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UPDATED SCIENTIFIC ASSESSMENT OF PROGRESS TOWARDS SELECTED AICHI BIODIVERSITY TARGETS AND OPTIONS TO ACCELERATE PROGRESS

Note by the Executive Secretary

I. BACKGROUND

1. In decision XII/1, the Conference of the Parties welcomed the fourth edition of the *Global Biodiversity Outlook* (GBO-4) and recognized that, while there had been encouraging progress towards meeting some elements of most Aichi Biodiversity Targets, in most cases, the progress would not be sufficient to achieve the targets unless further urgent and effective action was taken to reduce the pressures on biodiversity and prevent its continued decline.

2. In decision XIII/30, the Conference of the Parties requested the Executive Secretary, subject to the availability of resources, to prepare, in collaboration with members of the Biodiversity Indicators Partnership and other relevant partners, for the consideration of the Subsidiary Body on Scientific, Technical and Technological Advice at a meeting held prior to the fourteenth meeting of the Conference of the Parties, updated scientific assessments of progress towards the Aichi Biodiversity Targets, focusing in particular on those targets on which the least progress had been made and making use of available data and the indicators contained in the annex to decision XIII/28, as appropriate, as well as other information sources used for GBO-4. In the same decision, the Executive Secretary was requested to develop options to accelerate progress towards the achievement of those targets which have been identified as the least advanced. In light of these requests, this note has been prepared.

3. The mid-term term assessment of progress towards the attainment of the Aichi Biodiversity Targets contained in GBO-4 concluded that, with the exception of Target 16 on the Nagoya Protocol, no target was on track to be met. In GBO-4, seven targets (1, 7, 11, 17, 18, 19 and 20) were assessed as having at least one element on which progress was being made, but at a rate that would not allow the targets to be reached by the deadline. Seven targets (2, 3, 4, 6, 9, 13 and 15) were assessed as having at least one element on which no significant overall progress was being made, and a further 5 targets (5, 8, 10, 12 and 14) had at least one element which was assessed as moving away from the target. Given the overall limited progress realized towards the achievement of the Aichi Biodiversity Targets, this note addresses all 20 targets.

4. In order to prepare the present note, scientific literature, primarily from peer-reviewed journals, was examined. The review was limited to publications that were published between 2014 (the year GBO-

* CBD/SBSTTA/22/1.

4 was published) and 2018. The Secretariat engaged a group of interns[1] to collect and summarize relevant information from relevant databases of scientific journals. In addition, information on indicators, provided through the Biodiversity Indicators Partnership, was reviewed. Of the 55 indicators used in GBO-4, 29 have had additional data points added. In addition, a further 17 indicators that were not used in GBO-4 were identified. This information is synthesized in section II of this note and all of the indicators with updated data points are contained in the annex. Section III provides some overarching observations. An earlier version of this document was made available for peer review. It has been revised taking into account the comments[2] received, as well as additional documentation identified during the course of the peer review period.

II. UPDATED SCIENTIFIC ASSESSMENT

Target-by-target analysis

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

5. Since the release of GBO-4, there has been relatively little published scientific information assessing peoples' awareness of biodiversity at the global level. One study which reviewed media coverage of biodiversity issues between 1991 and 2016 in Canada, the United Kingdom and the United States found that media coverage of climate change issues was significantly higher than for biodiversity and concluded that information on the challenges facing biodiversity is not reaching the general public[3]. A further study, based on scientific publications, newspapers and funding distributed through the World Bank and the National Science Foundation, came to a similar conclusion and that, to overcome this, the conservation community needs to learn from the discourse surrounding climate change and proactively use the growing interest in climate change as means of leveraging action to prevent biodiversity loss.[4] With regard to the marine environment specifically, an assessment of public perception about the threats to the marine environment and its protection, based on information from 21 countries, found that the majority of respondents (70%) felt that the marine environment was under threat from human activities however only 15% felt that the health of oceans was poor or threatened.[5]

6. Various studies have been undertaken on different approaches, tools and means of raising awareness as well as on advancing the understanding of what constitute effective awareness-raising mechanisms. There is also a growing recognition of the relationship between environmental education and attractions, such as zoos and aquariums.[6] For example, one study determined that visitors to zoos and aquariums who were exposed to educational material, such as interpretive graphic panels and informative films regarding biodiversity during their visits, exhibited an increased level of understanding of

[1] David Barrington Marquis, Madeleine Cazes, Cristina del Rio Cubilledo, El Gibbor Djiki, Louis Donelle, Sara El-Nounou, Sebastien Macdonald Dupuis, David Hoffmann, Yui Matsuo, Gabriel Ouellette, Alexandre Poulin, Fatima Shire, Jan Bernd Sievernich, Yidan Xu

[2] Comments were received from Brazil, Mexico, Japan, BirdLife International, IUCN, the IUCN Fisheries Expert Group, and the Inter-American Institute for Global Change Research (IAI)

[3] Legagneux P, et al (2018) Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. Front. Ecol. Evol. 5:175. doi: 10.3389/fevo.2017.00175

[4] Veríssimo, D. et al (2014). Has Climate Change Taken Prominence over Biodiversity Conservation?, BioScience, 64 (7), 625–629, https://doi.org/10.1093/biosci/biu079

[5] Lotze, H. K. et al (2018). Public perceptions of marine threats and protection from around the world. Ocean and Coastal Management 152, 14-22.

[6] Moss, A., et al (2015) Evaluating the contribution of zoos and aquariums to Aichi Biodiversity Target 1. Conservation Biology, 29: 537–544. doi:10.1111/cobi.12383

Clayton, S. et al (2017) Public Support for Biodiversity After a Zoo Visit: Environmental Concern, Conservation Knowledge, and Self-Efficacy, Curator: The Museum Journal, 60, 1, 87 biodiversity and greater awareness of actions they could take to protect it.[7] Other studies have attempted to understand how a growing trend towards urbanization may be having a negative effect on people's awareness of biodiversity and, relatedly, how there is a need to understand how people who live in urban environments understand biodiversity.[8] Studies have also explored how digital games can contribute to biodiversity awareness[9] and how tourism, in particular eco-tourism, can be used to increase biodiversity awareness.

7. There are three indicators related to Aichi Biodiversity Target 1 which have updated data since GBO-4 was published. Two of these are related to the Biodiversity Barometer (% of respondents that have heard of biodiversity and % of respondents giving correct definition of biodiversity) and suggest improvements in people's awareness of biodiversity[10]. The third indicator (online interest in biodiversity) suggests a decline[11].

8. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. The scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target. Additional possible actions to accelerate progress towards this target, identified in the literature, include the need to develop national communication strategies for biodiversity which speak to specific national priorities and which frame biodiversity in a similar light to other economic and social imperatives.[12] Relatedly it has also been suggested that an international communication strategy for biodiversity would be beneficial, particularly given that the level of media attention devoted to biodiversity is generally limited. The role of the scientific community in raising awareness of biodiversity issues by conveying accurate and clear information, focusing on global biodiversity issues and on the value of biodiversity to human wellbeing and fostering the interest of media in biodiversity, has also been noted[13].

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

9. The integration of biodiversity values into national and local policies and processes is an issue for which there is relatively little scientific information. However, one assessment has identified that the quality of governance contributed more to responses to and investment in biodiversity than did wealth, and identified governance as an important issue in conservation planning.[14] Much of the information that is available on this target generally focuses on the national or regional level. For example, one recent study explored different opportunities and challenges related to the mainstreaming of ecosystem services in policies of the European Union. Among the issues identified were the difficulty of reflecting ecosystems services across various spheres of responsibility, and the need for policy makers to consider

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[7] Moss, A. et al (2017), Impact of a global biodiversity education campaign on zoo and aquarium visitors. Frontiers in Ecology and the Environment, 15: 243–247. DOI: 10.1002/FEE.1493

[8] Shwartz, A. (2014) Enhancing urban biodiversity and its influence on city-dwellers: An experiment, Biological Conservation, 171- 82-90.

[9] Sandbrook, C., (2015), Digital Games and Biodiversity Conservation. Conservation Letters, 8: 118–124.

[10] Union for Ethical BioTrade (UEBT), Biodiversity Barometer (Amsterdam, 2017). http://www.biodiversitybarometer.org/

[11] Internet Live Stats, 2017. Google Search Statistics. http://www.internetlivestats.com/google-search-statistics/

[12] Maze, K., et al (2016) Making the case for biodiversity in South Africa: Re-framing biodiversity communications. Bothalia, 46, dec.

[13] Legagneux P, et al (2018) Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. Front. Ecol. Evol. 5:175. doi: 10.3389/fevo.2017.00175.

[14] Baynham-Herd, Z., et al (2018). Governance explains variation in national responses to the biodiversity crisis. Environmental Conservation, 1-12. doi:10.1017/S037689291700056X.

the dynamics that may exist between different policies.[15] Another obstacle identified in the literature was the need to reconcile different perceptions among stakeholders of what constitutes an ecosystem service.[16] One possible tool to facilitate the implementation of this target is the System of Environmental and Economic Accounting (SEEA) adopted by the United Nations Statistical Commission. However, the integration of this framework in national accounting systems has been limited to date.[17]

10. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Similarly, the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.

11. Relative to other Aichi Biodiversity Targets, there has been little global-level information published on this issue since the release of the GBO-4. However, various assessments have been undertaken at the regional level (e.g. for Europe[18]) and at the national level.[19.] Different approaches to payment for ecosystem service (PES) schemes have also been explored. One study identified 550 active PES schemes generating between US$ 36 and US$ 42 billion in transactions each year.[20] Progress towards the attainment of this target will be further considered during the second meeting of the Subsidiary Body on Implementation.

Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

12. The information published since GBO-4 has identified various actions which are being taken by countries to make production and consumption more sustainable. For example, some countries have put in place policies promoting green development while others have implemented tariff systems to encourage renewable energy production and consumption.[21] Further, some countries have put in place

[15] Schleyer, C. et al (2015) Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU, Ecosystem Services. 16. 174-181.

[16] Verburg, R. et al (2016) Governing ecosystem services, National and local lessons from policy appraisal and implementation, Ecosystem Services,18. 186-197,

[17] Vardon, M. (2016). The accounting push and the policy pull: balancing environment and economic decisions, Ecological Economics, 124. 145-152.

[18] Merckx, T. et al (2015) Reshaping agri-environmental subsidies: From marginal farming to large-scale rewilding,Basic and Applied Ecology,16(2), 95-103,

[19] Gain, D. et al (2017).Expert Evaluation of Subsidies for the Management of Fragmented Private Forest in Regards to National Biodiversity Goals-The Case of Kochi Prefecture, Japan. Sustainability, 9, 626.

[20] Salzman, J. et al (2018). The global status and trends of payments for ecosystem services. Nature Sustainabilityvolume 1, pages136–144

[21] Pretty, J. and Bharucha, Z. P. (2014). Sustainable intensification in agricultural systems, Annals of Botany, Volume 114, 8, 1571–1596,

initiatives to reduce greenhouse gas emissions and programmes to modernize agricultural equipment.[22] Other studies have looked at the use of various certification systems.[23]

13. Much of the scientific information that has become available since the publication of GBO-4 has focused on the national or regional levels. By comparison, little global-level information summarizing trends and issues related to global sustainable production and consumption has become available. However, one global assessment estimated that green consumption represented less than 4% of global consumption and that strategies to increase this, particularly in emerging economies, are required.[24] It has also been observed that greater awareness is helping to increase the demand for greener products and services and that in industries, such as the food industry, this has led to improvements in labelling.[25] There has also been growing recognition of the role of trade patterns and teleconnections on the production and consumption of resources[26]. For example, an assessment of the material footprints of 186 countries found that countries' use of resources from non-domestic sources is about three times larger than the physical quantity of traded goods[27]. The same study also found that, as wealth increases, countries tend to reduce their consumption of domestic resources through international trade thereby allowing their material consumption to increase.

14. Three indicators used in GBO-4 have been updated since the report was released. These are the percentage of countries that are Category 1 CITES Parties,[28] which shows an increase, and the Red List Index for the impacts of utilization[29] and the Ecological Footprint,[30] both of which show a decrease. In addition, a new indicator, the Red List Index for internationally traded species,[31] has become available since GBO-4 was published and also shows a decrease.

15. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Similarly, the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of Aichi Biodiversity Target 4.

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

16. Since the publication of GBO-4, numerous studies on various habitats have been published. Some of these are based on new information while others are further examinations of data sets which were available when GBO-4 was published.

17. With regard to forests, globally the annual rate of net forest loss was halved from 7.3 million hectares per year in the 1990s to 3.3 million hectares per year between 2010 and 2015. From 2010 to 2015, tropical forest area declined at 58% of the rate in the 1990s. Temperate forest area expanded at a

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[22] Moraes Sá, J. (2017). Low-carbon agriculture in South America to mitigate global climate change and advance food security, Environment International, 98, 102-112,

[23] Keahey, J. (2017). The Promise and Perils of Market-based Sustainability Sociology of Development, 3(2), 43-162.

[24] Blok, V. et al (2015). From best practices to bridges for a more sustainable future: advances and challenges in the transition to global sustainable production and consumption: Introduction to the ERSCP stream of the Special volume, Journal of Cleaner Production, 108(A), 19-30.

[25] Miranda-Ackerman, M. et al (2017). Extending the scope of eco-labelling in the food industry to drive change beyond sustainable agriculture practices, Journal of Environmental Management,204(3), 814-824.

[26] Vörösmarty, C.J. et al (2015). What scale for water governance? Science. 349 (6247).

[27] Wiedmann, T.O. et al (2015). The material footpring of nations. Proceedings of the National Academy of Sciences 112(20), 6271-6276.

[28] CITES, National laws for implementing the Convention. https://cites.org/legislation

[29] IUCN Red List Index. http://www.iucnredlist.org/about/publication/red-list-index

[30] Galli, A., et al. (2014). Ecological footprint: Implications for biodiversity. Biological Conservation, 173, 121-132.

[31] IUCN Red List Index. http://www.iucnredlist.org/about/publication/red-list-index

rate of 2.2 million hectares per year while boreal and sub-tropical forest areas showed little net change. On a regional basis, forest area is expanding in Europe, North America, the Caribbean, East Asia, and Western-Central Asia, but is declining in Central America, South America, South and Southeast Asia and Africa.[32] Specifically with regard to primary forests, forest area declined by 2.5% globally and by 10% in the tropics over the 1990-2015[33] period.

18. Intact primary forests declined by 7.2% between 2000 and 2012 as a result of fragmentation and this rate of loss appears to be increasing. For example, the rate of loss in tropical forests was three times higher in 2011-2013 than in 2001-2003.[34] Nearly 20% of the world's remaining forest is within 100 meters of a forest edge and more than 70% is within 1 kilometre.[35] In one assessment of published global tree cover data, including both forest and forest interior areas, between 2000 and 2012, the net rate of forest loss was calculated at 3.2% of all forest area. In comparison, 9.9% of forest interior area was lost between 2000 and 2012. One of the conclusions from this study is that considering forest loss alone does not appropriately account for the ecological risk resulting from fragmentation.[36] A similar study, which assessed intact forest landscapes inside protected areas, based on remote sensing data, found that 3% of protected forests, 2.5% of intact forests and 1.5% of protected intact forests were lost globally between 2000 and 2012. However, the study also observed that there was high regional variation and that high rates of loss of protected and intact forests were associated with high gross domestic product and high rates of loss associated with a high proportion of agricultural land.[37]

19. Among the causes of forest lost that have been explored in the literature are economic factors, fire[38] and insect pests, severe weather and diseases.[39] Forest policies aimed at maximizing profits and unsustainable tenure regimes have also been identified as causes of forest loss.[40]

20. A number of studies have attempted to project trends in forest area. For example, one study projected global forest area to 2030 and concluded that forest area is expected to continue to decline but that the rate of loss will decrease from 0.13% at the beginning of the century to 0.06% per year by 2030. This decline is the result of a decrease in the rate of natural forest loss and an increase in planted forests. However, it is important to note that, although the overall rate of forest loss in 2030 is projected to be small, it masks important regional differences and in some regions forest area is projected to continue declining.[41]

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[32] Keenan, R. et al (2015). Dynamics of global forest area: Results from the FAO Global Forest Resources Assessment 2015, Forest Ecology and Management, 352, 9-20.

[33] Morales-Hidalgo, D. et al (2015). Status and trends in global primary forest, protected areas, and areas designated for conservation of biodiversity from the Global Forest Resources Assessment, Forest Ecology and Management, 352, 68-77.

[34] Potapov, P. et al (2017). The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013.Science Advances 3(1).

[35] Haddad, Nick M. et al (2015). Habitat fragmentation and its lasting impact on Earth’s ecosystems. Science Advances. 1(2).

[36] Riitters, K., et al. (2016) A global evaluation of forest interior area dynamics using tree cover data from 2000 to 2012. Landscape Ecology 31: 137. https://doi.org/10.1007/s10980-015-0270-9.

[37] Heino, Matias, et al. (2015). Forest loss in protected areas and intact forest landscapes: a global analysis. PLoS One 10.10: e0138918.

[38] Jolly, W. et al (2015). Climate-induced variations in global wildfire danger from 1979 to 2013, Nature Communications, 6, 7537.

[39] van Lierop, P. (2015). Global forest area disturbance from fire, insect pests, diseases and severe weather events, Forest Ecology and Management, 352, 78-88.

[40] Brandt, J. S., et al (2017). Effects of national forest-management regimes on unprotected forests of the Himalaya, 31-6, 1271-1282.

[41] d’Annunzio, R. (2015). Projecting global forest area towards 2030, Forest Ecology and Management, 352, 124-133.

21. Global mangrove cover was estimated to be 138,000 square kilometres in 2000, which is less than half of what it was in 1950.[42] A further study estimated that global mangrove area decreased from 170,000 square kilometres to 140,000 square kilometres between 1997 and 2014.[43] Further, while mangroves continue to be lost, the rate of loss appears to be declining. Globally, between 2000 and 2012, the rate of mangrove loss was estimated to be 0.16% and 0.39% per year. By comparison, in the 1980s, the rate of loss was estimated at 0.99% per year and in the 1990s it was estimated at 0.70% per year. However, there are regional differences. For example, in Southeast Asia, mangrove loss between 2000 and 2012 was estimated to be between 3.58% and 8.08%.[44] However, other studies have estimated the rate of loss in Southeast Asia to be significantly lower. For example, one study estimated that mangrove forest loss was on average 0.18% per year between 2000 and 2012.[45] Among the main drivers of mangrove loss are wood cutting for firewood and timber and clearing for aquaculture. Overall trends in mangrove cover are generally negative however there is a high degree of uncertainty making it difficult to determine rates of loss with any significant confidence.[46]

22. Wetlands declined by about 31% between 1970 and 2008. Further, the rate of decline appears to be constant.[47] Another study concluded that, in the absence of human intervention, there would be approximately 29.83 million square kilometres of wetlands. However, as of 2009, 33% of global wetlands have been lost.[48] A further study, reviewing 189 reports related to wetlands, found that between 64-71% of wetlands have been lost since 1900. Losses have been greater for inland wetlands as compared to coastal wetlands.[49]

23. Permanent surface water (both inland and coastal), based on satellite images from between 1984 and 2015, is estimated to have declined by almost 90,000 square kilometres. A further 72,000 square kilometres have gone from being permanent to seasonal. Over the same period, 213,000 square kilometres of permanent water bodies emerged, of which 29,000 square kilometres used to be seasonal. Much of the increase that has been observed is the result of the filling of reservoirs. However, these global trends also obscure strong regional variation. For example, more than 70% of the loss in global permanent water occurred in the Middle East and Central Asia.[50] An additional pressure on the world's inland water systems is fragmentation. For example, 48% of global river volume is moderately or severely impacted by flow regulation and/or fragmentation. The same study identified a total of 6374 large dams that currently exist and an additional 3377 that are planned or proposed. Assuming that all planned dams are built and

[42] Polidoro, B., (2014). Global patterns of mangrove extinction risk: Implications for ecosystemservices and biodiversity loss. In B. Maslo & J. Lockwood (Eds.), Coastal Conservation (Conservation Biology, pp. 15-36). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139137089.003.

[43] Pérez, A, et al. (2017). Changes in organic carbon accumulation driven by mangrove expansion and deforestation in a New Zealand estuary. Estuarine, Coastal and Shelf Science 192, 108-116.

[44] Hamilton, S. E. et al (2016), Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMFC-21). Global Ecol. Biogeogr., 25: 729–738. doi:10.1111/geb.12449

[45] Richard, D. et al (2016). Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012. Proceedings of the National Academy of Sciences, 113(2), 344-349.

[46] Friess, D. A. et al (2014), Variability in mangrove change estimates and implications for the assessment of ecosystemservice provision. Global Ecology and Biogeography, 23: 715–725. doi:10.1111/geb.12140.

