Supplementary Materials for

Essential Biodiversity Variables

H. M. Pereira,* S. Ferrier, M. Walters, G. N. Geller, R. H. G. Jongman, R. J. Scholes, M. W. Bruford, N. Brummitt, S. H. M. Butchart, A. C. Cardoso, N. C. Coops, E. Dulloo, D. P. Faith, J. Freyhof, R. D. Gregory, C. Heip, R. Höft, G. Hurtt, W. Jetz, D. Karp, M. A. McGeoch, D. Obura, Y. Onoda, N. Pettorelli, B. Reyers, R. Sayre, J. P. W. Scharlemann, S. N. Stuart, E. Turak, M. Walpole, M. Wegmann

*To whom correspondence should be addressed. E-mail: hpereira@fc.ul.pt

Published 18 January 2013, *Science* **339**, 277 (2013)
DOI: 10.1126/science.1229931

This PDF file includes

Supplementary text: Authors and affiliations

Henrique M. Pereira,[1]* Simon Ferrier,[2] Michele Walters,[3] Gary N. Geller,[4] Rob H.G. Jongman,[5] Robert J. Scholes,[3] Mike W. Bruford,[6] Neil Brummitt,[7] Stuart H. M. Butchart,[8] Ana C. Cardoso,[9] Nicholas C. Coops,[10] Ehsan Dulloo,[11] Daniel P. Faith,[12] Jörg Freyhof,[13] Richard D. Gregory,[14] Carlo Heip,[15] Robert Höft,[16] George Hurtt,[17] Walter Jetz,[18] Daniel S. Karp,[19] Melodie A. McGeoch,[20] David Obura,[21] Yusuke Onoda,[22] Nathalie Pettorelli,[23] Belinda Reyers,[24] Roger Sayre,[25] Jörn P.W. Scharlemann,[26,27] Simon N. Stuart,[28] Eren Turak,[29] Matt Walpole,[26] Martin Wegmann[30]

[1]Centro de Biologia Ambiental, Faculdade de Ciências da Universidade de Lisboa, 1749-016 Lisboa, Portugal.

[2]Ecosystem Sciences, Commonwealth Scientific and Industrial Research Organization (CSIRO), General Post Office Box 1700, Canberra, Australian Capital Territory 2601, Australia.

[3]Natural Resources and Environment, Council for Scientific and Industrial Research (CSIR), Post Office Box 395, Pretoria 0001, South Africa.

[4]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, USA.

[5]Alterra, Wageningen University and Research Center, Post Office Box 47, Wageningen 6700AA, Netherlands.

[6]Cardiff School of Biosciences, Sir Martin Evans Building, Museum Avenue, Cardiff CF10 3AX, UK.

[7]Natural History Museum, Cromwell Road, South Kensington, London SW7 5BD, UK.

[8]BirdLife International, Wellbrook Court, Girton Road, Cambridge CB3 0NA, UK.

[9]European Commission, Joint Research Centre, Institute for Environment and Sustainability, Via E. Fermi 2749, Building 46, 21027 Ispra, Italy.

[10]Department of Forest Resource Management, 2424 Main Mall, University of British Columbia, Vancouver, British Columbia V6T 1Z4, Canada.

[11]Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla, 00153 Rome, Italy.

[12]The Australian Museum, 6 College Street, Sydney 2010, Australia.

[13]The Leibniz Institute of Freshwater Ecology and Inland Fisheries—IGB, Muggelseedamm 10, 12587 Berlin, Germany.

[14]The Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, UK.

[15]Royal Netherlands Institute for Sea Research, Post Office Box 140, 4400 AC Yerseke, Netherlands.

[16]Secretariat of the Convention on Biological Diversity, World Trade Center, 413 St. Jacques Street, Suite 800, Montreal, Quebec, H2Y IN9, Canada.

[17]Department of Geography, University of Maryland, College Park, MD 20742, USA.

[18]Yale University, 165 Prospect Street, New Haven, CT 06520–8106, USA.

[19]Center for Conservation Biology, Department of Biology, Stanford University, Stanford, CA

94305, USA.

[20]School of Biological Sciences, Monash University, Clayton, Victoria 3800, Australia.

[21]Coastal Oceans Research and Development in the Indian Ocean (CORDIO) East Africa, Post Office Box 10135, Mombasa 80101, Kenya.

[22]Graduate School of Agriculture, Kyoto University, Kitashirakawa Oiwake-cho, Kyoto 606-8502, Japan.

[23]Institute of Zoology, Zoological Society of London, Regent's Park, London NW1 4RY, UK.

