international targets (e.g. Sustainable Development goals) by intergovernmental bodies. These include the UN's Global Biodiversity Outlook 4 (2014), and 5 (2020); the UN Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) global and regional assessments (2019); as well as for conservation assessments and planning by national and regional governments and conservation NGOs, for example the World Wide Fund for Nature (WWF), and Environment Canada.

2. Underpinning research

In 2010, the UN Convention on Biological Diversity Conference of the Parties adopted a set of targets – known as the Aichi Targets – to reduce the loss of biodiversity by 2020. Research undertaken at UCL and IOZ generated global-scale biodiversity indicators that better informed progress towards these targets and are now used routinely by governments and international bodies.

The IUCN Red List, which is based on criteria developed by our researchers at UCL and IOZ, has become a key information source for monitoring the status of global biodiversity. Over 100,000 species have now been assessed using the criteria, but it includes only a small sample of all species (estimated at closer to 10 million) and is biased towards well-studied vertebrates.

To address these problems, our researchers developed methods to track changes in extinction risk over time and a sampling approach for wider taxonomic coverage of the Red List Index (RLI): the Sampled Red List Index (SRLI, [R2]). The research addressed several key challenges, including determining which species groups should be included in the index, identifying minimum adequate sample sizes, and working out how to aggregate and weight the index. The resulting indicator assesses a representative set of species from a broader set of groups than other approaches (including invertebrates and plants) in a time- and cost-effective manner.

Our research demonstrated how to accurately apply this technique to a number of new taxonomic groups, including the first global assessment of Reptiles, identifying their global threats and conservation priorities [R5]. UCL researchers further developed a simulation approach to demonstrate that climate change impacts, which are widely considered one of the

most important threats to biodiversity, can be accounted for using Red List criteria such as occupied area and population size [R6].

While the RLI records changes in species richness, it is a weak metric of changes in wild species abundance, which is especially important for ecosystem functioning and conservation management. Responding to this weakness, IoZ and UCL researchers developed an aggregated indicator of trends in species population abundances: the Living Planet Index (LPI; [R1]). The underpinning research investigated the statistical methods that could be used to aggregate large quantities of data on trends in wildlife populations and their threats, evaluated potential biases, and examined how the data could be disaggregated (e.g. geographically, taxonomically, regionally, and by thematic area). The LPI now contains over 27,000 population trends for 4,700 species, making it one of the largest databases on wildlife abundance trends in the world, underpinning a suite of research papers investigating wildlife responses to changes in land use, climate, habitat loss and utilisation.

Many conservation assessments require information that is at more local scale and is more easily linked to ecological structure and function. Working with collaborators, UCL researchers developed a third index: The Biodiversity Intactness Index (BII; [R4]). BII records changes in a local terrestrial site's biodiversity in the face of human land use and related pressures (https://www.predicts.org.uk/), and now includes 666 studies and 47,044 species (over 2% of all species known to science). The BII indicator is based on novel global models of the impact of land use on local biodiversity [R3].

3. References to the research

[R1] Collen, B., Loh J., Holbrook, S., McRae, L., Amin, R., Baillie, J.E.M. (2009). 'Monitoring change in vertebrate abundance: the Living Planet Index'. *Conservation Biology.* 23, 317-327. DOI: http://dx.doi.org/10.1111/j.1523-1739.2008.01117.x. (The underpinning science for the Living Planet Index, cited 372 times)

[R2] Baillie, J.E.M., Collen, B., Amin, R., Akcakaya, H.R., Butchart, S.H.M., Brummit, N., Meagher, T.R., Ram, M., Hilton-Taylor, C., Mace, G.M. (2008). 'Towards monitoring global biodiversity'. *Conservation Letters.* 1, 18-26. DOI: http://dx.doi.org/10.1111/j.1755-263X.2008.00009.x. (The science underpinning the Sampled approach to the Red List, cited 182 times)