[47] Dixon, M.J.R., et al (2016) Tracking global change in ecosystemarea: The Wetland Extent Trends index. Biological Conservation, 193, 27-35.

[48] Shengjie Hu, et al (2017). Global wetlands: Potential distribution, wetland loss, and status,Science of The Total Environment, 586, 319-327.

[49] Davidson, N. C. 2014. *How much wetland has the world lost? Long-term and recent trends in global wetland area*. Marine and Freshwater Research 65:934–941

[50] Pekel, J et al (2016). High-resolution mapping of global surface water and its long-term changes. Nature, 540, 418-422.

dams currently under construction are completed, by 2030, 93% of global river volume would be moderately or severely impacted.[51]

24. Assessments of grasslands often arrive at different results[52] as there are various definitions and classes of grasslands[53]. Moreover, land cover maps generally have a high level of uncertainty.[54] Globally, agricultural expansion remains a main threat to grasslands, however many high-income countries are experiencing farmland abandonment.[55] A number of the studies published since GBO-4 have focused on acquiring a better understanding of grassland trends in specific countries, including Brazil,[56] Mexico,[57] and Mongolia.[58] These studies generally indicate a decline in grassland area.

25. With regard to the marine environment in general, one study examined the cumulative impacts on the marine ecosystem resulting from fishing, climate change and ocean and land stressors. The assessment found that that 66% of the ocean and 77% of the area under national jurisdiction showed increased human impact, while 5% of the ocean is heavily impacted and 10% has a very low level of impact. However, there have been some signs of improvement.[59] A further assessment looking at trends in the marine environment found that trends in habitat modification, including coral cover loss, mangrove loss, change in the cumulative number of marine wind turbines, change in cumulative area of the seabed under contract for mineral extraction in international waters, trends in the volume of global container port traffic and in changes in the cumulative number of marine dead zones, suggest that habitat change may be an increasingly important threat to marine wildlife[60]. For example, both dredging[61] and bottom trawling[62] can have a range of impacts on the marine environment depending on how they are carried out and regulated.

26. For kelp forests and sea grasses, there is a high degree of geographic variations in trends, both in terms of the magnitude of change and direction. One analysis observed that 38% of ecoregions had declining trends in kelp forests, while 27% of ecoregions showed positive trends and 35% had no detectable change.[63] With regard to seagrasses, a review of these ecosystems in the Western Pacific region found that at three sites seagrasses were stable, at four sites they were declining as a result of nutrient

[51] Grill,G. et al (2015) An index-based framework for assessing patterns and trends in river fragmentation and flow regulation by global dams at multiple scales Environmental. Research. Letters. 10 015001

[52] Dunn, J. B., et al (2017), Measured extent of agricultural expansion depends on analysis technique. Biofuels, Bioproducts and Biorefining., 11: 247–257. doi:10.1002/bbb.1750

[53] Dixon, A. P., et al (2014), Distribution mapping of world grassland types. J. Biogeogr., 41: 2003–2019. doi:10.1111/jbi.12381

[54] Congalton, R.G et al (2014) Global Land Cover Mapping: A Review and Uncertainty Analysis. Remote Sensing. 6, 12070-12093.

[55] Queiroz, C., et al (2014), Farmland abandonment: threat or opportunity for biodiversity conservation? A global review. Frontiers in Ecology and the Environment, 12: 288–296. doi:10.1890/120348

[56] Hermann, J.-M., et al. (2016). Forest–grassland biodiversity hotspot under siege: land conversion counteracts nature conservation. Ecosystem Health and Sustainability2(6):e01224. doi:10.1002/ehs2.1224

[57] Pool, D et al (2014). Rapid expansion of croplands in Chihuahua, Mexico threatens declining North American grassland bird species, Biological Conservation, 170,274-281.

[58] Wang, Z. et al (2017). What is the main cause of grassland degradation? A case study of grassland ecosystem service in the middle-south Inner Mongolia, CATENA, 150, 100-107.

[59] Halpern, B. S. et al. (2015) Spatial and temporal changes in cumulative human impacts on the world's ocean. Nature Communications. 6:7615 doi: 10.1038/ncomms8615.

[60] McCauley, D. J. et al (2015). Marine defaunation: Animal loss in the global ocean, Science 347(6219)

[61] Victoria L. G. et al (2015) A review of impacts of marine dredging activities on marine mammals, ICES Journal of Marine Science, Volume 72, Issue 2, 328–340,

[62] Clark, M. et al (2016) The impacts of deep-sea fisheries on benthic communities: a review, ICES Journal of Marine Science, Volume 73, i51–i69.

[63] Krumhansl, Kira A. et al (2016). Global patterns of kelp forest change over the past half-century, Proceedings of the National Academy of Sciences 113 (48) 13785-13790.

pollution, and at three sites they were declining as a result of sedimentation. Further, two sites experienced near complete loss of seagrasses but had begun to recover once sedimentation was reduced.[64]

27. Two indicators used in GBO-4 have been updated since the report was released. They are the Wetland Extent Trends Index[65] and the Wild Bird Index for habitat specialists which both show declines. In addition, two new indicators, area of tree cover loss[66] and the Red List Index for forest specialists both show trends that are negative for biodiversity.

28. Most of the scientific information related to this target that has become available since GBO-4 was published is focused on forests. Information on other habitats is increasing but is still limited at the global level. However, advances in remote sensing are opening up new opportunities to more effectively monitor changes in the Earth's ecosystems. Overall, the literature reviewed for this note suggests that the situation is largely unchanged from what was previously reported in GBO-4, namely that, globally, the rate of deforestation is declining but with significant regional variation, that many other habitats continue to experience high rates of decline and that habitats of all types continue to be fragmented and degraded. Similarly, recent scientific information suggests that the actions identified in GBO-4 to accelerate progress towards this target remain relevant.

Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

29. The Food and Agriculture Organization of the United Nations (FAO) estimated that marine capture production rose between 1950 and 1988 when it reached 78 million tonnes (excluding anchoveta). Between this time and 2003, marine capture production levelled off and, between 2003 and 2009, marine capture production remained stable. Since 2010, it has increased and, in 2014, reached 78.4 million tonnes.[67] However, another study that makes use of a wide variety of data and information sources to derive estimates for all fisheries components missing from official reported data, such as discards and assuming that illegal catches are not reported, suggests that marine capture production peaked at 130 million tonnes in 1996 and has been declining since. This decline is associated with declines in industrial catches (in part due to mandatory catch reductions imposed for stock rebuilding) and, to a lesser extent, with declining discards and despite industrial fishing having expanded from industrialized countries to the waters of developing countries.[68]

30. The percentage of fish stocks fished at biologically unsustainable levels increased from 10% in 1974 to 26% in 1989. Since 1990, the number of stocks being fished at unsustainable levels has continued to increase, though more slowly than it has in the past, and reached 31.4% in 2013.[69] Other studies have

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[64] Short, et al (2014). Monitoring in the Western Pacific region shows evidence of seagrass decline in line with global trends, Marine Pollution Bulletin, 83(2). 408-416.

[65] Dixon, M.J.R.et al (2016, with updated data) Tracking global change in ecosystem area: The Wetland Extent Trends index. Biological Conservation 193, 27–35.

[66] Hansen, M.C., et al (2013). High-resolution global maps of 21st-century forest cover change. Science, 342(6160), pp.850-853. Data available online from http://earthenginepartners.appspot.com/science-2013-global-forest.
Heino, M., et al. (2015). Forest loss in protected areas and intact forest landscapes: a global analysis. PloS one, 10(10), p.e0138918.

[67] FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp.

[68] Pauly, D., and Zeller, D. (2016). Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. Nature communications, 7

[69] FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp.

also suggested declines in the sustainability of fisheries. For example, one study estimated that the percentage of fisheries below critical thresholds increased from 63% in 2006 to 68% in 2012.[70]

31. A meta-analysis of 4,713 fisheries, representing 78% of global reported fish catch, found that the median fishery appears with a biomass slightly over biomass maximum sustainable yield (Bmsy) and a fishing pressure slightly over maximum rate of fishing mortality (Fmsy). Considering that, even in well managed systems, Bmsy and Fmsy limits have confidence intervals of +/- 50-60%, these results imply that the median fishery today is still fished around maximum sustainable yield.[71] However, during the last decades, this median has progressively moved towards overfishing. The same assessment shows that 32% of assessed fisheries were found to be in good biological condition but not necessarily in good economic condition. The assessment further concluded, based on a business-as-usual scenario, the continued collapse of many of the world's fisheries.[72] However, the same assessment found that sound management reforms to global fisheries could increase annual catch by 16 million metric tonnes, increase biomass by 619 million metric tonnes and increase profits by 53 billion US$, relative to a business-as-usual scenario. A further meta-analysis of 785 fish stocks found that 53% of stocks are below biomass maximum sustainable yield (Bmsy) and 34% of these are below 80% of Bmsy;[73] however, the same caveat regarding confidence intervals noted above applies here as well.

32. Other studies have examined situations regarding marine fisheries in specific areas. For example, one study estimated that, in the Baltic Sea, when illegal fishing is accounted for, actual catches may be 35-40% higher than reported,[74] while another study has shown that harvest control rules in the Barents Sea has led to an increase in cod biomass.[75]

33. Other studies have looked at specific marine ecosystems. For example, one assessment focusing on the Western and Adriatic regions of the Mediterranean Sea concluded that all fisheries stocks, under present management and fishery conditions, are at risk of overexploitation.[76] A similar study concluded that global biomass production in the marine environment predicted a long-term decline in global marine catch.[77] Given the importance of agricultural and fisheries productivity to human wellbeing, such trends are a challenge to the prospects for reaching Aichi Biodiversity Target 14.

34. A variety of research has also been undertaken on the effect of marine protected areas on fisheries.[78] This research shows that marine protected areas have the potential to make important

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[70] Worm, B. (2016). Averting a global fisheries disaster. Proceedings of the National Academy of Sciences, 113(18), 4895-4897.

[71] Thorson, J.T.;et al 2014. Probability of stochastic depletion an easily interpreted diagnostic for stock assessment modelling and fisheries management. ICES Journal of Marine Science, 72(2) 428-435.

[72] Costello, C. et al. (2016). Global fishery prospects under contrasting management regimes. Proceedings of the National. Academy of Science5125.5129

[73] Rosenberg, A.A et al., (2017). Applying a New Ensemble approach to estimating stock status of marine fisheries around the world. Conservation Letters. Doi: 10.1111/conl.12363

[74] Beddington, J. R., et al (2007). Current problems in the management of marine fisheries. science, 316(5832), 1713-1716.

[75] Kjesbu, O. S., et al (2014). Synergies between climate and management for Atlantic cod fisheries at high latitudes. Proceedings of the National Academy of Sciences, 111(9), 3478-3483.

[76] Liquete, C. et al (2016). Ecosystem services sustainability in the Mediterranean Sea: Assessment of status and trends using multiple modelling approaches. Scientific Reports 6, 34162.

[77] Galbraith, E.D. et al (2017). A coupled human-Earth model perspective on long-term trends in the global marine fishery. Nature Communications 8, 14884.

[78] Charles. A. et al (2016). Interactions of aquatic protected areas with fishery livelihoods and food security: concluding discussion: 149-155, In Westlund, L et al eds. Marine Protected Areas: Interactions with Fishery Livelihoods and Food Security. Rome, FAO. FAO Fisheries and Aquaculture Technical Paper, 603: 170

Charles, A. et al (2016). Fishing livelihoods as key to marine protected areas: insights from the World Parks Congress: 165-184. In IUCN-WCPA, ed. The legacy from the 2014 Sydney World Parks Congress. Aquatic conservation, 26(2): 255 p contributions to the attainment of this Aichi Biodiversity Target. However, their overall effect will depend on social, economic, and ecological objectives and conditions. Further, to be useful in enhancing the sustainability of fisheries, marine protected areas need to be considered alongside other fishery management measures (such as controlling efforts, removals, gear and practices) within the fishery management plan. The issue of marine protected areas is further considered under Aichi Biodiversity Target 11.

35. Other studies have explored means of improving the governance of fisheries. Among the issues raised has been the need to embed fisheries governance within a broader perspective on human rights to achieve changes in small-scale fisheries management.[79] Further, one study found that applying sound management reforms to global fisheries could result in an annual increase of more than 16 million metric tonnes of fish catch[80], a result that is sensitive to the extent of predator-prey relationships. It has further been noted that addressing issues related to illegal, unreported and unregulated fishing could promote fishery recovery and long lasting fishery gains in many regions, at little cost to local economies or food provision.[81]

36. Four indicators used in GBO-4 have been updated since the report was released. Three of these indicators, proportion of fish stocks in safe biological limits,[82] the marine trophic index[83] and the Red List Index for the impacts of fisheries,[84] all show negative trends. One indicator, Marine Stewardship Council certified fisheries (tonnes),[85] shows improvement, indicating a growing interest by companies in this seal of approval of their management.

37. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Similarly, the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

De Leo, G.A. et al (2015). The good, the bad and the ugly of marine reserves for fishery yields. Philosophical Transactions of the Royal Society B, 370: 20140276. http://dx.doi.org/10.1098/rstb.2014.0276

Westlund, L. et al (2017). Marine Protected Areas: Interactions with Fishery Livelihoods and Food Security. FAO Fisheries and Aquaculture Technical Paper, 603:172

Krueck, N. C., et al (2017). Marine Reserve Targets to Sustain and Rebuild Unregulated Fisheries. PLoS biology, 15(1), e2000537.

Costello, M. J., and Ballantine, B. (2015). Biodiversity conservation should focus on no-take Marine Reserves: 94% of Marine Protected Areas allow fishing. Trends in ecology & evolution, 30(9), 507-509.

Boonzaier, L., and Pauly, D. (2016). Marine protection targets: an updated assessment of global progress. Oryx, 50(01), 27-35.

[79] Pomeroy, R. (2016). A research framework for traditional fisheries: Revisited. Marine Policy, 70, 153-163.

[80] Costello, C. et al. (2016). Global fishery prospects under contrasting management regimes. Proceedings of the National Academy of Science, 5125.5129

[81] Cabral, R. B. Rapid and lasting gains from solving illegal fishing. Nature Ecology and Evolution 2, 65-658. doi:10.1038/s41559-018-0499-1

[82] FAO (2016). *The State of World Fisheries and Aquaculture 2016*, Food and Agriculture Organization of the United Nations, Rome.

[83] Pauly D, and Watson R (2005) Background and interpretation of the "Marine Trophic Index" as a measure of biodiversity. Philosophical Transactions of the Royal Society-Biological Sciences 360: 415-423.

Kleisner K, et al (2014) Region-based MTI: resolving geographic expansion in the Marine Trophic Index. Marine Ecology Progress Series 512:185-199.

[84] IUCN Red List Index. http://www.iucnredlist.org/about/publication/red-list-index

[85] Marine Stewardship Council, 2017. *MSC global impacts report 2017*. MSC, London. Marine Stewardship Council, 2014. *MSC Fisheries Certification Requirements. Version 2*. MSC, London.

38. Relatively little scientific information assessing the sustainability of agricultural systems at the global level has been made available since the publication of GBO-4. Much of the recent literature related to the sustainable management of agriculture has focused on the use of different agricultural techniques. For example, one study concluded that small-scale habitat restoration within intensive agricultural landscapes had positive effects on species vulnerable to habitat degradation.[86] Similarly, removing a small percentage of agricultural land from production at field edges to create wildlife habitat increased total agricultural yields. Relatedly, a study where 10% of cropland was replaced with strips of native plant species resulted in greater insect taxa richness, greater pollinator abundance, greater native bird species richness and a greater abundance of bird species of conservation need, when compared to fields that did not have such strips. It was also observed that these strips reduced water runoff, and had greater soil and phosphorus retention. Overall, the effect of the crop strips was an increase in biodiversity and ecosystem services and a modest reduction in crop production, equal to the land area taken out of crop production.[87] A further study found that creating annual flower strips along wheat fields reduced cereal leaf beetle density and plant damage caused by this beetle by increasing the presence of the beetle's natural enemies. The study concluded that flower strips promote pest control and could be considered as an alternative to insecticides.[88] With regard to pesticides, a study of 946 non-organic arable commercial farms in France found that, in 77% of cases, there was no conflict between low pesticide use and productivity. The study further found that pesticide use could be reduced by 42% without having a negative effect on productivity or profitability in 59% of farms.[89] This information is also relevant to Aichi Biodiversity Target 8.

39. Many studies of traditional farming systems emphasize the importance of enhancing plant diversity and complexity in farming systems to increase yield stability and reduce vulnerability to extreme climatic events.[90] Further empowering smallholder farmers to adopt more efficient agricultural practices has also been identified as a means of improving crops yields in a sustainable manner.[91] For example a study reporting on the results of a programme to engage smallholder farmers in China in adopting enhanced management practices resulted in average yield increases for maize, rice and wheat of between 10.8% and 11.5%, while also reducing the application of nitrogen by between 14.7% and 18.1%. The increase in production and decrease in nitrogen use generated the equivalent of US$ 12 billion, as well as reduced the amount of reactive nitrogen and greenhouse gases entering the environment.[92]

40. Research on various approaches to agriculture has also been published. For example, integrated crop water management, which combines improvements in irrigation efficiency, better use of rainwater and other low-tech solutions, has the potential to greatly increase global production and close the water-related yield gap.[93] Further, there has also been growing work on what has been termed precision agriculture, where tools, such as machine learning, have been used for the early identification of plant

[86] Kremen, C. and M'Gonigle, L. K. (2015). Editor's Choice: Small-scale restoration in intensive agricultural landscapes supports more specialized and less mobile pollinator species. Journal of Applied Science, 52-3, 602–610.

[87] Schulte, L. et al (2017). Prairie strips improve biodiversity and the delivery of multiple ecosystem services from corn–soybean croplands. Proceedings of the National Academy of Sciences. 10.1073/pnas.1620229114

[88] Tschumi, M. (2018). High effectiveness of tailored flower strips in reducing pests and crop plant damage. Proceedings of the Royal Society B. 282.

[89] Lechenet, M. et al (2017) Reducing pesticide use while preserving crop productivity and profitability on arable farms. Nature Plants 3, 17008.

[90] Gurr, G.M., et al (2016). Multi-country evidence that crop diversification promotes ecological intensification of agriculture. Nature Plants 2, 16014.

[91] Zhang, W, et al (2016). Closing yield gaps in China by empowering smallholder farmers. Nature, 537, 671-674.

[92] Cui, Z. et al (2018). Pursuing sustainable productivity with millions of smallholder farmers. Nature 555, 363-366.

[93] Jägermeyr, J., et al (2016). Integrated crop water management might sustainably halve the global food gap. Environmental Research Letters, 11, 2.

diseases and weed detection.[94] However, the application of such techniques has remained limited owing to relatively high associated costs.[95]

41. The potential benefits of increasing pollinator diversity as a means of increasing crop yields has also been explored in scientific literature published since the release of GBO-4. For example, a study based on an assessment of 344 fields in Africa, Asia and Latin America, of 33 pollinator-dependent crops, concluded that, in fields of less than 2 hectares, yield gaps could be closed by on average 24% through greater pollination.[96] The issue of pollination is further discussed under Aichi Biodiversity Target 14.

42. There have also been increases in the use of organic farming which is currently practiced on an estimated 37.2 million hectares of agricultural land in 162 countries. However, this represented less than 1% of global agricultural land in 2011.[97] An assessment of organic agriculture found that it increased species richness by on average 30%,[98] while another study found that organic agriculture produces around 20% lower yields compared with conventional agriculture, but that yields were more profitable and delivered greater ecosystem services and social benefits.[99] It has also been noted that growers are increasingly turning to certified organic farming systems to provide verification of production methods, decrease reliance on non-renewable resources, and capture high-value markets and premium prices.[100] Similarly, there has been an increase in the use of no-till agricultural methods which are estimated to be used on 125 million hectares, or about 9% of global arable land.[101] Techniques for both conservation and organic agriculture have been found to increase the abundance and biomass of all soil organisms, with the exception of predaceous nematodes, compared to conventional agricultural systems.[102] However, despite the potential benefits of conservation agriculture, studies have found that it is not widely applied due to limited economic incentives, particularly as relates to smallholder farmers.[103] Further, while the growing use of organic and no-till agriculture is generally regarded as positive, there is no guarantee that such methods are sustainable by themselves. One study which explored the potential benefits of organic agriculture for production found that greater use of organic agriculture, in combination with efforts to reduce food waste and consumption and production of animal products, could deliver substantial benefits to food systems.[104]

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[94] Behmann, J., et al (2015). A review of advanced machine learning methods for the detection of biotic stress in precision crop protection. Precision Agriculture 16, 239–260.

[95] Schieffer, J. and Dillon, C. (2015). The economic and environmental impacts of precision agriculture and interactions with agro-environmental policy. Precision Agriculture, 16-1, 46

[96] Garibaldi, L.A. et al (2016). Mutually beneficial pollinator diversity and crop yield outcomes in small and large farms. Science 351 (6271), 388-391.