[24]CSIR Natural Resources and Environment, Post Office Box 320, Stellenbosch 7599, South Africa.

[25]U. S. Geological Survey, 519 National Center, Reston, VA 20192, USA.

[26]United Nations Environment Programme World Conservation Monitoring Centre, 219 Huntingdon Road, Cambridge CB3 0DL, UK.

[27]School of Life Sciences, University of Sussex, Falmer, Brighton BN1 9QG, UK.

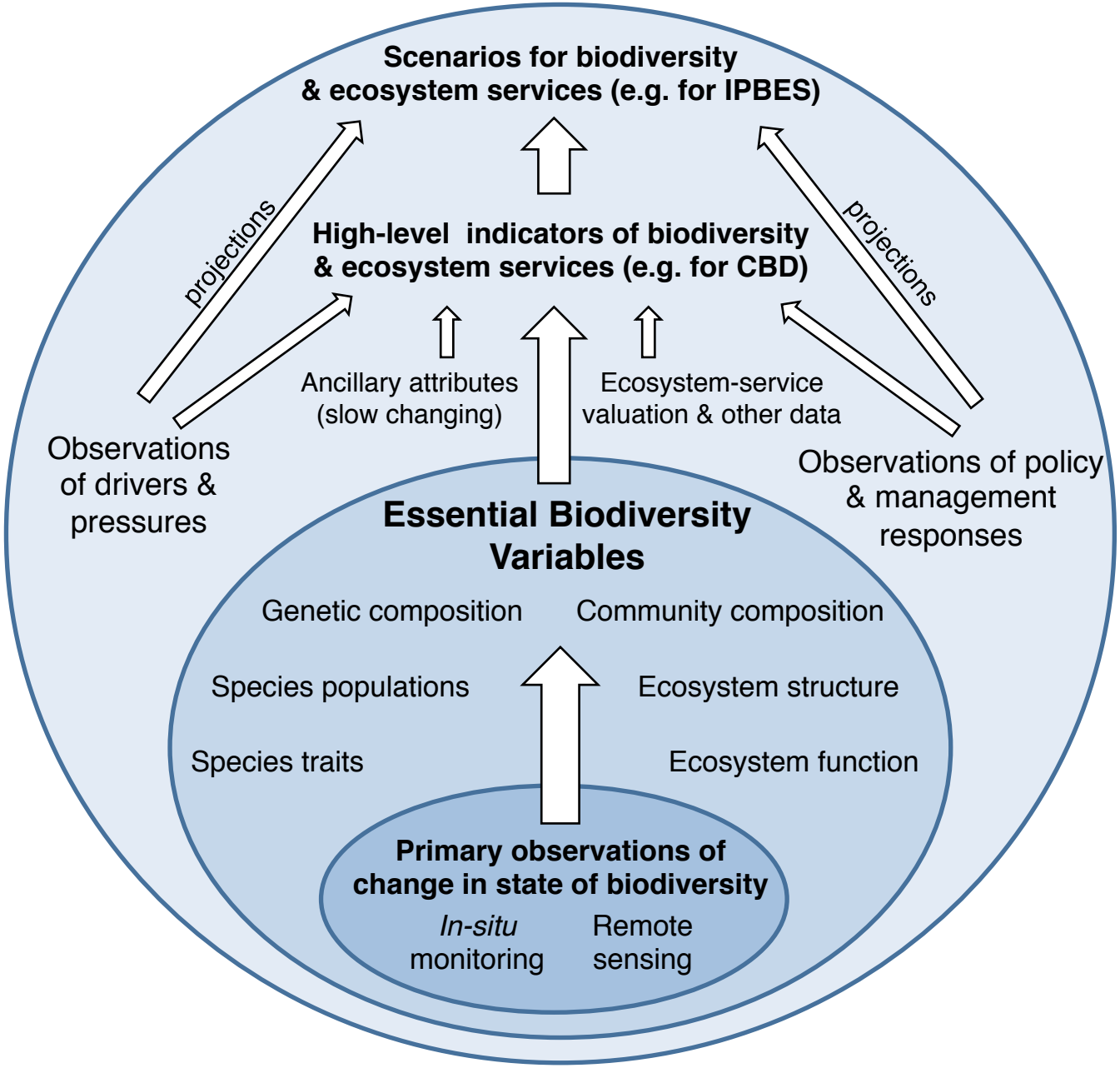
[28]IUCN Species Survival Commission, 7-9 North Parade Buildings, Bath BA1 1NS, UK.