[R3] Newbold, T., Hudson, L.N., Hill, S.L.L., Contu, S., Lysenko, I., Senior, R.A., Börger, L., Bennett, D.J., Choimes, A., Collen, B., Day, J., De Palma, A., Díaz, S., Echeverria-Londoño, S., Edgar, M.J., Feldman, A., Garon, M., Harrison, M.L.K., Alhusseini, T., Ingram, D.J., Itescu, Y., Kattge, J., Kemp, V., Kirkpatrick, L., Kleyer, M., Laginha Pinto Correia, D., Martin, C.D., Meiri, S., Novosolov, M., Pan, Y., Phillips, H.R.P., Purves, D.W., Robinson, A., Simpson, J., Tuck, S.L., Weiher, E., White, H.J., Ewers, R.M., Mace, G.M., Scharlemann, J.P.W. & Purvis, A. (2015). Global effects of land use on local terrestrial biodiversity. *Nature* 520: 45-50. DOI: http://doi.org/10.1038/nature14324. (the underpinning science for Biodiversity Intactness Index, cited 1791 times)

[R4] Newbold, T., Hudson, L.N., Arnell, A.P., Contu, S., De Palma, A., Ferrier, S., Hill, S.L.L., Hoskins, A.J., Lysenko, I., Phillips, H.R.P., Burton, V.J., Chng, C.W.T., Emerson, S., Gao, D., Pask-Hale, G., Hutton, J., Jung, M., Sanchez-Ortiz, K., Simmons, B.I., Whitmee, S., Zhang, H., Scharlemann, J.P.W. & Purvis, A. (2016). 'Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment'. *Science*. 353, 288-291. DOI: http://doi.org/10.1126/science.aaf2201. (Cited 559 times)

[R5] Böhm M, Collen B, Baillie JE, Bowles P, Chanson J, Cox N, Hammerson G, Hoffmann M, Livingstone SR, Ram M, Rhodin AG (2013). 'The conservation status of the world's reptiles'. *Biological Conservation.* 157, 372-85. DOI: (Assessment of Sample of Reptile species paper – taxonomic broadening, cited 700 times)

[R6] Pearson RG, Stanton JC, Shoemaker KT, Aiello Lammens ME, Ersts PJ, Horning N, Fordham DA, Raxworthy CJ, Ryu HY, McNees J, Akcakaya HR 2014. Life History and Spatial Traits Predict Extinction Risk Due to Climate Change. *Nature Climate Change* 4 (3): 217–21. DOI : https://doi.org/10.1038/nclimate2113. (underpinning research for understanding the role of Climate change, cited 284 times)

4. Details of the impact

Impacts on international policy-making

Establishing international biodiversity baselines and metrics: The indicators that we developed at UCL and IOZ have been instrumental in establishing baseline measures that underpin key international treaties and targets on biodiversity, which must be met if we are to mitigate the ongoing catastrophic decline in the planet's biodiversity. The indices have been used to track progress towards these critical targets, making signatory countries and other political and economic actors accountable for progress towards these goals and indicating priority areas for action.

Our research has underpinned the frameworks for measuring biodiversity of several international treaty organisations and conservation observatories. The LPI and SRLI have both been used to track progress towards meeting the UN Convention on Biological Diversity (CBD) targets in 2014 and 2020. They are quoted by the UN Global Biodiversity Outlook report as authoritative measures of the speed of biodiversity decline, for example in the report's section on progress towards the goals of the Strategic Plan and the Aichi Biodiversity Targets (goal C, improving biodiversity status): *"Two indicators of the state of biodiversity within this goal, the Living Planet Index and the Red List Index, show current declines and an extrapolation of continuing decline to 2020 based on current drivers."* [S1]**.** The two indices have also been highlighted as indicators for the post-2020 global target framework [S1]. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has also used the LPI, RLI and BII to quantify trends in biodiversity in its Global Assessment report on Biodiversity and Ecosystem Services [S2]. The SRLI has, for the first time, enabled the IPBES to quantify the threat to particular species and families and to communicate these figures in ways that make clear to laypeople the urgency and scale of threat to particular types of plants and animals. For example, the SRLI revealed that 18.99% of Reptiles are threatened with extinction and 40.55% of conifer trees and their relatives are threatened [S2, page 53]. Evidence from these indices have underpinned the IPBES' grave warning that *"around a million animal and plant species are currently threatened"* [S2, page 6].