[97] Lee, K.S. et al (2015). Measuring the environmental effects of organic farming: A meta-analysis of structural variables in empirical research, Journal of Environmental Management, 162, 263-274.

[98] Tuck, S. L., et al (2014). Land-use intensity and the effects of organic farming on biodiversity: a hierarchical meta-analysis. Journal of Applied Ecology, 51, 746–755.

[99] Reganold, J. P., and Wachter, J. M. (2016). Organic agriculture in the twenty-first century. Nature Plants 2 - 1522.

Ponisio, L. C., et al (2015). Diversification practices reduce organic to conventional yield gap. Proceedings of the Royal Society B-Biological Sciences, 282, 1799-7p.

[100] Reganold, J. P., and Wachter, J. M. (2016). Organic agriculture in the twenty-first century. Nature Plants 2 - 1522.

[101] Pittelkow, C. M., et al (2014). Productivity limits and potentials of the principles of conservation agriculture. Nature 517,365-368,

[102] Henneron, L., et al (2015). Fourteen years of evidence for positive effects of conservation agriculture and organic farming on soil life. Agronomy for Sustainable Development, 35 (1), 169-181.

[103] Palm, C., et al (2014). Conservation agriculture and ecosystem services: An overview. Agriculture, Ecosystems & Environment, 187, 87-105.

Stevenson, J. R., et al (2014). Evaluating conservation agriculture for small-scale farmers in Sub-Saharan Africa and South Asia. Agriculture, Ecosystems & Environment 187, 1-10.

[104] Muller, A. et al (2017) Strategies for feed the world more sustainably with organic agriculture. Nature Communications 8, 1290.

43. Other studies have explored the conditions which facilitate sustainable agricultural management. For example, an analysis of South American countries found that, in countries with good conventional governance, agricultural intensification led to an expanded agricultural footprint while, in countries with strong environmental governance, agricultural intensification led to a contracted agricultural footprint.[105] Scientific literature has also been paying greater attention to the potential of nature-based approaches for sustainable intensification of agriculture.[106]

44. With regard to forestry, policies related to sustainable forest management are reported to be in place for 98% of permanent forest land, representing some 1.1 billion hectares.[107] However, other studies have observed that the application of sustainable forest management in low-income and tropical countries is modest.[108]

45. Between 1990 and 2015, the area of planted forest increased from 4.06% to 6.95% of the total forest area although, between 2010 and 2015, the rate of increase slowed to 1.2%. This is below the 2.4% rate of increase that has been suggested is needed to supply the world's timber and fibre demand.[109] Most planted forests are composed of native species, with 20 countries accounting for 85% of the world's planted forest area and 20 different countries accounting for 87% of the world's supply of Roundwood.[110]

46. Research published since GBO-4 was released has contributed to the understanding of the relationship between tree diversity and ecosystem productivity. For example, an assessment of forest data from 44 countries found that a 10% loss in biodiversity resulted in a 3% decline in productivity, suggesting that the economic value of maintaining biodiversity for forest productivity is more than five times greater than the global conservation costs.[111]

47. Aquaculture is estimated to be the fastest growing animal based food production sector and, in 2016, provided more than 50% of the fish consumed globally.[112] Approximately 90% of aquaculture

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[105] Ceddiaa, M. G., et al (2014). Governance, agricultural intensification, and land sparing in tropical South America. Proceedings of the National Academy of Sciences of the United States, 111, 20.

[106] Rockström, J., et al (2017). Sustainable intensification of agriculture for human prosperity and global sustainability. Ambiom, 46-1, 4–17.

[107] MacDicken, K. G., et al (2015). Global progress toward sustainable forest management. Forest Ecology and Management, 352, 47-56.
Food and Agriculture Organization of the United Nations (FAO). (2015). Global Forest Resources Assessment 2015 - How are the world's forests changing? Second edition. Food and Agriculture Organization (FAO). Rome, Mountain Forum

[108] Food and Agriculture Organization of the United Nations (FAO). (2015). Global Forest Resources Assessment 2015 - How are the world's forests changing? Second edition. Food and Agriculture Organization (FAO). Rome, Mountain Forum
Sloan, S. and Jeffrey, A.S. (2015). Forest Resources Assessment of 2015 shows positive global trends but forest loss and degradation persist in poor tropical countries, Forest Ecology and Management, 352, 134.

[109] Payn, T et al (2015). Changes in planted forests and future global implications. Forest Ecology and Management, 352, 57.
Food and Agriculture Organization of the United Nations (FAO). (2015). Global Forest Resources Assessment 2015 -How are the world's forests changing? Second edition. Food and Agriculture Organization (FAO). Rome, Mountain Forum

[110] Payn, T., et al (2015). Changes in planted forests and future global implications. Forest Ecology and Management, 352, 57.
Food and Agriculture Organization of the United Nations (FAO). (2015). Global Forest Resources Assessment 2015 - How are the world's forests changing? Second edition. Food and Agriculture Organization (FAO). Rome, Mountain Forum

[111] Liang, J., et al (2016). Positive biodiversity-productivity relationship predominant in global forests. American Association for the Advancement of Science, 14-354, 6309.

[112] Food and Agriculture Organization of the United Nations (FAO). (2016). The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp.

production takes place in developing countries. There is a diversity of species used in aquaculture practices but it is generally dominated by 35 species.[113]

48. One of the main issues in the sustainable management of aquaculture is the products being used as feed. It has been estimated that more than 70% of global aquaculture production depends on external sources of feed. With increasing rates of aquaculture production, feed use is also increasing. Since 2000, aquaculture production has grown at an average annual rate of 10.3% and is expected to reach 65.4 million tonnes by 2020 compared to 39.6 million tons in 2012.[114] Aquaculture feed is currently derived from crop and crop byproducts, wild caught fish, fish processing byproducts and livestock byproducts.[115] As demand for aquaculture feed grows, competition for these crops and products will also increase, with potential implications for food security.[116] However, over the last few years, there have also been improvements to feeding efficiencies for some aquaculture species, such as Atlantic salmon, shrimp and tilapias[117].

49. Aquaculture has also been found to have potential impacts on coastal environments. For example, some studies found that aquaculture has resulted in land use change, the loss of coastal wetlands, pollution[118] and increased sensitivity to erosion. Aquaculture has also been linked to land subsidence.[119] Further, aquaculture has been linked to the introduction of veterinary medicines in water systems. For example, one study estimated that, on average, 25% of veterinary medicines used in aquaculture ponds enter the wider environment.[120]

50. Three indicators used in GBO-4 have been updated since the report was released. Two of these, area of agricultural land under organic production[121] and area of forest under sustainable management,[122] show positive trends. The other indicator, the Wild Bird Index for farmland birds, shows a decline. In addition, one indicator, nitrogen use balance,[123] has become available since GBO-4 was published, and shows a trend negative for biodiversity.

51. The scientific information that has become available since the publication of GBO-4 suggests that the situation is largely unchanged from what was previously reported. Similarly, the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

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[113] Troell, M., et al (2014b). Does aquaculture add resilience to the global food system? Proc. Natl. Acad. 111(37), 13257-13263.

[114] Tacon, A.G. J. and Metian, M. (2015). Feed Matters: Satisfying the Feed Demand of Aquaculture. Reviews in Fisheries Science & Aquaculture, 23-1, 1-10.

[115] Troell, M., et al (2014b). Does aquaculture add resilience to the global food system? Proc. Natl. Acad. 111(37), 13257-13263.

[116] El-Sayed, A.-F.M., et al (2015). Value chain analysis of the aquaculture feed sector in Egypt. Aquaculture 437, 92-101.

[117] Little, D. C., et al (2016). Aquaculture: a rapidly growing and significant source of sustainable food? Status, transitions and potential. Proceedings of the Nutrition Society (PROC NUTR SOC), 75(3), 274-286

[118] Ottinger, M., et al (2016). Aquaculture: Relevance, distribution, impacts and spatial assessments - A review. Ocean and Coastal Management, 119, p244.

[119] Chen, Y., et al (2014). The influence of polarimetric parameters and an object-based approach on land cover classification in coastal wetlands. Remote Sens. 6, 12575-12592

[120] Rico, A., and Van den Brink, P.J., (2014). Probabilistic risk assessment of veterinary medicines applied to four major aquaculture species produced in Asia. Sci. Total Environ. 468-469, 630-641.

[121] FiBL, Data collection on organic agriculture world-wide http://www.organic-world.net/statistics/statistics-data-collection.html

Willer, H. and Lernoud, J., 2017. The world of organic agriculture. Statistics and emerging trends 2017. Research Institute of Organic Agriculture (FiBL) and IFOAM Organics International, Bonn

[122] https://www.bipindicators.net/indicators/area-of-forest-under-sustainable-management-certification, https://info.fsc.org/, http://www.pefc.co.uk/

[123] Zhang, X., et al (2015). Managing nitrogen for sustainable development. *Nature*, *528*(7580), pp.51-59.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

52. Since the publication of GBO-4, a range of literature relevant to this target has been published. As was noted in GBO-4, most of the available global information continues to focus on the effects of nutrients. There is comparatively less global information available on other pollution sources. One exception to this is plastic pollution for which several new studies have been undertaken in recent years.

53. Without mitigation efforts, nitrogen pollution is predicted to rise between 100-150% above 2010 levels by 2050.[124] Estimates suggest that 50% of current nitrogen use is wasted and ends up as pollution,[125] with negative effects on terrestrial and aquatic environments. Global nitrogen and phosphorus transport to the sea more than doubled in the twentieth century, despite significant anthropogenic slowing of waterways, such as through the construction of canals and dams which increases nutrient retention.[126] For example, in East Asia, many large rivers and their estuaries, including the Yangtze river[127], the Changjiang river,[128] the Pearl River[129] and Sanggou Bay,[130] are severely affected by nutrient pollution, with increasing frequency of harmful algal blooms and growing hypoxic areas harmful to biodiversity. Similarly, estimates suggest that anthropogenic nitrogen and phosphorus sources (from agriculture and domestic sewage) outweigh natural sources 5-1 for nitrogen and 10-1 for phosphorous in the Parnaíba River Delta in Brazil, the largest river delta in the Americas.[131] An increasingly important cause of nutrient pollution in freshwater and coastal waters is aquaculture,[132] as it

[124] Bodirsky, B. L., et al (2014). Reactive nitrogen requirements to feed the world in 2050 and potential to mitigate nitrogen pollution. Nature Communications, 5, 3858.

[125] Lassaletta, L, et al (2014). 50 year trends in N use efficiency of world cropping systems: the relationship between yield and N input to cropland. Environmental Research Letters, 9(10), 105011.

[126] Suwarno, D., et al (2014). The effects of dams in rivers on N and P export to the coastal waters in Indonesia in the future. Sustainability of Water Quality and Ecology, 3, 55-66.

Maavara, T., et al (2015). Global phosphorus retention by river damming. Proceedings of the National Academy of Sciences, 112(51), 15603-15608.

Beusen, A. H. W., et al (2015). Coupling global models for hydrology and nutrient loading to simulate nitrogen and phosphorus retention in surface water–description of IMAGE–GNM and analysis of performance. Geoscientific Model Development, 8(12), 4045-4067.

[127] Ding, X. W., et al (2014). Effects of ecological factors and human activities on nonpoint source pollution in the upper reach of the Yangtze River and its management strategies. Hydrology and Earth System Sciences Discussions, 11(1), 691-721

Li, H. M., et al (2014). Increased nutrient loads from the Changjiang (Yangtze) River have led to increased Harmful Algal Blooms. Harmful Algae, 39, 92-101.

[128] Wang, J., et al (2015). Modeled long-term changes of DIN: DIP ratio in the Changjiang River in relation to Chl-α and DO concentrations in adjacent estuary. Estuarine, Coastal and Shelf Science, 166, 153-160.

Wang, H., et al (2016). Eutrophication-driven hypoxia in the East China Sea off the Changjiang Estuary. Environmental Science and Technology, 50(5), 2255-2263.

[129] Strokal, M., et al (2015). Increasing dissolved nitrogen and phosphorus export by the Pearl River (Zhujiang): a modeling approach at the sub-basin scale to assess effective nutrient management. Biogeochemistry, 125(2), 221-242

[130] Wang, X., et al (2014). An estimation of nutrient fluxes via submarine groundwater discharge into the Sanggou Bay—a typical multi-species culture ecosystem in China. Marine Chemistry, 167, 113-122.

[131] Filho, F. et al (2015). Natural and anthropogenic emissions of N and P to the Parnaíba River Delta in NE Brazil. Estuarine, Coastal and Shelf Science, 166, 34-44.

[132] Macuiane, M. A., et al (2016). Temporal and spatial changes in water quality in Lake Malawi/Niassa, Africa: implications for cage aquaculture management. Oceanography and Fisheries, 1(1), 555552.

Li, H., et al (2017). Environmental response to long-term mariculture activities in the Weihai coastal area, China. Science of The Total Environment, 601, 22-31.

generally suffers from low nitrogen and phosphorus use efficiency[133] and can produce nutrient loads 100 to 1000 times higher than surrounding tidal waters.[134]

54. Most research on nutrient pollution in the terrestrial environment relates to its effects on grassland vegetation. There is broad consensus that nutrient enrichment in grasslands generally reduces species diversity and richness.[135] Both nitrogen and phosphorous are susceptible to accumulating in soils.[136] Large accumulations of nutrients in major agricultural basins can continue to leach into water for decades, producing large time lags between the introduction of regulations and when the results of these can be seen.[137] For example, despite nitrogen deposition in peatlands in the United Kingdom falling in recent years, 69% of peatlands were still found to be above critical nitrogen levels.[138]

55. Effects of nutrient pollution on faunal diversity is not as well studied as effects on vegetation,[139] however there seems to be agreement that nitrogen deposition negatively affects fauna across ecosystem

[133] Zhang, Y., et al (2015). Nutrient discharge from China's aquaculture industry and associated environmental impacts. Environmental Research Letters, 10(4), 045002.

[134] Wu, H., et al (2014). Mariculture pond influence on mangrove areas in south China: Significantly larger nitrogen and phosphorus loadings from sediment wash-out than from tidal water exchange. Aquaculture, 426, 204-212

[135] Ceulemans, T., et al (2014). Soil phosphorus constrains biodiversity across European grasslands. Global change biology, 20(12), 3814-3822.

Field, C. D., et al (2014). The role of nitrogen deposition in widespread plant community change across semi-natural habitats. Ecosystems, 17(5), 864-877.

Lan, Z., et al (2015). Testing the scaling effects and mechanisms of N-induced biodiversity loss: evidence from a decade-long grassland experiment. Journal of Ecology, 103(3), 750-760.

Lepš, J. (2014). Scale-and time-dependent effects of fertilization, mowing and dominant removal on a grassland community during a 15-year experiment. Journal of applied ecology, 51(4), 978-987.

Li, K., et al (2015). Response of alpine grassland to elevated nitrogen deposition and water supply in China. Oecologia, 177(1), 65-72.

Niu K, et al (2014) Fertilization decreases species diversity but increases functional diversity: a 3-year experiment in Tibetan meadow. Agriculture, ecosystems & environment, 182, 106-112.

Zhang, T., et al (2015). Responses of plant community composition and biomass production to warming and nitrogen deposition in a temperate meadow ecosystem. PloS one, 10(4), e0123160.

Simkin, S. M., et al (2016). Conditional vulnerability of plant diversity to atmospheric nitrogen deposition across the United States. Proceedings of the National Academy of Sciences, 113(15), 4086-4091

Soons, M.B., et al (2016). Nitrogen effects on plant species richness in herbaceous communities are more widespread and stronger than those of P. Biological Conservation.

van den Berg, L. et al (2016). Evidence for differential effects of reduced and oxidised nitrogen deposition on vegetation independent of nitrogen load. Environmental Pollution, 208, 890-897.

Zhang, Y., et al (2014). Rapid plant species loss at high rates and at low frequency of N addition in temperate steppe. Global change biology, 20(11), 3520-3529

Zhang, T., et al (2015). Responses of plant community composition and biomass production to warming and nitrogen deposition in a temperate meadow ecosystem. PloS one, 10(4), e0123160.

[136] Van Meter, K. J., et al (2016). The nitrogen legacy: emerging evidence of nitrogen accumulation in anthropogenic landscapes. Environmental Research Letters, 11(3), 035014.

[137] Yan, X., et al (2014). Fertilizer N recovery efficiencies in crop production systems of China with & without consideration of residual effect of N. Environmental Research Letters, 9(9), 095002.

Powers, S. M., et al (2016). Long-term accumulation and transport of anthropogenic phosphorus in three river basins. Nature Geoscience, 9(5), 353-356.

[138] Payne, R. J. (2014). The exposure of British peatlands to nitrogen deposition, 1900–2030. Mires and Peat, 14(04), 1-9.

[139] Leff, J. W., et al (2015). Consistent responses of soil microbial communities to elevated nutrient inputs in grasslands across the globe. Proceedings of the National Academy of Sciences, 112(35), 10967-10972.

WallisDeVries, M. F., and Bobbink, R. (2017). Nitrogen deposition impacts on biodiversity in terrestrial ecosystems: Mechanisms and perspectives for restoration. Biological Conservation. Editorial.

types[140] by shifting vegetation community structure to one which favours herbivores with generalist or nitrophilous diets[141] and disrupts food webs at multiple trophic levels.[142]

56. The scientific literature directs a great deal of attention towards means of enhancing nutrient use efficiency. For example, with regard to aquaculture, it has been observed that organic aquaculture releases significantly less nitrogen and phosphorus relative to intensive methods[143] and that integrated multi-trophic aquaculture, systems cultivating multiple species at once, greatly increase nutrient efficiency. Further, it has been shown that adjusting the time of harvest to tidal patterns can reduce nutrient emissions by 10% without incurring extra costs to aquaculture operations[144]. It has also been shown that mangroves can act as nutrient sinks for aquaculture[145], however with possible negative repercussions on the mangroves.[146]

57. Possible actions to improve nutrient use efficiency in the terrestrial environment have also been explored in the scientific literature. These include incentivizing crop varietals engineered for lower nutrient requirements,[147] implementing modern integrated soil-crop system management which has been shown to achieve 97-99% of yields from intensive systems while using significantly less fertilizer,[148] using precise nitrogen-use targets[149] based on specific crop type and region,[150] and the application of fertilizer directly onto crops rather than mixed in to the soil.[151] Further, appropriately timing fertilizer application and the use of cover crops have been shown to reduce nitrogen losses by 30%. Similarly, the use of woodchips as ground cover exhibited an 80% removal of nitrogen while wetlands reduced nitrogen output by 45%.[152] The recycling of nutrient-rich (particularly potassium-rich) bioresources, such as

[140] Nijssen, M. E., et al (2017). Pathways for the effects of increased nitrogen deposition on fauna. Biological Conservation.
WallisDeVries, M. F., and Bobbink, R. (2017). Nitrogen deposition impacts on biodiversity in terrestrial ecosystems: Mechanisms and perspectives for restoration. Biological Conservation. Editorial

[141] Ferreira, R. C., et al (2015). Responses of estuarine nematodes to an increase in nutrient supply: an in situ experiment. Marine pollution bulletin, 90(1), 115-120.
Pöyry, J., Carvalheiro, et al (2017). The effects of soil eutrophication propagate to higher trophic levels. Global Ecology and Biogeography, 26(1), 18-30.

[142] Meunier, C. L., et al (2016). Impact of nitrogen deposition on forest and lake food webs in nitrogen-limited environments. Global change biology, 22(1), 164-179.

[143] Silva, C. A. R., Sternberg, L. D. S. L., Dávalos, P. B., & de Souza, F. E. S. (2017). The impact of organic and intensive farming on the tropical estuary. Ocean & Coastal Management, 141, 55-64.

[144] Cardoso-Mohedano, J. G., Bernardello, R., Sanchez-Cabeza, J. A., Páez-Osuna, F., Ruiz-Fernández, A. C., Molino-Minero-Re, E., & Cruzado, A. (2016). Reducing nutrient impacts from shrimp effluents in a subtropical coastal lagoon. Science of The Total Environment, 571, 388-397

[145] Wu, H., Peng, R., Yang, Y., He, L., Wang, W., Zheng, T., & Lin, G. (2014). Mariculture pond influence on mangrove areas in south China: Significantly larger nitrogen and phosphorus loadings from sediment wash-out than from tidal water exchange. Aquaculture, 426, 204-212.

[146] Suárez-Abelenda, M., Ferreira, T. O., Camps-Arbestain, M., Rivera-Monroy, V. H., Macías, F., Nóbrega, G. N., & Otero, X. L. (2014). The effect of nutrient-rich effluents from shrimp farming on mangrove soil carbon storage and geochemistry under semi-arid climate conditions in northern Brazil. Geoderma, 213, 551-559.