[29]Office of Environment and Heritage—New South Wales, 59-61 Goulburn Street, Sydney, New South Wales 2000, Australia.

[30]Department for Geography and Geology, Würzburg University, Campus Hubland Nord 86, 97074 Würzburg, Germany.

Supplementary Figure

Fig. S1. The essential biodiversity variables (EBVs) framework. Primary observations from in situ monitoring and remote-sensing systems are preprocessed and combined into EBVs. Thus, EBVs represent an intermediate data layer for harmonization between sampling protocols and measurement systems. All EBV classes should be included in a biodiversity monitoring program. EBVs inform multiple biodiversity and ecosystem-service indicators, such as those needed to assess the Aichi Biodiversity targets. Some indicators require the integration of EBVs with other sources of information such as data on ancillary biodiversity attributes (slowly changing variables), drivers and pressures, management and policy responses, and valuation and demand of ecosystem services. Future projections of drivers and policy responses can be used to develop scenarios for biodiversity and ecosystem services using models calibrated and validated with EBVs.


Scenarios for biodiversity
& ecosystem services (e.g. for IPBES)
projections
High-level indicators of biodiversity
& ecosystem services (e.g. for CBD)
projections
Ancillary attributes
(slow changing)
Ecosystem-service
valuation & other data
Observations
of drivers &
pressures
Observations of policy
& management
responses
Essential Biodiversity
Variables
Genetic composition
Community composition
Species populations
Ecosystem structure
Species traits
Ecosystem function
Primary observations of
change in state of biodiversity
In-situ
monitoring
Remote
sensing

References and Notes

1. S. H. M. Butchart *et al*., *Science* 328, 1164 (2010).
2. CBD, Decision X/2, The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets, Nagoya, Japan, 18 to 29 October 2010.
3. H. M. Pereira *et al*., *Annu. Rev. Environ. Resour.* 37, 25 (2012).
4. R. J. Scholes *et al*., *Curr. Opin. Environ. Sustain.* 4, 139 (2012).
5. R. P. Guralnick, et al., *Ecol. Lett.* 10, 663 (2007).
6. L. J. Martin *et al*., *Front. Ecol. Environ.* 10, 195 (2012).
7. C. K. Feld *et al*., *Oikos* 118, 1862 (2009).
8. GCOS, *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (*2010 Update*) (World Meteorological Organization, Geneva, 2010), p. 180; www.wmo.int/pages/prog/gcos/Publications/gcos-138.pdf.
9. Secretariat of the CBD, *Report of the Ad Hoc Technical Expert Group on indicators for the Strategic Plan for Biodiversity 2011–2020* (SCBD, Montreal, Canada, 2011); www.cbd.int/doc/meetings/sbstta/sbstta-15/information/sbstta-15-inf-06-en.pdf.
10. P. Bubb *et al*., *National Indicators, Monitoring and Reporting for the Strategic Plan for Biodiversity 2011–2020* (United Nations Environment Programme's World Conservation Monitoring Centre, Cambridge, 2011).
11. GEO BON, EBVs; www.earthobservations.org/geobon_ebv.shtml.
12. R. D. Gregory *et al*., *Philos. Trans. R. Soc. B Biol. Sci.* 360, 269 (2005).
13. D. P. Turner, *Front. Ecol. Environ.* 9, 111 (2010).
14. S. Ferrier, *Bioscience* 61:96 (2011).
15. W. Jetz et al., *Trends Ecol. Evol.* 27, 151 (2012).
16. H. M. Pereira *et al*., *Science* 330, 1496 (2010).
17. E. O. Wilson, *Science* 289, 2279 (2000).
18. International Oceanographic Commission, A framework for ocean observing—Consultative draft v.7 (United Nations Educational, Scientific and Cultural Organization, Paris, 2011), p. 26; http://unesdoc.unesco.org/images/0021/002112/211260e.pdf.
19. H. Tallis et al., *BioScience* 62, 977 (2012).
20. M. Lenzen et al., *Nature* 486, 109–112 (2012).

Acknowledgments: NASA, DIVERSITAS, Group on Earth Observations, European Space Agency—Centre for Earth Observation, and the Department of Science and Technology (South Africa) provided resources. H.M.P. was supported by Fundação para a Ciência e a Tecnologia of Portugal grant PTDC/AAC-AMB/114522/2009. M. Paganini helped organize a workshop. H.M.P., S.F., M. Walters, G.N.G., R.H.G.J., R.J.S., D.P.F., C.H., R.H., R.S., S.N.S., and M. Walpole are on the GEO BON steering committee.