Additionally the International Union for the Conservation of Nature (IUCN), the global authority on the status of the natural world and the measures needed to safeguard it, states that the IoZ/UCL work on the Red List and biodiversity indices *"has had, and continues to have, significant impact on* [their] *understanding of extinction risk and global biodiversity"* [S3].

Monitoring and conservation impact: As well as influencing global biodiversity monitoring and targets, IoZ/UCL research has led to new species-level IUCN monitoring and conservation efforts. As the global authority on the status of the natural world and conservation with over 1,400 member organisations and signatory governments, the IUCN maintains the Red List, the world's most comprehensive index on the extinction risk of animal, fungus and plant species. Revisions and refinements to the Sampled Red List by the our researchers has been used to determine the extinction risk of groups such as reptiles, which were not previously represented. This led to the assessment of 1,500 species and their subsequent listing on the IUCN Red List. New IUCN guidelines drawing on this research have also been established for assessing species vulnerability to climate change (section 12.1 of the IUCN Guidelines for Using the Red List Categories and Criteria) and this led to the creation of the IUCN climate change impacts modelling group, chaired by UCL researcher Pearson. For example the IUCN listed *Coffee*

arabica, which is a highly valuable crop, as endangered in 2018 following review of climate change impact models by the group [S3].

All three metrics (LPI, BII, RLI) underpinned the WWF's flagship biennial report, the 'Living Planet Report' in 2016 and 2018 [S4]. This report has a global reach: it is published in 110 countries and in more than 20 languages, and it is estimated that the press coverage reach was over 100 million people [S4]. In the UK, biodiversity loss figures from our indicators found in this report were cited as the impetus for an Early Day Motion on Global Biodiversity in the House of Commons on 31 October 2016: *"The catalyst for this debate was the Living Planet Report, prepared by the World Wildlife Fund and the Zoological Society of London, that shows that the global wildlife population fell by more than half between 1970 and 2012."* [S5] As a result of this debate, 41 MPs signed a motion urging the UK government to tackle the effects of climate change, habitat loss and degradation, species over-exploitation, pollution and animal diseases [S5].

The indicators developed at both UCL and IoZ (BII and LPI indices) informed the UN Environment Programme's assessment of the state of the environment, 'Global Environment Outlook 6' (2019) which explained the indices' ability to create a more nuanced and accurate picture of biodiversity and species loss than previous measures:

"...these indicators provide finer spatial and temporal resolution. Trends in global vertebrate species population abundances as measured by the Living Planet Index show an average decline of 60 per cent between 1970 and 2014... Globally, average local abundance of terrestrial species is estimated to have fallen to 85 per cent of modelled abundances in the absence of anthropogenic land-use change (Newbold et al. 2016)" [S6, page 156].

Research on these indices has thus led to a step-change in international environmental policy, whereby measures of biodiversity loss can be presented with confidence, informed and binding targets can be set and progress towards recovery can be accurately assessed.

Influencing regional and national policy-making

As a result of the widespread adoption of the tools developed at IoZ/UCL by major international and intergovernmental organisations, our researchers have undertaken commissioned assessments of biodiversity for a range of thematic groups across the world, including in:
The Arctic: The Arctic Species Trend Index [S7] was commissioned by the Arctic Council and the Conservation of Arctic Flora and Fauna (CAFF), based upon the methodology and dataset developed for the LPI. CAFF have described this as *"a new method and the first species indicator to understand and monitor the biodiversity of the Arctic"* [S12].
European wetlands: The LPI methodology and open-source tools were also used to produce the Wetland Extent Index [S8].
Rewilding Europe: Further adaptation of these tools underpinned a Rewilding Europe project on extinction risk and abundance, and was presented in the 'Wildlife Comeback in Europe' report in 2013 [S9]. This report celebrated successful conservation efforts in 18 mammal and 19 bird species across the continent of Europe, and our indicators were used to assess the impact of these interventions and the lessons that could be learned from them for future projects and policy makers.
Canada: IoZ researchers also developed a series of regional assessments of biodiversity, again building upon the methodology and data developed for the global LPI. The Sustainability Directorate, Environment and Climate Change Canada and IoZ researchers collaborated to adapt the LPI methodology to establish the Canadian Species Index. This filled a gap in intelligence on vertebrate population changes across Canada and enabling the measurement of progress towards the Canadian Environmental Sustainability Indicators and the 2020 Biodiversity Goals and Targets for Canada [S10], now used by the Canadian Government to monitor national biodiversity trends [S10].