[147] Withers, P. J., Sylvester-Bradley, R., Jones, D. L., Healey, J. R., & Talboys, P. J. (2014). Feed the crop not the soil: rethinking phosphorus management in the food chain.

[148] Chen, X., Cui, Z., Fan, M., Vitousek, P., Zhao, M., Ma, W., ... & Deng, X. (2014). Producing more grain with lower environmental costs. Nature, 514(7523), 486-489.

[149] Bai, Z., Ma, L., Ma, W., Qin, W., Velthof, G. L., Oenema, O., & Zhang, F. (2015). Changes in phosphorus use and losses in the food chain of China during 1950–2010 and forecasts for 2030. Nutrient cycling in agroecosystems, 104(3), 361-372.

[150] Zhang, X., Davidson, E. A., Mauzerall, D. L., Searchinger, T. D., Dumas, P., & Shen, Y. (2015). Managing nitrogen for sustainable development. Nature, 528(7580), 51-59.

[151] Withers, P. J., et al (2014). Feed the crop not the soil: rethinking phosphorus management in the food chain

[152] David, M. B., et al (2015). Navigating the socio-bio-geo-chemistry and engineering of nitrogen management in two Illinois tile-drained watersheds. Journal of environmental quality, 44(2), 368-381.

manure[153] and animal bones,[154] represents a means of reducing nutrient emissions while avoiding unnecessary nutrient use.

58. A further means of reducing the need for nutrient application that has been explored in the literature is to make better use of the nutrients which have accumulated in soils. Nitrogen and phosphorus are susceptible to accumulating in soils.[155] As such, there is a potential to make better use of these accumulated nutrients in some regions.[156] For example, it has been estimated that, if China were to effectively tap its soils' legacy phosphorus, it could provide 20% of its phosphorous needs over next 30 years.[157]

59. Establishing legislation and policies related to nutrient use has been shown to be effective in reducing nutrient pollution. For example, in the Baltic Sea, regulations from the 1980s have stabilized nutrient loads[158], although at levels which are still high[159]. Similarly, the European Union has established critical loads and regulations on nitrogen emissions which have shown to be effective in reducing nutrient pollution[160].

60. It has also been noted that some pollutants, despite their use being curtailed or banned, are still having negative effects on biodiversity owing to their long life spans and biomagnification. For example, an examination of the presence of polychlorinated biphenyls (PCB) in cetacean species in Europe found that 3 out of 4 sampled species had PCB levels in excess of toxicity thresholds.[161]

61. With regard to plastics, various assessments have shown that plastic debris is found throughout the marine environment.[162] It has been estimated that, in 2010, 275 million metric tonnes of plastic waste were generated, of which between 4.8 and 12.7 million metric tonnes entered the ocean. It is further estimated that, by 2025, the cumulative quantity of plastic waste that could enter the ocean from land will increase by an order of magnitude.[163] Other studies have estimated the concentration of plastic pollution

[153] Bai, Z. H., et al (2014). Changes in pig production in China and their effects on nitrogen and phosphorus use and losses. Environmental science & technology, 48(21), 12742-12749.
Bai, Z., et al (2015). Changes in phosphorus use and losses in the food chain of China during 1950–2010 and forecasts for 2030. Nutrient cycling in agroecosystems, 104(3), 361-372.
Strokal, M., et al (2016). Alarming nutrient pollution of Chinese rivers as a result of agricultural transitions. Environmental Research Letters, 11(2), 024014.
Withers, P. J., et al (2014). Feed the crop not the soil: rethinking phosphorus management in the food chain.
[154] Simons, A., et al (2014). Filling the phosphorus fertilizer gap in developing countries. Nature Geoscience, 7(1), 3-3.
[155] Van Meter, K. J., et al (2016). The nitrogen legacy: emerging evidence of nitrogen accumulation in anthropogenic landscapes. Environmental Research Letters, 11(3), 035014.
[156] Withers, P. J., et al (2014). Feed the crop not the soil: rethinking phosphorus management in the food chain.
[157] Sattari, S. Z., et al (2014). Key role of China and its agriculture in global sustainable phosphorus management. Environmental Research Letters, 9(5), 054003.
[158] Andersen, J. H., et al (2017). Long-term temporal and spatial trends in eutrophication status of the Baltic Sea. Biological Reviews. 92:135-149.
[159] Fleming-Lehtinen V., et al (2015). Recent developments in methodology reveal Baltic Sea eutrophication problem is expanding. Ecological Indicators 48, 380-388.
[160] Jones, L., et al (2016). Can on-site management mitigate nitrogen deposition impacts in non-wooded habitats?. Biological Conservation.
WallisDeVries, M. F., and Bobbink, R. (2017). Nitrogen deposition impacts on biodiversity in terrestrial ecosystems: Mechanisms and perspectives for restoration. Biological Conservation. Editorial.
[161] Jepson, P. D. et al (2016). PCB pollution continues to impact populations of orcas and other dolphins in European waters. Scientific Reports 6 (18573)doi:10.1038/srep18573
[162] Pham CK, et al. (2014) Marine Litter Distribution and Density in European Seas, from the Shelves to Deep Basins. PLoS ONE 9(4): e95839. https://doi.org/10.1371/journal.pone.0095839
Desforges, J. et al (2014). Widespread distribution of microplastics in subsurface seawater in the NE Pacific Ocean. Marine Pollution Bulletin. 79 (1-2),94-99.
[163] Jambeck, J.R., et al (2015) Plastic waste inputs from land into the ocean. Science. 347 (6223), 768-770.

to be in the order of 580,000 pieces per square kilometre. A substantial proportion of plastic entering the marine environment originates from large rivers with population-rich catchments.[164] A recent assessment of what has been termed the Great Pacific Garbage Patch concluded that at least 79 thousand tonnes of plastic are floating in a 1.6 million square kilometre area. By weight, more than 75% was larger than 5 centimetres in size, 46% was composed of fishing nets and 8% was micro plastic. Further, it is estimated that microplastics make up more than 94% of the estimated 1.8 trillion pieces of plastic in the ocean.[165] While less information is available on the presence of plastic in freshwater systems, it has been suggested that the presence and impacts of plastic pollution may be just as prevalent in freshwater environments as it is in the marine environment.[166]

62. Marine plastic has been found to have various effects on biodiversity. Three hundred and forty publications have documented encounters between 693 species and marine debris, 92% of which were related to plastic. Further, 17% of these species were listed as threatened or near threatened.[167] In addition, one study projected that, by 2050, 99% of all seabird species will have ingested plastic.[168] Marine plastics have also been found in various other species, including cetaceans.[169] Further, recent studies have also pointed to the negative effect of plastic pollution on coral reefs. An assessment of 150 reefs in the Asia Pacific region found that the likelihood that corals were affected by diseases increased between 4% and 89% when they were in contact with plastic. The study further estimated that 11.1 billion plastic items were found in the coral reefs in the region and that this could increase by a further 40% by 2025.[170]

63. Numerous governments, at different scales, have enacted strategies, including outright bans, partial bans, customer charges, taxes and fees related to the use of plastic bags, as well as regulating the thickness of plastic bags, as a means of reducing the amount of plastic entering the environment. While there appears to be growing momentum with regard to the introduction of these types of measures, relatively little research has been carried out on their effectiveness.[171] However, a study examining the effects of container deposit legislation in Australia and the United States found that the number of containers in debris surveys was 40% less in states with legislation,[172] and results of a study of 25 years of marine debris data from the United Kingdom of Great Britain and Northern Ireland suggest that a decline in plastic bag litter may be associated with a plastic bag tax policy.[173]

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[164] Schmidt, C. et al (2017). Export of Plastic Debris by Rivers into the Sea Environmental Science & Technology 51 (21), 12246-12253.

[165] Lebreton, L. et al (2018). Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic. Scentific Reports 8, 4666. doi:10.1038/s41598-018-22939-w

[166] Eerkes-Medrano, D. et al (2015). Microplastics in freshwater systems: A review of the emerging threats, identification of knowledge gaps and prioritisation of research needs. Water Research 75, 63

[167] Gall, S.C and Thompson, R.C. (2015). The impact of debris on marine life. Marine Pollution Bulletin.92 (1-2). 170-179.

[168] Wilcox, C. et al (2015). Threat of plastic pollution to seabirds is global, pervasive, and increasing. Proceedings of the National Academy of Sciences. 112 (38). 11899-11904

[169] Besseling, E, et al (2015)/ Microplastic in a macro filter feeder: Humpback whale Megaptera novaeangliae. Marine Pollution Bulleting. 95 (1), 248-252.

Baulch, S. and Perry C. (2014). Evaluating the impacts of marine debris on cetaceans. Marine Pollution Bulletin. 80 (1-2). 210-221.

[170] Lamb, Joleah B. et al (2018). Plastic waste associated with disease on coral reefs. Science 359 (6374) 460-462.

[171] Xanthos, D. et al. (2017). International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): A review. Marine Pollution Bulletin, 118 (1–2), 17-26.

[172] Schuyler,Q, et al (2018). Economic incentives reduce plastic inputs to the ocean, Marine Policy,0308-597X,. doi.org/10.1016/j.marpol.2018.02.009.

[173] Maes, T. et al (2018). Below the surface: Twnety-five years of seafloor litter monitoring in coastal seas of North West Europe (1992-2017). Science of the Total Environment. 630, 790-798.

64. One indicator used in GBO-4, the Red List index (impacts of pollution), [174] has been updated since the report was released. This indicator shows a decrease. In addition, one new indicator, pesticide use,[175] has become available since GBO-4 was prepared. This indicator also shows a trend negative for biodiversity.

65. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this Aichi Biodiversity Target is largely unchanged from what was previously reported. Similarly, the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

66. Invasive alien species continue to be one of the main direct causes of biodiversity loss globally. An assessment of 16,926 established alien species found that, for all taxonomic groups, the increase in alien species does not exhibit any sign of decreasing. This suggests that the effectiveness of actions to mitigate the introduction of invasive alien species needs to be increased.[176] A further study came to a similar conclusion.[177] The economic costs of invasive alien insects on goods and services and on human health also have been estimated at US$ 70 billion and US$6.9 billion per year, respectively.[178]

67. Introduction pathways for invasive alien species are generally well identified however it has been suggested that more attention needs to be devoted to identifying the mechanism related to the spread of invasive alien species, once they have been introduced, so that appropriate measures can be more easily taken.[179] For example, a review of 22 research articles examining the dispersal of alien plant species found that water birds, such as ducks, geese, swans, herons and gulls, were a common mechanism of secondary introduction.[180] Further, even though pathways are relatively well known, there is limited data on the establishment and spread of species.[181]

68. A number of approaches to prioritizing potential invasive alien species have been reviewed in the literature. Some of these approaches, such as FinnPrio, have been developed in light of specific national contexts.[182] Others, such as the Generic Impact Scoring System, which scores 12 types of impacts and

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[174] IUCN Red List Index http://www.iucnredlist.org/about/publication/red-list-index

[175] Food and Agriculture Organization of the United Nations. FAOSTAT. Pesticides (use). (Latest update: Dataset) Accessed (06 Mar 2014). http://ref.data.fao.org/dataset?entryId=5e70fee4-fb65-43b6-8da1-b6de4626b9bd&tab=about

[176] Seebens et al. 2017. No saturation in the accumulation of alien species Worldwide. Nature Communications 8 (14435). doi:10.1038/ncomms14435

[177] Seebens et al. (2018). Global rise in emerging alien species results from increased accessibility of new source pools. Proceedings of the National Academy of Sciences. E2264. DOI: 10.1073/pnas.1719429115

[178] Bradshaw et al (2016). Massive yet grossly underestimated global costs of invasive insects. Nature Communications. 7(12986). doi:10.1038/ncomms12986

[179] Baker, C.M. (2016) Target the Source: Optimal Spatiotemporal Resource Allocation for Invasive Species Control. Conservation Letters 10(1), 41-48.

Chapman, D et al (2016). Modelling the introduction and spread of non-native species: international trade and climate change drive ragweed invasion. Global Change Biology 22, 3067–3079 doi: 10.1111/gcb.13220.

[180] Green, A., J. (2016). The importance of water birds as an overlooked pathway of invasion for alien species. Diversity and Distribution Vol. 22

[181] Davidson et al, (2017). Development of a risk assessment framework to predict invasive species establishment for multiple taxonomic groups and vectors of introduction. Management of Biological Invasions Vol. 8 Issue 1

Greve et al, (2017). Terrestrial invasions on sub-Antarctic Marion and Prince Edward Islands. Bothalia - African Biodiversity & Conservation Vol. 48

[182] Heikkila et al. (2016). FinnPRIO: a model for ranking invasive plant pests based on risk. Biological Invasions Vol.18.

associated risks, are more general.[183] Other more general approaches include relative impact potential, which attempts to determine the impact of management schemes and what consequences certain invasive alien species have on specific environments,[184] classifying invasive alien species according to the magnitude of their socio-economic,[185] and environmental impacts[186,187], and horizon scanning,[188] which attempts to project current risks into the future based on experiences from surrounding and/or related environments[189]. Further, the need to consider species, pathways and sites in prioritizing schemes has also been noted,[190] as has the need to consider the feasibility of eradication[191] and to have minimum standards for risk assessment.[192] Work has also been undertaken to help Parties make better use of existing guidance, including on the interpretation and application of pathway categorization.[193]

69. A number of obstacles to the application of pest risk analysis schemes have also been identified in the literature, including the lack of trained professionals, the presence of vulnerable biodiversity, the remoteness of the areas being considered, and the consideration of cultural, economic and social issues which impact people.[194] Studies have also identified ways to improve the effectiveness of pest risk analysis schemes by, for example, ensuring the participation of local experts, including indigenous peoples and local communities.[195] A further gap noted in the literature is harmonized and representative

[183] Nentwig et al. (2016). The generic impact scoring system (GISS): a standardized tool to quantify the impacts of alien species. Environmental Monitoring Assessment Vol. 188

[184] Dick et al. (2017). Invader Relative Impact Potential: a new metric to understand and predict the ecological impacts of existing, emerging and future invasive alien species. Journal of Applied Ecology Vol. 54

[185] Bacher et al. 2017. Socio-economic impact classification of alien taxa (SEICAT). Methods in Ecology and Evolution 9 (1). doi.org/10.1111/2041-210X.12844

[186] Hawkins et al. 2015. Framework and guidelines for implementing the proposed IUCN Environmental Impact Classification for Alien Taxa (EICAT). Diversity and Distributions 21 (11).

[187] Blackburn TM, et al. (2014) A Unified Classification of Alien Species Based on the Magnitude of their Environmental Impacts. PLoS Biol 12(5): e1001850.

[188] Roy et al 2014. Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain 20(12). https://doi.org/10.1111/gcb.12603

Roy et al 2015. Invasive Alien Species - Prioritising prevention efforts through horizon scanning ENV.B.2/ETU/2014/0016. European Commission.

[189] Matthews, J., et al (2017). A new approach to horizon-scanning: identifying potentially invasive alien species and their introduction pathways. Management of Biological Invasions, 8(1), 37-52. DOI: 10.3391/mbi.2017.8.1.04.

[190] McGeogh et al. 2016. Prioritizing species, pathways, and sites to achieve conservation targets for biological invasion. Biological Invasions 18 (2), 299-314.

[191] Booy et al. 2017. Risk management to prioritise the eradication of new and emerging invasive non-native species. Biological Invasions 19(8), 2401-2417.

[192] Roy et al. 2017. Developing a framework of minimum standards for the risk assessment of alien species. Journal of Applied Ecology 55(2). doi.org/10.1111/1365-2664.13025

[193] IUCN. 2017. Guidance for interpretation of CBD categories on introduction pathways. Technical note prepared by IUCN for the European Commission.

[194] Shackleton et al. 2016. Identifying barriers to effective management of widespread invasive alien trees: Prosopis species (mesquite) in South Africa as a case study. Global Environmental Change Vol. 38

Soliman and al. 2016. A Regional Decision Support Scheme for Pest Risk Analysis in Southeast Asia. Risk Analysis Vol 36

Walsh et al. 2016 Outbreak of an undetected invasive species triggered by a climate anomaly. Ecosphere Vol. 7

[195] Soliman et al. 2016. A Regional Decision Support Scheme for Pest Risk Analysis in Southeast Asia. Risk Analysis Vol 36

Stamoulie and al. 2017. Coral reef grazer-benthos dynamics complicated by invasive algae in a small marine reserve. Scientific Reports.

data on invasions. However, initiatives to address this gap are underway, including the Global Register of Introduced and Invasive Species.[196]

70. Studies have also explored different techniques to identify invasive alien species. These include the use of environmental DNA (eDNA) to identify potential invasive species from the DNA of other known invasive species.[197] Environmental DNA has been found, in some studies, to outperform standard survey methods.[198] The potential applications of eDNA techniques, including eDNA barcoding, are being increasingly recognized and explored.[199] Other identification techniques, based on genetic material discussed in the literature, include Double Droplet Polymerase Chain Reaction,[200] and Dual Loci.[201] The potential use of participatory citizen science in the identification of invasive alien species has also been noted, particularly given that it is cost and time efficient and can be applied to large areas.[202] For example, one study found that, when citizen science was combined with the use of mobile applications or picture identification sheets, participants were 90% accurate in their identifications.[203]

71. Research has also been undertaken to better determine what types of habitats are more prone to invasion. For example, invasive alien species have been found to be able to take advantage of artificial structures in the marine environment, such as docks and wave breaks, more so than native species.[204] It has also been observed that research facilities in remote areas may be potential introduction pathways.[205] Artificial beaches and dunes have also been found to be vulnerable to invasion,[206] while artificial water catchments have been found to be a possible introduction pathway to the wider environment.[207]

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[196] Pagad et al. 2018. Introducing the Global Register of Introduced and Invasive Species. Scientific Data. 5 (170202) doi:10.1038/sdata.2017.202

[197] Simmons and al. 2015. Active and passive environmental DNA surveillance of aquatic invasive species. Canadian Journal of Fisheries and Aquatic Sciences Vol. 73

Brown and al. 2016. Early detection of aquatic invaders using metabarcoding reveals a high number of non-indigenous species in Canadian ports. Diversity and Distribution: A journal of Conservation Biogeography Vol. 22

[198] Lim and al. 2016. Next-generation freshwater bioassessment: eDNA metabarcoding with a conserved metazoan primer reveals species-rich and reservoir-specific communities. Royal Society Open Science

Comtet and al. 2015. DNA (meta)barcoding of biological invasions: a powerful tool to elucidate invasion processes and help managing aliens. Biological Invasins Vol. 10

[199] Corlett, R.T. 2017. A bigger toolbox: Biotechnology in Biodiversity Conservation. Trends in Biotechnology Vol. 35

Dahl, K.A., Patterson, W.F., Robertson, A. et al. Biol Invasions (2017) 19: 1917. https://doi.org/10.1007/s10530-017-1407-3

Port, J. A., O'Donnell, J. L., Romero-Maraccini, O. C., Leary, P. R., Litvin, S. Y., Nickols, K. J., Yamahara, K. M. and Kelly, R. P. (2016), Assessing vertebrate biodiversity in a kelp forest ecosystem using environmental DNA. Mol Ecol, 25: 527–541. doi:10.1111/mec.13481

[200] Nathan L.M. et al (2014)Quantifying Environmental DNA Signals for Aquatic Invasive Species

Across Multiple Detection Platforms. Environmental Science and Technology. 48, 12800-12806.

[201] Wang, A. et al (2017) Evaluation of six candidate DNA barcode loci for identification of five important invasive grasses in eastern Australia. PLoS ONE 12(4):e0175338.

[202] Goczal, R. et al (2016)Citizen monitoring of invasive species: wing morphometry as a tool for detection of alien Tetropium species. Journal of Applied Entomology. 141, 496-506.

[203] Maistrello, L. (2016). Citizen science and early detection of invasive species: phenology of first occurrences of Halyomorpha halys in Southern Europe. Biological Invasions. 18, 3109-3116.

[204] Lagos and al. 2017. Do low oxygen environments facilitate marine invasions? Relative tolerance of native and invasive species to low oxygen conditions. Global Change Biology Vol 23

[205] Hughes and al. 2016. Evaluation of non-native species policy development and implementation within the Antarctic Treaty area. Biological Conservation Vol. 200

[206] Pedram and al. 2016. The Role of Beach Nourishment on the Success of Invasive Asiatic Sand Sedge. Northeastern Naturalist Vol. 22

[207] Drake and al. 2017. Graph theory as an invasive species management tool: case study in the Sonoran Desert. Landscape Ecology Vol.32

72. Much of the research on invasive alien species since the publication of GBO-4 has focused on techniques for preventing, controlling or eradicating invasive alien species. For example, the use of sodium hypochlorite as a means of controlling species invading coral reefs[208] has been explored, as has the use of sodium hydroxide to treat ship ballast water for invasive bacteria.[209] Other studies looked at the effectiveness of other control methods, including self-resetting traps and toxicant-free bait,[210] and phytosanitary irradiation.[211] Biological control of invasive species is a further method which has been explored in the literature. However, many studies have noted the importance of post-release monitoring programs, and the potential for secondary invasions from the introduction of biological control agents[212] and the need to consider the effect of the biological control agent on the ecosystem it is being introduced to.[213] One general observation from the available scientific literature, related to eradication, is that there is generally a lack of methods which have been found to be successful and that could be applied to a variety of species in different taxonomic groups.[214]

73. Studies have also been undertaken to better quantify the impacts of invasive alien species control and eradication programmes. For example, 236 native terrestrial island animal species, of which 107 were highly threatened bird, mammal and reptile species, were found to have benefits from the eradication of 251 invasive mammals on 181 islands.[215] One region where the control of invasive alien species is showing some success is in Antarctica. Under the Antarctic Treaty System, the introduction pathways for invasive alien species have been identified and prioritized and actions to manage them have been put in place. Similarly, actions to control or eradicate invasive alien species have also been undertaken.[216]

74. Trends in invasive alien species are influenced by various factors, including scientific, technological and socio-political issues. For example, an exercise to identify challenges and opportunities related to the introduction and spread of invasive alien species concluded that genetic modification tools, Arctic globalization, the commercial use of microbes in crop production, invasive microbial pathogens and intercontinental trade agreements all had the potential to significantly impact the control and spread of invasive alien species in the future.[217] The study further concluded, based on the diversity of issues

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[208] Altvater, L. et al (2017). Use of sodium hypochlorite as a control method for the non-indigenous coral species Tubastraea coccinea Lesson, 1829. Management of Biological Invasions 8(2), 197-204.

[209] Starliper, C.E. et al (2015). Efficacy of pH elevation as a bactericidal strategy for treating ballast water of freight carriers. Journal of Advanced Research. 6, 501-509.

[210] Carter, A. et al (2016). Controlling sympatric pest mammal populations in New Zealand with self-resetting, toxicant-free traps: a promising tool for invasive species management. Biological Invasions. 18, 1272-1736.

[211] Hallman, G. (2016).Phytosanitary Irradiation of Heliothis virescens and Helicoverpa zea (Lepidoptera: Noctuidae). Florida Entomologist. 99(2). 178-181.

[212] González, E. et al (2107). Secondary invasions of noxious weeds associated with control of invasive Tamarix are frequent, idiosyncratic and persistent. Biological Conservation. 213, 106-114.

[213] Stamoulis, K. A. (2016). Coral reef grazer-benthos dynamics complicated by invasive algae in a small marine reserve. Scientific Reports. 7.

[214] van Wilgen, B, W. and Wannenburgh, A. (2016). Co-facilitating invasive species control, water conservation and poverty relief: achievements and challenges in South Africa's Working for Water programme. Current Opinion in Environmental Sustainability. 19, 7-17.

Lodge, D.M. et al (2016). Risk Analysis and Bioeconomics of Invasive Species to Inform Policy and Management. Annual Review of Environment of Resources. 41, 453-88.

[215] Jones, H. P. et al (2016). Invasive mammal eradication on islands results in substnail conservation gains. Proceedings of the National Academy of Sciences of the United States of America. 113 (15), 4033-4038; doi.org/10.1073/pnas.1521179113

[216] Chown SL, et al. (2017) Antarctica and the strategic plan for biodiversity. PLoS Biol 15(3): e2001656. https://doi.org/10.1371/journal.pbio.2001656

[217] Ricciardi et al. 2017. Invasion Science: A Horizon Scan of Emerging Challenges and Opportunities. Trends in Ecology and Evolution. 32 (6), 464-474.

identified, that the control of invasive alien species would benefit from the application of more multidisciplinary approaches.

75. One indicator used in GBO-4, the Red List Index (impacts of invasive alien species), has been updated since the report was released. The indicator shows a trend negative for biodiversity.[218]

76. The scientific information that has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Similarly, the information published since 2014 indicates that the actions identified in GBO-4 to accelerate progress towards this target remain relevant. Other potential actions which have been identified in the literature include undertaking actions to diversify species lists, where there are gaps for some genera,[219] greater efforts in identifying secondary invasion pathways,[220] identifying areas at high risk of invasion[221], linking databases on invasive alien species,[222] and greater efforts to control and contain invasive alien species along trade routes.[223]

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

77. There has been relatively little scientific information published on the global status of coral reefs since the release of GBO-4. However, an assessment of sea surface temperatures found that 97% of areas examined showed rising sea surface temperatures, and that the occurrence of temperatures known to cause bleaching increased threefold between 1985-1991 and 2006-2012. Climate models suggest that this trend is likely to continue[224]. Further, by 2050, there is a high probability that more than half of tropical corals will suffer a collapse and that the coral reefs that remain will be dominated by those taxa which are most resistant to pressures[225]. There has also been research to better understand the extent to which coral reefs are covered by protected areas. For example, it is estimated that approximately 27% of the world's coral reef area is located in protected areas but with significant geographic variation[226].

78. Various regional, national and subnational assessments of coral reefs have also been undertaken. For example, one study concluded that, of the coral reefs in the Pacific, those in Australia were the least affected by local threats but that extensive bleaching has occurred on the Great Barrier Reef. Further, in the Atlantic and Caribbean region, coral cover has fallen by on average 47% over the 27 year period

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[218] IUCN Red List Index http://www.iucnredlist.org/about/publication/red-list-index

[219] Liedhold et al. 2016 Global compositional variation among native and non-native regional insect assemblages emphasizes the importance of pathways. Biological Invasions Vol.18

[220] Solarz et al. 2017. Birds and alien species dispersal: on the need to focus management efforts on primary introduction pathways – comment on Reynolds et al. and Green. Diversity and Distribution: A journal of Conservation Biogeography Vol.23

[221] Vanderhoeven et al. 2017. Tracking Invasive Alien Species (TrIAS): Building a data-driven framework to inform policy. Research Ideas and Outcomes Vol. 3

Hyatt-Twynam et al. 2017. Risk-based management of invading plant disease. New Phytologist Vol. 214

[222] Saul et al. 2016. Assessing patterns in introduction pathways of alien species by linking major invasion data bases. Journal of Applied Ecology Vol.54

[223] Roy and al. 2014. Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain. Global Change Biology Vol 20, Issue 12

[224] Heron, S. F. et al. (2016) Warming Trends and Bleaching Stress of the World's Coral Reefs 1985–2012. Sci. Rep. 6, 38402; doi: 10.1038/srep38402.

[225] Tkachenko, K.S. (2017) Coral reefs in the face of ecological threats of the 21st century. Biology Bulletin Reviews 7: 64. https://doi.org/10.1134/S2079086416050091

[226] White, A. T., et al (2014). Marine protected areas in the Coral Triangle: progress, issues, and options. Coastal Management, 42(2), 87-106

leading to 2012,[227] and that temperature increases have impacted parts of the Caribbean, such as the Florida Keys[228].

79. Most of the focus in the scientific literature has been on the effects of climate change and/or ocean acidification on coral reefs, as opposed to the other pressures specified in Aichi Biodiversity Target 10. One exception to this is research related to coastal nutrient pollution which has been identified as one of the major factors contributing to the increase in coral disease and coral bleaching[229], affecting around 25% of reefs worldwide.[230]

80. A major focus in recent scientific literature has been on increasing the understanding of how coral reefs respond to warming temperatures and their ability to recover from disturbances[231]. For example, some research has found that some corals have developed resistance to warming ocean temperatures, and that this adaptation process has been occurring since the beginning of the industrial period[232]. Similarly, in places such as the Great Barrier Reef, research has found that bleaching events of the past three decades have been mitigated by induced thermal tolerance of reef-building corals but that this protective mechanism may be lost as a result of increasing temperatures[233]. Other studies have looked at the effects of climate change and ocean acidification on changes to reef dynamics, such behavioural changes in reef fish[234] as well as predation rates[235]. Some studies have also attempted to predict the occurrence of bleaching events in the future. For example, it has been estimated that in some regions annual bleaching will begin occurring between 2020 and 2034, and possibly sooner[236], and as a consequence coral rugosity will decrease dramatically over the next three decades[237].

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[227] Sale, P. F. (2015). Coral reef conservation and political will. Environmental Conservation, 42(02), 97-101.

[228] Manzello, D. P. (2015). Rapid recent warming of coral reefs in the Florida Keys. Scientific reports, 5, 16762.

[229] Vega Thurber, R. L., et al (2014). Chronic nutrient enrichment increases prevalence and severity of coral disease and bleaching. Global change biology, 20(2), 544-554.

[230] Kroon, F. J., et al (2014). Informing policy to protect coastal coral reefs: Insight from a global review of reducing agricultural pollution to coastal ecosystems. Marine pollution bulletin, 85(1), 33-41.

[231] Kavousi, J., Reimer, J. D., Tanaka, Y., & Nakamura, T. (2015). Colony-specific investigations reveal highly variable responses among individual corals to ocean acidification and warming. Marine environmental research, 109, 9-20.

Elahi, R., et al (2016). Ocean warming and the demography of declines in coral body size. Marine Ecology Progress Series, 560, 147-158.

Bozec, Y. M., et al (2015). The dynamics of architectural complexity on coral reefs under climate change. Global change biology, 21(1), 223-235.

Burdett, H. L., et al (2014). Effects of high temperature and CO2 on intracellular DMSP in the cold-water coral Lophelia pertusa. Marine biology, 161(7), 1499-1506.

Swain, T. D., et al (2016). Coral bleaching response index: a new tool to standardize and compare susceptibility to thermal bleaching. Global change biology, 22(7), 2475-2488.

Munday, P. L., et al (2017). Potential for adaptation to climate change in a coral reef fish. Global change biology, 23(1), 307-317.

[232] Logan, C. A., et al (2014). Incorporating adaptive responses into future projections of coral bleaching. Global Change Biology, 20(1), 125-139.

[233] Ainsworth, T. D., et al (2016). Climate change disables coral bleaching protection on the Great Barrier Reef. Science, 352(6283), 338-342.

[234] Nagelkerken, I., and Munday, P. L. (2015). Animal behaviour shapes the ecological effects of ocean acidification and warming: moving from individual to community-level responses. Global change biology. 22(3),974-989.

[235] Ferrari, M, et al (2015). Interactive effects of ocean acidification and rising sea temperatures alter predation rate and predator selectivity in reef fish communities. Global change biology 21(5): 1848-1855.

[236] Manzello, D. P. (2015). Rapid recent warming of coral reefs in the Florida Keys. Scientific reports, 5, 16762.

[237] Bozec, Y. M., et al (2015). The dynamics of architectural complexity on coral reefs under climate change. Global change biology, 21(1), 223-235.

81. Studies have also been undertaken to explore the possibility of restoring or rehabilitating coral reefs through various process. One approach to coral restoration is the gardening concept whereby coral-nubbins are farmed in nurseries and then transplanted. Over 86 coral species and more than 100,000 colonies have been successfully farmed to date.[238] Another form of restoration is larval seeding, however there are questions concerning the long-term effectiveness of this approach.[239]

82. Most of the research related to Aichi Biodiversity Target 10 has tended to focus on coral reefs. However, a number of studies have also explored the negative impacts of climate change and drought on inland water systems[240]. Further, a recent assessment of Antarctica and the Southern Ocean concluded that, despite the region’s remoteness, its biodiversity prospects are similar to those of the rest of the Earth, with growing pressures from habitat degradation and loss, pollution from remote sources and fishing activity. Further, while information is limited, the conservation status of many species appears to be in decline as a result of pressures such as climate change and invasive alien species.[241]

83. Three indicators used in GBO-4 have been updated since the report was released. These indicators, percentage live coral cover[242], glacial mass balance[243] and mean polar sea ice extent, all show trends that are negative for biodiversity. In addition, two indicators, climate impact index for birds and area of mangrove forest cover[244], have become available since GBO-4 was published. Both of these indicators also show trends that are negative for biodiversity.

84. The scientific information that has become available since the publication of GBO-4 suggests that the situation is largely unchanged from what was previously reported. Similarly, the scientific information published since 2014 suggests that the actions identified in GBO-4 to accelerate progress towards this target remain relevant. Further, some studies have further emphasized the importance of addressing issues related to sediment input to coral reefs[245], the need to strengthen management responses[246], as well as the need to design and manage marine protected areas with the effects of climate change in mind[247]. Further, as mentioned in relation to Aichi Biodiversity Target 8, reducing pollution, such as plastic, could greatly

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[238] Rinkevich, B. (2014). Rebuilding coral reefs: does active reef restoration lead to sustainable reefs? Current Opinion in Environmental Sustainability. 6, 28-36.

[239] Edwards AJ, et al (2015) Direct seeding of mass-cultured coral larvae is not an effective option for reef rehabilitation. Marine Ecology Progress Series. 525:105-116.

[240] Mosley, L. (2015). Drought impacts on the water quality of freshwater systems; review and integration, Earth-Science Reviews, 140,203-214.

O'Reilly, C. M. et al. (2015), Rapid and highly variable warming of lake surface waters around the globe, Geophysical Research Letters. 42, 10,773–10,781, doi:10.1002/2015GL066235.

[241] Chown SL, et al. (2017) Antarctica and the strategic plan for biodiversity. PLoS Biol 15(3): e2001656. https://doi.org/10.1371/journal.pbio.2001656

[242] Obura, D., et al (2017). Coral reef status report for the Western Indian Ocean. Global Coral Reef Monitoring Network (GCRMN)/International Coral Reef Initiative (ICRI). pp 144.

[243] WGMS, 2016. Global Glacier Change Bulletin No. 1 (2012–2013). Zemp, M., Gärtner-Roer, I., Nussbaumer, S. U., Hüsler, F., Machguth, H., Mölg, N., Paul, F., and Hoelzle, M. (eds.), ICSU(WDS)/IUGG(IACS)/UNEP/UNESCO/WMO, World Glacier Monitoring Service, Zurich, Switzerland, 230 pp., publication based on database version: doi:10.5904/wgms-fog-2015-11.

[244] Hamilton, S.E. and Casey, D., (2016). Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMFC-21). Global Ecology and Biogeography 25(6),729-738. doi: 10.1111/geb.12449.

[245] Oleson, K. L., et al (2017). Upstream solutions to coral reef conservation: The payoffs of smart and cooperative decision-making. Journal of Environmental Management, 191, 8-18.

[246] Sale, P. F. (2015). Coral reef conservation and political will. Environmental Conservation, 42(02), 97-101.

[247] Magris, R. A., et al. (2015). Conservation planning for coral reefs accounting for climate warming disturbances. PloS one, 10(11), e0140828.

Chollett, I., et al (2014). Redefining thermal regimes to design reserves for coral reefs in the face of climate change. PloS one, 9(10), e110634.

reduce the pressures on coral reefs. Actions to reach Aichi Biodiversity Target 10 for coral reefs and closely associated ecosystems were adopted by the Conference of the Parties in decision XII/23.

Target 11: By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

85. It is estimated that protected areas cover 15% of terrestrial and inland waters, excluding Antarctica.[248] In the marine environment, 6.96% of the entire ocean and 16.02% of areas under national jurisdiction are protected.[249] However, the World Database on Protected Areas, on which these figures are based, does not include complete information on privately protected areas or on areas conserved by indigenous peoples and local communities. Work is underway to better understand what would constitute other effective area-based conservation measures[250] and, if all of the information on these areas was included, the figures would likely be higher. In addition, a number of countries have made commitments to further expand their protected areas systems, suggesting that these numbers will increase between now and 2020.

86. With regard to the representativeness of protected areas, in October 2017, it was estimated that 43.9% of non-Antarctic terrestrial ecoregions had 17% of their area covered by protected areas[251], while 40.5% of marine areas had more than 10% of their area protected. However, one assessment found that some terrestrial ecoregions had so little natural or semi-natural area left that having 17% of their area protected would not be possible.[252] In 2016, 19.3% of key biodiversity areas were completely covered by protected areas and 19.5% of Alliance for Zero Extinction sites were completely covered[253]. A further assessment of birds and mammals found that, while there are significant gaps in the functional and phylogenetic diversity of these species, this could be significantly reduced through a 5% expansion in protected areas[254].

87. An assessment of marine protected areas concluded that these areas currently do match multiple biodiversity aspects, including taxonomic, phylogenic and function diversity. This assessment suggests that the most diverse marine areas are not currently well represented in protected area systems.[255]

88. One assessment concluded that, between 25% and 37% of terrestrial ecoregions, had protected area networks of sufficient size and configuration to maintain connectivity for median dispersal distances

[248] UNEP-WCMC and IUCN (2017a), Protected Planet: World Database on Protected Areas (WDPA) [Online], [December, 2017], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net. Reference for terrestrial protected area coverage.

[249] UNEP-WCMC and IUCN (2017b) Marine Protected Planet [On-line], [December, 2017], Cambridge, UK: UNEP-WCMC and IUCN Available at: www.protectedplanet.net/marine. Reference for marine protected area coverage.

[250] Laffoley D, et al. (2017). An introduction to 'other effective area-based conservation measures' under Aichi Target 11 of the Convention on Biological Diversity: Origin, interpretation and emerging ocean issues. Aquatic Conservation: Marine Freshwater Ecosystems. 2017;27(S1):130–137.

[251] JRC (Joint Research Centre of the European Commission) (2017), The Digital Observatory for Protected Areas (DOPA) Explorer 2.0 [On-line], [10/2017], Ispra, Italy. Available at: http://dopa-explorer.jrc.ec.europa.eu. Reference for coverage of terrestrial and marine ecoregions.

[252] Dinerstein, E., et al (2017). An ecoregion-based approach to protecѲng half the terrestrial realm. BioScience, bix014, doi: 10.1093/biosci/bix014.

[253] BirdLife International (2016). Analysis of protected area coverage of Key Biodiversity Areas using the April 2016 WDPA release for the Protected Planet Report 2016.

[254] Pollock L. J. et al (2017). Large conservation gains possible for global biodiversity facets. Nature 546, 141-144.

[255] Lindegren, M. et al (2018). A global mismatch in the protection of multiple marine biodiversity components and ecosystem services. Scientific Reports 8, 4099. doi:10.1038/s41598-018-22419-1

of between 1 and 100 kilometres. For protected areas globally, between 8.5% and 11.7% are considered 'well-connected' for the same range of median dispersal distances.[256] A further study concluded that 7.5% of terrestrial areas are covered by protected connected lands globally, and that 30% of countries could be considered as having currently met the connectivity element of this Aichi Biodiversity Target.[257] Specifically for migratory birds, one assessment found that only 9% of 1451 migratory birds had all stages of their annual cycle covered by protected areas. By comparison, for non-migratory birds, this figure was 45%.[258]

89. With regard to management effectiveness, as of 2015, only about 21% of Parties to the CBD have completed management effectiveness evaluations in at least 60% of their protected areas.[259] Further, a study evaluating 722 protected areas sites with multiple management effectiveness assessments, found that almost 70% showed an improvement in management while about 25% had decreases.[260] In the marine environment, an assessment of management and ecological data from 433 and 218 marine protected areas, respectively, exploring the relationship between management processes, fish populations and ecological effects, found that many marine protected areas failed to be meet thresholds for effective and equitable management. While 71% of the marine protected areas were found to have positive effects on fish populations, the results were highly variable. The provision of adequate staff and financial resources were found to be the highest predictor of conservation impact, with adequately resourced marine protected areas having 2.9 times greater ecological effects than those marine protected areas without sufficient resources.[261] Research has also been undertaken to develop indicators to be able to better assess and track management effectiveness.[262]

90. In recent years, there has been an increase in the number of protected areas with shared or private governance or that are being governed by indigenous peoples and local communities.[263] Protected areas which consider social issues in their design and management often have more positive conservation outcomes.[264] However, there have been relatively few assessments of the social impacts of protected areas.[265]

91. Protected areas have also been found to be facing various pressures which threaten their effectiveness. An assessment, based on information from 1,961 protected areas from 149 countries, found

[256] Bastin, S.S., et al (2017). Protected areas in the world's ecoregions: how well connected are they? Ecological Indicators, 76, 144– 158. doi: 10.1016/j.ecolind.2016.12.047.

[257] Suara, S. et al (2017). Protected area connectivity: Shortfalls in global targets and country level priorities. Biologixal Conservation 219, 53-67. doi.org/10.1016/j.biocon.2017.12.020

[258] Runge, C.A. et al (2015). Protected areas and global conservation of migratory birds. Science. 350 (6265), 1255-1258.

[259] Coad, L., et al (2015). Measuring impact of protected area management interventions: current and future use of the Global Database of Protected Area Management Effectiveness. Philosophical Transactions of the Royal Society B, 370 (1681). doi: 10.1098/rstb.2014.0281.

[260] Geldmann, J., et al (2015). Changes in protected area management effectiveveness over time: A global analysis. Biological ConservaӨon, 191, 692–699. doi: 10.1016/j.biocon.2015.08.029

[261] Gill, D. A., et al (2017) Capacity shortfalls hinder the performance of marine protected areas globally. Nature 543, 665-669.