Australia: In Australia, IoZ researchers collaborated with the nation's Threatened Species Recovery Hub and the University of Queensland to help develop the Australian Threatened Species Index (TSX) to track wildlife abundance of threatened species there.
UK: The Biodiversity Intactness Index of the UK, developed by UCL researchers, was featured in the UK's 'State of Nature Report' (2016), an annual snapshot of the state of the UK's biodiversity assembled from data from over 50 organisations [S11].

5. Sources to corroborate the impact

[S1] Secretariat of the Convention on Biological Diversity (2014) 'Global Biodiversity Outlook 4'. Montréal, 155 pages. https://www.cbd.int/gbo/gbo4/publication/gbo4-en.pdf and Convention on Biological Diversity CBD/WG2020/2/3/Add.1 Preliminary Draft Monitoring Framework for the goals and preliminary draft monitoring framework for targets. https://www.cbd.int/doc/c/2f5f/ea7d/3c7ff4e05fb89094a2222144/wg2020-02-03-add1-en.pdf

[S2] IPBES (2019): 'Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services'. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. https://ipbes.net/global-assessment

[S3] Letter of Support from Craig Hilton-Taylor, Head of Red List Unit, IUCN Global Species Programme.

[S4] WWF (2018) *Living Planet Report 2018: Aiming higher* (eds. Grooten N & Almond REA). WWF, Gland, Switzerland. Letter of Support from Rosamunde Almond, Editor in Chief, Living Planet Report, WWF.

[S5] Early day motion #624. Tabled 31 October 2016 (2016-17 Session) https://edm.parliament.uk/early-day-motion/49877/global-biodiversity "That this House has considered in full the contents of the WWF Living Planet Report 2016 and recognises the significant threat presented to the natural world through a 58 per cent decline in the recorded global populations of fish, birds, mammals and amphibians from 1970 to 2012" https://hansard.parliament.uk/Commons/2016-11-01/debates/A42AE11E-B9CE-41EF-931B-F83A384B75AB/GlobalBiodiversity?highlight=early%20day%20motion%20624#contribution-FED3142A-7BE2-4183-BB8D-5BDE37CB7947

[S6] UN Environment (2019). 'Global Environment Outlook – GEO-6: Healthy Planet, Healthy People.' Nairobi. DOI 10.1017/9781108627146.

[S7] Deinet S, Zöckler C, Jacoby D, Tresize E, Marconi V, McRae L, Svoboda M, & Barry T (2015). 'The Arctic Species Trend Index: Migratory Birds Index'. Conservation of Arctic Flora and Fauna, Akureyri, Iceland.

[S8] Dixon, M. J. R., Loh, J., Davidson, N. C., Beltrame, C., Freeman, R., & Walpole, M. (2016). Tracking global change in ecosystem area: The Wetland Extent Trends index. *Biological Conservation*, *193*, 27-35.

[S9] Deinet S, Ieronymidou C, McRae L, Burfield IJ, Foppen RP, Collen B, & Böhm M. (2013) 'Wildlife comeback in Europe: the recovery of selected mammal and bird species'. Final report to Rewilding Europe by ZSL, BirdLife International and the European Bird Census Council. London, UK: ZSL.

[S10] Environment and Climate Change Canada (2019) Canadian Environmental Sustainability Indicators: Canadian species index. Consulted on August 30th, 2020. Available at: www.canada.ca/en/environment-climate-change/services/environmental-indicators/canadianspecies-index.html. Letter of Support from Environment and Climate Change Canada.

[S11] Hayhow, D.B., Burns, F., Eaton, M.A., et al., 2016. *State of Nature 2016.* State of Nature Partnership.

[S12] Letter of support from Arctic Council and the Conservation of Arctic Flora and Fauna (CAFF)