[262] Zafra-Calvo, N. et al (2017). Towards an indicator system to assess equitable management in protected areas, Biological Conservation, 211(A).134-141.

[263] Juffe-Bignoli, et al (2014). Protected Planet Report 2014. Cambridge, UK: UNEPWCMC

[264] Oldekop, J.A., et al A global assessment of the social and conservation outcomes of protected areas. Conservation Biology, 30(1), 133–141. doi: 10.1111/cobi.12568

[265] Franks, P. and Small, R. (2016). Understanding the social impacts of protected areas: a community perspecӨve. IIED Research Report. London: IIED.

that 61% of all protected areas were impacted by unsustainable hunting, 55% were affected by recreational disturbances and 49% by natural system modification from fires or their suppression[266].

92. Two indicators used in GBO-4, percentage of marine and coastal areas covered by protected areas and percentage of terrestrial areas covered by protected areas[267], have been updated since the report was released and both show positive trends. In addition, the indicator, percentage of key biodiversity areas covered by protected areas, which was not available for use in GBO-4, has a positive trend as well.

93. There has been significant progress towards the attainment of this target since it was adopted, and the commitments that have been made by Parties suggest that progress will continue to be made between now and 2020[268]. Overall, the scientific information that has become available since the publication of GBO-4 suggests that progress towards this target is largely unchanged from what was previously reported. Similarly, the scientific literature suggests that the actions identified in GBO-4 remain relevant to the achievement of this Aichi Biodiversity Target.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

94. While significant data gaps and time lags remain, Aichi Biodiversity Target 12 continues to be one of the global targets for which the most information is available. Since the publication of GBO-4, numerous publications related to species extinction and conservation status have been published. Many of these have focused on more detailed assessments of indicators related to conservation status. For example, at the global level, an assessment of Red List Index information for vertebrates from 1988 to 2008 found that more than 50% of the global deterioration in the conservation status of birds, mammals and amphibians in the Red List Index was concentrated in less than 1% of the world's surface area, 4% of its ecoregions and 4% of countries.[269] An analysis of range contraction, based on information on 27,600 vertebrate species and information on extinctions between 1900 and 2015 in 177 mammal species, concluded that the rate of population loss in terrestrial vertebrates is extremely high with 32% of species decreasing. Further, of the 177 mammal species assessed, all have lost 30% or more of their range while 40% have undergone population declines.[270]

95. In addition to global studies on trends in species conservation status and extinction, there has also been a range of publications that have examined the conservation status of specific species. For example, an assessment of plants based on a Sampled Red List Index (SRLI) found that more than 20% of plant species assessed are threatened with extinction. Most threatened plant species are found in tropical rainforest, where the greatest threat to plants is habitat conversion resulting from livestock and agriculture and the harvesting of natural resources. Gymnosperms (e.g. conifers and cycads) are the most threatened group. However, a third of plant species considered had yet to be assessed or are so poorly known that their threat status could not be assessed.[271] Further, an assessment of trends in pollinators found that pollinating bird and mammal species are deteriorating in status with, on average, 2.5 species per year having moved one Red List category closer toward extinction between 1988 and 2012. This represents a

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[266] Schulze, K. et al (2018). An assessment of threats to terrestrial protected areas. Conservation Letters. DOI: 10.1111/conl.12435

[267] IUCN and UNEP-WCMC (2016), The World Database on Protected Areas (WDPA) [On-line], Cambridge, UK: UNEP-WCMC. Available at: www.protectedplanet.net.

[268] Gannon, P. et al (2017). Status and prospects for achieving AICHI biodiversity target 11: Implications of national commitments and priority actions. Parks 23.2, 13-26.

[269] Rodrigues ASL, et al. (2014) Spatially Explicit Trends in the Global Conservation Status of Vertebrates. PLoS ONE 9(11): e113934. https://doi.org/10.1371/journal.pone.0113934

[270] Ceballos, G. et al (2017). Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. Proceedings of the National Academy of Sciences. 114(30):201704949

[271] Brummitt NA, et al. (2015) Green Plants in the Red: A Baseline Global Assessment for the IUCN Sampled Red List Index for Plants. PLoS ONE 10(8): e0135152. https://doi.org/10.1371/journal.pone.0135152

substantial increase in the extinction risk across this group of species.[272] Also, while the conservation status of bats improved from 1985 to 2000 as human disturbances to roosting sites were reduced, it declined sharply (7%) by 2015, due principally to threats from white-nose syndrome and wind energy.[273]

96. There is comparatively less information on marine extinctions than on terrestrial ones. However, a study looking at extinction rates in marine and non-marine species found that, for the best studied taxonomic groups, on average between 20 and 25% of species are threatened with extinction regardless of the realm they inhabit[274].

97. A number of studies have focused on extrapolating current extinction and conservation status trends into the future using various scenarios and models. For example, an assessment based on spatial distribution models with historical and projected deforestation, suggests that between 36% and up to 57% of all Amazonian tree species are likely to qualify as globally threatened under the International Union for Conservation of Nature (IUCN) Red List criteria by 2050. This would increase the number of threatened plant species on Earth by 22%[275]. Similarly, under different climate and land use change scenarios and assuming a business-as-usual scenario, it was found that population abundance of terrestrial carnivore and ungulate species would decline by between 18% and 35%, while extinction would increase from between 8% and 23%, by 2050. However, an alternative scenario, one in which meat consumption per capita is limited, waste in the agricultural production chain is reduced and where less energy-intensive lifestyles are adopted, resulted in reductions in extinction risk and population losses[276]. Further, a meta-analysis of 131 published papers projecting the impacts of climate change on species extinction concluded that, as temperature rises, extinction risk will accelerate. The proportion of species that could go extinct as a result of climate change will increase from 2.8% at present to 5.2% with a 2°C post-industrial temperate rise. If temperature increase reaches 3°C, extinction risk is estimated to increase to 8.5% while, if temperatures rise by 4.3°C, 16% of species will be threatened by climate change. Extinctions were predicted to be highest in South America, Australia, and New Zealand and were not found to vary by taxonomic group[277].

98. Scenario studies have also been undertaken for specific ecosystems. For example, an assessment of the Brazilian Cerrado found that 46% of native vegetation cover has been lost and that less than 20% remains undisturbed. Under a business-as-usual scenario, it is projected that between 31% to 34% of the remaining Cerrado would be lost by 2056 and that this would bring about the extinction of approximately 480 endemic plant species. However, an alternative scenario, one where a mix of policies to reconcile agricultural expansion, conservation and restoration was applied, suggests that the region's projected increase in crop and beef production could be realized without further loss to the Cerrado.[278]

99. Some studies have also been undertaken to assess the threats facing particular groups of species in specific locations. For example, an assessment of the illegal killing and taking of birds in Europe concluded that between .4 and 2.1 million birds per year are illegally killed or taken in the region. The

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[272] Regan, E. C., (2015), Global Trends in the Status of Bird and Mammal Pollinators. Conservation Letters, 8: 397–403. doi:10.1111/conl.12162

[273] Hammerson, G.A. et al (2017). Strong geographic and temporal patterns in conservation status of North American bats, Biological Conservation, 212(A) 144-152,

[274] Webb, Thomas J. and Mindel, Beth L. (2015) Global Patterns of Extinction Risk in Marine and Non-marine Systems. Current Biology 25(4), 506-511.doi: 10.1016/j.cub.2014.12.023

[275] ter Steege, Han et al (2015). Estimating the global conservation status of more than 15,000 Amazonian tree species Science Advances 1(10) DOI: 10.1126/sciadv.1500936

[276] Visconti, P., et al (2016), Projecting Global Biodiversity Indicators under Future Development Scenarios. CONSERVATION LETTERS, 9: 5–13. doi:10.1111/conl.12159

[277] Urban, Mark C. (2015). Accelerating extinction risk from climate change. Science 348 (6234)571-573 10.1126/science.aaa4984

[278] Strassburg, B.B.N. et al (2017). Moment of truth for the Cerrado hotspot. Nature Ecology and Evolution. 0099

report noted that birds were primarily killed or taken for sport, food, and predator/pest control and pointed to the need for greater efforts to ensure existing legislation on this issue is complied with and enforced[279]. A similar assessment for the Mediterranean region estimated that between 11 and 36 million birds may be killed or taken each year in the region for food, sport, use as cage-birds or decoys[280]. A further study examining trends in insects in Germany over a 27 year period concluded that there had been a 76% decline in insect biomass in 63 nature protection areas[281].

100. Two indicators used in GBO-4 have been updated since the report was released. These indicators, Red List Index[282] and the Living Planet Index, both show trends that are negative for biodiversity.

101. A review of the scientific information that has become available since the publication of GBO-4 suggests that the situation is largely unchanged from what was previously reported, namely, that conservation status is worsening globally and that there has been no meaningful change in the rate of extinction at the global level. While there have been some regional, national and local successes, on the whole, species are increasingly at risk of extinction and the world community is not currently on track to reach Aichi Biodiversity Target 12.

102. The scientific literature that has been published since 2014 suggests that the actions identified to accelerate progress towards this target in GBO-4 remain relevant. In addition, there is increasing evidence that it is possible to improve the conservation status of species. For example, it has been estimated, based on IUCN Red List data from 1996 to 2008 that, in the absence of conservation action, at least 148 species would have deteriorated by one Red List Category, among which 6 would have been listed as extinct or extinct in the wild[283]. The same assessment noted that, while some species benefited from highly targeted actions, most benefited from conservation actions, such as habitat protection. Since the publication of GBO-4, a number of publications have noted the need to enhance monitoring systems for species. For example, an assessment based on the IUCN Red List noted that, unless funding is scaled up by 2025, 83% of Red List assessments will be outdated and the average age of assessments will be above 30 years[284]. Similarly, a set of priority regions has been identified to help assess the conservation status of freshwater fish[285].

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

103. In situ conservation networks should be able to capture a large proportion of the allelic variation of cultivated plants. However, they are less likely to be able to capture rare variations[286]. Further, while

[279] Brochet, A., et al (2017). Illegal killing and taking of birds in Europe outside the Mediterranean: Assessing the scope and scale of a complex issue. Bird Conservation International, 1-31. doi:10.1017/S0959270917000533.

[280] Brochet, A., et al (2016). Preliminary assessment of the scope and scale of illegal killing and taking of birds in the Mediterranean. Bird Conservation International, 26(1), 1-28. doi:10.1017/S0959270915000416.

[281] Hallmann, C. A. et al (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLOS ONE 12(10): e0185809.

[282] IUCN Red List Index http://www.iucnredlist.org/about/publication/red-list-index

[283] Hoffmann, M., et al (2015), The difference conservation makes to extinction risk of the world's ungulates. Conservation Biology, 29: 1303–1313. doi:10.1111/cobi.12519

[284] Rondinini, C., et al (2014), Update or Outdate: Long-Term Viability of the IUCN Red List. Conservation Letters, 7: 126–130. doi:10.1111/conl.12040

[285] Hermoso, V., et al (2017), Optimal allocation of Red List assessments to guide conservation of biodiversity in a rapidly changing world. Glob Change Biol, 23: 3525–3532. doi:10.1111/gcb.13651

[286] Whitlock, R. et al., (2016). Consequences of in-situ strategies for the conservation of plant genetic diversity. Biological Conservation, Volume 203, pp. 134-142.

genetic erosion continues to occur worldwide, a large amount of crop diversity is still retained in developing countries by smallholder farmers[287].

104. With regard to ex situ plant conservation, over 1,750 gene banks have been established. These banks maintain approximately 7.4 million accessions[288]. However, it has been estimated that only between 28% and 38% of threatened plants have five populations in ex situ collections[289]. With regard to crop wild relatives, an assessment, based on 1,076 taxa related to 81 crops and on information collected from biodiversity, herbarium and gene bank databases, concluded that the diversity of crop wild relatives is poorly represented in gene banks. The assessment found that, for 313 taxa associated with 63 crops, no accessions exist and that a further 257 taxa are represented by less than 10 accessions. The study also concluded that more than 70% of taxa are underrepresented and are of priority for collecting, with important geographic collecting gaps in the Mediterranean and the Near East, western and southern Europe, Southeast and East Asia, and South America[290]. Another study found that crop wild relatives are estimated to only represent between 2% and 18% of accessions[291]. Some specific crop wild relatives that have been identified as being underrepresented in collections and at risk are pigeonepea[292], potato[293] and eggplant[294]. One issue which has been identified as a possible obstacle to the conservation of crop wild relatives is that it is often unclear if they fall under the responsibility of the conservation or agriculture communities[295].

105. Protected areas also contain crop wild relatives; however protected areas are rarely established for this purpose and are therefore these wild relative are not necessarily actively conserved or accounted for in protected areas management. Similarly these species are rarely subject to monitoring and management interventions[296].

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[287] Bellon, M. R., et al (2014). Conserving landraces and improving livelihoods: International Journal of Agricultural Sustainability how to assess the success of on-farm conservation projects?, 13(2), p. 167–182.

[288] Food and Agriculture Organization. (2010) The Second Report on the State of World's Plant Genetic Resources for Food and Agriculture. Food and Agriculture Organization. Rome.

Tyagi, R. K. and Agrawal, A., 2015. Revised genebank standards for management of plant genetic resources. Indian Journal of Agricultural Sciences, 85(2), pp. 157-165.

[289] Godefroid et al. (2011) To what extent are threatened European plant species conserved in seed banks? Biological Conservation 144(5), p. 1494-1498.

Whitlock, R. et al., 2016. Consequences of in-situ strategies for the conservation of plant genetic diversity. Biological Conservation, Volume 203, pp. 134-142.

[290] Eastwood, H. (2016). Global conservation priorities for crop wild relatives. Nature Plants doi:10.1038/nplants.2016.22.

[291] Guarino et al.(2010) Adapting to climate change: the importance of ex situ conservation of crop genetic diversity. International conference on Food Security and Climate Change in Dry Areas. 1–4 February. Amman, Jordan.

Dempewolf, H. et al., 2017. Past and Future Use of Wild Relatives in Crop Breeding. Crop Science, Volume 57, p. 1070–1082.

[292] Khoury, C. K. et al., 2015. Crop wild relatives of pigeonpea [Cajanus cajan (L.) Millsp.]: Distributions, ex situ conservation status, and potential genetic resources for abiotic stress tolerance. Biological Conservation, Volume 184, pp. 259-270.

[293] Castaneda Alzarez, N. P. et al., 2015. Ex Situ Conservation Priorities for the Wild Relatives of Potato (Solanum L. Section Petota). PLOS One. 10(8): e0135152.

[294] Syfert, M. M. et al., 2016. Crop wild relatives of the brinjal eggplant (Solanum melongena): Poorly represented in genebanks and many species at risk of extinction. American Jounral of Botany, 103(4), pp. 635-651.

[295] Edwards, C. E., 2017. Strengthening the Link between International Conservation Policy and Plant Conservation Genetics to Achieve More Effective Plant Conservation. Annals of the Missouri Botanical Garden, 102(2), pp. 397-407.

[296] Maxted, N. et al., (2015). ECPGR Concept for in situ conservation of crop wild relatives in Europe, s.l.: European Cooperative Programme for Plant Genetic Resources.

106. In addition to ex situ and in situ conservation issues, several studies have been published since GBO-4 was released exploring how different techniques can be used to better identify, catalogue and store genetic information. For example, advances in DNA sequencing are enabling more efficient sequencing of crop wild relatives and their use for crop improvements[297]. Similarly, advances in next-generation DNA sequencing (NGS) technology have facilitated the sequencing of diverse crop genomes, as well as facilitated the association of different genetic traits to crop traits[298]. Further, DNA sequencing platforms are continuing to improve, as are software programmes for assessing genetic diversity[299].

107. With regard to farmed and domesticated animals, there is a general trend towards reduced genetic variation both in and across breeds[300]. Further, a general observation from the literature suggests that institutional frameworks and capacity to manage animal genetic resources need to be enhanced[301]. However, globally, national gene banking efforts have increased[302].

108. While there are few recent global studies on the status of farmed and domesticated animal genetic diversity, a number of assessments have been undertaken at the national and regional levels. For example, one assessment concluded that, in Africa, livestock genetic resources are at risk as a result of uncontrolled cross breeding and domestic breeds being placed with exotic ones. While more than 15 indigenous cattle breeds have been named in Africa, these breeds remain largely uncharacterized[303]. In addition, genetic information has been collected for a number of species from various countries and regions, including cattle in Africa[304], chicken in Oman[305] and in the African, Asian and European regions[306], goats in Asia[307] and sheep in South Africa[308] and Italy[309]. Further, it is anticipated that the conservation of farmed and domesticated animals will benefit from advances in next-generation DNA

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[297] Brozynska, M., et al (2016). Genomics of crop wild relatives: expanding the gene pool for crop improvement. Plant Biotechnology Survey, Volume 14, p. 1070–1085.

Dempewolf, H. et al., (2017). Past and Future Use of Wild Relatives in Crop Breeding. Crop Science, Volume 57, p. 1070–1082.

[298] Abberton, M. et al., (2016). Global agricultural intensification during climate change: a role for genomics. Plant Biology Journal, Volume 14, p. 1095–1098.

[299] Henry, R. J., (2014). Sequencing of wild crop relatives to support the conservation and utilization of plant genetic resources. Plant Genetic Resources, Volume 12, p. S9–S11.

Govindaraj, M., et al (2015). Importance of Genetic Diversity Assessment in Crop Plants and Its Recent Advances: An Overview of Its Analytical Perspectives. Genetics Research International. Volume 2015, 431487,

[300] Biscarini, F. et al., 2015. Challenges and opportunities in genetic improvement of local livestock breeds. Frontiers in Genetics, Volume 6.

[301] Leroy, G. et al., 2017. Stakeholder involvement and the management of animal genetic resources across the world. Livestock Science, Volume 198, pp. 120-128.

[302] Rezende Paiva, S., et al (2016). Conservation of animal genetic resources – A new tact. Livestock Science, Volume 193, pp. 32-38.

[303] Mwai, O., et al (2015). African Indigenous Cattle: Unique Genetic Resources in a Rapidly Changing World. Asian-Australasian Journal of Animal Sciences, 28(7), pp. 911-921.

[304] Kim, J. et al., (2017). The genome landscape of indigenous African cattle. Genome Biology, 18(34).

[305] Al-Qamashoui, B., et al (2014). Assessment of genetic diversity and conservation priority of Omani local chickens using microsatellite markers. Tropical Animal Health and Production, 46(5), pp. 747-752.

[306] Lyimo, C. M. et al., (2014). Global diversity and genetic contributions of chicken populations from African, Asian and European regions. Animal Genetics, 45(6), pp. 836-848.

[307] Periasamy, K. et al., (2017). Mapping molecular diversity of indigenous goat genetic resources of Asia. Small Ruminant Research, Volume 148, pp. 2-10.

[308] Cloete, S., et al (2014). The adaption of the South Africa sheep industry to new trends in animal breeding and genetics: A review. South African Journal of Animal Science, 44(2), pp. 307-321.

[309] Ciani, E. et al., (2014). Genome-wide analysis of Italian sheep diversity reveals a strong geographic pattern and cryptic relationships between breeds. Animals Genetics, 45(2), pp. 256-266.

sequencing, much like as is the case with crop and crop wild relatives. However, this technology will need to become more readily available for it to reach its full potential[310].

109. Since GBO-4 was released in 2014, two indicators related to this target have become available. The first of these, the number of plant genetic resources for food and agriculture secured in conservation facilities[311], shows an increase, while the other, the Red List index for wild relatives of farmed and domesticated species[312], shows a decline.

110. A review of the scientific information which has become available since the publication of GBO-4 suggests that the progress towards this target is largely unchanged from what was previously reported. Further, the scientific literature that has been published since 2014 suggests that the actions identified to accelerate progress towards this target in GBO-4 remain relevant. Additional possible actions identified in the literature include increasing awareness among policy makers of the role of genetic resources in climate change adaptation[313], and the need for better information-sharing systems for genetic resources[314].

Target 14:By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

111. Aichi Biodiversity Target 14 is a broad target. This makes assessing progress towards its attainment challenging. Further, progress towards its attainment is interrelated with progress towards other Aichi Biodiversity Targets, including targets 5, 6, 7, 10, 11, 12, 13 and 18. As such, information on the progress towards these targets can also inform progress towards Aichi Biodiversity Target 14.

112. A recent assessment using a set of 21 indicators related to 13 different ecosystems services found that 60% of the indicators related to ecosystem benefits had positive trends, while 86% of state indicators showed a decline. The assessment concludes that there has been no overall progress in reaching Aichi Biodiversity Target 14[315].

113. With regard to the marine environment, the Ocean Health Index, which measures changes to ten societal objectives related to ocean health, increased by one point between 2012 and 2013, representing a small positive change. At the country level, scores improved by 0.06 points on average[316]. Other studies have looked at specific marine ecosystems. For example, one assessment focusing on the Western and Adriatic regions of the Mediterrnean Sea concluded that all fisheries resources are at risk of overexploitation[317]. A similar study concluded that global biomass production in the marine environment

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[310] Bruford, M. W. et al., (2015). Prospects and challenges for the conservation of farm animal genomic resources, 2015-2025. Frontiers in Genetics, Volume 6.

Mwai, O., et al (2015). African Indigenous Cattle: Unique Genetic Resources in a Rapidly Changing World. Asian-Australasian Journal of Animal Sciences, 28(7), pp. 911-921.

[311] Food and Agriculture Organization of the United Nations. SDG Indicator 2.5.1 - Conservation of genetic resources for food and agriculture. http://www.fao.org/sustainable-development-goals/indicators/2.5.1/en/

[312] IUCN Red List Index http://www.iucnredlist.org/about/publication/red-list-index

[313] Belew, A. K., et al (2016). The State of Conservation of Animal Genetic Resources in Developing Countries: A Review. International Journal of Pharma Medicine and Biological Sciences, 5(1), pp. 58-66.

[314] Scherf, B. and Baumung, R., (2015). Monitoring the implementation of the Global Plan of Action for Animal Genetic Resources. Biodiversity, 16(2-3), pp. 149-156.

[315] Shepherd, E.J. et al. (2016). Status and Trends in Global Ecosystem Services and Natural Capital: Assessing Progress Toward Aichi Biodiversity Target 14. Conservation Letters, November/December 2016, 9(6), 429–437.

[316] Halpern, B. S. et al. (2015) Spatial and temporal changes in cumulative human impacts on the world's ocean. Nature Communications. 6:7615 doi: 10.1038/ncomms8615.

[317] Liquete, C. et al (2016). Ecosystem services sustainability in the Mediterranean Sea: Assessment of status and trends using multiple modelling approaches. Scientific Reports 6, 34162.

predicted a long-term decline in global marine catch[318]. Given the importance of agricultural and fisheries productivity to human wellbeing, such trends are a challenge to the prospects for reaching Aichi Biodiversity Target 14. Information related to fisheries is further addressed under the section of this note dealing with Aichi Biodiversity Target 6.

114. Mangrove ecosystems have received considerable attention in the scientific literature. Mangroves provide a range of ecosystem services and as such are particularly relevant to Aichi Biodiversity Target 14. As noted under Aichi Biodiversity Target 5, mangroves are in decline globally. Such declines can have various effects. For example, one study on the Matang Mangrove Forest Reserve in Peninsular Malaysia found that ecosystem services, including cockle production, are declining and that pressures on species, such as migratory birds, are increasing as a result of mangrove loss and degradation. These pressures are largely the result of wood harvesting and charcoal production[319].

115. Another issue relevant to Aichi Biodiversity Target 14 explored in the literature is freshwater. One assessment of global freshwater ecosystems estimates that 82% of the world's population relies on upstream areas which are highly threatened for water services (in some countries, such as China and India, this percentage could be as high as 88%). Developing countries are particularly vulnerable as they often lack the means to construct infrastructure that can reduce water-related threats[320]. A second study looking specifically at protected areas reached a similar conclusion. It estimated that, on a global scale, 80% of downstream communities that rely on freshwater from upstream protected areas are using water that is under threat[321]. Studies related to the provision of freshwater have also been undertaken at the national level. For example, a study examining wetland degradation in Madagascar concluded that overexploitation, climate change, invasive species and other human disturbances are causing freshwater habitat loss with related impacts on species abundance and diversity[322].

116. Ecosystem services provided by soils have also been examined in the scientific literature. A global assessment on soil health indicates that soil erosion mainly affects Asia, Sahel, Central America and Africa[323]. However, pressures on soil are widespread. For example, an assessment of soil in the European Union concluded that soil erosion and land intensification resulting from urbanization have resulted in the loss of soil functions[324].

117. Work has also been undertaken to determine the relationship between diversity and the provision of ecosystem services. For example, a study of grassland plants indicates that 84% of 147 grassland plant species considered in 17 different biodiversity experiments promoted ecosystem functioning. Further, the different species promoted ecosystem functioning in different ways, at different periods of time and under different circumstances. The study ultimately concluded that more species are needed to maintain ecosystem functions and services than had previously been suggested[325].

118. A further ecosystem service which has received considerable attention is pollination. Pollinators, pollination and food production was the focus of one the thematic assessments undertaken by the

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[318] Galbraith, E.D. et al (2017). A coupled human-Earth model perspective on long-term trends in the global marine fishery. Nature Communications 8, 14884.

[319] Aziz, A. et al. (2015). Investigating the decline of ecosystem services in a production mangrove forest using Landsat and object-based image analysis. Estuarine, Coastal and Shelf Science 164, 353-366.

[320] Green, P. A., (2015). Freshwater ecosystem services supporting humans: Pivoting from water crisis to water solutions. Global Environmental Change 34, 108-118.

[321] Harrison, I.J. (2016). Protected areas and freshwater provisioning: a global assessment of freshwater provision, threats and management strategies to support human water security. Aquatic Conservation: Marine and Freshwater Ecosystems 26, 103-120.

[322] Bamford, A et al. (2017). Profound and pervasive degradation of Madagascar's freshwater wetlands and links with biodiversity. Plos ONE 12, no. 8: 1-15.

[323] Rojas, R. V., et al (2016). Healthy soils, a prerequisite for sustainable food security. Environ. Earth Sci. 75:108.

[324] European Environment Agency. (2015). The European Environment State and Outlook 2015.

[325] Isbell, F. (2017). High plant diversity is needed to maintain ecosystem services. Nature 477, 199-202.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services[326]. Among the key messages of that assessment was that between 5% and 8% of current global crop production depends on animal pollination, and that wild pollinators have declined in occurrence and diversity at local and regional scales. Other studies have found that the diversity of pollinators and pollination services decrease with the intensification of agriculture[327]. As two-thirds of the world's major food crops are pollinator-dependent, the intensification of agriculture may lead to adverse effect on yields. Conversely, increasing wild insect pollinator richness and abundance was found to result in high and more consistent crop yields[328]. However, a further study has shown that achieving a 50% pollination threshold in a single site requires on average 5.5 bee species but that, over a larger region, 55 species were needed. The study ultimately concluded that providing crop pollination in natural systems must increase by an order of magnitude when compared with field experiments[329].

119. A number of studies have been published since the release of GBO-4 examining the impacts of human vulnerability and health resulting from various forms of biodiversity loss. For example, one study found that the Mediterranean Sea's capacity to provide and supply coastal protection is declining[330]. Similarly, in southern Spain, there has been an observed increase in coastal hazards, including flooding, shoreline erosion, storm surges and sea level rise, as a result of land use change associated with urbanization and tourism.

120. With regard to human health, deforestation has been associated with a range of health issues, including malaria transmission and increased microbial load in water bodies. For example, an assessment, examining the relationship between land cover and childhood diarrheal disease in 35 countries, found that upstream tree cover was associated with a smaller probability of diarrheal disease downstream in rural communities. Further, in rural areas, a 30% increase in tree cover upstream had an effect similar to improving sanitation on the incidence of disease, suggesting that improving natural capital can be viewed as a public health investment[331]. Further, in Cambodia, an assessment found that each 10% loss in forest area was associated with an increase of about 14% in the incidence of diarrhoea in children under 5 years of age. In contrast, a 10% increase in protected area coverage was associated with a 3.5% decrease in diarrhoea [332]. Medicinal plants, an important element of human health in some countries, have also received attention in the literature. For example, a study of medicinal plant use in Lingshi, Bhutan, found that some plant species have been highly exploited as international demand has increased. This, in turn, has resulted in illegal harvesting practices[333]. Similarly, a study examining medicinal plants in China estimated that 603 are threatened, 44 are critically endangered, 189 are endangered and 370 are

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[326] IPBES (2016). The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production. S.G. Potts, V. L. Imperatriz-Fonseca, and H. T. Ngo, (eds). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 552 pages.

[327] Deguines, N., et al (2014), Large-scale trade-off between agricultural intensification and crop pollination services. Frontiers in Ecology and the Environment, 12: 212–217. doi:10.1890/13005

[328] Garibaldi, L. A., et al (2014), From research to action: enhancing crop yield through wild pollinators. Frontiers in Ecology and the Environment, 12: 439–447. doi:10.1890/130330

[329] Winfree, R. et al (2018). Species turnover promotes the importance of bee diversity for crop pollination at regional scales Science 359, 791-793.

Kremen, C. (2018). The value of pollinator species diversity. Science 359 (6377), 741-742.

[330] Liquete, C. et al (2016). Ecosystem services sustainability in the Mediterranean Sea: Assessment of status and trends using multiple modelling approaches. Scientific Reports 6, 34162.

[331] Herrera, D. et al (2017). Upstream watershed condition predicts rural children's health across 35 developing countries. Nature Communications 8, 811. doi:10.1038/s41467-017-00775-2

[332] Pienkowski, T. et al (2017). Empirical evidence of the public health benefits of tropical forest conservation in Cambodia: a generalised linear mixed-effects model analysis, The Lancet Planetary Health 1(5) e180-e187.

[333] Lakey et al (2016). Ecological status of high altitude medicinal plants and their sustainability: Lingshi, Bhutan. BMC Ecology 16, no. 1

vulnerable[334]. There has also been research linking the impact of human activities to microbiota and human and ecosystem health[335].

121. Two indicators related to this target have been updated since 2014. Both indicators, the Red List Index for pollinator species and the Red List Index for species used for food and medicine, show declines.

122. Overall, the information that has become available since the publication of GBO-4 suggests that Aichi Biodiversity Target 14 is not currently on track to be reached. However, the amount of information remains limited, particularly with regard to cultural issues and issues associated with the needs of women and the poor and vulnerable. Further, the information that has become available since the publication of GBO-4 indicates that the actions identified therein to help accelerate progress towards this Aichi Biodiversity Target remain relevant.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

123. The scientific literature on restoration, carbon sequestration and ecosystem resilience published since the release of GBO-4 has addressed a range of issues. Various case studies looking at the effects and approaches to restoration activities in specific locations have been prepared[336]. Others have further advanced the understanding of different restoration techniques[337] and/or the conditions under which restoration is most likely to be successful[338]. However, despite the large amount of research on this subject, relatively little focuses on the global scale.

124. Recent literature suggests that land degradation affects about 1.5 billion people. Of these 250 million people reside in drylands and about one billion people in over 100 countries are at risk[339].

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[334] Chi, X, et al. (2017). Threatened medicinal plants in China: Distributions and conservation priorities. Biological Conservation 210 (A): 89-95.

[335] Flandroy, L. et al (2018). The impact of human acitivities and lifestyles on the interlinked microbiota and health of humans and of ecosystems. Science of the Total Environment. 627, 10-18-1038.

[336] Barral, M. P. et al (2015) Quantifying the impacts of ecological restoration on biodiversity and ecosystem services in agroecosystems: A global meta-analysis, Agriculture, Ecosystems & Environment,202,223-231.

Lü, R. Y. et al (2017) Biodiversity and Ecosystem Functional Enhancement by Forest Restoration: A Meta-analysis in China. Land Degradation and Development., 28: 2062–2073. doi: 10.1002/ldr.2728.

Waldén E, and Lindborg R (2016) Long Term Positive Effect of Grassland Restoration on Plant Diversity - Success or Not? PLoS ONE 11(5): e0155836. doi:10.1371/journal.pone.0155836

[337] Kimiti, D. W et al (2017), Low-cost grass restoration using erosion barriers in a degraded African rangeland. Restoration Ecology, 25: 376–384. doi:10.1111/rec.12426

YirdawE., et al (2017). Rehabilitation of degraded dryland ecosystems – review. Silva Fennica vol. 51 no. 1B article id 1673. 32 p. https://doi.org/10.14214/sf.1673

Jiang, T. et al (2015). Current status of coastal wetlands in China: Degradation, restoration, and future management, Estuarine, Coastal and Shelf Science,164, 265-275.

[338] Moreno-Mateos, D., et al (2015), Ecosystem response to interventions: lessons from restored and created wetland ecosystems. J Appl Ecol, 52: 1528–1537. doi:10.1111/1365-2664.12518

Yamindago, R. (2015) Restoring coastal ecosystems - a case study Malang and Gresik regency, Indonesia. Journal of Coastal Conservation 19: 119. https://doi.org/10.1007/s11852-015-0373-0

Durka, W., et al (2017), Genetic differentiation within multiple common grassland plants supports seed transfer zones for ecological restoration. J Appl Ecol, 54: 116–126. doi:10.1111/1365-2664.12636

Crouzeilles, R. et al (2016). A global meta-analysis on the ecological drivers of forest restoration success. Nature Communications 7. http://dx.doi.org/10.1038/ncomms11666

[339] Yirdaw, E.et al (2017). Rehabilitation of degraded dryland ecosystems – review. Silva Fennica vol. 51 no. 1B article id 1673. 32 p. https://doi.org/10.14214/sf.1673

Globally, the main drivers of land degradation are human in origin and include wetland reclamation, construction, overexploitation of biological resources, and environmental pollution.

125. There are various estimates of the amount of degraded areas that exists at the global level, which in part is due to the different ways in which degradation has been defined. For example, it has been estimated that two billion hectares of the world's deforested and degraded forest lands contain opportunities for restoration[340]. Specifically, with regard to peatlands, a major carbon sink, approximately 15 million hectares are degraded or viable for restoration[341].

126. Numerous studies have documented national restoration projects, some of which are undertaking restoration activities on a significant scale[342]. However, since GBO-4 was published, there has been limited new information on the scale of restoration activities being undertaken at the global level. An exception to this is an assessment of river ecosystems which found that there has been an increasing trend towards the removal of dams in some countries. For example, in the United States, more than 1200 dams have been removed mostly within the last two decades[343].

127. Various studies have provided further insight into the benefits of restoration actions. For example, a global meta-analysis indicated that the restoration of degraded systems enhanced overall biodiversity by 44%[344]. Similarly, in forest restoration, revegetation accelerated recovery of species richness and composition[345]. In wetland ecosystems, restoration was found to enhance the diversity of vertebrates, vascular plants, and terrestrial and aquatic invertebrates, but had no significant effect on macroinvertebrate diversity[346]. In forest ecosystems afforestation has been found to have benefits for soil health.[347] Further the restoration of agroecosystems has been found to, generally, enhance biodiversity and the supply of ecosystem services other than agricultural production[348].

128. The benefits of natural restoration have also been explored in recent scientific literature. For example, an assessment of above-ground biomass in 45 forest sites in the neotropics found that secondary forests are highly productive and resilient. They were also found to act as carbon sinks and increased water availability[349]. A similar study concluded that secondary forests in the Latin American Tropics, over a 40 year period, either through natural regeneration or assisted regeneration, could sequester an amount of carbon equal to that generated from fossil fuel use and industrial processes throughout Latin

[340] World Resources Institute (2014). Atlas of Forest and Landscape Restoration Opportunities.

[341] Haapalehto, T. et al (2014). The effects of long-term drainage and subsequent restoration on water table level and pore water chemistry in boreal peatlands, Journal of Hydrology,519(B), 1493-1505.

[342] Parry, L.E. (2014). Restoration of blanket peatlands, Journal of Environmental Management, 133, 193-205.

Himner, R. A., et al (2017), An overview of peatland restoration in North America: where are we after 25 years?. Restoration Ecology, 25: 283–292. doi:10.1111/rec.12434

Liu, Y., et al (2017) Soil Organic Carbon and Inorganic Carbon Accumulation Along a 30-year Grassland Restoration Chronosequence in Semi-arid Regions (China). Land Degrad. Develop., 28: 189–198. doi: 10.1002/ldr.2632.,

[343] Grill, G. et al (2015) An index-based framework for assessing patterns and trends in river fragmentation and flow regulation by global dams at multiple scales. Environmental Research Letters. 10 015001

[344] Crouzeilles, R et al (2016). A global meta-analysis on the ecological drivers of forest restoration success. Nature Communications 7. http://dx.doi.org/10.1038/ncomms11666

[345] Moreno-Mateos, D., et al (2015), Ecosystem response to interventions: lessons from restored and created wetland ecosystems. J Appl Ecol, 52: 1528–1537. doi:10.1111/1365-2664.12518

[346] Meli P, et al. (2017) A global review of past land use, climate, and active vs. passive restoration effects on forest recovery. PLoS ONE 12(2): e0171368. https://doi.org/10.1371/journal.pone.0171368

[347] Chengjie R, et al (2016) Linkages of C:N:P stoichiometry and bacterial community in soil following afforestation of former farmland,Forest Ecology and Management,376, 59-66,

[348] Barral, M. P. et al (2015) Quantifying the impacts of ecological restoration on biodiversity and ecosystem services in agroecosystems: A global meta-analysis, Agriculture, Ecosystems and Environment, 202, 223-231.

[349] Poorter, L. et al (2016) Biomass resilience of Neotrpopical secondary forests. Nature. 530, pages 211–214.

America between 1993 and 2014[350]. However, another study, based on twelve years of satellite data, suggests that tropical forests are a net source of carbon as a result of deforestation, forest degradation and disturbance[351]. Further, an analysis of 400 studies, examining the recovery of ecosystems following disturbances, concluded that restored ecosystems rarely fully recover and that active restoration, when compared to simply ending the disturbance causing the degradation, did not result in more rapid or more complete recovery. These results suggest that the passive recovery of ecosystems should be considered as a first option for restoration, and that more active restoration should be used to overcome specific obstacles. However, the authors of this study also note that these results need to be interpreted with caution, as few studies directly compared different restoration actions in similar locations and with similar disturbances.[352]

129. Restoration has also been identified as a potential natural solution to climate change. For example, a study found that a combination of 20 conservation, restoration and improved land management actions could increase carbon storage and/or prevent greenhouse gas emissions. These solutions could account for 37% of the carbon dioxide mitigation needed, between now and 2030, to have more than a 66% chance of keeping warming below two degrees Celsius. The study also concludes that these actions would have additional benefits, including improved soil health, increased habitat, better water filtration and flood buffering and enhanced resilience.[353]

130. The cost of ecosystem restoration vary with the habitat and technique employed. It has been estimated that the cost of wetland restoration ranged from $6,177 (2013 US dollars) per hectare to $160,618 per hectare[354]. Similarly, a synthesis of 235 studies of coral reef, seagrass, mangrove, saltmarsh and oyster reef restoration projects from around the world found that the median and average costs of restoring one hectare of marine coastal habitat were between US$ 80,000 and US$ 1,600,000, respectively[355]. However, it has also been estimated that the ecosystem restoration and reclamation industry generates 126,000 jobs and approximately US$ 9.5 billion in annual expenditure. Indirectly, it has been estimated to generate US$ 15 billion in annual expenditure and another 95,000 jobs.[356]

131. A review of the scientific literature which has become available since 2014 suggests that progress towards this target is largely unchanged from what was previously reported in GBO-4. Further, the literature suggests that the actions identified in GBO-4 to accelerate progress towards this target remain relevant. However, there is also a growing body of information on actions which could be taken to improve restoration techniques and effectiveness. These include placing greater emphasis on monitoring the effects of restoration activities[357], the need to consider appropriate time scales[358], and tailoring the

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[350] Chazdon, R. L. et al (2016). Carbon sequestration potential of second-growth forest regeneration in the Latin American Tropics. Science Advances 2(5) e1501639.

[351] Baccini, A. et al (2017). Tropical forests are a net carbon source based on aboveground measurements of gain and loss. Science. 10.1126/science.aam5962.

[352] Jones, H. P. et al (2018). Restoration and repair of Earth's damaged ecosystems. Proceedings of the Royal Society B. 285 (1873). DOI: 10.1098/rspb.2017.2577

[353] Griscom, B. W. et al (2017). Natural climate solutions. Proceedings of the National Academy of Sciences. 114 (44) 11645-11650.

[354] Moreno-Mateos, D., et al (2015), Ecosystem response to interventions: lessons from restored and created wetland ecosystems. J Appl Ecol, 52: 1528–1537. doi:10.1111/1365-2664.12518

[355] Bayraktarov, E., et al (2016). The cost and feasibility of marine coastal restoration. Ecological Applications, 26: 1055–1074.

[356] BenDor T, et al (2015) Estimating the Size and Impact of the Ecological Restoration Economy. PLoS ONE 10(6): e0128339. https://doi.org/10.1371/journal.pone.0128339

[357] Isbell, F et al (2015). Biodiversity increases the resistance of ecosystem productivity to climate extremes. Nature 526, 574-577.

Lamers, L. P. M., et al. (2015), Ecological restoration of rich fens in Europe and North America: from trial and error to an evidence-based approach. Biol Rev, 90: 182–203. doi:10.1111/brv.12102 goals of ecosystem restoration to be able to deal with changing climatic conditions. Further, some studies have explored the positive role of legislation in promoting restoration[359], and the positive impact that creating multi-sectoral coalitions or partnerships can have in supporting restoration[360].

Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

132. The fourth edition of the Global Biodiversity Outlook concluded that, as the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization entered into force on 12 October 2014, Aichi Biodiversity Target 16 was met. As of January 2018, 105 Parties to the CBD have ratified the Protocol and actions continue to be taken to support its operationalization. Progress in the attainment of this target is not readily available from the scientific literature, however updated information on the operationalization of the Protocol will be presented and discussed during the second meeting of the Subsidiary Body on Implementation, in the context of assessment and review of the effectiveness of the Nagoya Protocol.

Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

133. The fourth edition of the *Global Biodiversity Outlook* concluded that national biodiversity strategies and action plans (NBSAPs) were expected to be in place for most Parties by 2015. However, by the December 2015 deadline for Aichi Biodiversity Target 17, only 69 Parties had submitted an NBSAP prepared or revised/updated after the adoption of the Strategic Plan for Biodiversity 2011-2020. As of March 2018, 154 Parties have submitted NBSAPs since COP-10. Information on progress in the attainment of this target is not readily available from the scientific literature, however updated information on the development and implementation of NBSAPs will be presented and discussed during the second meeting of the Subsidiary Body on Implementation.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

134. Several studies have noted that there appears to be a general decline or erosion of traditional knowledge[361], however there have been few studies documenting progress towards Aichi Biodiversity Target 18 at a global level. Numerous studies have documented specific examples of how the traditional knowledge, innovations and practices of indigenous peoples and local communities could be strengthened

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Waldén E, and Lindborg R (2016) Long Term Positive Effect of Grassland Restoration on Plant Diversity - Success or Not? PLoS ONE 11(5): e0155836. https://doi.org/10.1371/journal.pone.0155836

[358] Crouzeilles, R et al (2016). A global meta-analysis on the ecological drivers of forest restoration success. Nature Communications 7. http://dx.doi.org/10.1038/ncomms11666

[359] Vidal, C. et al (2016). Biodiversity Conservation of Forests and their Ecological Restoration in Highly-modified Landscapes. Biodiversity in Agricultural Landscapes of Southeastern Brazil. 136-150. 10.1515/9783110480849-010

[360] Meli P, et al. (2017) A global review of past land use, climate, and active vs. passive restoration effects on forest recovery. PLoS ONE 12(2): e0171368. https://doi.org/10.1371/journal.pone.0171368

[361] Hidayati, S. et al (2017). Using Ethnotaxonomy to assess Traditional Knowledge and Language vitality: A case study with the Urang Kanekes (Baduy) of Banten, Indonesia. Indian journal of traditional knowledge. 16. 576-582.

in relevant national legislation and international obligations, such as global patent systems[362] or in combating biopiracy. Other studies have documented experiences in specific regions, such as South Asia[363] and Africa[364]. Various studies also document means through which traditional knowledge can be applied to ecosystem management and conservation[365].

135. While there is growing documentation on the potential value of traditional knowledge, it has been noted that there is often a lack of communication between indigenous peoples and local communities and the scientific community[366]. For example, it has been noted that global assessments of biodiversity often do not take local and traditional knowledge into account[367]. This is despite there being numerous examples of how bringing traditional knowledge together with science can lead to constructive solutions to various challenges[368], as well as result in policies which are more tailored to on-the-ground realities[369]. However, one example which is counter to this general trend is the conceptual framework of the Intergovernmental Platform on Biodiversity and Ecosystem Services which gives explicit consideration of diverse scientific disciplines, stakeholders, and knowledge systems, including indigenous and local knowledge[370].

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[362] Amechi, E. P. (2015) Using Patents to Protect Traditional Knowledge on the Medicinal Uses of Plants in South Africa, Law, Environment and Development Journal 51,

[363] Barpujari, I., Sarma, U. K. (2017). Traditional Knowledge in the Time of Neo-Liberalism: Access and Benefit-Sharing Regimes in India and Bhutan.The International Indigenous Policy Journal, 8(1) . Retrieved from: http://ir.lib.uwo.ca/iipj/vol8/iss1/3

[364] Kaya, H.O. (2016). Indigenous knowledge and biodiversity for sustainable food security in South Africa. Journal of Human Ecology 52(2): 141-147.

[365] Rah, P. (2016). Indigenous knowledge and practices of the Phakeyals: a study in Barphake village of Margherita. The Clarion- International Multidisciplinary Journal. 5. 98. 10.5958/2277-937X.2016.00038.1.

Leni D.et al (2016) Indigenous knowledge and practices for the sustainable management of Ifugao forests in Cordillera, Philippines, International Journal of Biodiversity Science, Ecosystem Services & Management, 12:1-2, 5-13, DOI: 10.1080/21513732.2015.1124453

Chun,J. (2014). A legal approach to induce the traditional knowledge of forest resources,Forest Policy and Economics, 38,40-45.

O'Neill, Alexander R.et al (2017). Integrating ethnobiological knowledge into biodiversity conservation in the Eastern Himalayas. Journal of Ethnobiology and Ethnomedicine13(21).

Pásková, M. (2015). The Potential of Indigenous knowledge for Rio Coco Geopark Geotourism, Procedia Earth and Planetary 15,886-891.

Quave, C. L. and Pieroni, Andrea (2015). A reservoir of ethnobotanical knowledge informs resilient food security and health strategies in the Balkans. Nature Plants 1 (14021). Ritchie, 2015;

Rivero-Romero, A. D. et al (2016). Traditional climate knowledge: a case study in a peasant community of Tlaxcala, Mexico. Journal of Ethnobiology and Ethnomedicine 12(33).

Kaya, H.O. (2016). Indigenous knowledge and biodiversity for sustainable food security in South Africa. Journal of Human Ecology 52(2): 141-147.

[366] Abreu, J. S. et al (2017). Is there dialogue between researchers and traditional community members? The importance of integration between traditional knowledge and scientific knowledge to coastal management,Ocean & Coastal Management,141, 10-19.

[367] Sutherland, W., et al (2014). How can local and traditional knowledge be effectively incorporated into international assessments? Oryx, 48(1), 1-2. doi:10.1017/S0030605313001543

[368] Tengö, M., et al. AMBIO (2014) 43: 579. https://doi.org/10.1007/s13280-014-0501-3

[369] Barua, Prabal. (2017). Indigenous Knowledge Practices for Climate Change Adaptation in the Southern Coast of Bangladesh. International Journal of Knowledge Management. 15. 1-21.

[370] Diaz, S. et al (2015). The IPBES Conceptual Framework – connecting nature and people. Current Opinion in Environmental Sustainability 14, 1-16.

IPBES Decision 2/4: Conceptual framework for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://www.ipbes.net/sites/default/files/downloads/Decision%20IPBES_2_4.pdf

136. With regard to the integration of traditional knowledge in the operations of the Convention, it has been observed that countries often include actions related to the respect and integration of traditional and local knowledge in their NBSAPs but that participation mechanisms are limited[371]. Further, it has also been observed that there is often limited capacity to meaningfully engage indigenous peoples and local communities in policy decisions[372].

137. A review of the scientific information which has become available since 2014 suggests that the situation is largely unchanged from what was previously reported in GBO-4. Further, the recent scientific literature suggests that the actions identified in GBO-4 to accelerate progress towards this target remain relevant.

Target 19:By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

138. The scientific articles referenced in this note indicate that the amount of available biodiversity information is increasing at a rapid pace. These articles imply that progress is continuing to be made towards the attainment of this target and it is clear that significantly more biodiversity information is available today than when Aichi Biodiversity Target 19 was adopted, though gaps remain.

139. While the amount of biodiversity information is increasing, there has been less progress in widely sharing this information and in applying it to policy decisions. However, there has been research undertaken to help address this. For example, research has been undertaken on methodologies for the transfer of knowledge on biodiversity management from experts to citizens, including by using tools such as network analysis[373], the development of observation networks[374], as well as by better understanding how people perceive biodiversity information[375]. Similarly, there has been work to better document types of knowledge which have tended to receive less attention from the scientific community, such as traditional medical knowledge[376] and knowledge related to traditional medicinal plants[377]. In addition, a range of research has been carried out to develop methods to better collect and catalogue biodiversity information. This includes work related to DNA barcoding[378]. Given the current limitations in some biodiversity-rich countries in relation to biodiversity monitoring, studies have also been undertaken to

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[371] Ferrari, M. et al (2015) Community-based monitoring and information systems (CBMIS) in the context of the Convention on Biological Diversity (CBD), Biodiversity, 16:2-3, 57-67, DOI: 10.1080/14888386.2015.1074111

[372] Escott, H. et al (2015). Incentives and constraints to Indigenous engagement in water management, Land Use Policy,49,382-393.

Brondizio, E. S.and Tourneau, F (2016). Environmental governance for all. Science. 352 (6291)

[373] Nesshover et al. 2016. The Network of Knowledge approach: improving the science and society dialogue on biodiversity and ecosystem services in Europe. Biodiversity Conservation Vol. 25

[374] Despot-Belmont et al. 2017. EU BON's contributions towards meeting Aichi Biodiversity Target 19. Research Ideas and Outcomes Vol. 3

[375] Celis- Diez et al 2017. Biocultural Homogenization in Urban Settings: Public Knowledge of Birds in City Parks of Santiago, Chile Sustainability Vol.9

[376] Kim eral. 2015 Development of a template for the classification of traditional medical knowledge in Korea. Journal of Ethnopharmacology Vol. 178

[377] Sher et al. 2017. Promoting Sustainable Use of Medicinal and Aromatic Plants for Livelihood Improvement and Biodiversity Conservation under Global Climate Change, through Capacity Building in the Himalaya Mountains, Swat District, Pakistan. Annals of the Missouri Botanical Garden, Vol.102

[378] Ashfaq et al. 2017. Mapping global biodiversity connections with DNA barcodes: Lepidoptera of Pakistan. PLoS ONE Vol. 12

better understand capacity-building needs[379], while other studies have attempted to evaluate the funding needs associated with maintaining different conservation knowledge products[380].

140. Two indicators used in GBO-4, number of biodiversity papers published[381] and the number of species occurrence records in the Global Biodiversity Information Facility[382], have been updated since 2014. Both indicators show increases. In addition, two indicators not used in GBO-4, the species status information index[383] and the proportion of known species assessed through the IUCN Red List[384], have become available since GBO-4 was published. Both of these indicators show positive trends.

141. The information that has become available since the publication of GBO-4 suggests that progress towards this target is largely unchanged from what was previously reported. The amount of biodiversity knowledge available continues to increase and, while progress has been made in sharing and applying this knowledge, more efforts are needed in this regard. Further, the recent scientific literature suggests that the actions identified in GBO-4 to accelerate progress towards this target remain relevant.

Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

142. The fourth edition of the *Global Biodiversity Outlook* concluded that further efforts will be needed to significantly increase the financial resources, from all sources, for effective implementation of the Strategic Plan for Biodiversity 2011-2020. Further, the report noted that there was insufficient data to report with confidence on progress towards the mobilization of financial resources from all sources. Since the publication of GBO-4, the Conference of the Parties has put a financial reporting mechanism in place which will provide information relevant to the assessment of progress towards this target. Information on progress in the attainment of this target is not readily available from the scientific literature, however updated information on resource mobilization will be presented and discussed during the second meeting of the Subsidiary Body on Implementation. The amount of work focused on acquiring a better understanding of the impact on financing on biodiversity outcomes is on the rise. For example, a model, based on information from 109 countries, found that biodiversity investment reduced biodiversity loss by 29% between 1996 and 2008[385]. Further, two indicators used in GBO-4 have been updated since 2014. The indicators, official development assistance provided in support of the CBD objectives[386] and funding provided by the Global Environment Facility, both show positive trends.

III. CONCLUSIONS

143. A variety of scientific information relevant to the Aichi Biodiversity Targets has become available since the publication of the fourth edition of the *Global Biodiversity Outlook* in 2014. This

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[379] Schmeller et al (2017). Building capacity in biodiversity monitoring at the global scale. Biodiversity and Conservation 26(12) 2765–2790

[380] Juffe-Bignoli et al. (2016). Assessing the Cost of Global Biodiversity and Conservation Knowledge. PLoS ONE Vol. 11 Issue 8

[381] Web of Science Service for UK Education http://wok.mimas.ac.uk/

[382] The GBIF Network https://www.gbif.org/the-gbif-network

[383] Meyer, C., et al (2015). Global priorities for an effective information basis of biodiversity distributions. Nature communications 6: 8221.

[384] IUCN Red List of Threatened Species. Summary Statistics. http://www.iucnredlist.org/about/summary-statistics

[385] Waldron, A. et al (2017). Reductions in global biodiversity loss predicted from conservation spending. Nature 551, 356-367.

[386] OECD, 2015. Biodiversity related official development assistance 2015. Available at: https://www.oecd.org/dac/environment-development/Biodiversity-related-ODA.pdf

information has furthered our understanding of various issues related to biodiversity, including approaches and methodologies that can be used for its conservation and sustainable use. It has also furthered our understanding of different biological processes and the ways in which society interacts with and impacts biodiversity. However, this information does not easily lend itself to an updated assessment of progress towards the Aichi Biodiversity Targets. Further, many of the studies reviewed in this note employ different definitions for similar ecosystems and/or processes as well as apply methodologies in their research. This makes direct comparisons of their conclusions difficult, if not impossible.

144. For a number of the Aichi Biodiversity Targets, relatively little information has become available in the last four years. This is particularly the case for those targets which address socio-economic issues, such as Aichi Biodiversity Targets 1, 2, and 3, as well as Aichi Biodiversity Target 18. This gap points to the need to encourage a higher level of involvement of the social science sector in assessments of progress towards the targets.

145. Of the 46 indicators reviewed in this note[387], 19 showed trends that could be considered positive for biodiversity, and one showed a trend which was unclear. The remainder of the indicators showed trends that were negative for biodiversity. All of the 19 indicators showing positive trends related to responses that Parties are taking to conserve and use biodiversity in a sustainable manner. The 26 indicators that showed a negative trend for biodiversity related to the status of biodiversity, pressures and derived benefits. Further, those indicators that were used in GBO-4, and that have updated data points, showed that the overall direction of the trend has not changed. This information suggests, as reported previously in GBO-4 that, while the responses to biodiversity loss are increasing, biodiversity is continuing to decline.

146. In most cases, the information that is available does not suggest that there have been any significant changes to the assessment of progress towards the attainment of the Aichi Biodiversity Targets presented in GBO-4. However, it is important to note that, while this review has focused on research published after 2014, a great deal of the data sets and information, on which these publications are based, was collected prior to 2014. There may therefore be time lags between when information on observable changes was collected and when it was published. Similarly, most biological systems require relatively long periods of time to respond to change. It is therefore not surprising that, in the four years since GBO-4 was published, there would be little observable change to biological systems.

147. The available scientific information suggests that the actions identified in GBO-4 to accelerate progress towards the attainment of the Aichi Biodiversity Targets remain relevant. The information in the scientific literature generally provides further specificity as to how the actions identified in GBO-4 could be implemented and/or different issues that should be considered when implementing them.

[387] 7 of these indicators are not currently included in the list of indicators welcomed by the Conference of the Parties in decision XIII/28.

Annex

INDICATORS WITH UPDATED DATA POINTS

1. 55 indicators were used in the assessment of progress towards the Aichi Biodiversity Targets in the fourth edition of the *Global Biodiversity Outlook*. Since 2014, 29 indicators have had additional data points added. In addition, a further 17 indicators that were not used in GBO-4 have been identified as being relevant in assessing progress towards the Aichi Biodiversity Targets[388]. The trends of all 46 (updated and new) indicators used in the assessment are presented in the table below.

2. Note that these trends refer only to the trend suggested by the indicator and do not represent an assessment of progress towards the Aichi Biodiversity Target.

3. The assessment of progress towards the attainment of the Aichi Biodiversity Targets contained in the fourth edition of the *Global Biodiversity Outlook* was based on information from the fifth national reports, national biodiversity strategies and action plans, scientific literature and other reports, indicator-based extrapolations and model-based scenarios.

Indicator[389]	**Most relevant Aichi Target**	**Indicator type**	**Time period covered by the indicator data**	**Indicator trend reported in GBO-4 in 2014[390]**	**Current trend suggested by the indicator**
Biodiversity Barometer (% of respondents that have heard of biodiversity)	1	Response	2009-2016	Increasing	Increasing
Biodiversity Barometer (% of respondents giving correct definition of biodiversity)	1	Response	2009-2016	Increasing	Increasing
Online interest in biodiversity (proportion of google searches)	1	Response	2004-2016	Decreasing	Decreasing
Percentage of countries that are Category 1 CITES Parties	4	Response	1994-2016	Increasing	Increasing
Red List Index (internationally traded species)	4	State	1988-2016	Not available	Decreasing
Red List Index (impacts of utilisation)	4	Pressure	1986-2016	Decreasing	Decreasing
Ecological Footprint (number of earths needed to support human society)	4	Pressure	1961-2012	Increasing	Increasing
Area of tree cover loss	5	State	2001-2016	Not available	Increasing
Wetland Extent Trends Index	5	State	1970-2015	Decreasing	Decreasing
Red List index (forest specialists)	5	State	1988-2016	Not available	Decreasing
Wild Bird Index (habitat specialists)	5	State	1968-2014	Decreasing	Decreasing
Marine Stewardship Council certified fisheries (tonnes)	6	Response	1999-2016	Increasing	Increasing
Proportion of fish stocks in safe biological limits	6	State	1974-2013	Decreasing	Decreasing
Marine trophic index*	6	Pressure	1960-2014	Not available	Decreasing

[388] The updated indicator information was provided through the Biodiversity Indicators Partnership.

[389] Those indicators marked with an * are not currently reflected in the list of indicators welcomed by the Conference of the Parties in decision XIII/28

[390] For those indicators not available at the time GBO-4 was prepared the term "not available" is used.

Red List Index (impacts of fisheries)	6	Pressure	1988-2016	Decreasing	Decreasing
Nitrogen use balance*	7	Pressure	1961-2011	Not available	Increasing
Area of agricultural land under organic production	7	Response	1999-2014	Increasing	Increasing
Wild Bird Index (farmland birds)	7	State	1980-2014	Decreasing	Decreasing
Area of forest under sustainable management: total FSC and PEFC forest management certification	7	Response	2000-2016	Increasing	Increasing
Pesticide use	8	Pressure	2000-2011	Not available	Increasing
Red List Index (impacts of pollution)	8	State	1988-2016	Decreasing	Decreasing
Red List Index (impacts of invasive alien species)	9	Pressure	1988-2016	Decreasing	Decreasing
Percentage live coral cover	10	State	1972-2016	Decreasing	Decreasing
Climatic Impact Index for Birds	10	Pressure	1980-2010	Not available	Increasing
Area of mangrove forest cover*	10	State	2000-2014	Not available	Decreasing
Glacial mass balance*	10	State	1957-2015	Decreasing	Decreasing
Mean polar sea ice extent *	10	State	1979-2015	Decreasing	Decreasing
Percentage of marine and coastal areas covered by protected areas	11	Response	1990-2016	Increasing	Increasing
Percentage of terrestrial areas covered by protected areas	11	Response	1990-2016	Increasing	Increasing
Percentage of Key Biodiversity Areas covered by protected areas	11	Response	1980-2017	Not available	Increasing
Red List Index	12	State	1994-2016	Decreasing	Decreasing
Living Planet Index	12	State	1970-2012	Decreasing	Decreasing
Number of plant genetic resources for food and agriculture secured in conservation facilities	13	Response	1995-2016	Not available	Increasing
Red List Index (wild relatives of farmed and domesticated species)	13	Benefit	1988-2016	Not available	Decreasing
Percentage change in local species richness*	14	State	1970-2014	Not available	Unclear
Red List Index (pollinator species)	14	Benefit	1988-2016	Decreasing	Decreasing
Red List Index (species used for food and medicine)	14	Benefit	1986-2017	Not available	Decreasing
Percentage of global rural population with access to improved water resources	14	Response	1990-2015	Increasing	Increasing
Percentage of countries that have ratified the Nagoya Protocol	16	Response	2011-2017	Not available	Increasing
Percentage of countries with revised NBSAPs	17	Response	2010-2017	Not available	Increasing
Number of biodiversity papers published*	19	Response	1980-2016	Increasing	Increasing

Number of species occurrence records in the Global Biodiversity Information Facility	19	Response	2003-2016	Increasing	Increasing
Species Status Information Index	19	Response	1980-2014	Not available	Increasing
Proportion of known species assessed through the IUCN Red List	19	Response	2000-2017	Not available	Increasing
Official Development Assistance provided in support of the CBD objectives	20	Response	2006-2015	Increasing	Increasing
Funding provided by the Global Environment Facility	20	Response	1991-2016	Increasing	Increasing

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